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ROLLING BEARINGS for INDUSTRIAL MACHINERY

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CAT. No. E1103

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

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

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

NSK will celebrate 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 four parts, labelled A through D. 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 Bearings series (NSKHPS™). Lastly, part D covers industry-related product information.

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

NSK

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Part A

TECHNICAL INFORMATION

1. TYPES AND FEATURES OF ROLLING BEARINGS

1.TYPES AND FEATURES OF ROLLING BEARINGS

1.1 Design and Classification

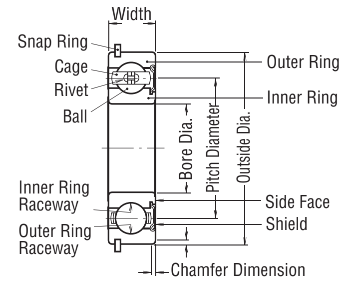
Rolling bearings generally consist of two rings, rolling elements, and a cage, and they are classified into radial bearings or thrust bearings depending on the direction of the main load. In addition, depending on the type of rolling elements, they are classified into ball bearings or roller bearings,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

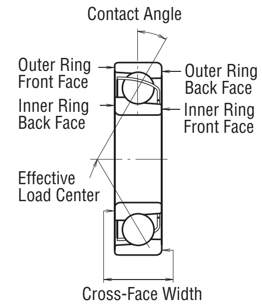
Compared with plain bearings, rolling bearings have the following major advantages:

(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 the structure surrounding rolling bearings is simple.
(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.

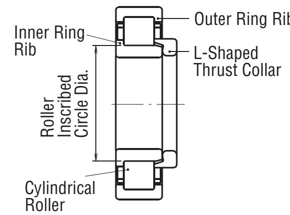
Furthermore, different types of rolling bearings have their own individual advantages. The features of the most common rolling bearings are described on Pages A010 to A013 and in Table 1.1 (Pages A014 and A015).



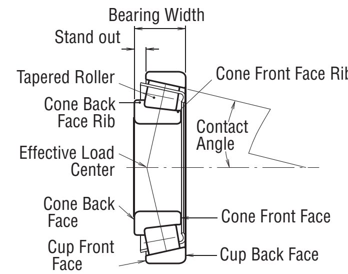
Single-Row Deep Groove Ball Bearing



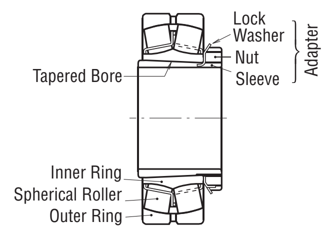
Single-Row Angular Contact Ball Bearing



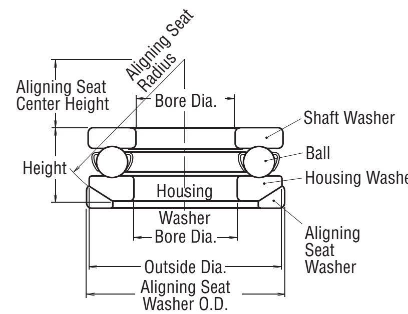
Cylindrical Roller Bearing



Tapered Roller Bearing



Spherical Roller Bearing



Single-Direction Thrust Ball Bearing

Fig. 1.1 Name of Bearing Parts

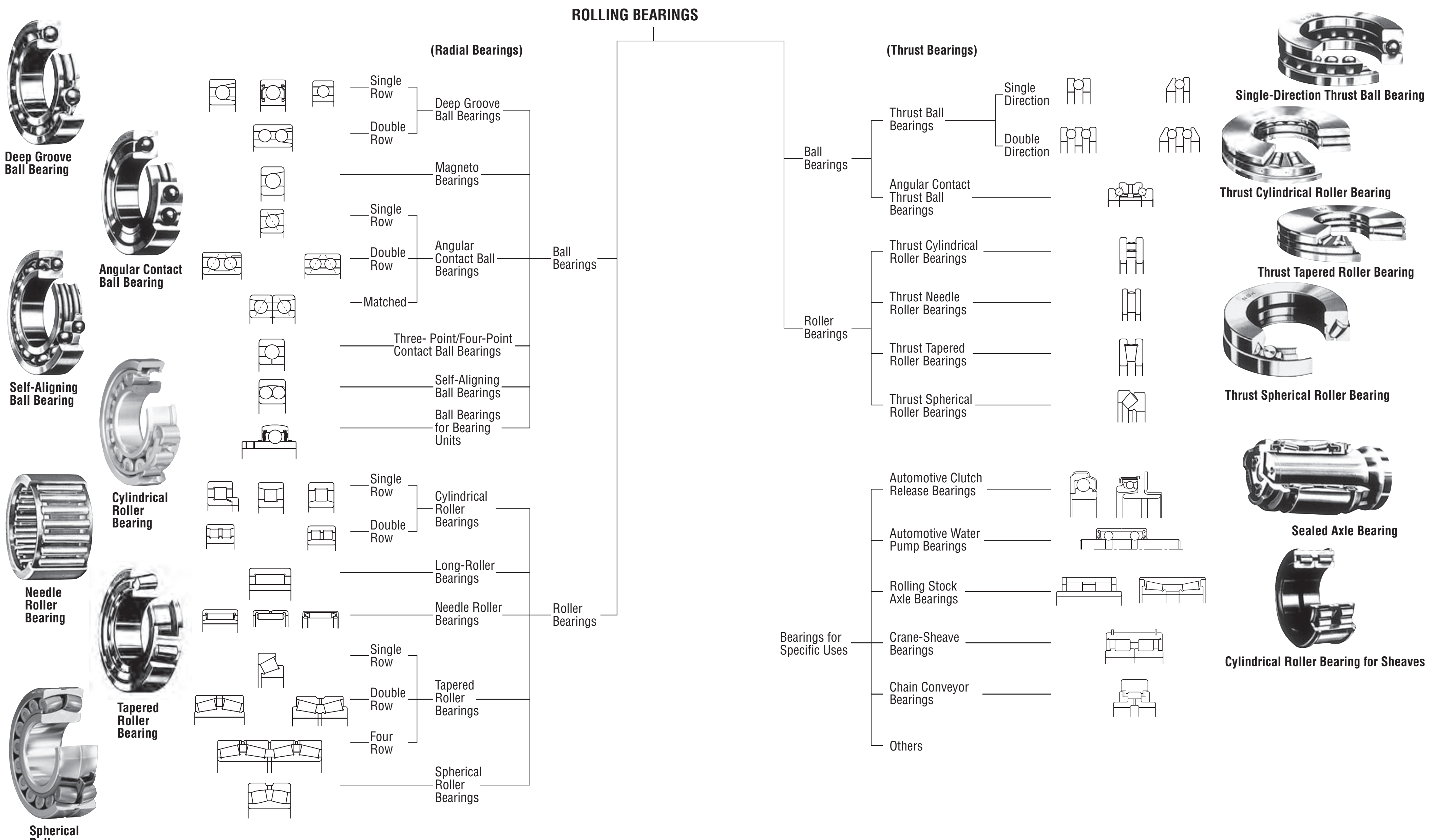
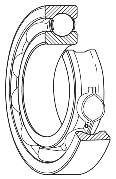


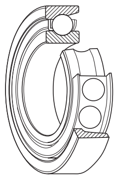
Fig. 1.2 Classification of Rolling Bearings

Single-Row Deep Groove Ball Bearings



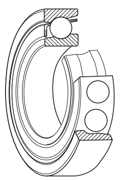
Single-row deep groove ball bearings are the most common type of rolling bearings. Their use is very widespread. The raceway grooves on both the inner and outer rings have circular arcs of slightly larger radius than that of the balls. In addition to radial loads, axial loads can be imposed in either direction. Because of their low torque, they are highly suitable for applications where high speeds and low power loss are required.
In addition to open type bearings, these bearings often have steel shields or rubber seals installed on one or both sides and are prelubricated with grease. Also, snap rings are sometimes used on the periphery. As to cages, pressed steel ones are the most common.

Magneto Bearings



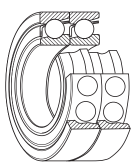
The inner groove of magneto bearings is a little shallower than that of deep groove bearings. Since the outer ring has a shoulder on only one side, the outer ring may be removed. This is often advantageous for mounting. In general, two such bearings are used in duplex pairs. Magneto bearings are small 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



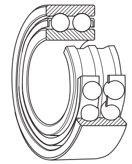
Individual bearings of this type are capable of taking radial loads and also axial loads in one direction. Four contact angles of 15°, 25°, 30°, and 40° are available. The larger the contact angle, the higher the axial load capacity. For high speed operation, however, the smaller contact angles are preferred. Usually, two bearings are used in duplex pairs, and the clearance between them must be adjusted properly.
Pressed-steel cages are commonly used, however, for high precision bearings with a contact angle less than 30°, polyamide resin cages are often used.

Duplex Bearings



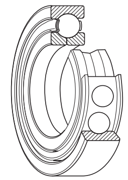
A combination of two radial bearings is called a duplex pair. Usually, they are formed using angular contact ball bearings or tapered roller bearings. Possible combinations include face-to-face, which have the outer ring faces together (type DF), back-to-back (type DB), or both front faces in the same direction (type DT). DF and DB duplex bearings are capable of taking radial loads and axial loads in both direction. Type DT is used when there is a strong axial load in one direction and it is necessary to impose the load equally on each bearing.

Double-Row Angular Contact Ball Bearings



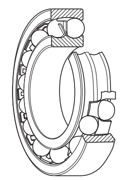
Double-row angular contact ball bearings are basically two single-row angular contact ball bearings mounted back-to-back except that they have only one inner ring and one outer ring, each having raceways. They can take axial loads in both direction.

Four-Point Contact Ball Bearings



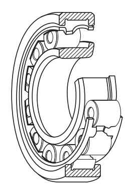
The inner and outer rings of four-point contact ball bearings are separable because the inner ring is split in a radial plane. They can take axial loads from either direction. The balls have a contact angle of 35° with each ring. Just one bearing of this type can replace a combination of face-to-face or back-to-back angular contact bearings.
Machined brass cages are generally used.

Self-Aligning Ball Bearings



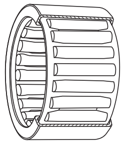
The inner ring of this type of bearing has two raceways and the outer ring has a single spherical raceway with its center of curvature coincident with the bearing axis. Therefore, the axis of the inner ring, balls, and cage can deflect to some extent around the bearing center. Consequently, minor angular 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



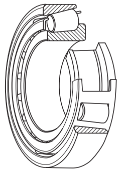
In bearings of this type, the cylindrical rollers are in linear contact with the raceways. They have a high radial load capacity and are suitable for high speeds.
There are different types designated NU, NJ, NUP, N, NF for single-row bearings, and NNU, NN for double-row bearings depending on the design 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 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 rings 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 also used.

Needle Roller Bearings



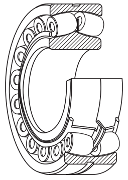
Needle roller bearings contain many slender rollers with a length 3 to 10 times their diameter. As a result, the ratio of the bearing outside diameter to the inscribed circle diameter is small, and they have a rather high radial load capacity.
There are numerous types available, and many have no inner rings. 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 are without cages.

Tapered Roller Bearings



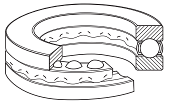
Bearings of this type use conical rollers guided by a back-face rib on the cone. These bearings are capable of taking high radial loads and also axial loads in one direction. In the HR series, the rollers are increased in both size and number giving it an even higher load capacity.
They are generally 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 cones or cups of the two opposed bearings. Since they are separable, the cone assemblies and cups can be mounted independently.
Depending upon the contact angle, tapered roller bearings are divided into three types called the 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

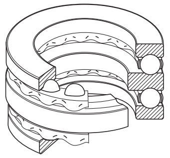


These bearings have barrel-shaped rollers between the inner ring, which has two raceways, and the outer ring which has one spherical raceway. Since the center of curvature of the outer ring raceway surface coincides with the bearing axis, they are self-aligning in a manner similar to that of self-aligning ball bearings. Therefore, if there is deflection of the shaft or housing or misalignment of their axes, it is automatically corrected so 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

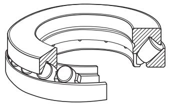


Double-Direction Thrust Ball Bearings



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 that attached to the housing is called the housing washer(or outer ring).
In double-direction thrust ball bearings, there are three rings with the middle one (center ring) being fixed to the shaft.
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 the smaller bearings and machined cages in the larger ones.

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 in 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 of Rolling Bearings

Features \ Bearing Types		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		★			★	★	★	★	☆	☆	
Tapered Bore in Inner Ring								☆		☆	
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 use on free-end is not possible.	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

Features \ Bearing Types		Cylindrical Roller Bearings with Thrust Collars	Needle Roller Bearings	Tapered Roller Bearings	Double-and Multiple-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.
Load Capacity	Radial Loads	⊙	⊙	⊙	◎	◎	×	×	×	×	×	○	—
	Axial Loads	↔ ◯	×	← ⊙	↔ ⊙	↔ ◯	← ⊙	← ⊙	↔ ⊙	← ◎	← ◎	← ◎	—
	Combined Loads	◯	×	⊙	◎	⊙	×	×	×	×	×	○	—
High Speeds		⊙	⊙	◯	◯	◯	×	×	◯	○	○	○	A022 A098
High Accuracy				⊙			⊙		◎				A023 A126 A151
Low Noise and Torque													A023
Rigidity		⊙	⊙	⊙	◎				⊙	◎	◎		A023 A192
Angular Misalignment		◯	○	◯	○	◎	×	◎	×	×	×	◎	A022 Blue pages of each brg. type
Self-Aligning Capability						☆		☆				☆	A022
Ring Separability		☆	☆	☆	☆		☆	☆	☆	☆	☆	☆	A023 A024
Fixed-End Bearing		☆			☆	☆							A026 to A029
Free-End Bearing			☆		★	★							A026 to A029
Tapered Bore in Inner Ring						☆							A150 B008 B012
Remarks		Including NUP type		Two bearings are usually mounted in opposition. Clearance adjustment is necessary.	KH, KV types are also available but use on free-end is impossible.					Including needle roller thrust bearings		To be used with oil lubrication	
Page No.		C124	C341	C182	C182 C246	C258	C296	C296	—	C314	C322	C332	

◎ Excellent ⊙ Good ◯ Fair ○ Poor × Impossible ← One direction only ↔ Two directions

☆ Applicable ★ Applicable, but it is necessary to allow shaft contraction/elongation at fitting surfaces of bearings.

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.)

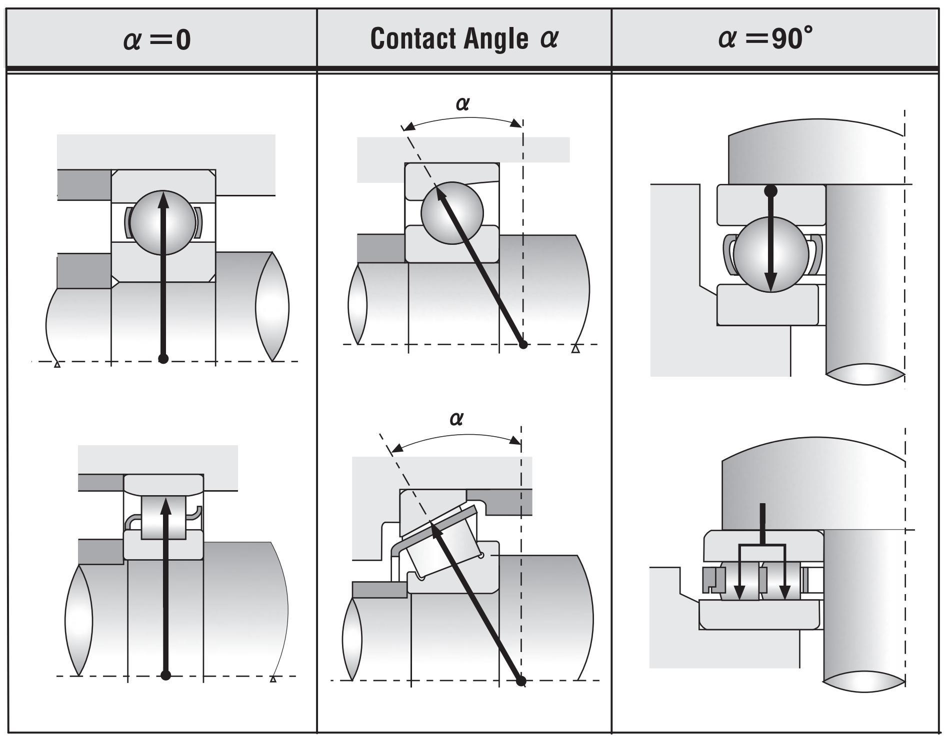


Fig. 1.3 Contact Angle α

1.4 Types of Load on Bearings

An example deep groove ball bearing is shown.
Figure 1.4 shows the types of the load applied to a rolling bearing.

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

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

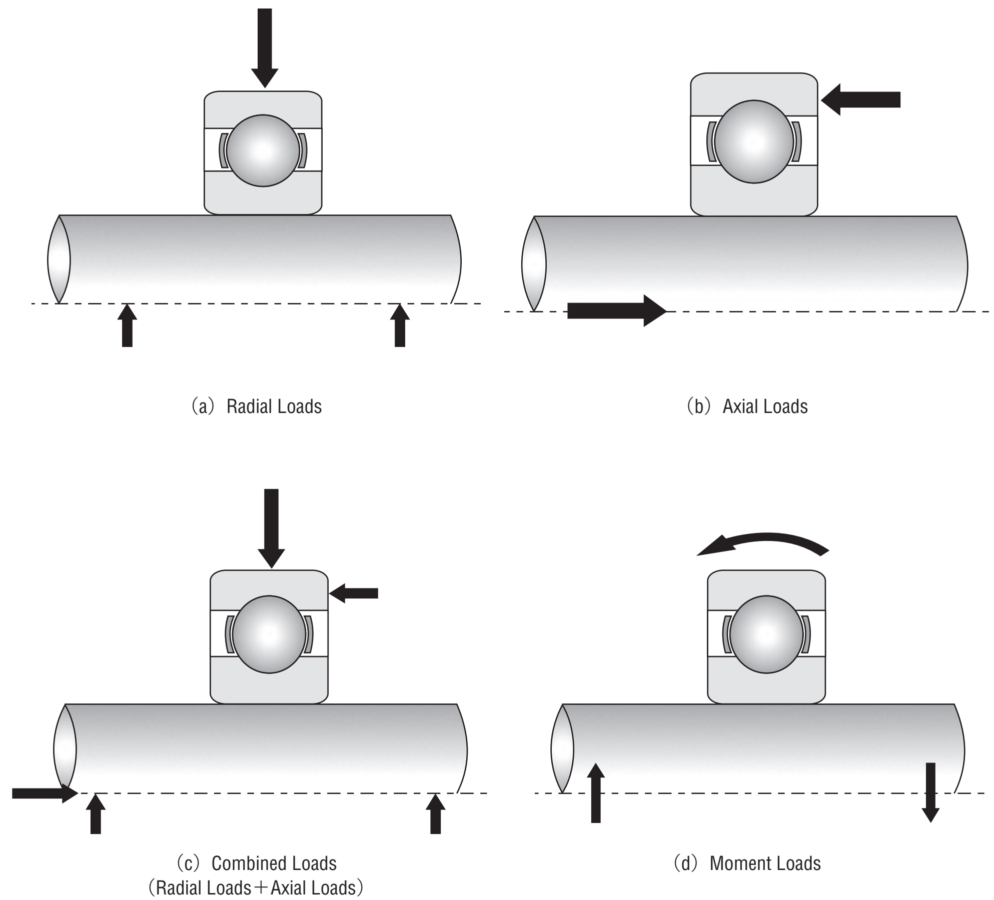


Fig. 1.4 Types of Load

2. SELECTION OF BEARING TYPES

2. SELECTION OF BEARING TYPES

2.1 Bearing Selection Procedure

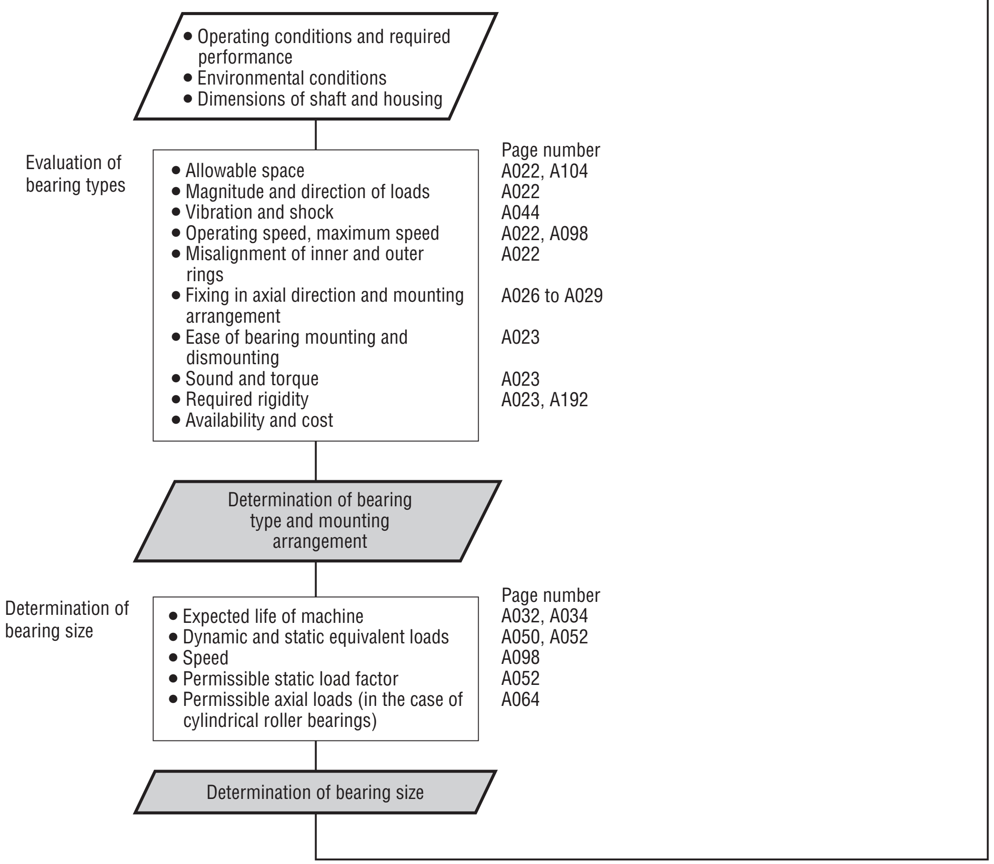
The number of applications for rolling bearings is almost countless and the operating conditions and environments also vary greatly. In addition, the diversity of operating conditions and bearing requirements continue to grow with the rapid advancement of technology. Therefore, it is necessary to study bearings carefully from many angles to select the best one from the thousands of types and sizes available.

Usually, a bearing type is provisionally chosen considering the 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, it is necessary 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 your 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 of the bearing selection procedure.



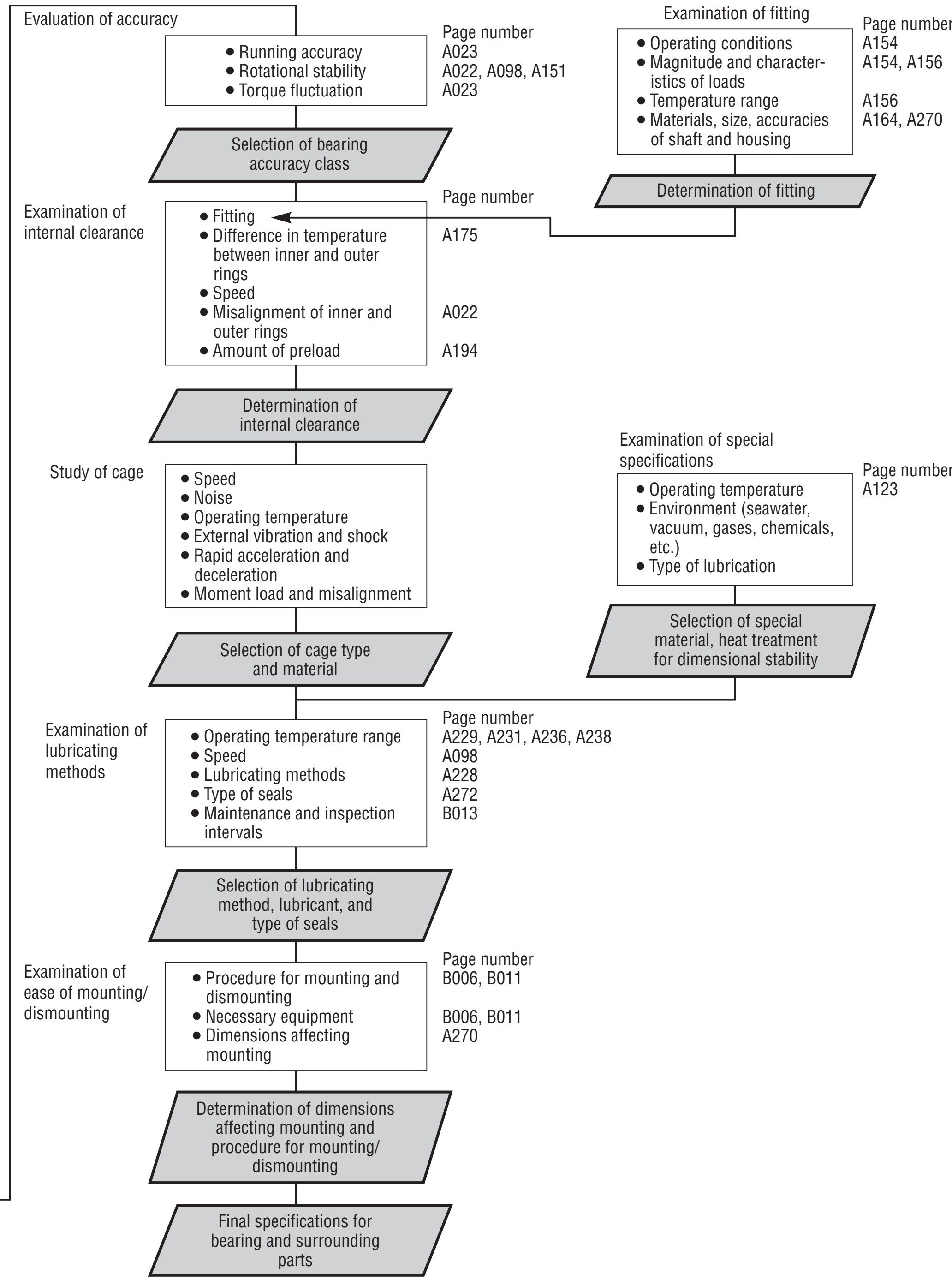


Fig. 2.1 Flow Chart for Selection of Rolling Bearings

2.2 Allowable Bearing Space

The allowable space for a rolling bearing and its adjacent parts is generally limited so the type and size of the bearing must be selected within such limits. In most cases, the shaft diameter is fixed first by the machine design; therefore, the bearing is often selected based on its bore size. For rolling bearings, there are numerous standardized dimension series and types, and the selection of the optimum bearing from among them is necessary. 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 the radial load capacity (see Page A032) in a manner that depends on the bearing design as shown in Fig. 2.3. This figure makes it clear 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 depending, not only the type of bearing, but also its size, type of cage, loads, lubricating method, heat dissipation, etc. Assuming the common oil bath lubrication method, the bearing types are roughly ranked from higher speed to lower as shown in Fig. 2.4.

2.5 Misalignment of Inner/Outer Rings and Bearing Types

Because of deflection of a shaft caused by applied loads, dimensional error 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 a small angle less than 0.0012 radian (4').
When a large misalignment is expected, bearings having a 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).

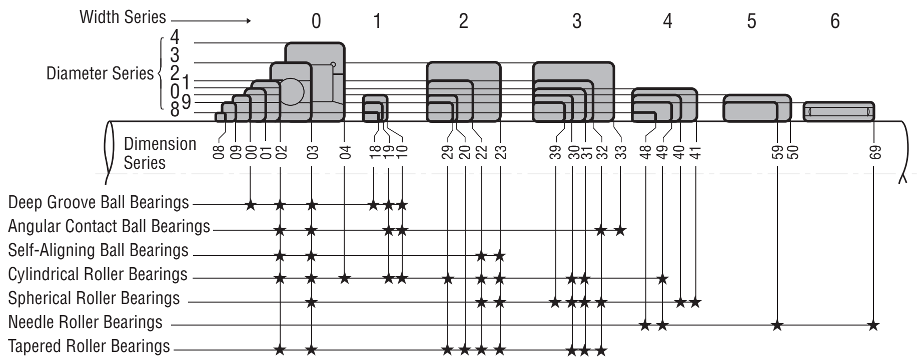
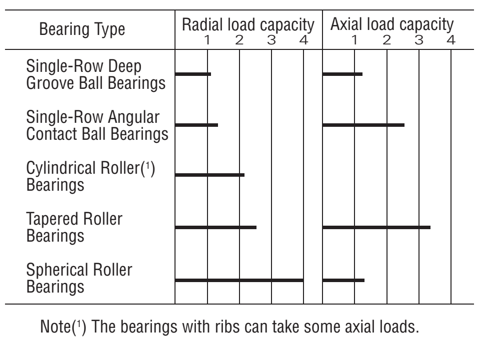


Fig. 2.2 Dimension Series of Radial Bearings



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

Fig. 2.3 Relative Load Capacities of Various Bearing Types

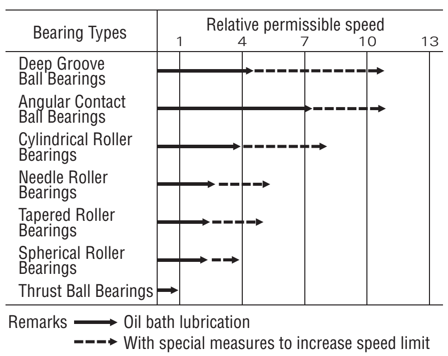


Fig. 2.4 Relative Permissible Speeds of Various Bearing Types

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

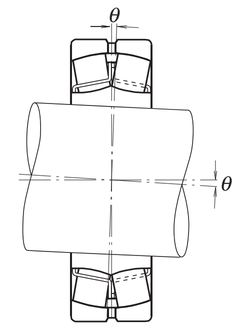


Fig. 2.5 Permissible Misalignment of Spherical Roller Bearings

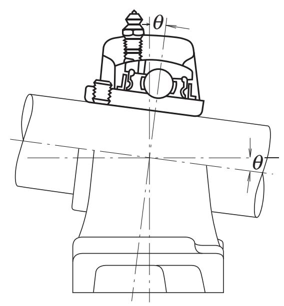


Fig. 2.6 Permissible Misalignment of Ball Bearing Units

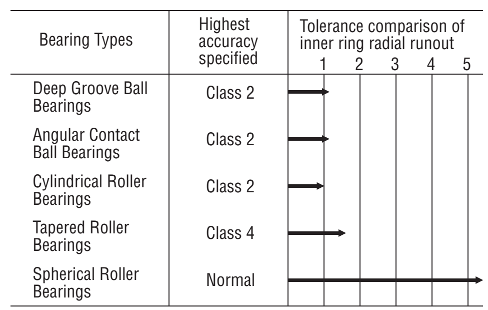


Fig. 2.7 Relative Inner Ring Radial Runout of Highest Accuracy Class for Various Bearing Types

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. For the main spindles of machine tools, it is necessary to have high rigidity of the bearings together with the rest of the spindle. Consequently, since roller bearings are deformed less by load, they are more often selected than ball bearings. When extra high rigidity is required, bearings are given a preload, which means that 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

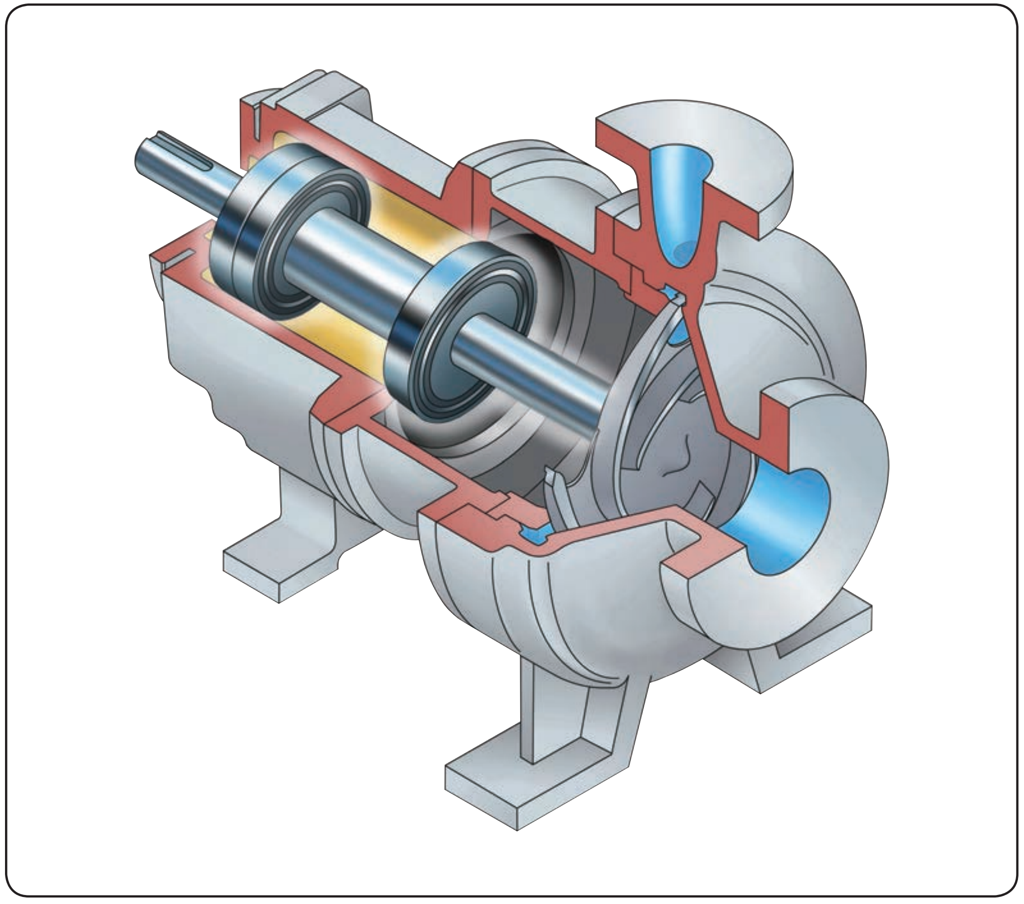
Since rolling bearings are manufactured with very high precision, noise and torque are minimal. For deep groove ball bearings and cylindrical roller bearings particularly, the noise level is sometimes specified depending on their purpose. For high precision miniature ball bearings, the starting torque is specified. Deep groove ball bearings are recommended for applications in which low noise and torque are required, such as motors and 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 Class 5, 4 or 2 are usually used.
The running accuracy of rolling bearings is specified in various ways, and the 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.
For applications requiring high running accuracy, deep groove ball bearings, angular contact ball bearings, and cylindrical roller bearings are most suitable.

2.9 Mounting and Dismounting of Various Bearing Types

Separable types of bearings like cylindrical roller bearings, needle roller bearings and tapered roller bearings are convenient for mounting and dismounting. For machines in which bearings are mounted and dismounted rather often for periodic inspection, these types of bearings are recommended. Also, self-aligning ball bearings and spherical roller bearings (small ones) with tapered bores can be mounted and dismounted relatively easily using sleeves.



3. SELECTION OF BEARING ARRANGEMENT

3. SELECTION OF BEARING ARRANGEMENT

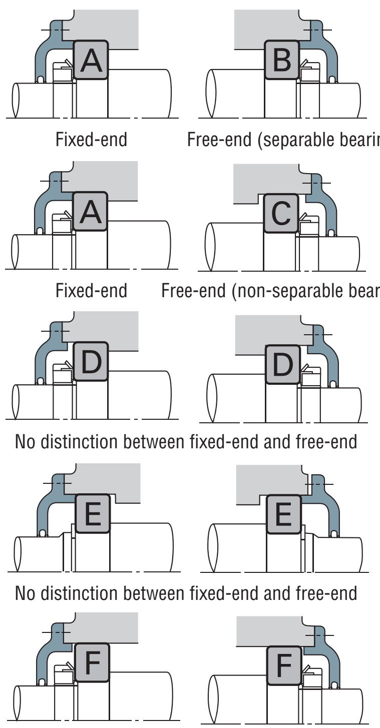
In general, shafts are supported by only two bearings. When considering the bearing mounting arrangement, the following items must be investigated:

(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 the loads at their proper positions and to transmit them.

3.1 Fixed-End and Free-End Bearings

Among the bearings on a shaft, only one can be a "fixed-end" bearing that is used to fix the shaft axially. For this fixed-end bearing, a type which can carry both radial and axial loads must be selected.
Bearings other than the fixed-end one 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 are 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. When these types are used, mounting and dismounting are also easier.
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 fitting 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 it is done at the bore.
(2) For each type, two bearings are used in opposition.

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 of 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

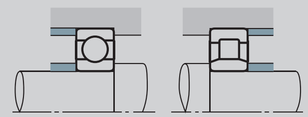
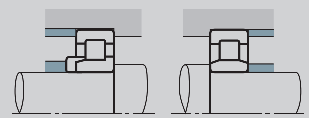
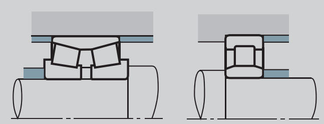
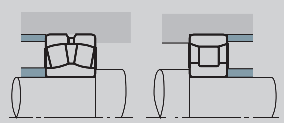
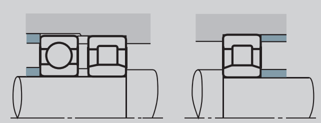
Bearing Arrangements		Remarks	Application Examples
Fixed-end	Free-end		
		○This is a common arrangement in which abnormal loads are not applied to bearings even if the shaft expands or contracts. ○If the mounting error is small, this is suitable for high speeds.	Medium size electric motors, blowers
		○This can withstand heavy loads and shock loads and can take some axial load. ○Every type of cylindrical roller bearing is separable. This is helpful when interference is necessary for both the inner and outer rings.	Traction motors for rolling stock
		○This is used when loads are relatively heavy. ○For maximum rigidity of the fixed-end bearing, it is a back-to-back type. ○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 is also 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 is suitable for high speeds and heavy radial loads. Moderate axial loads can also be applied. ○It is necessary to provide some clearance 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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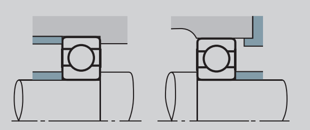
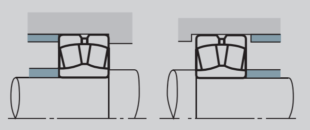
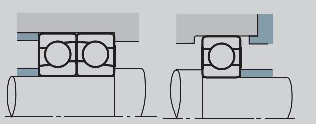
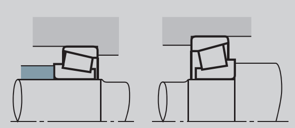
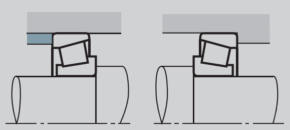
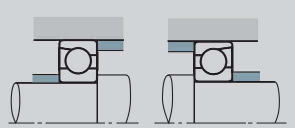
Table 3. 1 Representative Bearing Mounting Arrangements and Application Examples (cont'd)

Bearing Arrangements		Remarks	Application Examples
Fixed-end	Free-end		
		○This is the most common arrangement. ○It can sustain not only radial loads, but moderate axial loads also.	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 a 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, attention must be paid to the 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 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

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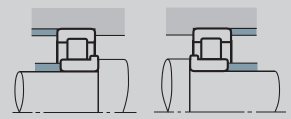
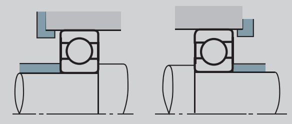
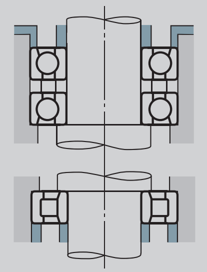
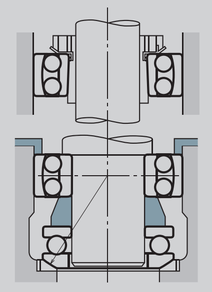
When there is no distinction between fixed-end and free-end	Remarks	Application Examples
 NJ + NJ mounting	○This can withstand heavy loads and shock loads. ○It can be used if interference is necessary for both the inner and outer rings. ○Care must be taken so the axial clearance doesn't become too small during running. ○NF type + NF type mounting is also possible.	Final reduction gears of construction machines
	○Sometimes a spring is used at 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 on the fixed end. ○Cylindrical roller bearing is 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. These functions must be performed for a prolonged period. Even if bearings are properly mounted and correctly operated, they will eventually fail to perform satisfactorily due to an increase in noise and vibration, loss of running accuracy, deterioration of grease, or fatigue flaking of the rolling surfaces.
Bearing life, in the broad sense of the term, is the period during which bearings continue to operate and to satisfy their required functions. This bearing life may be defined as noise life, abrasion life, grease life, or rolling fatigue life, depending on which one 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 of the seals or the 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 time 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, which are of the same type, size, and material and 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-prelubricated 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.

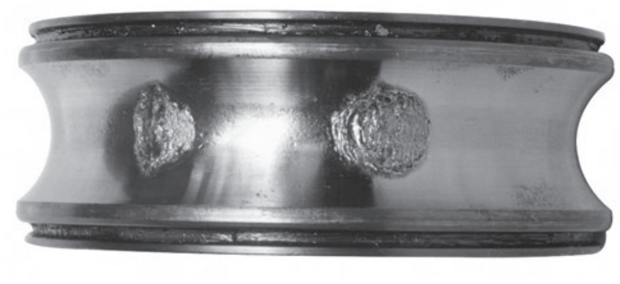


Fig. 4.1 Example of Flaking

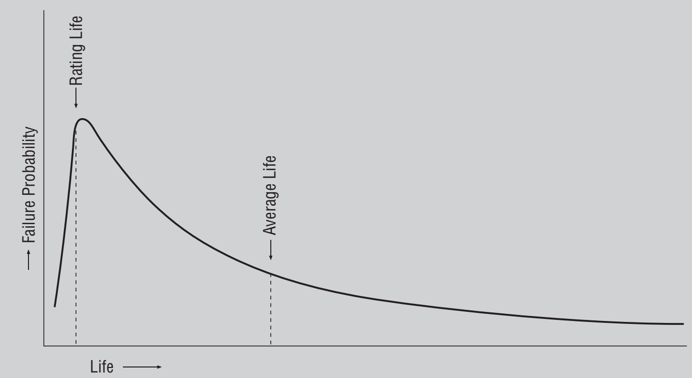


Fig. 4.2 Failure Probability and Bearing Life

4.2.2 Machinery in which Bearings are Used and Projected Life

It is not advisable to select bearings with unnecessarily high load ratings, for 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 are to 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 an empirical fatigue life factor derived from customary operating experience for various machines. Also refer to Table 4.2.

Table 4.1 Fatigue Life Factor f_h for Various Bearing Applications

Operating Periods	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 like vacuum cleaners and washing machines ・Hand 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 Parameters	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	$f_n=\left(\frac{10^6}{500\times60n}\right)^{\frac{1}{3}}=(0.03n)^{-\frac{1}{3}}$	$f_n=\left(\frac{10^6}{500\times60n}\right)^{\frac{3}{10}}=(0.03n)^{-\frac{3}{10}}$

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

In the case of bearings that run at a constant speed, it is convenient to express the fatigue life in terms of hours. 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, determine a fatigue life factor f_h appropriate for the projected life of the machine and then calculate the basic load rating C by means of the following equation.

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

A bearing which 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 temperature, 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 the higher temperature using the following equation:

$$C_t=f_t\cdot C \quad \cdots\cdots (4.4)$$

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 large bearings are used at higher than 120°C, they must be given special dimensional stability heat treatment to prevent excessive dimensional changes. The basic load rating of bearings given 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

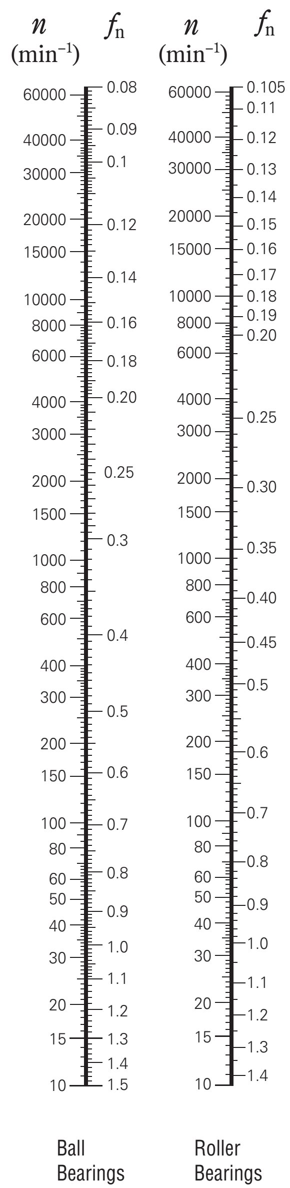


Fig. 4.3 Bearing Speed and Speed Factor

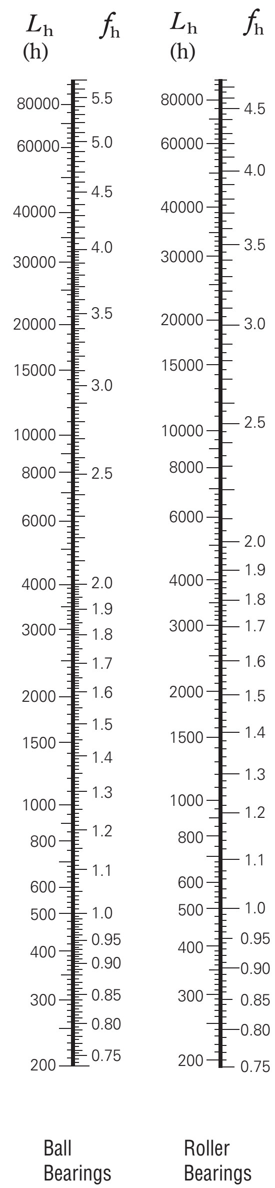


Fig. 4.4 Fatigue Life Factor and Fatigue Life

4.2.5 Correction of Basic Rating Life

As described previously, the basic equations for calculating the 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**)

The 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 the fatigue life. In addition, the developent 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 the results of tests by NSK show that life is greatly improved when 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), it is sufficient to assume that is greater than one.

Table 4.4 Reliability Factor a_1

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

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 the bearing temperature is high.
- When the 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 for 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($a_2 \times a_3$), and not consider them independently. In this case, under normal lubricating and operating conditions, the product ($a_2 \times a_3$) 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 sufficient fluid-film thickness is secured, the product of ($a_2 \times a_3$) 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. Generally, however, the machine becomes inoperative if a bearing in any part fails. It may therefore be necessary in certain cases to know the fatigue life of a group of bearings used in one machine. The fatigue life of 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 revolution or hours to which 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 below equation is obtained:

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

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

L of Equation (4.8) can be determined with ease by using Fig. 4.5.

Take the value L_1 of 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 the intersection with the L scale. In this way, the value L_A of

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

is determined. Take this value L_A on the L_1 scale and the value L_3 on the L_2 scale, connect them with a straight line, and read an intersection with the L scale. In this way, the value L of

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

can be determined.

Example

Assume that the calculated fatigue life of bearings of automotive front wheels as follows:
280 000 km for inner bearing
320 000 km for outer bearing
Then, the fatigue life of bearings of the wheel can be determined at 160 000 km from Fig. 4.5.
If the fatigue life of the bearing of the right-hand wheel takes this value, the fatigue life of the left-hand wheel will be the same. As a result, the fatigue life of the front wheels as a group will become 85 000 km.

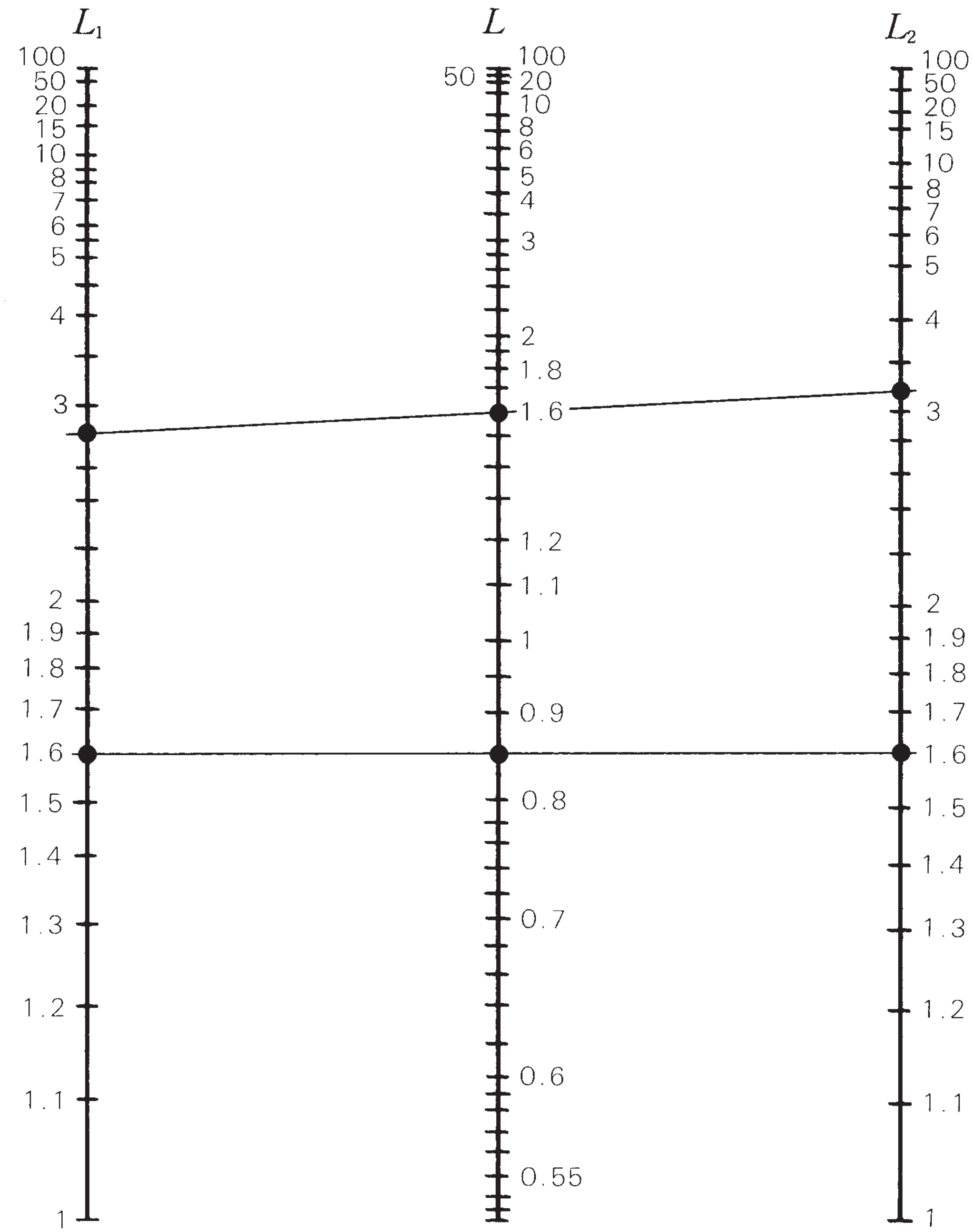


Fig. 4.5 Chart for Life Calculation

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 can now have a longer rolling fatigue life in a cleaner environment, 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, based on the theories of G. Lundberg and A. Palmgren (L-P theory, hereafter) addresses only sub-surface originated flaking. This is the phenomenon in which cracks initially occur due to dynamic shear stress immediately below the rolling surface then progressively reach the surface in the form of flaking.

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

NSK's new life calculation formula theorizes that rolling fatigue life is the sum total of the combined effects of both sub-surface originated flaking and surface originated flaking occurring simultaneously.

NSK New Life Calculation Formula

(1) Sub-surface originated flaking
A pre-condition of sub-surface originated flaking of 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 applied on the ordinate and the abscissa, respectively.
In the figure, line L_{10} theoretical is the theoretical line obtained using the conventional life calculation formula. As maximum surface contact pressure decreases, the actual life line separates from the line created by using conventional theoretical calculation and moves towards longer life. This separation suggests the presence of fatigue load limit P_u below which no rolling fatigue occurs. This is better illustrated in Fig. 4.7.

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

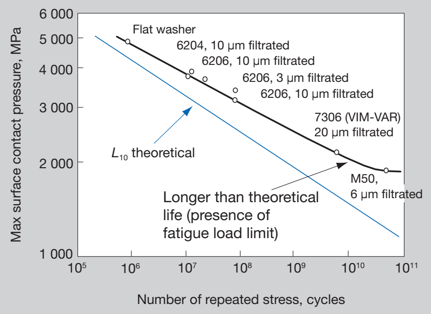


Fig. 4.6 Life Test Result under Clean Lubrication Condition

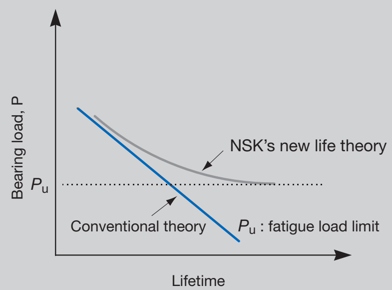


Fig. 4.7 NSK's New Life Theory That Considers Fatigue Limit

(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 the foreign particles are mixed in the lubricant, the particles are pressed onto the raceways by the rolling elements and dents occur on the surfaces of the raceways and rolling elements. Stress concentration occurs at the edges of the dents, generating fine cracks, which over time, propagate into flaking of the raceways and rolling elements.
As shown in Fig. 4.8, the actual life is shorter than conventional calculated life, under conditions of contaminated lubrication at low max surface pressure. The actual life line separates from the line created by theoretical life calculations and moves towards a shorter life. 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 Value of Contamination Coefficient a_c

	Very clean	Clean	Normal	Contaminated	Heavily contaminated
a_c factor	1	0.8	0.5	0.4–0.1	0.05
Application guide	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 bearing for electrical appliances and information technology equipment, etc.	Sealed grease lubricated bearing for electric motors Sealed grease bearing for railway axle boxes and machine tools, etc.	Normal usage Automotive hub unit bearing, etc.	Bearing for automotive transmission; Bearing for industrial gearbox; Bearing for construction machine, etc.	—

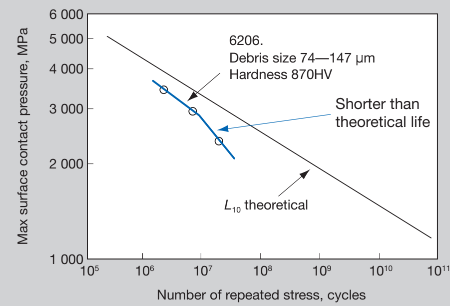


Fig. 4.8 Life Test Result under Contaminated Lubrication Condition

Therefore, the NSK new life calculation formula considers the trend in the results of the life test under conditions of clean environment and at low load zone. Based on these results, the new life equation is a function of $(P\text{-}P_u)/C$, which is affected by specific lubrication conditions identified by the lubrication parameter. Also, it is assumed that effects of different types and shapes of foreign particles are strongly influenced by the bearing load and lubrication conditions present, and that such a relationship can be expressed as a function of the load parameter. This relationship of the new life calculation formula is defined by $(P\text{-}P_u)/C\cdot 1/a_c$.
Calculation formula for surface originated flaking, based on the above concept, is as follows:

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

(3) Calculation of Contamination Coefficient a_c
The contamination coefficient in terms of lubrication cleanliness is shown in Table 4.5. Test results on ball and roller bearings with grease lubrication and clean filtration show the life as being a number of times longer than that of the contaminated calculation. Yet when the foreign object is harder than Hv350, hardness becomes a factor and a dent appears on the raceway. Fatigue damage from these dents, can progress to flaking in a short time. Test results on ball and roller bearings under conditions of foreign object contamination show from 1/3 to 1/10 the life when compared with conventionally calculated life.
Based on these test results, the contamination coefficient a_c is classified into five steps for NSK's new life theory.

(4) New life calculation formula L_{able}

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

$$ln\frac{1}{S} \propto N^{e}\int_{V}\frac{(\tau-\tau_{u})^{c}}{Z_{o}^{h}}dV \times \left\{\frac{1}{f(a_{c}, a_{L})}\right\} \cdots\cdots\cdots \quad \textbf{(4.12)}$$

$$L_{able} = a_{1} \cdot a_{NSK} \cdot L_{10} \cdots\cdots\cdots \quad \textbf{(4.13)}$$

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:

$$a_{NSK} \propto F\left\{\frac{P\text{-}P_{u}}{C} \cdot \frac{1}{a_{c}}, a_{L}\right\} \cdots\cdots\cdots \quad \textbf{(4.14)}$$

NSK's new life theory considers the life extending affect of improved material and heat treatment by correcting the 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 the correction factor a_{NSK} as a function of the new life calculation formula. Also in this new life calculation formula, point contact and line contact are considered separately for ball and roller bearings respectively.

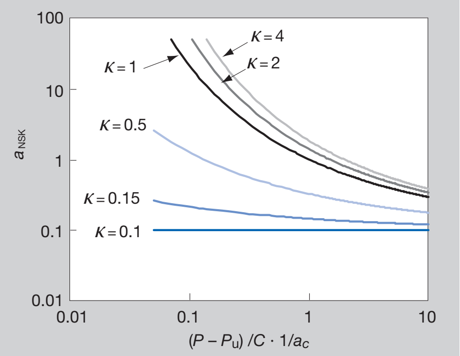


Fig. 4.9 New Life Calculation Diagram for Ball Bearings

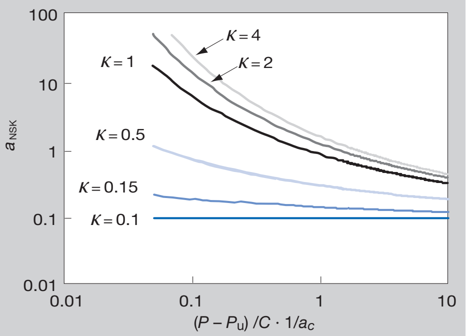


Fig. 4.10 New Life Calculation Diagram for Roller Bearings

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 revolving elements themselves, the transmission power of gears and belting, the load produced by the operation of the machine in which the bearings are used, etc. These loads can be theoretically calculated, but some of them are difficult to estimate. Therefore, it becomes necessary to correct the estimated 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 operation of the machine. The actual load may be calculated using the following equation:

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

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

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

f_w : Load factor

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

Table 4.6 Values of Load Factor f_w

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

4.3.2 Bearing Loads in Belt or Chain Transmission Applications

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

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

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

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

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

In the case of a chain transmission, the values corresponding to f_b should be 1.25 to 1.5.

Table 4.7 Belt Factor f_b

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

4.3.3 Bearing Loads in Gear Transmission Applications

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

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

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

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

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

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 using the gear factor f_g by multiplying the theoretically calculated load by this factor.
The values of f_g should generally be those in Table 4.8. When vibration from other sources accompanies gear operation, 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:

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

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

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, and then, the sum of the vectors may be calculated according to the load direction.

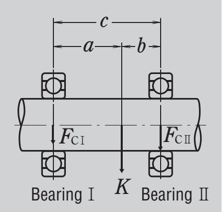


Fig. 4.11 Radial Load Distribution (1)

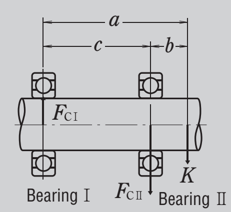


Fig. 4.12 Radial Load Distribution (2)

4.3.5 Average of Fluctuating Load

When the load applied on bearings fluctuates, an average load which 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

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

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

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:

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

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

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

where F_{min} : Minimum value of fluctuating load (N), {kgf}
F_{max} : Maximum value of fluctuating load (N), {kgf}

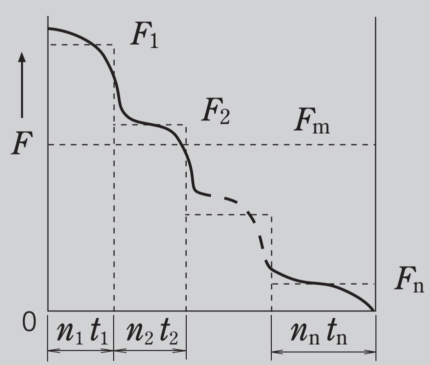


Fig. 4.13 Incremental Load Variation

(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)

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

In the case of Fig. 4.15 (b)

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

(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 $F_R \geqq F_S$

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

b) Where $F_R < F_S$

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

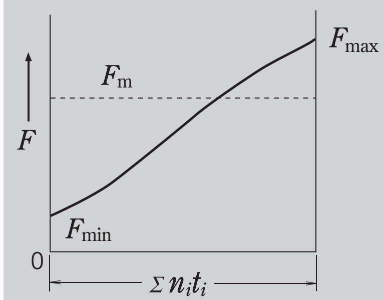


Fig. 4.14 Simple Load Fluctuation

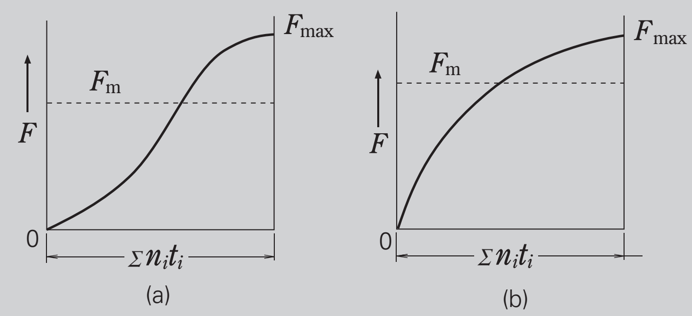


Fig. 4.15 Sinusoidal Load Variation

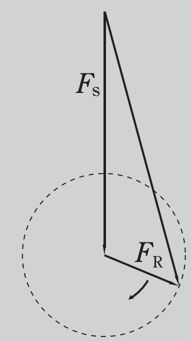


Fig. 4.16 Rotating Load and Stationary Load

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 an unbalanced or a vibration weight, and the stationary load, which is caused by gravity or power transmission, may act simultaneously. The combined mean effective load when the indeterminate load caused by rotating and static loads can be calculated as follows. There are two kinds of combined loads; rotating and stationary which are classified depending on the magnitude of these loads, as shown in Fig. 4.17.

Namely, the combined load becomes a running load with its 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:

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

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

The value F can be approximated by Load Equations (4.33) and (4.34) which vary sinusoidally depending on the magnitude of F_R and F_S, that is, in such a manner that 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 $F_R \ll F_S$.

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

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

$F_R > F_S$,

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

$F_R < F_S$,

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

Curves of Equations (4.32), (4.33), (4.35), and (4.36) are as shown in Fig. 2.

The mean value F_m of the load varying 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).

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

$$F_R \geqq F_S,\ F_m=F_R+0.3F_S \quad \cdots\cdots \quad (4.37)$$
$$F_R \leqq F_S,\ F_m=F_S+0.3F_R \quad \cdots\cdots \quad (4.38)$$

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

$$F_R \geqq F_S,\ F_m=F_R+0.5F_S \quad \cdots\cdots \quad (4.39)$$
$$F_R \leqq F_S,\ F_m=F_S+0.5F_R \quad \cdots\cdots \quad (4.40)$$

Generally, as the value F exists somewhere among Equations (4.37), (4.38), (4.39), and (4.40), the factor 0.3 or 0.5 of the second terms of Equations (4.37) and (4.38) as well as (4.39) and (4.40) is assumed to change linearly along with F_S/F_R or F_R/F_S. Then, 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:

$F_R \geqq F_S$,

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

$F_R \leqq F_S$,

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

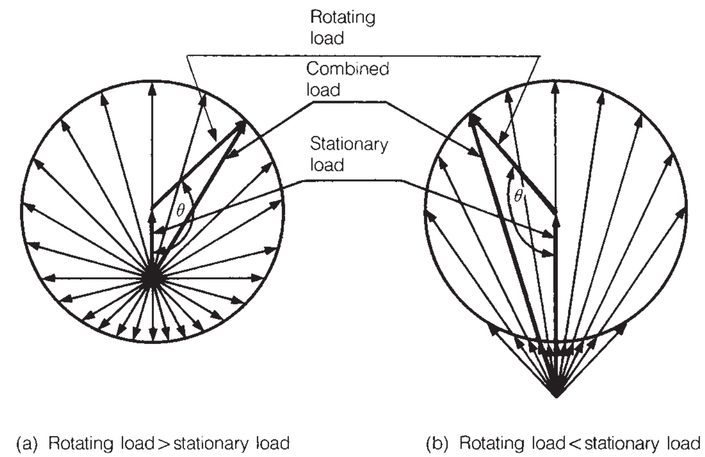


Fig. 4.17 Combined Load of Rotating and Stationary Loads

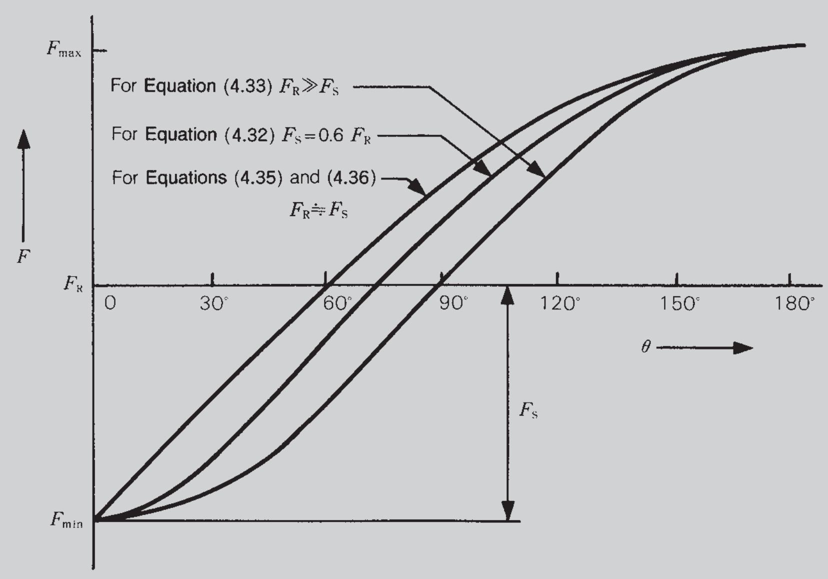


Fig. 4.18 Chart of Combined Loads

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 that has a constant magnitude and passes through the center of the bearing, and will give the same bearing life that the bearing would attain under actual conditions of load and rotation should be estimated. 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 of 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 of 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:

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

where F_{ai} : Component load in the axial direction (N), {kgf}
F_r : Radial load (N), {kgf}
Y : Axial load factor

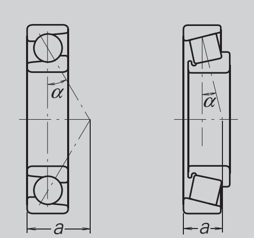


Fig. 4.19 Effective Load Centers

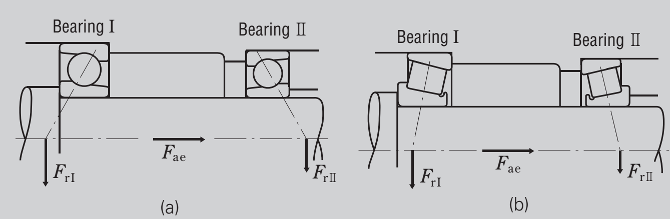


Fig. 4.20 Loads in Opposed Duplex Arrangement

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

where $F_{ae} + \dfrac{0.6}{Y_{II}}F_{rII} \geqq \dfrac{0.6}{Y_I}F_{rI}$

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

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

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

4.5 Static Load Ratings and Static Equivalent Loads

4.5.1 Static Load Ratings

When subjected to an excessive load or a strong shock load, 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. The nonelastic deformation increases in area and depth as the load increases, and when the load exceeds a certain limit, the smooth running of the bearing is impeded.
The basic static load rating is defined as that static load which produces the following calculated contact stress at the center of the contact area between the rolling element subjected to the maximum stress and the raceway surface.

For self-aligning ball bearings	4 600MPa {469kgf/mm²}
For other ball bearings	4 200MPa {428kgf/mm²}
For roller bearings	4 000MPa {408kgf/mm²}

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's diameter. The basic static load rating C_o is written C_{or} for radial bearings and C_{oa} for thrust bearings in the bearing tables.
In addition, following the modification of the criteria for basic static load rating by ISO, the new C_o values for NSK's ball bearings became about 0.8 to 1.3 times the past values and those for roller bearings about 1.5 to 1.9 times. Consequently, the values of permissible static load factor f_s have also changed, so please pay attention to this.

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 under actual conditions, while the bearing is stationary (including very slow rotation or oscillation), in the area of contact between the most heavily stressed rolling element and bearing raceway. 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.

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

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

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

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

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 with $\alpha = 90°$ 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 and also their application and operating conditions.
The permissible static load factor f_s is a safety factor that is applied to the basic static load rating, and it is defined by the ratio in Equation (4.50). The generally recommended values of f_s are listed in Table 4.9. Conforming to the modification of the static load rating, the values of f_s were revised, especially for bearings for which the values of C_o were increased, please keep this in mind when selecting bearings.

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

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

For spherical thrust roller bearings, the values 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 Examples of Bearing Calculations

(Example1)
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, {255kgf} and speed n =900 min^{-1}.

The basic load rating C_r of **6208** is 29 100N, {2 970kgf} (Bearing Table, Page C024). Since only a radial load is applied, the equivalent load P may be obtained as follows:

$$P = F_r = 2\,500\text{N}, \quad \{255\text{kgf}\}$$

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:

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

This value is suitable for industrial applications, air conditioners being regularly used, etc., and according to the equation in Table 4.2 or Fig. 4.4 (Page A036), it corresponds approximately to 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 000N, {306kgf}
Speed n =1 900 min^{-1}
Basic rating life L_h≧10 000h

The fatigue life factor f_h of ball bearings with a rating fatigue life longer than 10 000 hours is f_h≧2.72.
Because f_n = 0.26, P = F_r = 3 000N. {306kgf}

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

therefore, $C_r \geqq 2.72 \times \dfrac{3\,000}{0.26} = 31\,380\text{N}$, {3 200kgf}

Among the data listed in the bearing table on Page B12, **6210** should be selected as one that satisfies the above conditions.

(Example3)
Obtain C_r / P or fatigue life factor f_h when an axial load F_a=1 000N, {102kgf} 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 obtainable, depending on the magnitude of f_0F_a/C_{or}, from the table above the single-row deep groove ball bearing table.
The basic static load rating C_{or} of ball bearing **6208** is 17 900N, {1 820kgf} (Page C024)

$$f_0F_a/C_{or} = 14.0 \times 1\,000/17\,900 = 0.782$$

$$e \fallingdotseq 0.26$$

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

$$P = XF_r + YF_a$$

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

$$= 3\,070\text{N}, \quad \{313\text{kgf}\}$$

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

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

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

(Example 4)
Select a spherical roller bearing of series 231 satisfying the following conditions:
Radial load F_r = 45 000N
Axial load F_a = 8 000N
Speed n = 500min^{-1}
Basic rating life L_h≧30 000h

The value of the fatigue life factor f_h which makes L_h≧30 000h is bigger than 3.45 from Fig. 4.4 (Page A036).

The dynamic equivalent load P of spherical roller bearings is given by:

when $F_a / F_r \leqq e$

$$P = XF_r + YX_a = F_r + Y_3F_a$$

when $F_a / F_r > e$

$$P = XF_r + YF_a = 0.67\,F_r + Y_2F_a$$

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

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 bearings of series 231:

Therefore, $P = XF_r + YF_a = F_r + Y_3F_a$

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

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

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

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

consequently, $C_r \geqq 490\,000\text{N}$
Among spherical roller bearings of series 231 satisfying this value of C_r, the smallest is **23126CE4**
(C_r = 505 000N)
Once the bearing is determined, substitude the value of Y_3 in the equation and obtain the value of P.

$$P = F_r + Y_3F_a = 45\,000 + 2.4 \times 8\,000$$

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

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

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

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

(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 cup back faces is 50 mm.
Calculate the basic rating life of each bearing when beside the radial load F_r = 5 500N, {561kgf}, axial load F_{ae}=2 000N,{204kgf} are applied to **HR30305DJ** as shown in Fig. 4.21. The speed is 600 min^{-1}.

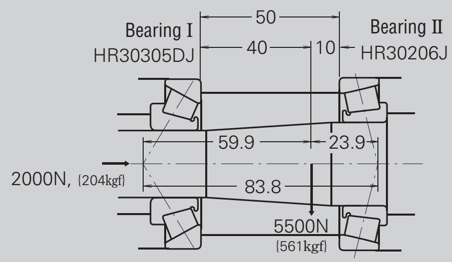


Fig. 4.21 Loads on Tapered Roller Bearings

To distribute the radial load F_r on bearings I and II, the effective load centers must be located for tapered roller bearings. 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:

$$F_{rI} = 5\,500 \times \frac{23.9}{83.8} = 1\,569\text{N}, \quad \{160\text{kgf}\}$$

$$F_{rII} = 5\,500 \times \frac{59.9}{83.8} = 3\,931\text{N}, \quad \{401\text{kgf}\}$$

From the data in the bearing table, the following values are obtained;

Bearings	Basic dynamic load rating C_r (N) {kgf}	Axial load factor Y_1	Constant e
Bearing I (**HR30305DJ**)	38 000 {3 900}	$Y_I = 0.73$	0.83
Bearing II (**HR30206J**)	43 000 {4 400}	$Y_{II} = 1.6$	0.38

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

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

$$=3\,474\text{N}, \{354\text{kgf}\}$$

$$\frac{0.6}{Y_{I}}F_{rI}=\frac{0.6}{0.73}\times 1\,569=1\,290\text{N}, \{132\text{kgf}\}$$

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

For bearing I

$F_{rI}=1\,569\text{N}$, {160kgf}

$F_{aI}=3\,474\text{N}$, {354kgf}

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

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

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

$=3\,164\text{N}$, {323kgf}

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

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

and the rating fatigue life $L_h=500\times 5.04^{\frac{10}{3}}=109\,750\text{h}$

For bearing II

since $F_{rII}=3\,931\text{N}$, {401kgf}, $F_{aII}=0$

the dynamic equivalent load

$P_{II}=F_{rII}=3\,931\text{N}$, {401kgf}

the fatigue life factor

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

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

Remarks 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 $F_r=245\,000\text{N}$
Axial load $F_a=49\,000\text{N}$
Speed $n=500\text{min}^{-1}$
Size limitation
Shaft diameter: 300mm
Bore of housing: Less than 500mm

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 limitation (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 CAE4**	1 540 000	0.19	3.5
	460	118	**23060 CAE4**	2 400 000	0.24	2.8
	460	160	**24060 CAE4**	2 890 000	0.32	2.1
	500	160	**23160 CAE4**	3 350 000	0.31	2.2
	500	200	**24160 CAE4**	3 900 000	0.38	1.8

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

$$P=F_r+Y_3F_a$$

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

$$f_h=f_n\frac{C_r}{P}=\frac{0.444\,C_r}{F_r+Y_3F_a}=3\text{ to }5$$

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

$$C_r=\frac{(F_r+Y_3F_a)\times(3\text{ to }5)}{0.444}$$

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

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

The bearings which satisfy this range are **23060CAE4**, **24060CAE4**, **23160CAE4**, and **24160CAE4**.

4.7 Bearing Type and Allowable Axial Load

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

(1) Change of 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 the contact angle and width. When heat generation or seizure has occurred, the bearing should be disassembled and checked for running trace to discover whether there has been a change in the contact angle during operation. In this way, it is possible to see whether an abnormal axial load has been sustained.

The relation shown below can be established among the axial load F_a on a bearing, the load of rolling element Q, and the contact angle α when the load is applied. (See Equations (9.8), (9.9), and (9.10) in Section 9.6.2)

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

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

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

Namely, δ_a is the change in Equation (4.52) to determine 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 a bearing are necessary in this case for calculation, the contact angle α was approximated from the axial load. The basic static load rating C_{0r} is expressed by Equation (4.53) for the case of a single row radial ball bearing.

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

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):

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

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

In other words, "h" is assumed and 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 A for each bore number of an angular contact ball bearing in Table 4.14. The relationship between $A\,F_a$ and α is shown in Fig. 4.22.

Example 1

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

A=0.212 is calculated from Table 4.14 and $A\,F_a$=0.212×35.0=7.42 and α≒26° are obtained from Fig. 4.22. An initial contact angle of 15° has changed to 26° under the axial load.

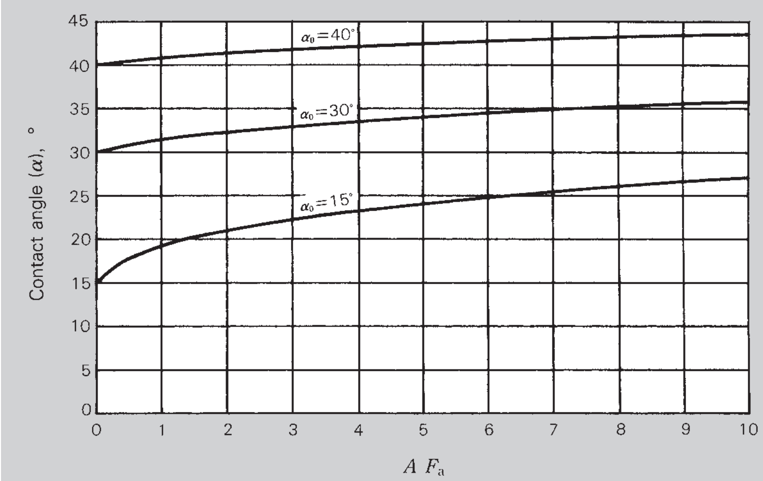


Fig. 4.22 Change of the Contact Angle of Angular Contact Ball Bearing under Axial Load

Table 4.14 Constant A Value of Angular Contact Ball Bearing

Units: kN^{-1}

Bearing bore No.	Bearing series 70			Bearing series 72			Bearing series 73		
	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 a deep groove ball bearing are similarly shown in Table 4.15 and Fig. 4.23.

Example 2

Change in the contact angle is calculated when the 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 10° is obtained from Fig. 3, Page C014. A=0.303 is determined from Table 4.15 and $A\ F_a$=0.303×24.75≒7.5 and α≒24° from Fig. 4.23.

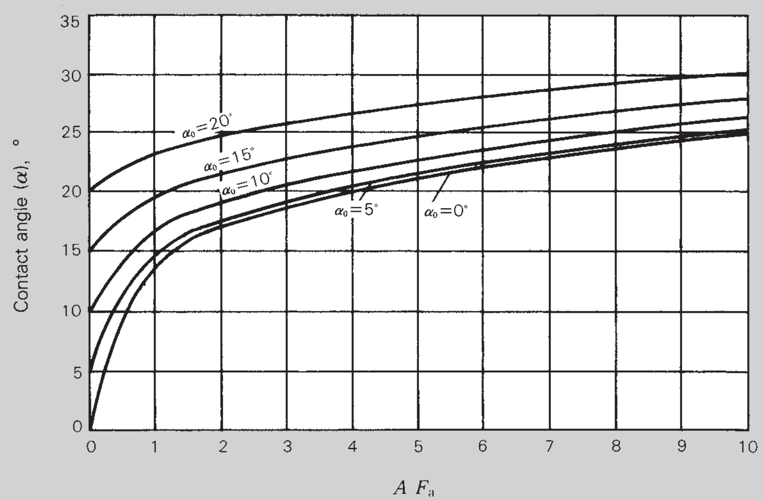


Fig. 4.23 Change in the Contact Angle of the Deep Groove Ball Bearing under Axial Load

Table 4.15 Contact A Value of Deep Groove Ball Bearing

Units: kN^{-1}

Bearing bore No.	Bearing series 62				
	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 means 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. Note also 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 is determined as follows. The contact angle α for F_a is determined from the right term of Equation (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 also 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 internal specifications of a bearing are known, Fig. 4.25 shows the result of a calculation to determine the allowable axial load for a deep groove radial ball bearing.

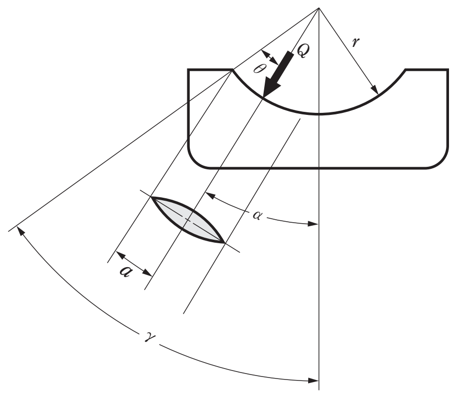


Fig. 4.24

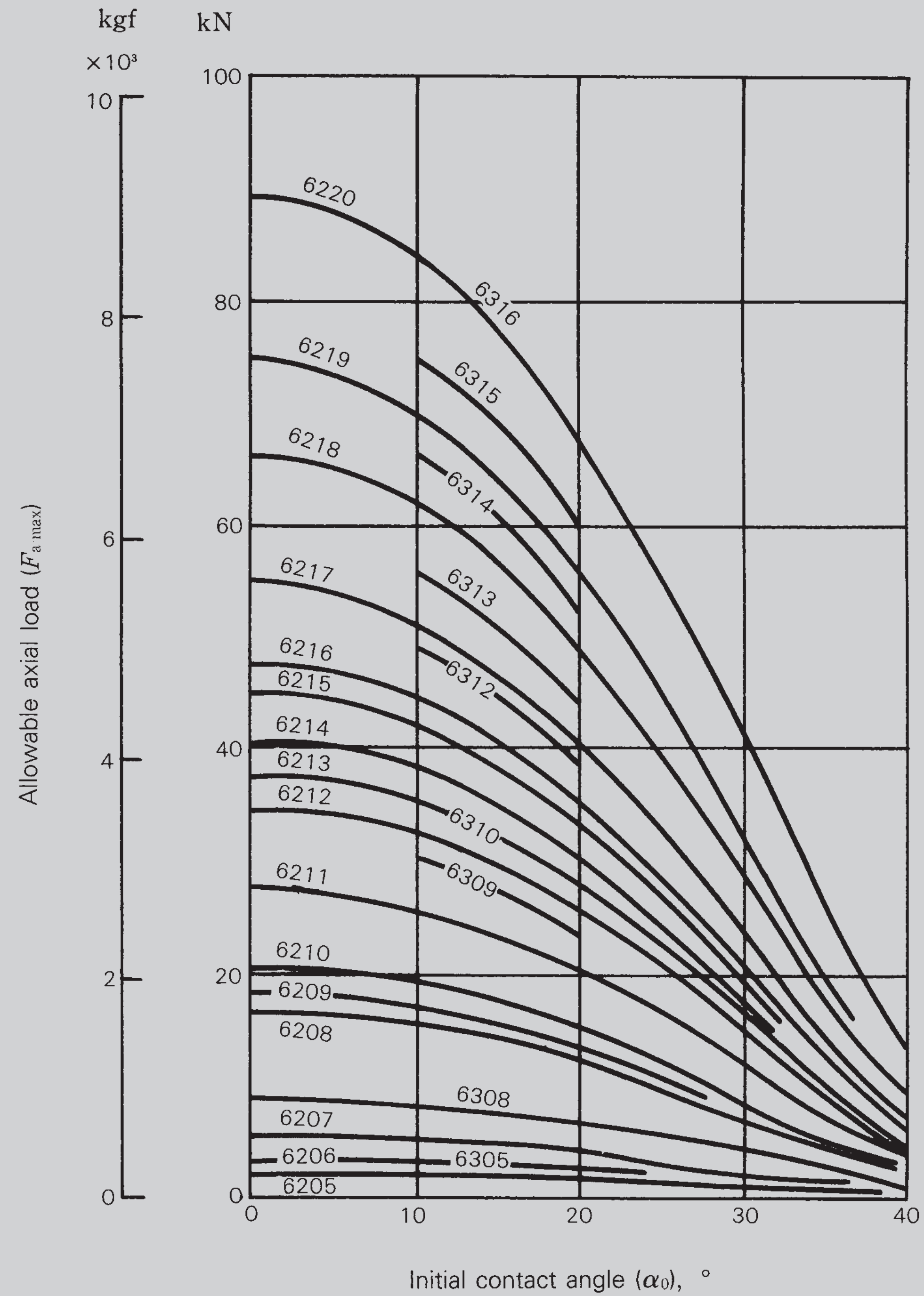


Fig. 4.25 Allowable Axial Load for a Deep Groove Ball Bearing

4.7.2 Allowable Axial Load (Break Down Strength of The Ribs) for a Cylindrical Roller Bearings

Both the inner and outer rings may be exposed to an axial load to a certain extent 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, or the rib strength.
The allowable axial load (the load considered the heat generation between the end face of rollers and the rib face) for the cylindrical roller bearing of the diameter series 3, which is applied continuously under grease or oil lubrication, is shown in Fig. 4.26.

Grease lubrication (Empirical equation)

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

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

Oil lubrication (Empirical equation)

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

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

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 the equations (4.55) and (4.56), the examination for the rib strength is excluded. Concerning the rib strength, please consult with NSK.
To enable the cylindrical roller bearing to sustain the axial load capacity stably, it is necessary to take into account the following points concerning the bearing and its surroundings.

- ○ 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.

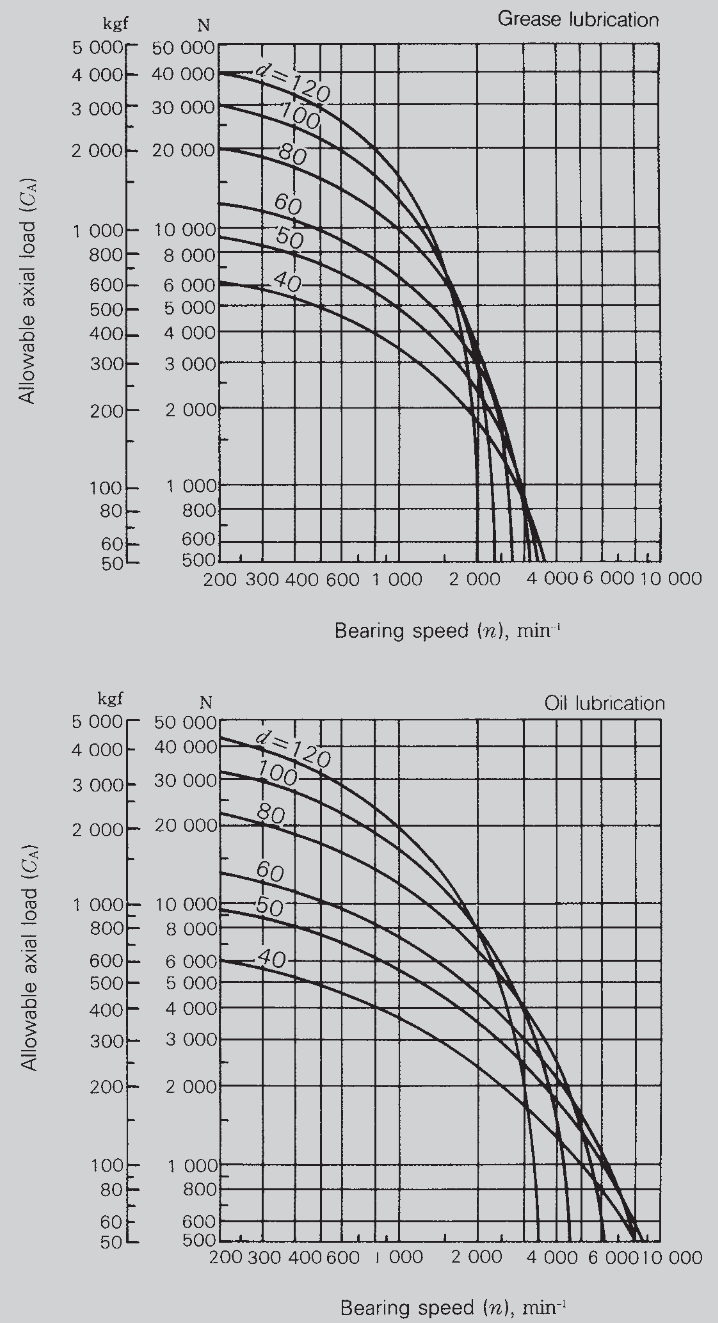
Moreover, if the bearing speed is very slow or exceeds 50% of the allowable speed in the bearing catalog, or if the bearing bore diameter exceeds 200 mm, it is required for each bearing to be precisely checked for lubrication, cooling method, etc. Please contact NSK in such cases.

f: Load factor

	f value
Continuous loading	1
Intermittent loading	2
Short time loading	3

k: Dimensional factor

	k value
Bearing diameter series 2	0.75
Bearing diameter series 3	1
Bearing diameter series 4	1.2



Conditions are continuous loading ($f=1$) and bearing diameter series 3 ($k=1.0$)

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 applications such as aircraft, satellites, or rockets, greatly increased reliability is demanded of each component. This concept is being applied 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 for which 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 life. For example, the average value is employed frequently to describe the life span of human beings. However, if the average value were used for bearings, then too many bearings would fail before the average life value is reached. On the other hand, if a low or minimum value is used as a criterion, then too many bearings would have a life much longer than the set value. In this view, the value 90% was chosen for common practice. The value 95% could have been taken as the statistical reliability, but nevertheless, the slightly looser reliability of 90% was taken for bearings empirically from the practical and economical viewpoint. A 90% reliability however is not acceptable for parts of aircraft or electronic computers or communication systems these days, and a 99% or 99.9% reliability is demanded 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%). Below the damage ratio of 10% (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 the 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 as shown in the table below 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=0.33×L_{10}=3 300 hours. In this manner, the reliability of the bearing life can be matched to the degree of reliability required of the equipment and difficulty of overhaul and inspection.

Table 4.16 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	0.62	0.53	0.44	0.33	0.21

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.

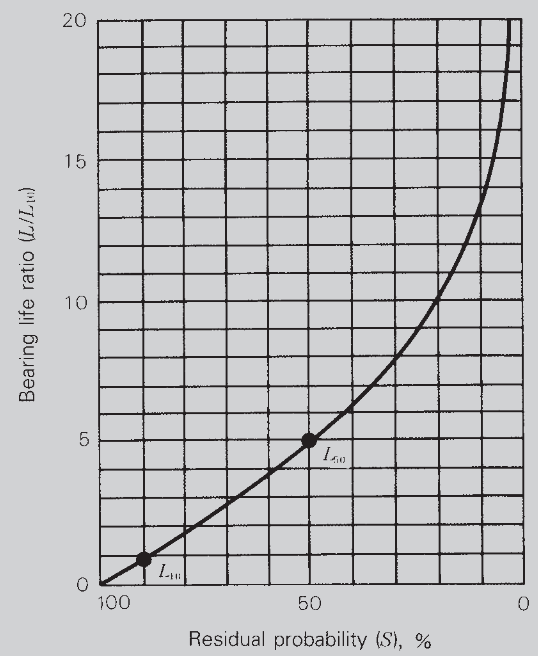


Fig. 4.27 Bearing Life and Residual Probability

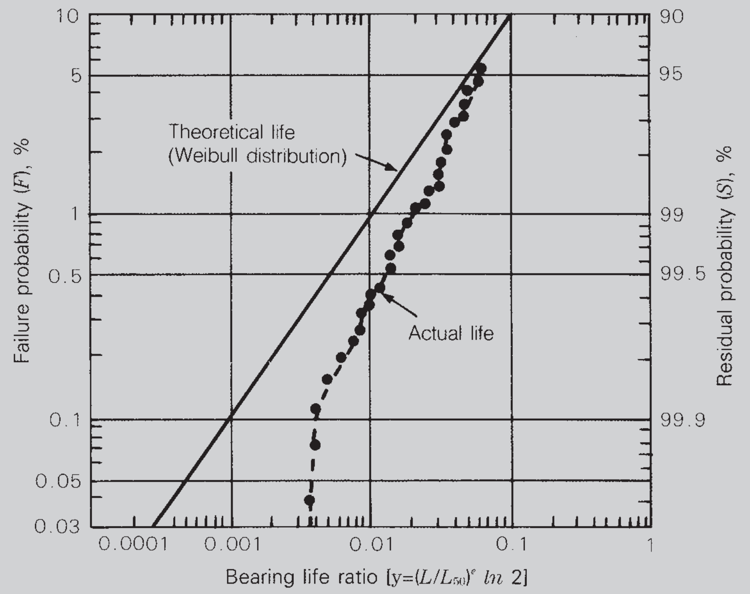


Fig. 4.28 Life Distribution in the Low Failure Ratio Range

4.8.2 Radial Clearance and Fatigue Life

As shown in the catalog, etc., the fatigue life calculation equation of rolling bearings is Equation (4.57):

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

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 is based on a prerequisite that 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 internal clearance is zero. In this sense, the normal fatigue life calculation is intended to obtain the value when the clearance is zero. When the effect of the radial clearance is taken into account, the bearing fatigue life can be calculated as follows. 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 bearing

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

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

$\cdots$ **(4.58)**

For cylindrical roller bearing

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

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

$\cdots$ **(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 the radial internal clearance is Δ_r can also be obtained as shown in Table 4.17.

Fig. 4.30 shows the relationship between the radial clearance and bearing fatigue life while taking 6208 and NU208 as examples.

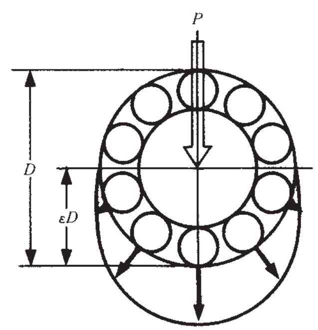


Fig. 4.29 Load Distribution with ε=0.5

Table 4.17 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

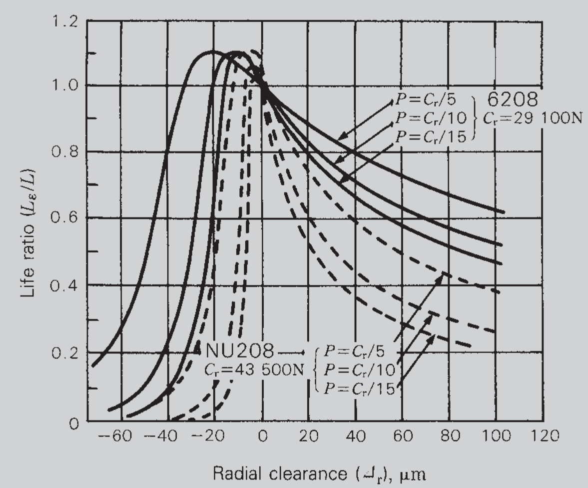


Fig. 4.30 Radial Clearance and Bearing Life Ratio

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 it is essential to take utmost care with machining and assembly accuracies of surrounding shafts and housing if 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 different sizes of bearings are selected as examples from the 62 and 63 series deep-groove ball bearings.

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 $L_\theta / L_{\theta=0}$. The result is shown in Figs. 4.31 to 4.34.

As an example of ordinary running conditions, the radial load F_r (N) {kgf} and axial load F_a (N) {kgf} were assumed respectively to be approximately 10% (normal load) and 1% (light preload) of the dynamic load rating C_r (N) {kgf} of a bearing and were used as load conditions for the calculation. Normal radial clearance was used and the shaft fit was set to around j5. Also taken into account was the decrease of the internal clearance due to expansion of the inner ring. 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 problem.

When the misalignment exceeds a certain limit, however, the fatigue life degrades rapidly as shown in the figure. Attention is therefore necessary in this respect.

When the clearance is small, not much effect is observed as long as the misalignment is small, as shown in the figure. But the life decreases substantially when the misalignment increases. As previously mentioned, it is essential to minimize the mounting error as much as possible when a bearing is to be used.

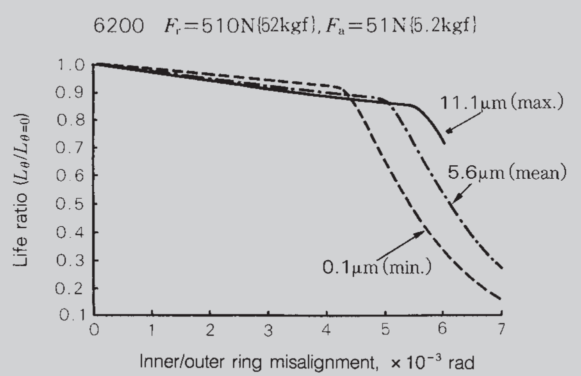


Fig. 4.31

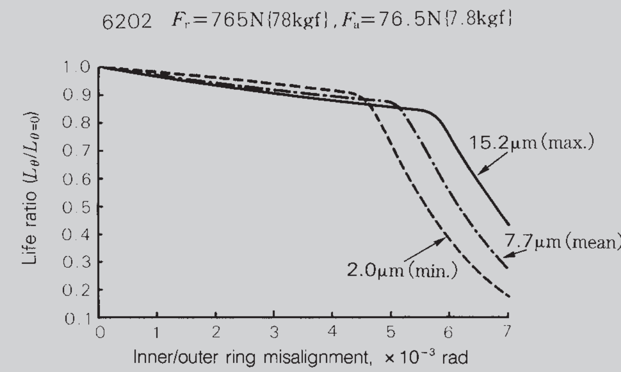


Fig. 4.32

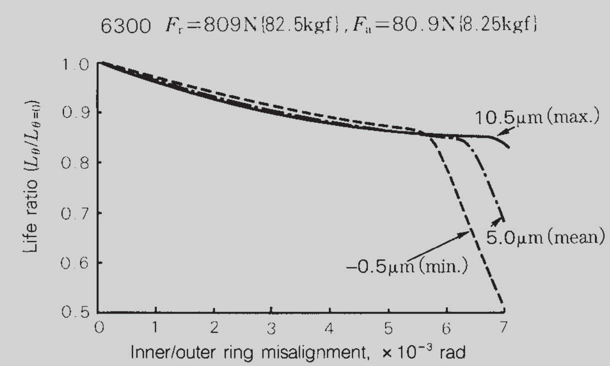


Fig. 4.33

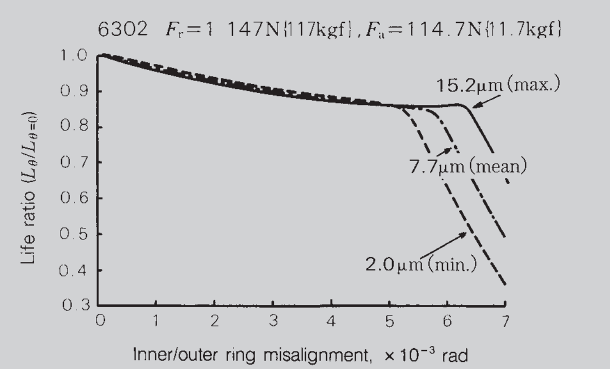


Fig. 4.34

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, there arises misalignment between the inner and outer rings of the bearings, thereby lowering their fatigue life. The degree of life degradation depends on the bearing type and interior design but also varies depending on the radial internal clearance and the magnitude of load during operation.

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

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 that with misalignment is L_θ.

Figs. 4.35 and 4.36 show the case with constant load (10% of basic dynamic load rating C_r of a bearing) for each case when the internal clearance is a normal, C3 clearance, or C4 clearance. Figs. 4.37 and 4.38 show the case 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. But the life ratio itself differs among bearing series and dimensions, with life degradation rapid in 22 and 23 series bearings (wide type). It is advisable to use a bearing of special design when considerable misalignment is expected during application.

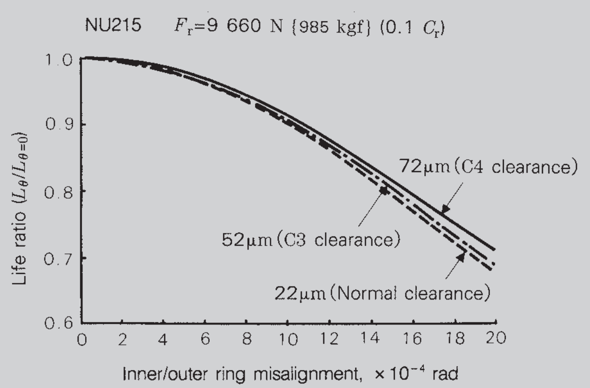


Fig. 4.35

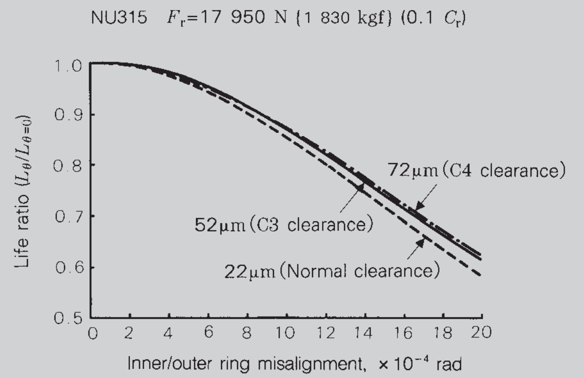


Fig. 4.36

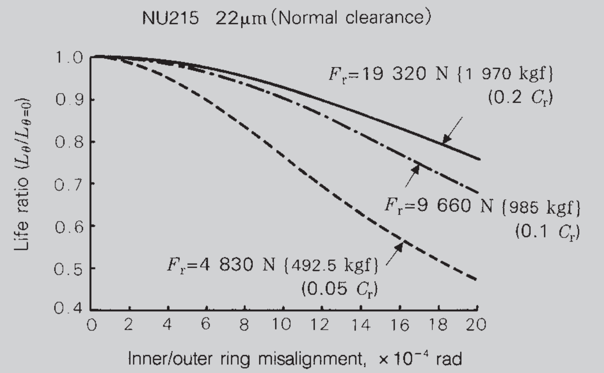


Fig. 4.37

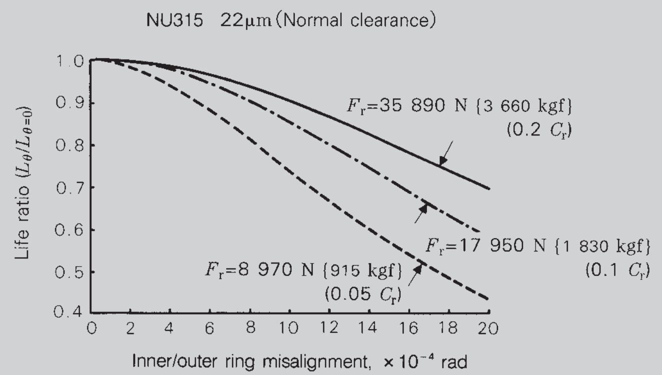


Fig. 4.38

4.8.5 Oil Film Parameters and Rolling Fatigue Life

Based on numerous experiments and experiences, the rolling fatigue life of rolling bearings can be shown to be closely related to the lubrication.
The rolling fatigue life is expressed by the maximum number of rotations, which a bearing can endure, until the raceway or rolling surface of a bearing develops fatigue in the material, resulting in flaking of the surface, under action of cyclic stress by the bearing. Such flaking begins with either microscopic non-uniform portions (such as non-metallic inclusions, cavities) in the material or with microscopic defect in the material's surface (such as extremely small cracks or surface damage or dents caused by contact between extremely small projections in the raceway or rolling surface). The former flaking is called sub-surface 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 state of 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 (flaw, dent, etc.), the life is determined mainly by sub-surface originating flaking. On the other hand, a decrease in Λ tends to develop 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 using different lubricants and bearing materials (● and ▲ in Fig. 4.40). Fig. 4.40 shows a summary of the principal experiments selected from among those reported up to now. As is evident, the life decreases rapidly at around $\Lambda \fallingdotseq 1$ when compared with the life values at around Λ=3 ~ 4 where life changes at a slower rate. The life becomes about 1/10 or less at $\Lambda \leqq 0.5$. This is a result of severe surface-originating flaking.
Accordingly, it is advisable for extension of the fatigue life of rolling bearings to increase the oil film parameter (ideally to a value above 3) by improving lubrication conditions.

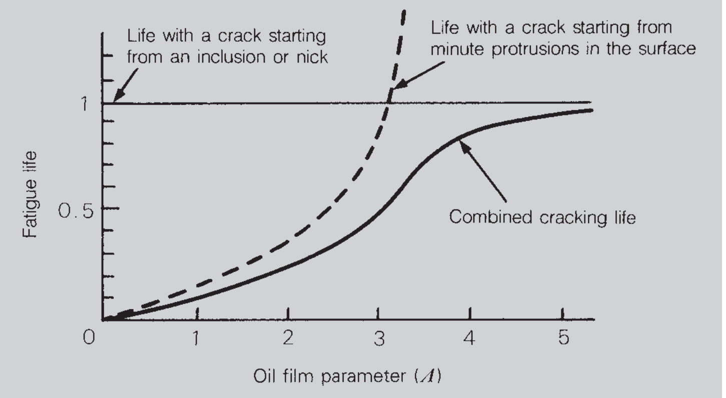


Fig. 4.39 Expression of Life According to Λ (Tallian, et al.)

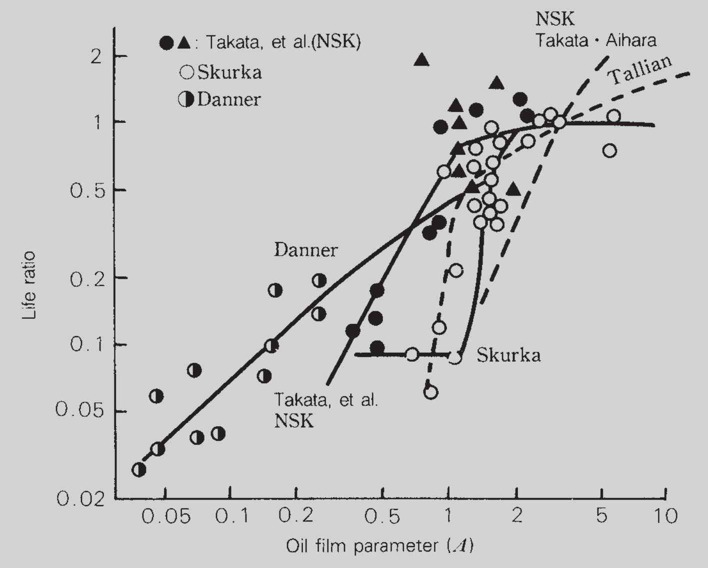


Fig. 4.40 Typical Experiment with Λ and Rolling Fatigue Life
(Expressed with reference to the life at Λ=3)

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 − surface roughness ratio), the most critical among the EHL qualities.

(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, lubricating conditions cannot be discussed without considering this surface roughness. For example, given a particular mean oil film thickness, there are two conditions which 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 an oil film parameter in the study and application of EHL.

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

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 contacting surface

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

(2) Oil Film Parameter Calculation Diagram

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

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

The oil film thickness to be used is that of the inner ring under the maximum rolling element load (at which the thickness becomes minimum).

Equation (4.61) can be expressed as follows by grouping into terms (R) for speed, (A) for viscosity, (F) for load, and (J) for bearing technical specifications. t is a constant.

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

R and A may be quantities not dependent on a 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 determined roughly from the bearing size, however, such change may be limited to 20 to 30%. As a result, F is handled as a lump with the term J of bearing specifications [$F=F(J)$]. Traditional Equation (4.62) can therefore be grouped as shown below:

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

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

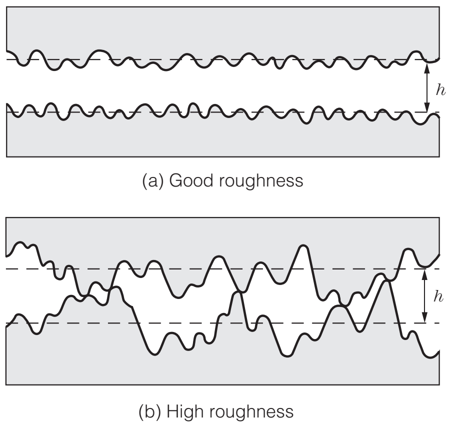


Fig. 4.41 Oil Film and Surface Roughness

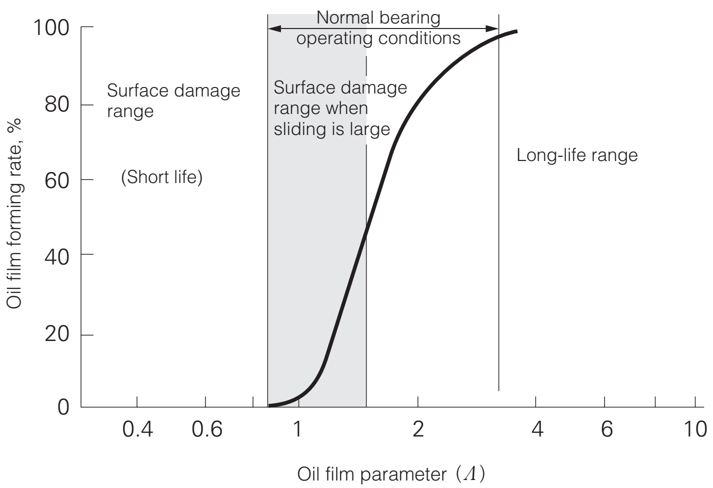


Fig. 4.42 Effect of Oil Film on Bearing Performance

The oil film parameter Λ, which is most vital among quantities related to EHL, is expressed by a simplified equation shown below. The fatigue life of rolling bearings becomes shorter when Λ is smaller.

In the equation $\Lambda = T \cdot R \cdot A \cdot D$ terms include A for oil viscosity η_0 (mPa·s, {cp}), R for the speed n (min^{-1}), and D for bearing bore diameter d (mm). The calculation procedure is described below.

(i) Determine the value T from the bearing type (Table 4.18).

(ii) Determine the R value for n (min^{-1}) from Fig. 4.43.

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

Generally, the kinematic viscosity ν_0 (mm^2/s, {cSt}) is used and conversion is made as follows:

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

ρ is the density (g/cm^3) and uses the approximate value as shown below:

Mineral oil ρ=0.85
Silicon oil ρ=1.0
Diester oil ρ=0.9

When it is not known whether the mineral oil is naphthene or paraffin, use the paraffin curve shown in Fig. 4.44.

(iv) Determine the D value from the diameter series and bore diameter d (mm) in Fig. 4.45.

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

Table 4.18 Value T

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

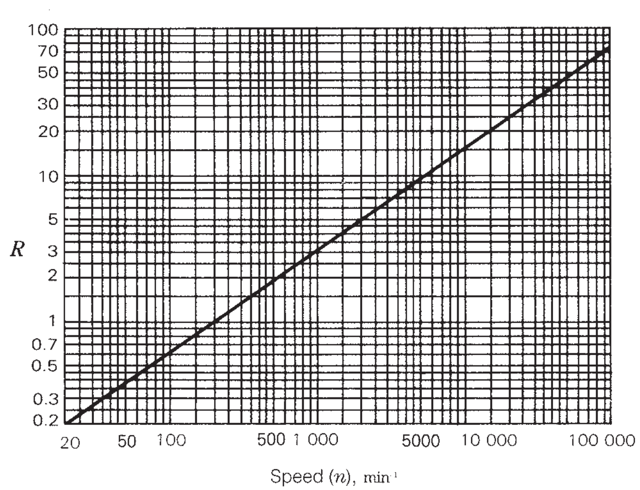


Fig. 4.43 Speed Term, R

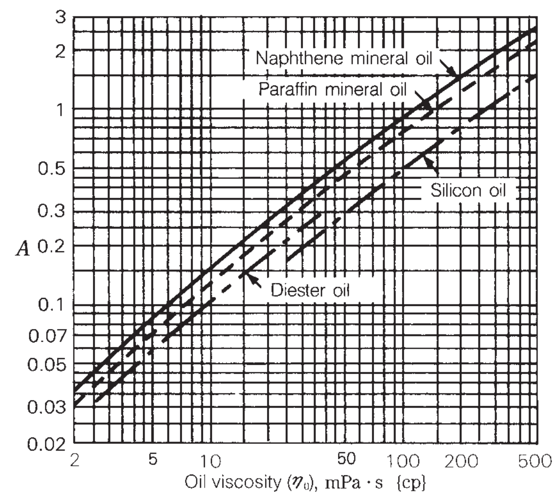


Fig. 4.44 Term Related to Lubricant Viscosity, A

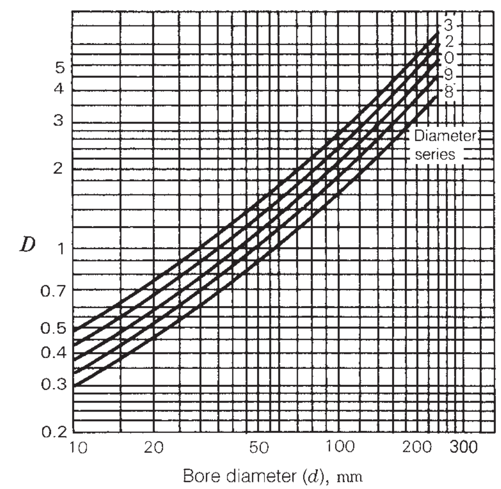


Fig. 4.45 Term Related to Bearing Specifications, D

Examples of EHL oil film parameter calculation are described below.

(**Example 1**)
The oil film parameter is determined when a deep groove ball bearing 6312 is operated with paraffin mineral oil (η_0=30 mPa·s, {cp}) at the speed 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**)
The oil film parameter is determined when a cylindrical roller bearing NU240 is operated with paraffin mineral oil (η_0=10 mPa·s, {cp}) at the speed 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) Effect of Oil Shortage and Shearing Heat Generation
The oil film parameter obtained above is the value when the requirements, that is, the contact inlet fully flooded with oil and isothermal inlet are satisfied. However, these conditions may not be satisfied depending on lubrication and operating conditions.
One such condition is called starvation, and the actual oil film paramerer value may become smaller than determined by Equation (4.64). Starvation might occur if lubrication becomes limited. In this condition, a guideline for adjusting the oil film parameter is 50 to 70% of the value obtained from Equation (4.64).

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

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

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 rolling element set.

Conditions for the calculation (Example 1) include $d_m n$=9.5 × 10^4 and η_0=30 mPa·s, {cp}, and Hi is nearly equivalent to 1 as is evident from Fig. 4.46. There is therefore almost no effect of shearing heat generation.
Conditions for (Example 2) are $d_m n$=7×10^5 and η_0=10 mPa·s, {cp} while Hi=0.76, which means that the oil film parameter is smaller by about 25%. Accordingly, Λ is actually 2.7, not 3.6.

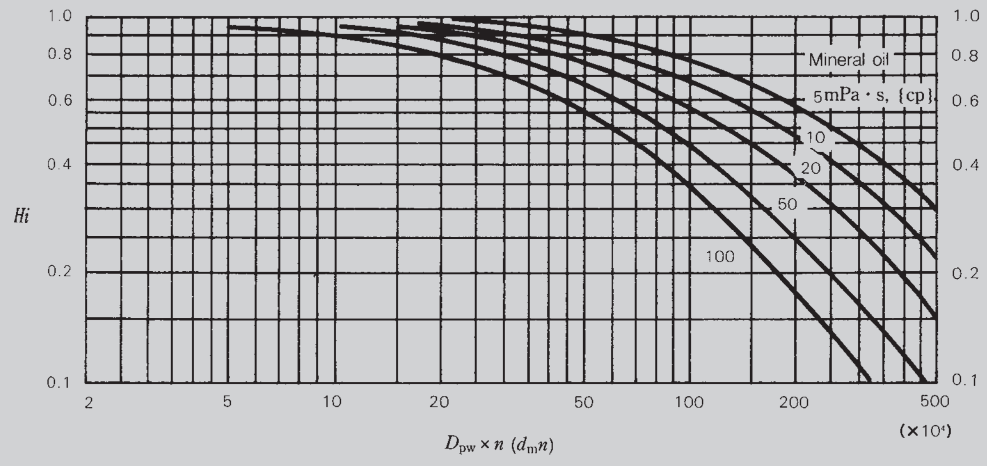


Fig. 4.46 Oil Film Thickness Decrease Factor Hi Due to Shearing Heat Generation

4.8.7 Load Calculation of Gears

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

There is an extremely close relationship among the two mechanical elements, 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 the 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: Driving 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.

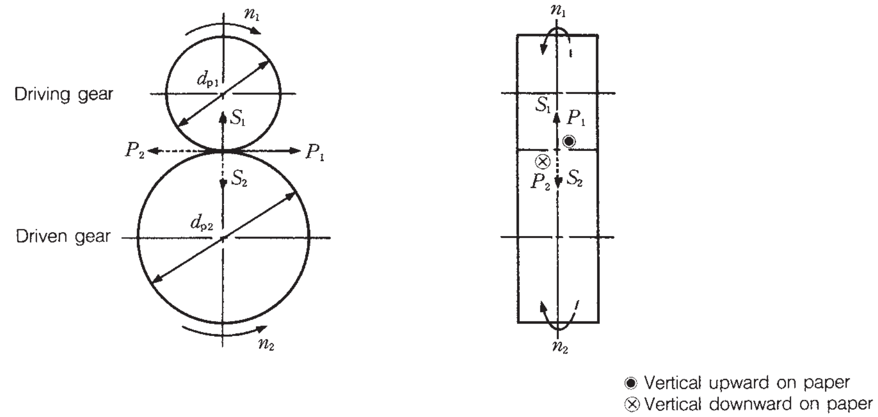


Fig. 4.47 Spur Gear

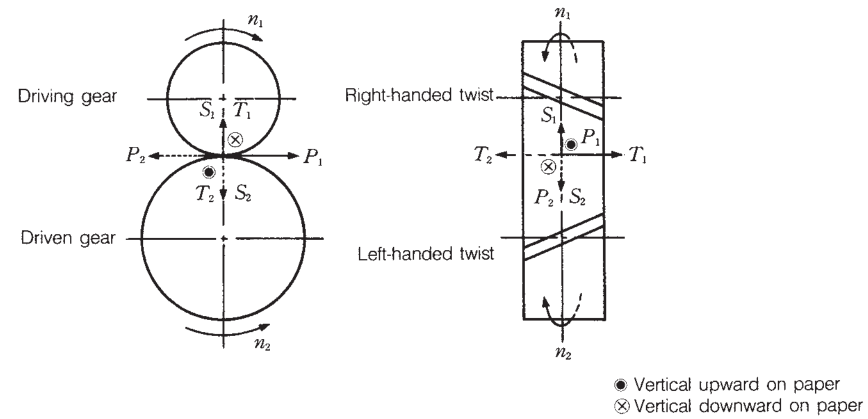


Fig. 4.48 Helical Gear

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 4.19

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 direction is shown referring to left side of Fig. 4.49.

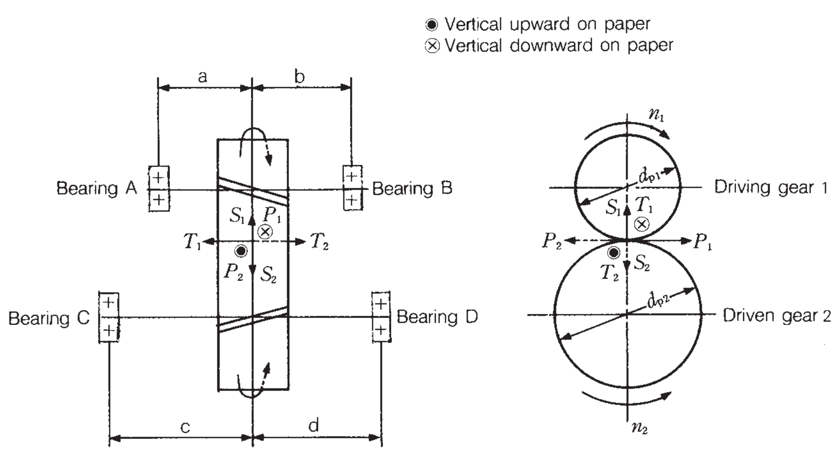


Fig. 4.49

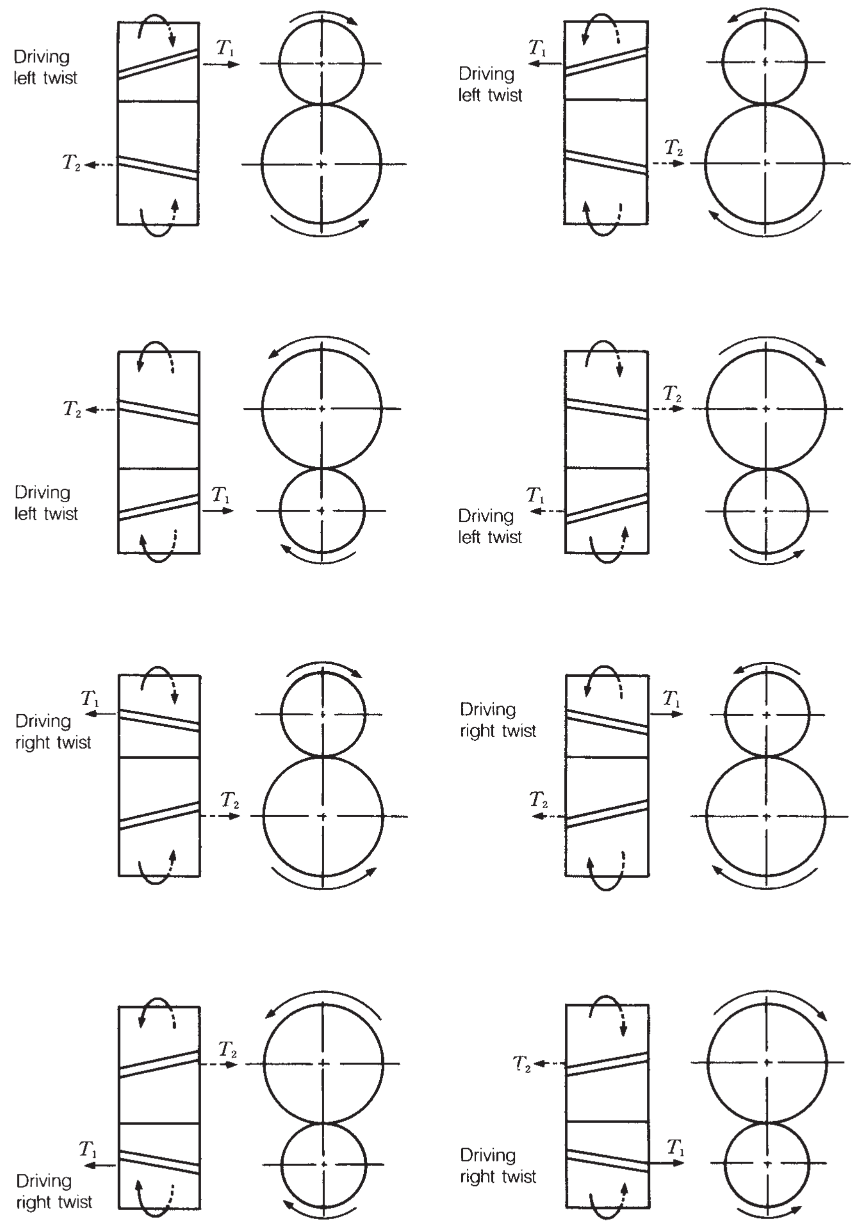


Fig. 4.50 Thrust Direction

(2) Calculation of Load Acting on Straight Bevel Gears

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

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

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

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

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

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

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 4.20

◉ Vertical upward on paper
⊗ Vertical downward on paper

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 direction is shown referring to Fig. 4.52.

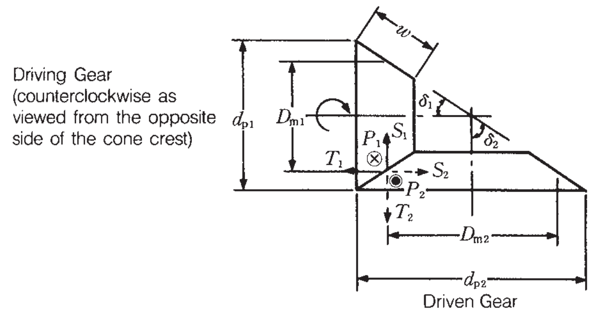


Fig. 4.51

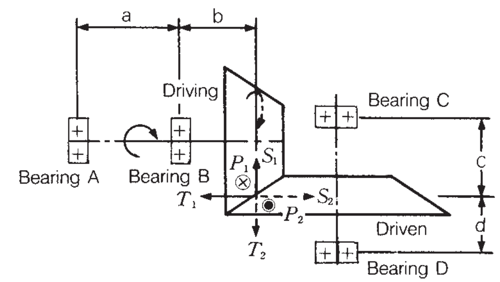


Fig. 4.52

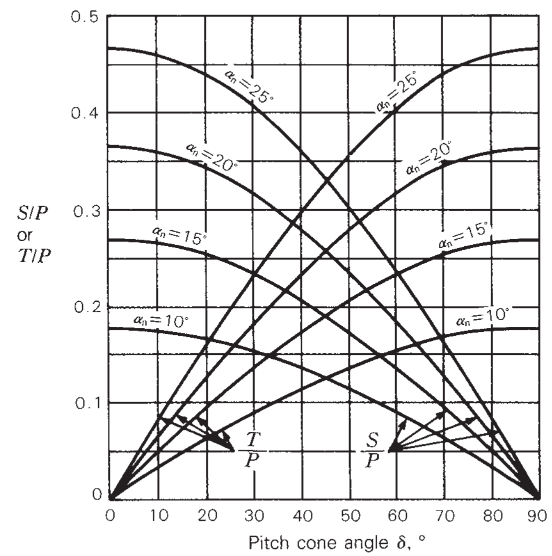


Fig. 4.53

(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 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:

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

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

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 T are as follows depending on the running direction and gear twist direction:

(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

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

The positive (plus) calculation result means that the load is acting in a direction to separate the gears while a negative (minus) one means that the load is acting in a direction to bring the gears nearer.

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 Acting on Straight Bevel Gears."

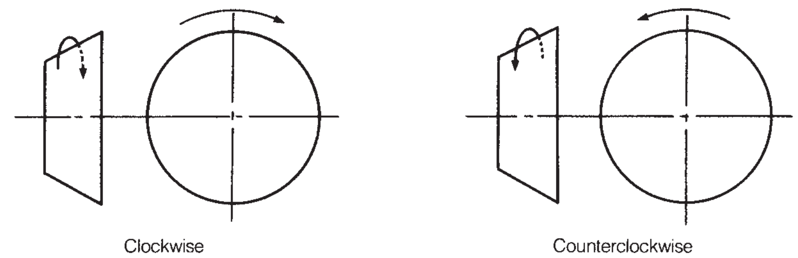


Fig. 4.54

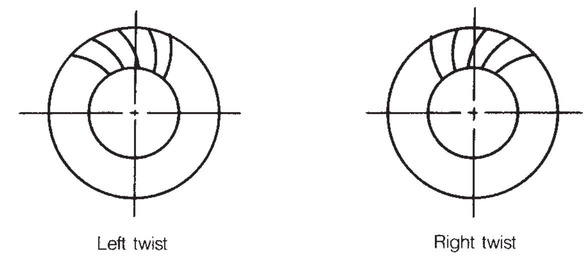


Fig. 4.55

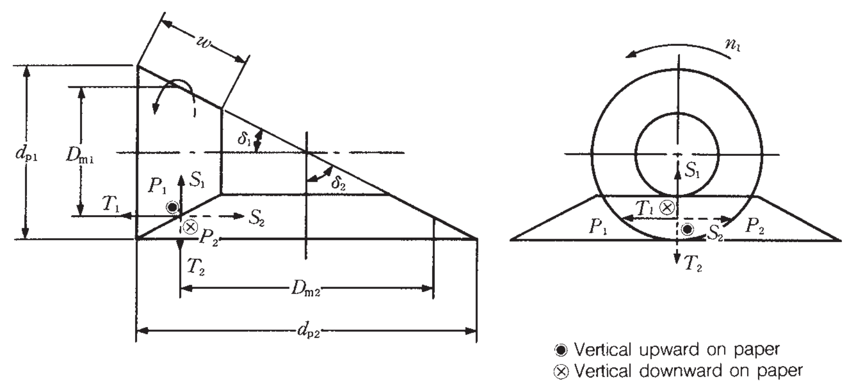


Fig. 4.56

(4) Calculation of Load Acting on Hypoid Gears

The force acting at the meshing point of Hypoid Gears is calculated as follows:

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

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

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

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

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

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

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 T are as follows depending on the running direction and gear twist direction:

(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

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

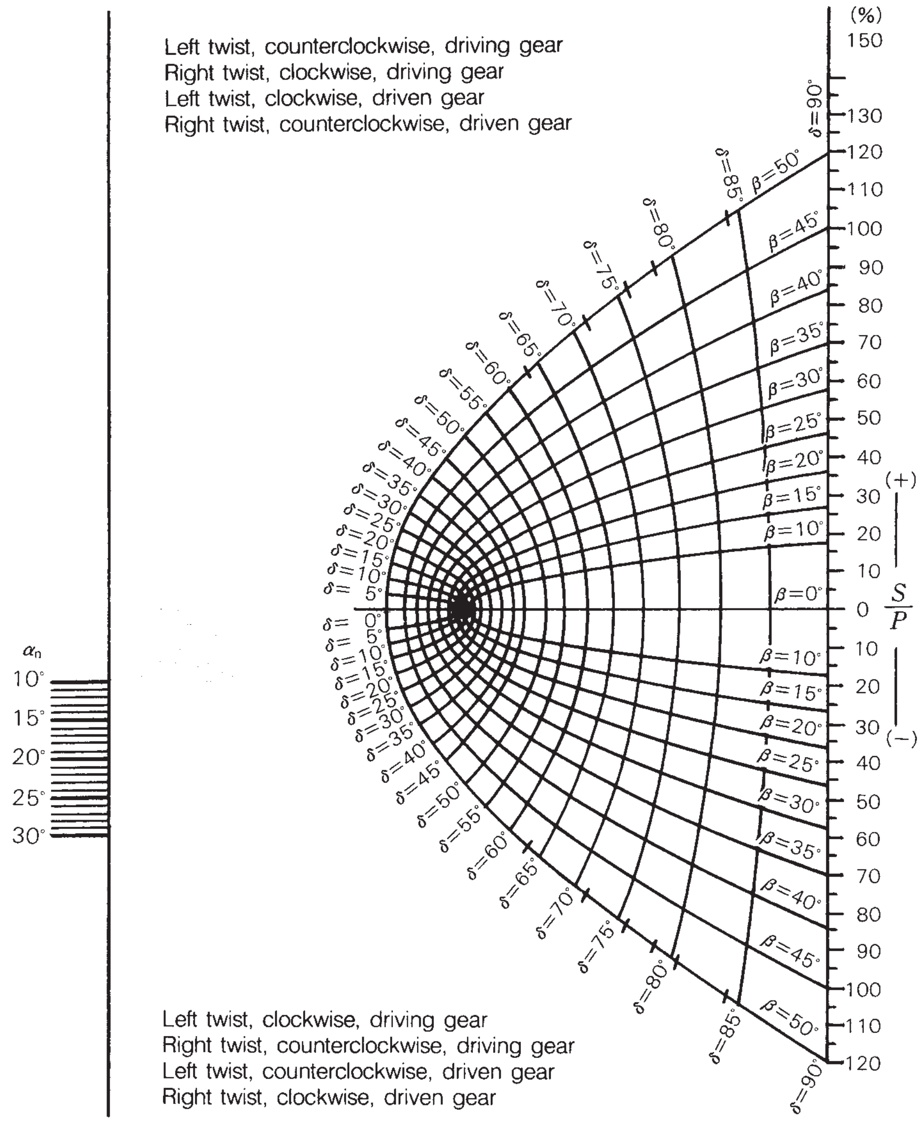
The positive (plus) calculation result means that the load is acting in a direction to separate the gears while a negative (minus) one means that the load is acting in a direction to bring the gears nearer.

For the 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."

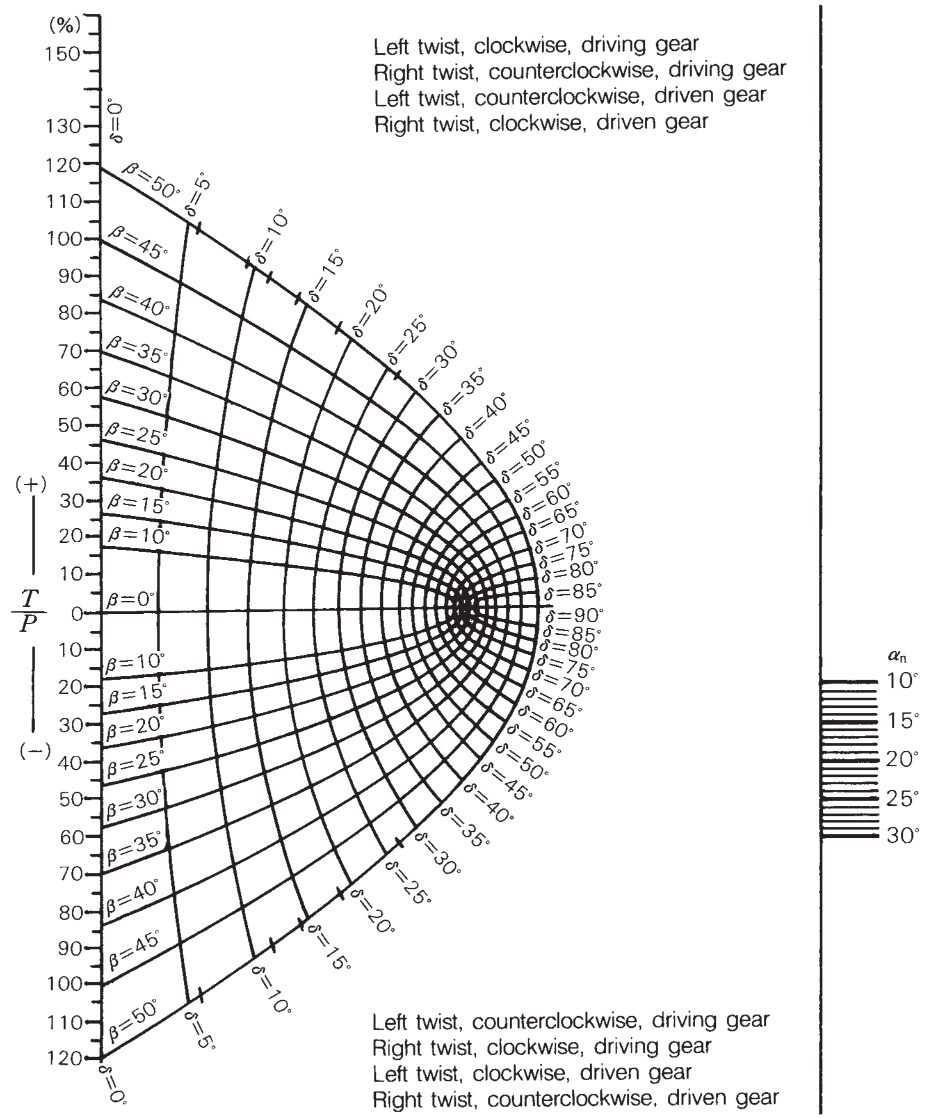
The next calculation diagram is used to determine the approximate value and direction of separating force S and thrust T.

[How To Use]
The method of determining the separating force S is shown. The thrust T can also be determined in a similar manner.

1. Take the gear normal pressure angle α_n from the vertical scale on the left side of the diagram.
2. Determine the intersection between the pitch cone angle δ and the twist angle β. Determine one point which is either above or below the β=0 line according to the rotating direction and gear twist direction.
3. Draw a line connecting the two points and read the point at which the line cuts through the right vertical scale. This reading gives the ratio (S/P, %) of the separating force S to the tangential force P in percentage.



Calculation Diagram of Separating Force S



Calculation Diagram of Thrust T

(5) Calculation of Load on Worm Gear

A worm gear is a kind of spigot gear, which can produce a high reduction ratio with small volume. The load at a meshing point of worm gears is calculated as shown in Table 4.21. Symbols of Table 4.21 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: For the frictional angle, the value obtained

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

as shown in Fig. 4.57 is used.

When V_R is 0.2 m/s or less, then use ψ=8°.
When V_R exceeds 6 m/s, use ψ=1°4′.

α_n : Gear normal pressure angle
α_a : Shaft plane pressure angle
Z_w : No. of threads (No. of teeth of worm gear)
Z_2 : No. of teeth of worm wheel
Subscript 1: For driving worm gear
Subscript 2: For driving 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.

The load on the bearing is obtained from the magnitude and direction of each component at the meshing point of the worm gears according to the method shown in Table 4.17 of Section 4.8.7 (1), Calculation of loads on spur, helical, and double-helical gears.

Table 4.21

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}

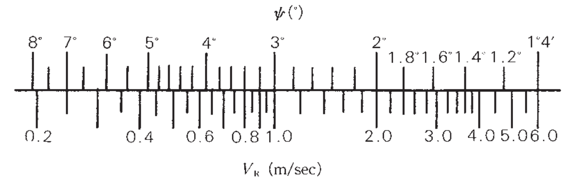


Fig. 4.57

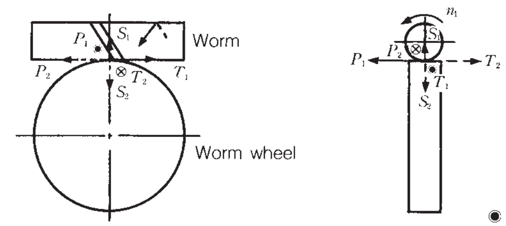


Fig. 4.58 Right Twist Worm Gear

◉ Vertical upward on paper
⊗ Vertical downward on paper

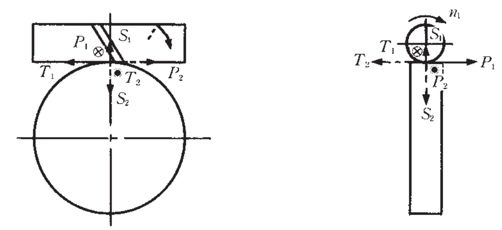


Fig. 4.59 Right Twist Worm Gear (Worm Rotation is Opposite that of Fig. 4.58)

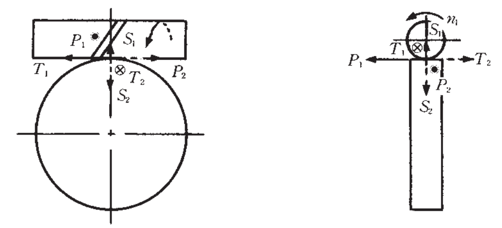


Fig. 4.60 Left Twist Worm Gear

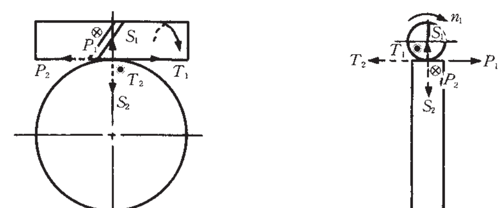
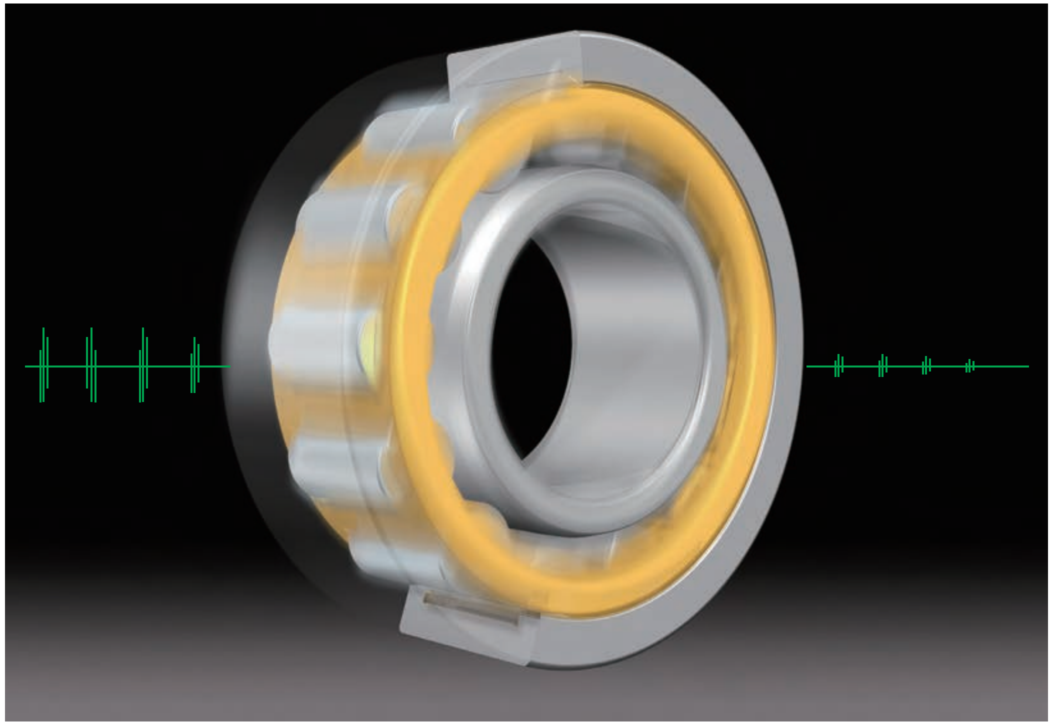


Fig. 4.61 Left Twist Worm Gear (Worm Rotation is Opposite that of Fig. 4.60)



5. SPEEDS

5. SPEEDS

In this catalog, NSK uses four definitions of speed shown in Table 5.1.

Table 5.1 Overview of Speeds

Speeds	Overview	Applicable lubrication methods
Limiting Speed (Grease)	Empirically obtained and comprehensive bearing limiting speed in grease lubrication.	Grease lubrication
Limiting Speed (Oil)	Empirically obtained and comprehensive bearing limiting speed in 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 the reference conditions defined by ISO 15312. One among various criteria showing the suitability for operation at high speed.	Oil bath lubrication when subject to reference 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 listed only in the tables of single row cylindrical roller bearings and spherical roller bearings.

5.1 Limiting Speed (Grease/Oil)

When bearings are operating, 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 form and material, load, lubricating method, and heat dissipating method including the design of the bearing's surroundings.

The limiting speed (grease) and limiting speed (oil) in the bearing tables are applicable to bearings of standard design and subjected to normal loads, i.e. $C/P \geqq 12$ and $F_a/F_r \leqq 0.2$ approximately. 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 speed (grease) or limiting speed (oil), it is necessary to select a grease or oil which has good high speed characteristics.

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

5.1.1 Correction of Limiting Speed (Grease/Oil)

When the 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 limiting speed 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. It is recommended that NSK be consulted regarding high speed applications.

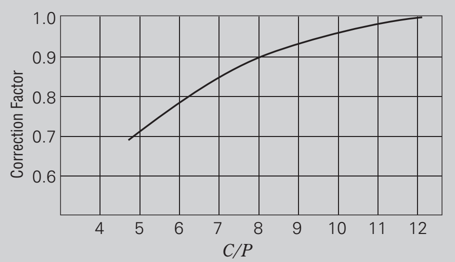


Fig. 5.1 Limiting Speed Correction Factor Variation with Load Ratio

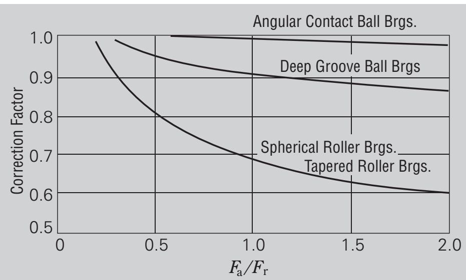


Fig. 5.2 Limiting Speed Correction Factor for Combined Radial and Axial Loads

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

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

The maximum permissible speed for contact rubber 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 the reference conditions defined by ISO 15312. It is one among various criteria showing the suitability for operation at high speed.

The below reference conditions are defined by ISO 15312.

- -Outer-ring fixed, Inner-ring rotating
- -Mean ambient temperature 20 degrees C
- -Mean bearing temperature at the outer ring 70 degrees C
- -Load on radial bearings 0.05 Cor
- -Oil bath lubrication
- -Lubricant ISO VG32 (radial bearings)
- -Normal bearing internal clearance

The heat dissipation through the housing and shaft can be obtained from Fig.5.3. In Fig.5.3, A_r (mm²) is the heat emitting reference surface area. ISO defines A_r as the total area of the bearing's inner ring bore surface and outer ring outside surface (radial bearings), and q_r (W/mm²) as the heat flow density. The heat dissipation is calculated by multiplying the bearing seating surface area (A_r) by the heat flow density (q_r).

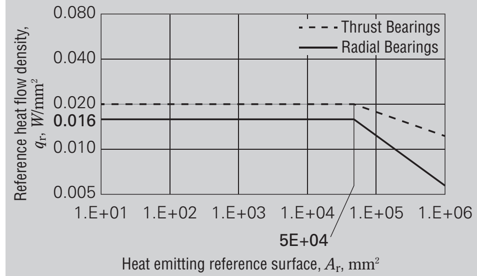


Fig. 5.3 Reference Heat Flow Density

5.3 Limiting Speed (Mechanical)

Limiting speed (mechanical) is the mechanical and kinematic limiting speed of bearings achievable under ideal conditions for lubrication, heat dissipation and temperature, 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 bearings of standard design and subjected to normal loads (C/P = 12 approximately).

In the bearing tables of 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 of the other bearing types, the limiting speeds (grease) and limiting speeds (oil) are listed.

5.4 Technical Data

5.4.1 Rotation and Revolution Speed of Rolling Element

When the rolling element rotates without slip between bearing rings, the distance which the rolling element rolls on the inner ring raceway is equal to that on the outer ring raceway. This fact allows establishment of a relationship among rolling speed n_i and n_e of the inner and outer rings and the number of rotation n_a of rolling elements.
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 the inner or outer ring being stationary). The rotation and revolution of the rolling element can be related as expressed by Equations (5.1) through (5.4).

No. of rotation

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

Rotational circumferential speed

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

No. of revolutions (No. of cage rotation)

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

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

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

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})

The rotation and revolution of the rolling element is shown in Table 5.3 for inner ring rotating (n_e=0) and outer ring rotating (n_i=0) respectively at 0°≦ α <90° and at α=90°.
As an example, Table 5.4 shows the rotation speed n_a and revolution speed n_c of the rolling element during rotating of the inner ring of ball bearings 6210 and 6310.

Table 5.4 n_a and 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's Rotation Speed n_a, Rotational Circumferential Speed v_a, Revolution Speed n_c, and Revolutional Circumferential Speed v_c

Contact angle	Rotation/revolution speed	Inner ring rolling (n_e=0)	Outer ring rolling (n_i=0)
0° ≦ α < 90°	n_a (min^{-1})	$-\left(\frac{1}{\gamma}-\gamma\right)\frac{n_i}{2}\cdot\cos\alpha$	$\left(\frac{1}{\gamma}-\gamma\right)\frac{n_e}{2}\cdot\cos\alpha$
	v_a (m/s)	$\frac{\pi D_w}{60\times10^3}n_a$	
	n_c (min^{-1})	$(1-\gamma)\frac{n_i}{2}$	$(1+\gamma)\frac{n_e}{2}$
	v_c (m/s)	$\frac{\pi D_{pw}}{60\times10^3}n_c$	
α = 90°	n_a (min^{-1})	$-\frac{1}{\gamma}\cdot\frac{n_i}{2}$	$\frac{1}{\gamma}\cdot\frac{n_e}{2}$
	v_a (m/s)	$\frac{\pi D_w}{60\times10^3}n_a$	
	n_c (min^{-1})	$\frac{n_i}{2}$	$\frac{n_e}{2}$
	v_c (m/s)	$\frac{\pi D_{pw}}{60\times10^3}n_c$	

Reference 1. ±: The "+" symbol indicates clockwise rotation while the "−" symbol indicates counterclockwise rotation.
2. $\gamma=\frac{D_w\cos\alpha}{D_{pw}}$ (0° ≦ α <90°), $\gamma=\frac{D_w}{D_{pw}}$ (α=90°)

6. BOUNDARY DIMENSIONS AND IDENTIFYING NUMBERS FOR BEARINGS

6. BOUNDARY DIMENSIONS AND IDENTIFYING NUMBERS FOR BEARINGS

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, are the dimensions that define their external geometry. They include bore diameter d, outside diameter D, width B, bearing width(or height) T, chamfer dimension r, etc. It is necessary to know all of these dimensions 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 Table 6.1 to 6.3 (Pages A106 to A115).

In these boundary dimension tables, for each bore number, which prescribes the bore diameter, other boundary dimensions are listed for each diameter series and dimension series. A very large number of series are possible; however, not all of them are commercially available so more can be added in the future. Across the top of each bearing table (6.1 to 6.3), representative bearing types and series symbols are shown (refer to Table 6.5, Bearing Series Symbols, Page A121).

The relative cross-sectional dimensions of radial bearings (except tapered roller bearings) and thrust bearings for the various series classifications 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 are specified by ISO 464. Also, 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).

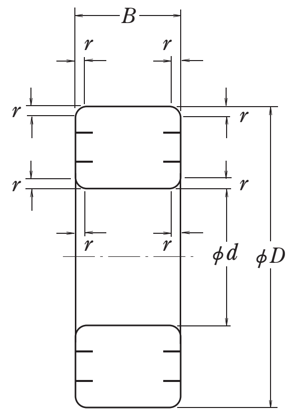


Fig. 6.1 Boundary Dimensions of Radial Ball and Roller Bearings

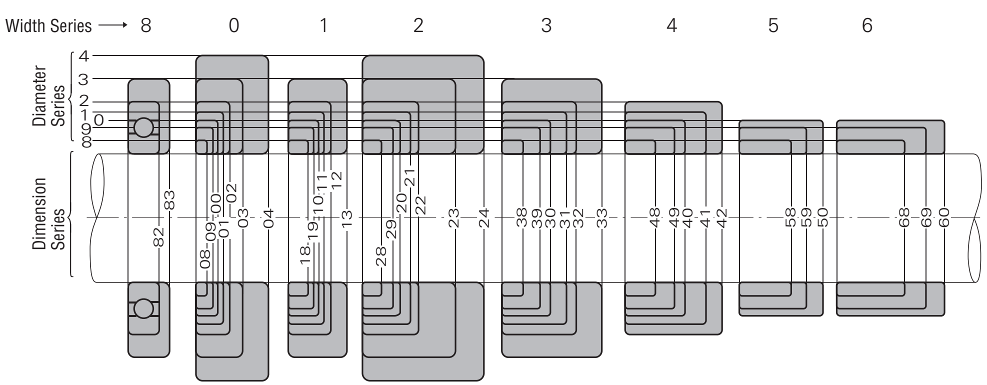


Fig. 6.6 Comparison of Cross Sections of Radial Bearings (except Tapered Roller Bearings) for various Dimensional Series

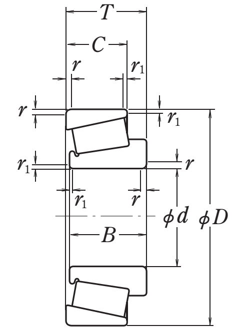


Fig. 6.2 Tapered Roller Bearings

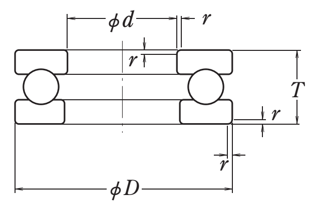


Fig. 6.3 Single-Direction Thrust Ball Bearings

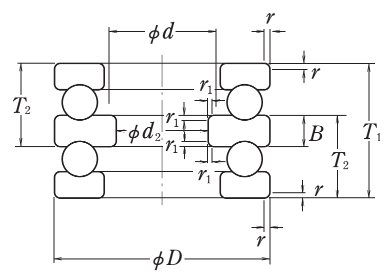


Fig. 6.4 Double-Direction Thrust Ball Bearings

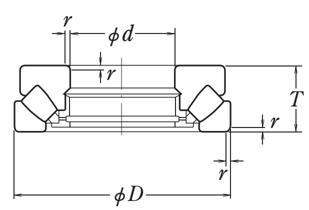


Fig. 6.5 Spherical Thrust Roller Bearings

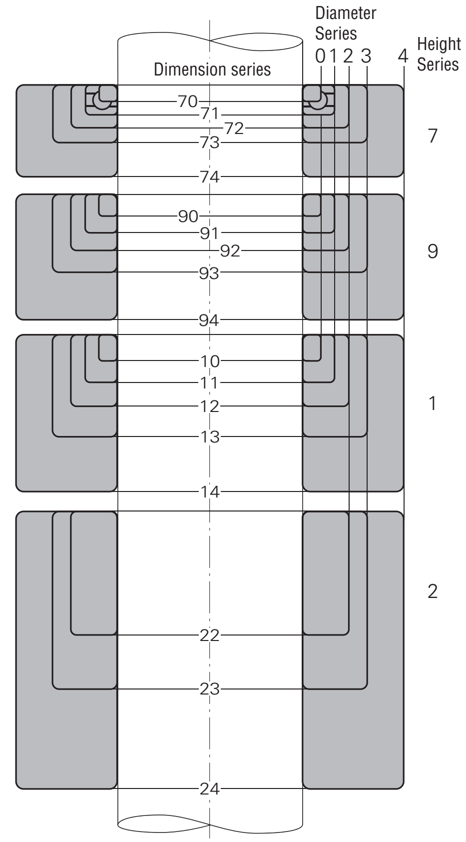


Fig. 6.7 Comparison of Cross Sections of Thrust Bearings (except Diameter Series 5) for Various Dimension Series

BOUNDARY DIMENSIONS AND IDENTIFYING NUMBERS FOR BEARINGS

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

Units: mm

Single-Row Ball Brgs.									68										69 79										160	60 70							
Double-Row Ball Brgs.																																					
Cylindrical Roller Brgs.										N28	NN38	NN48							N19	N29	NN39	NN49								N10	N20	NN30	NN40				
Needle Roller Brgs.												NA48										NA49	NA59	NA69													
Spherical Roller Brgs.																					239											230	240				
		Diameter Series 7					Diameter Series 8										Diameter Series 9											Diameter Series 0									
			Dimension Series					Dimension Series							Dimension Series			Dimension Series							Dimension Series				Dimension Series							Dimension Series	
Bore Number	d	D	17	27	37	17~37	D	08	18	28	38	48	58	68	08	18~68	D	09	19	29	39	49	59	69	09	19~39	49~69	D	00	10	20	30	40	50	60	00	10~60
			B			r (min.)		B							r (min.)			B							r (min.)				B							r (min.)	
—	0.6	2	0.8	—	—	0.05	2.5	—	1	—	1.4	—	—	—	—	0.05	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	2.5	1	—	—	0.05	3	—	1	—	1.5	—	—	—	—	0.05	4	—	1.6	—	2.3	—	—	—	—	0.1	—	—	—	—	—	—	—	—	—	—	—
—	1.5	3	1	—	1.8	0.05	4	—	1.2	—	2	—	—	—	—	0.05	5	—	2	—	2.6	—	—	—	—	0.15	—	6	—	2.5	—	3	—	—	—	—	0.15
2	2	4	1.2	—	2	0.05	5	—	1.5	—	2.3	—	—	—	—	0.08	6	—	2.3	—	3	—	—	—	—	0.15	—	7	—	2.8	—	3.5	—	—	—	—	0.15
—	2.5	5	1.5	—	2.3	0.08	6	—	1.8	—	2.6	—	—	—	—	0.08	7	—	2.5	—	3.5	—	—	—	—	0.15	—	8	—	2.8	—	4	—	—	—	—	0.15
3	3	6	2	2.5	3	0.08	7	—	2	—	3	—	—	—	—	0.1	8	—	3	—	4	—	—	—	—	0.15	—	9	—	3	—	5	—	—	—	—	0.15
4	4	7	2	2.5	3	0.08	9	—	2.5	3.5	4	—	—	—	—	0.1	11	—	4	—	5	—	—	—	—	0.15	—	12	—	4	—	6	—	—	—	—	0.2
5	5	8	2	2.5	3	0.08	11	—	3	4	5	—	—	—	—	0.15	13	—	4	—	6	10	—	—	—	0.2	0.15	14	—	5	—	7	—	—	—	—	0.2
6	6	10	2.5	3	3.5	0.1	13	—	3.5	5	6	—	—	—	—	0.15	15	—	5	—	7	10	—	—	—	0.2	0.15	17	—	6	—	9	—	—	—	—	0.3
7	7	11	2.5	3	3.5	0.1	14	—	3.5	5	6	—	—	—	—	0.15	17	—	5	—	7	10	—	—	—	0.3	0.15	19	—	6	8	10	—	—	—	—	0.3
8	8	12	2.5	—	3.5	0.1	16	—	4	5	6	8	—	—	—	0.2	19	—	6	—	9	11	—	—	—	0.3	0.2	22	—	7	9	11	14	19	25	—	0.3
9	9	14	3	—	4.5	0.1	17	—	4	5	6	8	—	—	—	0.2	20	—	6	—	9	11	—	—	—	0.3	0.3	24	—	7	10	12	15	20	27	—	0.3
00	10	15	3	—	4.5	0.1	19	—	5	6	7	9	—	—	—	0.3	22	—	6	8	10	13	16	22	—	0.3	0.3	26	—	8	10	12	16	21	29	—	0.3
01	12	18	4	—	5	0.2	21	—	5	6	7	9	—	—	—	0.3	24	—	6	8	10	13	16	22	—	0.3	0.3	28	7	8	10	12	16	21	29	0.3	0.3
02	15	21	4	—	5	0.2	24	—	5	6	7	9	—	—	—	0.3	28	—	7	8.5	10	13	18	23	—	0.3	0.3	32	8	9	11	13	17	23	30	0.3	0.3
03	17	23	4	—	5	0.2	26	—	5	6	7	9	—	—	—	0.3	30	—	7	8.5	10	13	18	23	—	0.3	0.3	35	8	10	12	14	18	24	32	0.3	0.3
04	20	27	4	—	5	0.2	32	4	7	8	10	12	16	22	0.3	0.3	37	7	9	11	13	17	23	30	0.3	0.3	0.3	42	8	12	14	16	22	30	40	0.3	0.6
/22	22	—	—	—	—	—	34	4	7	—	10	—	16	22	0.3	0.3	39	7	9	11	13	17	23	30	0.3	0.3	0.3	44	8	12	14	16	22	30	40	0.3	0.6
05	25	32	4	—	5	0.2	37	4	7	8	10	12	16	22	0.3	0.3	42	7	9	11	13	17	23	30	0.3	0.3	0.3	47	8	12	14	16	22	30	40	0.3	0.6
/28	28	—	—	—	—	—	40	4	7	—	10	—	16	22	0.3	0.3	45	7	9	11	13	17	23	30	0.3	0.3	0.3	52	8	12	15	18	24	32	43	0.3	0.6
06	30	37	4	—	5	0.2	42	4	7	8	10	12	16	22	0.3	0.3	47	7	9	11	13	17	23	30	0.3	0.3	0.3	55	9	13	16	19	25	34	45	0.3	1
/32	32	—	—	—	—	—	44	4	7	—	10	—	16	22	0.3	0.3	52	7	10	13	15	20	27	36	0.3	0.6	0.6	58	9	13	16	20	26	35	47	0.3	1
07	35	—	—	—	—	—	47	4	7	8	10	12	16	22	0.3	0.3	55	7	10	13	15	20	27	36	0.3	0.6	0.6	62	9	14	17	20	27	36	48	0.3	1
08	40	—	—	—	—	—	52	4	7	8	10	12	16	22	0.3	0.3	62	8	12	14	16	22	30	40	0.3	0.6	0.6	68	9	15	18	21	28	38	50	0.3	1
09	45	—	—	—	—	—	58	4	7	8	10	13	18	23	0.3	0.3	68	8	12	14	16	22	30	40	0.3	0.6	0.6	75	10	16	19	23	30	40	54	0.6	1
10	50	—	—	—	—	—	65	5	7	10	12	15	20	27	0.3	0.3	72	8	12	14	16	22	30	40	0.3	0.6	0.6	80	10	16	19	23	30	40	54	0.6	1
11	55	—	—	—	—	—	72	7	9	11	13	17	23	30	0.3	0.3	80	9	13	16	19	25	34	45	0.3	1	1	90	11	18	22	26	35	46	63	0.6	1.1
12	60	—	—	—	—	—	78	7	10	12	14	18	24	32	0.3	0.3	85	9	13	16	19	25	34	45	0.3	1	1	95	11	18	22	26	35	46	63	0.6	1.1
13	65	—	—	—	—	—	85	7	10	13	15	20	27	36	0.3	0.6	90	9	13	16	19	25	34	45	0.3	1	1	100	11	18	22	26	35	46	63	0.6	1.1
14	70	—	—	—	—	—	90	8	10	13	15	20	27	36	0.3	0.6	100	10	16	19	23	30	40	54	0.6	1	1	110	13	20	24	30	40	54	71	0.6	1.1
15	75	—	—	—	—	—	95	8	10	13	15	20	27	36	0.3	0.6	105	10	16	19	23	30	40	54	0.6	1	1	115	13	20	24	30	40	54	71	0.6	1.1
16	80	—	—	—	—	—	100	8	10	13	15	20	27	36	0.3	0.6	110	10	16	19	23	30	40	54	0.6	1	1	125	14	22	27	34	45	60	80	0.6	1.1
17	85	—	—	—	—	—	110	9	13	16	19	25	34	45	0.3	1	120	11	18	22	26	35	46	63	0.6	1.1	1.1	130	14	22	27	34	45	60	80	0.6	1.1
18	90	—	—	—	—	—	115	9	13	16	19	25	34	45	0.3	1	125	11	18	22	26	35	46	63	0.6	1.1	1.1	140	16	24	30	37	50	67	90	1	1.5
19	95	—	—	—	—	—	120	9	13	16	19	25	34	45	0.3	1	130	11	18	22	26	35	46	63	0.6	1.1	1.1	145	16	24	30	37	50	67	90	1	1.5
20	100	—	—	—	—	—	125	9	13	16	19	25	34	45	0.3	1	140	13	20	24	30	40	54	71	0.6	1.1	1.1	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	6	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 chamfers: (a) Chamfers of the grooves in outer rings that have snap ring grooves.
(b) For thin section cylindrical roller bearings, the chamfers on side without rib and bearing bore (in case of an inner ring) or outer surface (in case of an outer ring).
(c) For angular contact ball bearings, the chamfers between the front face and bore (in case of an inner ring) or outer surface (in case of an outer ring).
(d) Chamfers on inner rings of bearings with tapered bores.

Table 6. 1 Boundary Dimensions of Radial Bearings (except Tapered Roller Bearings) — 2 —

Units: mm

Diameter Series 1

Bore Number	d	D	B: Dimension Series 01	B: 11	B: 21	B: 31	B: 41	r (min.): Dimension Series 01	r (min.): 11~41
Single-Row Ball Brgs.									
Double-Row Ball Brgs.									
Cylindrical Roller Brgs.						NN 31			
Needle Roller Brgs.									
Spherical Roller Brgs.						231	241		
—	0.6	—	—	—	—	—	—	—	—
1	1	—	—	—	—	—	—	—	—
—	1.5	—	—	—	—	—	—	—	—
2	2	—	—	—	—	—	—	—	—
—	2.5	—	—	—	—	—	—	—	—
3	3	—	—	—	—	—	—	—	—
4	4	—	—	—	—	—	—	—	—
5	5	—	—	—	—	7	—	—	—
6	6	—	—	—	8	10	—	—	—
7	7	—	—	—	9	11	14	—	—
8	8	—	—	—	10	12	15	—	—
9	9	—	—	—	10	12	16	—	—
00	10	—	—	—	12	14	18	—	—
01	12	—	—	—	12	14	18	—	—
02	15	—	—	—	12	14	18	—	—
03	17	—	—	—	13	15	20	—	—
04	20	—	—	—	15	18	24	—	—
/22	22	—	—	—	16	19	25	—	—
05	25	—	—	—	16	19	25	—	—
/28	28	—	—	—	17	20	27	—	—
06	30	—	—	—	18	21	28	—	—
/32	32	—	—	—	19	23	30	—	—
07	35	—	—	—	21	25	33	—	—
08	40	—	—	—	22	26	35	—	—
09	45	—	—	—	22	26	35	—	—
10	50	—	—	—	22	26	35	—	—
11	55	—	—	—	24	30	40	—	—
12	60	—	—	—	24	30	40	—	—
13	65	—	—	—	27	34	45	—	—
14	70	—	—	—	27	34	45	—	—
15	75	—	—	—	30	37	50	—	—
16	80	—	—	—	30	37	50	—	—
17	85	—	—	—	31	41	56	—	—
18	90	150	—	—	33	45	60	—	2
19	95	160	—	—	39	52	65	—	2
20	100	165	21	30	39	52	65	1.1	2
21	105	175	22	33	42	56	69	1.1	2
22	110	180	22	33	42	56	69	1.1	2
24	120	200	25	38	48	62	80	1.5	2
26	130	210	25	38	48	64	80	1.5	2
28	140	225	27	40	50	68	85	1.5	2.1
30	150	250	31	46	60	80	100	2	2.1
32	160	270	34	51	66	86	109	2	2.1
34	170	280	34	51	66	88	109	2	2.1
36	180	300	37	56	72	96	118	2.1	3
38	190	320	42	60	78	104	128	3	3
40	200	340	44	65	82	112	140	3	3
44	220	370	48	69	88	120	150	3	4
48	240	400	50	74	95	128	160	4	4
52	260	440	57	82	106	144	180	4	4
56	280	460	57	82	106	146	180	4	5
60	300	500	63	90	118	160	200	5	5
64	320	540	71	100	128	176	218	5	5
68	340	580	78	106	140	190	243	5	5
72	360	600	78	106	140	192	243	5	5
76	380	620	78	106	140	194	243	5	5
80	400	650	80	112	145	200	250	6	6
84	420	700	88	122	165	224	280	6	6
88	440	720	88	122	165	226	280	6	6
92	460	760	95	132	175	240	300	6	7.5
96	480	790	100	136	180	248	308	6	7.5
/500	500	830	106	145	190	264	325	7.5	7.5
/530	530	870	109	150	195	272	335	7.5	7.5
/560	560	920	115	160	206	280	355	7.5	7.5
/600	600	980	122	170	218	300	375	7.5	7.5
/630	630	1030	128	175	230	315	400	7.5	7.5
/670	670	1090	136	185	243	336	412	7.5	7.5
/710	710	1150	140	195	250	345	438	9.5	9.5
/750	750	1220	150	206	272	365	475	9.5	9.5
/800	800	1280	155	212	272	375	475	9.5	9.5
/850	850	1360	165	224	290	400	500	12	12
/900	900	1420	165	230	300	412	515	12	12
/950	950	1500	175	243	315	438	545	12	12
/1000	1000	1580	185	258	335	462	580	12	12
/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

Diameter Series 2

Bore Number	d	D	B: Dimension Series 82	B: 02	B: 12	B: 22	B: 32	B: 42	r (min.): Dimension Series 82	r (min.): 02~42
Single-Row Ball Brgs.				62 72		622	632			
Double-Row Ball Brgs.				12		42 22	52 53			
Cylindrical Roller Brgs.				N 2		N 22	N 32			
Needle Roller Brgs.										
Spherical Roller Brgs.						222	232			
—	0.6	—	—	—	—	—	—	—	—	—
1	1	—	—	—	—	—	—	—	—	—
—	1.5	—	—	—	—	—	—	—	—	—
2	2	—	—	—	—	—	—	—	—	—
—	2.5	—	—	—	—	—	—	—	—	—
3	3	10	2.5	4	—	—	5	—	0.1	0.15
4	4	13	3	5	—	—	7	—	0.15	0.2
5	5	16	3.5	5	—	—	8	—	0.15	0.3
6	6	19	4	6	—	—	10	—	0.2	0.3
7	7	22	5	7	—	—	11	—	0.3	0.3
8	8	24	5	8	—	—	12	—	0.3	0.3
9	9	26	6	8	—	—	13	—	0.3	0.3
00	10	30	7	9	—	14	14.3	—	0.3	0.6
01	12	32	7	10	—	14	15.9	—	0.3	0.6
02	15	35	8	11	—	14	15.9	20	0.3	0.6
03	17	40	8	12	—	16	17.5	22	0.3	0.6
04	20	47	9	14	—	18	20.6	27	0.3	1
/22	22	50	9	14	—	18	20.6	27	0.3	1
05	25	52	10	15	—	18	20.6	27	0.3	1
/28	28	58	10	16	—	19	23	30	0.6	1
06	30	62	10	16	—	20	23.8	32	0.6	1
/32	32	65	11	17	—	21	25	33	0.6	1
07	35	72	12	17	—	23	27	37	0.6	1.1
08	40	80	13	18	—	23	30.2	40	0.6	1.1
09	45	85	13	19	—	23	30.2	40	0.6	1.1
10	50	90	13	20	—	23	30.2	40	0.6	1.1
11	55	100	14	21	—	25	33.3	45	0.6	1.5
12	60	110	16	22	—	28	36.5	50	1	1.5
13	65	120	18	23	—	31	38.1	56	1	1.5
14	70	125	18	24	—	31	39.7	56	1	1.5
15	75	130	18	25	—	31	41.3	56	1	1.5
16	80	140	19	26	—	33	44.4	60	1	2
17	85	150	21	28	—	36	49.2	65	1.1	2
18	90	160	22	30	—	40	52.4	69	1.1	2
19	95	170	24	32	—	43	55.6	75	1.1	2.1
20	100	180	25	34	—	46	60.3	80	1.5	2.1
21	105	190	27	36	—	50	65.1	85	1.5	2.1
22	110	200	28	38	—	53	69.8	90	1.5	2.1
24	120	215	—	40	42	58	76	95	—	2.1
26	130	230	—	40	46	64	80	100	—	3
28	140	250	—	42	50	68	88	109	—	3
30	150	270	—	45	54	73	96	118	—	3
32	160	290	—	48	58	80	104	128	—	3
34	170	310	—	52	62	86	110	140	—	4
36	180	320	—	52	62	86	112	140	—	4
38	190	340	—	55	65	92	120	150	—	4
40	200	360	—	58	70	98	128	160	—	4
44	220	400	—	65	78	108	144	180	—	4
48	240	440	—	72	85	120	160	200	—	4
52	260	480	—	80	90	130	174	218	—	5
56	280	500	—	80	90	130	176	218	—	5
60	300	540	—	85	98	140	192	243	—	5
64	320	580	—	92	105	150	208	258	—	5
68	340	620	—	92	118	165	224	280	—	6
72	360	650	—	95	122	170	232	290	—	6
76	380	680	—	95	132	175	240	300	—	6
80	400	720	—	103	140	185	256	315	—	6
84	420	760	—	109	150	195	272	335	—	7.5
88	440	790	—	112	155	200	280	345	—	7.5
92	460	830	—	118	165	212	296	365	—	7.5
96	480	870	—	125	170	224	310	388	—	7.5
/500	500	920	—	136	185	243	336	412	—	7.5
/530	530	980	—	145	200	258	355	450	—	9.5
/560	560	1030	—	150	206	272	365	475	—	9.5
/600	600	1090	—	155	212	280	388	488	—	9.5
/630	630	1150	—	165	230	300	412	515	—	12
/670	670	1220	—	175	243	315	438	545	—	12
/710	710	1280	—	180	250	325	450	560	—	12
/750	750	1360	—	195	265	345	475	615	—	15
/800	800	1420	—	200	272	355	488	615	—	15
/850	850	1500	—	206	280	375	515	650	—	15
/900	900	1580	—	218	300	388	515	670	—	15
/950	950	1660	—	230	315	412	530	710	—	15
/1000	1000	1750	—	243	330	425	560	750	—	15
/1060	1060	—	—	—	—	—	—	—	—	—
/1120	1120	—	—	—	—	—	—	—	—	—
/1180	1180	—	—	—	—	—	—	—	—	—
/1250	1250	—	—	—	—	—	—	—	—	—
/1320	1320	—	—	—	—	—	—	—	—	—
/1400	1400	—	—	—	—	—	—	—	—	—
/1500	1500	—	—	—	—	—	—	—	—	—

Diameter Series 3

Bore Number	d	D	B: Dimension Series 83	B: 03	B: 13	B: 23	B: 33	r (min.): Dimension Series 83	r (min.): 03~33
Single-Row Ball Brgs.				63 73		623	633		
Double-Row Ball Brgs.				13		43 23	53 33		
Cylindrical Roller Brgs.				N 3		N 23	N 33		
Needle Roller Brgs.									
Spherical Roller Brgs.				213		223			
—	0.6	—	—	—	—	—	—	—	—
1	1	—	—	—	—	—	—	—	—
—	1.5	—	—	—	—	—	—	—	—
2	2	—	—	—	—	—	—	—	—
—	2.5	—	—	—	—	—	—	—	—
3	3	13	—	5	—	—	7	—	0.2
4	4	16	—	5	—	—	9	—	0.3
5	5	19	—	6	—	—	10	—	0.3
6	6	22	—	7	—	11	13	—	0.3
7	7	26	—	9	—	13	15	—	0.3
8	8	28	—	9	—	13	15	—	0.3
9	9	30	—	10	—	14	16	—	0.6
00	10	35	9	11	—	17	19	0.3	0.6
01	12	37	9	12	—	17	19	0.3	1
02	15	42	9	13	—	17	19	0.3	1
03	17	47	10	14	—	19	22.2	0.6	1
04	20	52	10	15	—	21	22.2	0.6	1.1
/22	22	56	11	16	—	21	25	0.6	1.1
05	25	62	12	17	—	24	25.4	0.6	1.1
/28	28	68	13	18	—	24	30	0.6	1.1
06	30	72	13	19	—	27	30.2	0.6	1.1
/32	32	75	14	20	—	28	32	0.6	1.1
07	35	80	14	21	—	31	34.9	0.6	1.5
08	40	90	16	23	—	33	36.5	1	1.5
09	45	100	17	25	—	36	39.7	1	1.5
10	50	110	19	27	—	40	44.4	1	2
11	55	120	21	29	—	43	49.2	1.1	2
12	60	130	22	31	—	46	54	1.1	2.1
13	65	140	24	33	—	48	58.7	1.1	2.1
14	70	150	25	35	—	51	63.5	1.5	2.1
15	75	160	27	37	—	55	68.3	1.5	2.1
16	80	170	28	39	—	58	68.3	1.5	2.1
17	85	180	30	41	—	60	73	2	3
18	90	190	30	43	—	64	73	2	3
19	95	200	33	45	—	67	77.8	2	3
20	100	215	36	47	51	73	82.6	2.1	3
21	105	225	37	49	53	77	87.3	2.1	3
22	110	240	42	50	57	80	92.1	3	3
24	120	260	44	55	62	86	106	3	3
26	130	280	48	58	66	93	112	3	4
28	140	300	50	62	70	102	118	4	4
30	150	320	—	65	75	108	128	—	4
32	160	340	—	68	79	114	136	—	4
34	170	360	—	72	84	120	140	—	4
36	180	380	—	75	88	126	150	—	4
38	190	400	—	78	92	132	155	—	5
40	200	420	—	80	97	138	165	—	5
44	220	460	—	88	106	145	180	—	5
48	240	500	—	95	114	155	195	—	5
52	260	540	—	102	123	165	206	—	6
56	280	580	—	108	132	175	224	—	6
60	300	620	—	109	140	185	236	—	7.5
64	320	670	—	112	155	200	258	—	7.5
68	340	710	—	118	165	212	272	—	7.5
72	360	750	—	125	170	224	290	—	7.5
76	380	780	—	128	175	230	300	—	7.5
80	400	820	—	136	185	243	308	—	7.5
84	420	850	—	136	190	250	315	—	9.5
88	440	900	—	145	200	265	345	—	9.5
92	460	950	—	155	212	280	365	—	9.5
96	480	980	—	160	218	290	375	—	9.5
/500	500	1030	—	170	230	300	388	—	12
/530	530	1090	—	180	243	325	412	—	12
/560	560	1150	—	190	258	335	438	—	12
/600	600	1220	—	200	272	355	462	—	15
/630	630	1280	—	206	280	375	488	—	15
/670	670	1360	—	218	300	400	515	—	15
/710	710	1420	—	224	308	412	530	—	15
/750	750	1500	—	236	325	438	560	—	15
/800	800	1600	—	258	355	462	600	—	15
/850	850	1700	—	272	375	488	630	—	19
/900	900	1780	—	280	388	500	650	—	19
/950	950	1850	—	290	400	515	670	—	19
/1000	1000	1950	—	300	412	545	710	—	19
/1060	1060	—	—	—	—	—	—	—	—
/1120	1120	—	—	—	—	—	—	—	—
/1180	1180	—	—	—	—	—	—	—	—
/1250	1250	—	—	—	—	—	—	—	—
/1320	1320	—	—	—	—	—	—	—	—
/1400	1400	—	—	—	—	—	—	—	—
/1500	1500	—	—	—	—	—	—	—	—

Diameter Series 4

Bore Number	d	D	B: Dimension Series 04	B: 24	r (min.): Dimension Series 04~24
Single-Row Ball Brgs.			64 74		
Double-Row Ball Brgs.			104		
Cylindrical Roller Brgs.			N 4		
Needle Roller Brgs.					
Spherical Roller Brgs.					
—	0.6	—	—	—	—
1	1	—	—	—	—
—	1.5	—	—	—	—
2	2	—	—	—	—
—	2.5	—	—	—	—
3	3	—	—	—	—
4	4	—	—	—	—
5	5	—	—	—	—
6	6	—	—	—	—
7	7	—	—	—	—
8	8	30	10	14	0.6
9	9	32	11	15	0.6
00	10	37	12	16	0.6
01	12	42	13	19	1
02	15	52	15	24	1.1
03	17	62	17	29	1.1
04	20	72	19	33	1.1
/22	22	—	—	—	—
05	25	80	21	36	1.5
/28	28	—	—	—	—
06	30	90	23	40	1.5
/32	32	—	—	—	—
07	35	100	25	43	1.5
08	40	110	27	46	2
09	45	120	29	50	2
10	50	130	31	53	2.1
11	55	140	33	57	2.1
12	60	150	35	60	2.1
13	65	160	37	64	2.1
14	70	180	42	74	3
15	75	190	45	77	3
16	80	200	48	80	3
17	85	210	52	86	4
18	90	225	54	90	4
19	95	240	55	95	4
20	100	250	58	98	4
21	105	260	60	100	4
22	110	280	65	108	4
24	120	310	72	118	5
26	130	340	78	128	5
28	140	360	82	132	5
30	150	380	85	138	5
32	160	400	88	142	5
34	170	420	92	145	5
36	180	440	95	150	6
38	190	460	98	155	6
40	200	480	102	160	6
44	220	540	115	180	6
48	240	580	122	190	6
52	260	620	132	206	7.5
56	280	670	140	224	7.5
60	300	710	150	236	7.5
64	320	750	155	250	9.5
68	340	800	165	265	9.5
72	360	850	180	280	9.5
76	380	900	190	300	9.5
80	400	950	200	315	12
84	420	980	206	325	12
88	440	1030	212	335	12
92	460	1060	218	345	12
96	480	1120	230	365	15
/500	500	1150	236	375	15
/530	530	1220	250	400	15
/560	560	1280	258	412	15
/600	600	1360	272	438	15
/630	630	1420	280	450	15
/670	670	1500	290	475	15
/710	710	—	—	—	—
/750	750	—	—	—	—
/800	800	—	—	—	—
/850	850	—	—	—	—
/900	900	—	—	—	—
/950	950	—	—	—	—
/1000	1000	—	—	—	—
/1060	1060	—	—	—	—
/1120	1120	—	—	—	—
/1180	1180	—	—	—	—
/1250	1250	—	—	—	—
/1320	1320	—	—	—	—
/1400	1400	—	—	—	—
/1500	1500	—	—	—	—

Remarks The chamfer dimensions listed in this table do not necessarily apply to the following chamfers: (a) Chamfers of the grooves in outer rings that have snap ring grooves.
(b) For thin section cylindrical roller bearings, the chamfers on side without rib and bearing bore (in case of an inner ring) or outer surface (in case of an outer ring).
(c) For angular contact ball bearings, the chamfers between the front face and bore (in case of an inner ring) or outer surface (in case of an outer ring).
(d) Chamfers on inner rings of bearings with tapered bores.

BOUNDARY DIMENSIONS AND IDENTIFYING NUMBERS FOR BEARINGS

Table 6. 2 Boundary Dimensions of Tapered Roller Bearings

Units: mm

Bore Number	d	329 (Diameter Series 9) D	329 Dimension Series 29 I B	I C	I T	II B	II C	II T	Chamfer Dimension r (min.) Cone	Cup	320 X / 330 (Diameter Series 0) D	320 X Dimension Series 20 B	C	T	330 Dimension Series 30 B	C	T	Chamfer Dimension r (min.) Cone	Cup	331 (Diameter Series 1) D	331 Dimension Series 31 B	C	T	Chamfer Dimension r (min.) Cone	Cup
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	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Bore Number	d	302 / 322 / 332 (Diameter Series 2) D	302 Dimension Series 02 B	C	T	322 Dimension Series 22 B	C	T	332 Dimension Series 32 B	C	T	Chamfer Dimension r (min.) Cone	Cup	303 or 303D / 313 / 323 (Diameter Series 3) D	303 or 303D Dimension Series 03 B	C	C (1)	T	313 Dimension Series 13 B	C	T	323 Dimension Series 23 B	C	T	Chamfer Dimension r (min.) Cone	Cup
00	10	30	9	—	9.7	14	—	14.7	—	—	—	0.6	0.6	35	11	—	—	11.9	—	—	—	17	—	17.9	0.6	0.6
01	12	32	10	9	10.75	14	—	14.75	—	—	—	0.6	0.6	37	12	—	—	12.9	—	—	—	17	—	17.9	1	1
02	15	35	11	10	11.75	14	—	14.75	—	—	—	0.6	0.6	42	13	11	—	14.25	—	—	—	17	14	18.25	1	1
03	17	40	12	11	13.25	16	14	17.25	—	—	—	1	1	47	14	12	—	15.25	—	—	—	19	16	20.25	1	1
04	20	47	14	12	15.25	18	15	19.25	—	—	—	1	1	52	15	13	—	16.25	—	—	—	21	18	22.25	1.5	1.5
/22	22	50	14	12	15.25	18	15	19.25	—	—	—	1	1	56	16	14	—	17.25	—	—	—	21	18	22.25	1.5	1.5
05	25	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
/28	28	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
06	30	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
/32	32	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
07	35	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
08	40	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
09	45	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
10	50	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
11	55	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
12	60	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
13	65	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
14	70	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
15	75	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
16	80	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
17	85	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
18	90	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
19	95	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
20	100	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
21	105	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
22	110	200	38	32	41	53	46	56	—	—	—	3	2.5	240	50	42	—	54.5	57	38	63	80	65	84.5	4	3
24	120	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
26	130	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
28	140	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
30	150	270	45	38	49	73	60	77	—	—	—	4	3	320	65	55	—	72	75	50	82	108	90	114	5	4
32	160	290	48	40	52	80	67	84	—	—	—	4	3	340	68	58	—	75	79	—	87	114	95	121	5	4
34	170	310	52	43	57	86	71	91	—	—	—	5	4	360	72	62	—	80	84	—	92	120	100	127	5	4
36	180	320	52	43	57	86	71	91	—	—	—	5	4	380	75	64	—	83	88	—	97	126	106	134	5	4
38	190	340	55	46	60	92	75	97	—	—	—	5	4	400	78	65	—	86	92	—	101	132	109	140	6	5
40	200	360	58	48	64	98	82	104	—	—	—	5	4	420	80	67	—	89	97	—	107	138	115	146	6	5
44	220	400	65	54	72	108	90	114	—	—	—	5	4	460	88	73	—	97	106	—	117	145	122	154	6	5
48	240	440	72	60	79	120	100	127	—	—	—	5	4	500	95	80	—	105	114	—	125	155	132	165	6	5
52	260	480	80	67	89	130	106	137	—	—	—	6	5	540	102	85	—	113	123	—	135	165	136	176	6	6
56	280	500	80	67	89	130	106	137	—	—	—	6	5	580	108	90	—	119	132	—	145	175	145	187	6	6
60	300	540	85	71	96	140	115	149	—	—	—	6	5	—	—	—	—	—	—	—	—	—	—	—	—	—
64	320	580	92	75	104	150	125	159	—	—	—	6	5	—	—	—	—	—	—	—	—	—	—	—	—	—
68	340	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
72	360	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Remarks
1. Other series not conforming to this table are also specified by ISO.
2. In the Dimension Series of Diameter Series 9, Classification I is those specified by the old standard, Classification II is those specified by the ISO.
2. Dimension Series not classified 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.

Note (1) Regarding steep-slope bearing 303D, in DIN, the one corresponding to 303D of JIS is numbered 313. For bearings with bore diameters larger than 100 mm, those of dimension series 13 are numbered 313.

Table 6. 3 Boundary Dimensions of Thrust Bearings (Flat Seats) — 1 —

Units: mm

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

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

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).

Table 6. 3 Boundary Dimensions of Thrust Bearings (Flat Seats) — 2 —

Units: mm

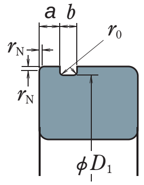
Thrust Ball Brgs.				511								512		522						
Spherical Thrust Roller Brgs.												292								
		Diameter Series 0					Diameter Series 1					Diameter Series 2								
			Dimension Series					Dimension Series					Dimension Series							
			70	90	10			71	91	11			72	92	12	22	22			
																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

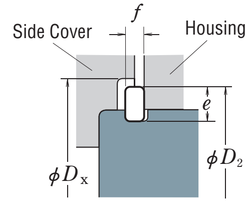
		513		523								514		524							Thrust Ball Brgs.	
	293									294											Spherical Thrust Roller Brgs.	
Diameter Series 3									Diameter Series 4									Diameter Series 5				
	Dimension Series									Dimension Series									Dimension Series			
	73	93	13	23	23					74	94	14	24	24					95			
					Central Washer									Central Washer								
D	T	T	T	T	d_2	B	r (min.)	r_1 (min.)	D	T	T	T	T	d_2	B	r (min.)	r_1 (min.)	D	T	r (min.)	d	Bore Number
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

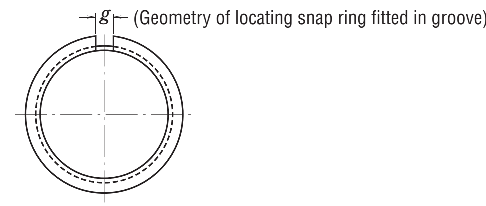
Remarks 1. Dimension Series 22, 23, and 24 are double direction bearings.
2. The maximum permissible outside diameter of shaft and central washers and minimum permissible bore diameter of housing washers are omitted here. (Refer to the bearings tables for Thrust Bearings).

BOUNDARY DIMENSIONS AND IDENTIFYING NUMBERS FOR BEARINGS

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







Units: mm

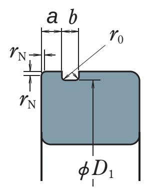
Applicable Bearings			Snap Ring Groove								
d Dimension Series		*D*	Snap Ring Groove Diameter D_1		Snap Ring Groove Position *a* Bearing Dimension Series				Snap Ring Groove Width *b*		Radius of Bottom Corners r_0
					18		19				
18	19		max.	min.	max.	min.	max.	min.	max.	min.	max.
—	10	**22**	20.8	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

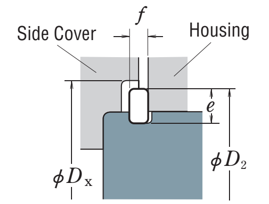
Remarks The minimum permissible chamfer dimensions r_N on the snap-ring-groove side of the outer rings are as follows:
Dimension series 18 : For outside diameters of 78mm and less, use 0.3mm chamfer.
For all others exceeding 78mm, use 0.5mm chamfer.
Dimension series 19 : For outside diameters of 24mm and less, use 0.2mm chamfer.
For 47mm and less, use 0.3mm chamfer.
For all others exceeding 47mm, use 0.5mm chamfer (However, for an outside diameter of 68 mm, use a 0.3 mm chamfer, which is not compliant with ISO 15).

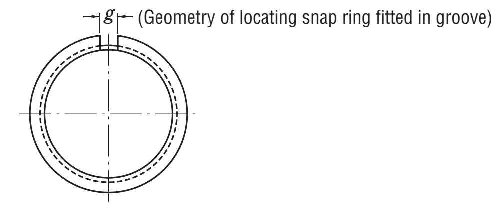
Locating Snap Ring							Side Cover
Locating Snap Ring Number	Cross Sectional Height *e*		Thickness *f*		Geometry of snap ring fitted in groove (Reference)		Stepped Bore Diameter (Reference) D_X
					Slit Width *g*	Snap Ring Outside Diameter D_2	
	max.	min.	max.	min.	approx.	max.	min.
NR 1022	2.0	1.85	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

BOUNDARY DIMENSIONS AND IDENTIFYING NUMBERS FOR BEARINGS

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







Units: mm

Applicable Bearings					Snap Ring Groove									Locating Snap Ring							Side Cover
d				D	Snap Ring Groove Diameter D_1		Snap Ring Groove Position a (Bearing Diameter Series)				Snap Ring Groove Width b		Radius of Bottom Corners r_0	Locating Snap Ring Number	Cross Sectional Height e		Thickness f		Geometry of snap ring fitted in groove (Reference): Slit Width g	Snap Ring Outside Diameter D_2	Stepped Bore Diameter (Reference) D_X
Diameter Series							0		2, 3, 4												
0	2	3	4		max.	min.	max.	min.	max.	min.	max.	min.	max.		max.	min.	max.	min.	approx.	max.	min.
10	—	—	—	**26**	24.5	24.25	1.35	1.19	—	—	1.17	0.87	0.2	**NR 26**(1)	2.06	1.91	0.84	0.74	3	28.7	29.4
12	—	—	—	**28**	26.5	26.25	1.35	1.19	—	—	1.17	0.87	0.2	**NR 28**(1)	2.06	1.91	0.84	0.74	3	30.7	31.4
—	10	9	8	**30**	28.17	27.91	—	—	2.06	1.9	1.65	1.35	0.4	**NR 30**	3.25	3.1	1.12	1.02	3	34.7	35.5
15	12	—	9	**32**	30.15	29.9	2.06	1.9	2.06	1.9	1.65	1.35	0.4	**NR 32**	3.25	3.1	1.12	1.02	3	36.7	37.5
17	15	10	—	**35**	33.17	32.92	2.06	1.9	2.06	1.9	1.65	1.35	0.4	**NR 35**	3.25	3.1	1.12	1.02	3	39.7	40.5
—	—	12	10	**37**	34.77	34.52	—	—	2.06	1.9	1.65	1.35	0.4	**NR 37**	3.25	3.1	1.12	1.02	3	41.3	42
—	17	—	—	**40**	38.1	37.85	—	—	2.06	1.9	1.65	1.35	0.4	**NR 40**	3.25	3.1	1.12	1.02	3	44.6	45.5
20	—	15	12	**42**	39.75	39.5	2.06	1.9	2.06	1.9	1.65	1.35	0.4	**NR 42**	3.25	3.1	1.12	1.02	3	46.3	47
22	—	—	—	**44**	41.75	41.5	2.06	1.9	—	—	1.65	1.35	0.4	**NR 44**	3.25	3.1	1.12	1.02	3	48.3	49
25	20	17	—	**47**	44.6	44.35	2.06	1.9	2.46	2.31	1.65	1.35	0.4	**NR 47**	4.04	3.89	1.12	1.02	4	52.7	53.5
—	22	—	—	**50**	47.6	47.35	—	—	2.46	2.31	1.65	1.35	0.4	**NR 50**	4.04	3.89	1.12	1.02	4	55.7	56.5
28	25	20	15	**52**	49.73	49.48	2.06	1.9	2.46	2.31	1.65	1.35	0.4	**NR 52**	4.04	3.89	1.12	1.02	4	57.9	58.5
30	—	—	—	**55**	52.6	52.35	2.08	1.88	—	—	1.65	1.35	0.4	**NR 55**	4.04	3.89	1.12	1.02	4	60.7	61.5
—	—	22	—	**56**	53.6	53.35	—	—	2.46	2.31	1.65	1.35	0.4	**NR 56**	4.04	3.89	1.12	1.02	4	61.7	62.5
32	28	—	—	**58**	55.6	55.35	2.08	1.88	2.46	2.31	1.65	1.35	0.4	**NR 58**	4.04	3.89	1.12	1.02	4	63.7	64.5
35	30	25	17	**62**	59.61	59.11	2.08	1.88	3.28	3.07	2.2	1.9	0.6	**NR 62**	4.04	3.89	1.7	1.6	4	67.7	68.5
—	32	—	—	**65**	62.6	62.1	—	—	3.28	3.07	2.2	1.9	0.6	**NR 65**	4.04	3.89	1.7	1.6	4	70.7	71.5
40	—	28	—	**68**	64.82	64.31	2.49	2.29	3.28	3.07	2.2	1.9	0.6	**NR 68**	4.85	4.7	1.7	1.6	5	74.6	76
—	35	30	20	**72**	68.81	68.3	—	—	3.28	3.07	2.2	1.9	0.6	**NR 72**	4.85	4.7	1.7	1.6	5	78.6	80
45	—	32	—	**75**	71.83	71.32	2.49	2.29	3.28	3.07	2.2	1.9	0.6	**NR 75**	4.85	4.7	1.7	1.6	5	81.6	83
50	40	35	25	**80**	76.81	76.3	2.49	2.29	3.28	3.07	2.2	1.9	0.6	**NR 80**	4.85	4.7	1.7	1.6	5	86.6	88
—	45	—	—	**85**	81.81	81.31	—	—	3.28	3.07	2.2	1.9	0.6	**NR 85**	4.85	4.7	1.7	1.6	5	91.6	93
55	50	40	30	**90**	86.79	86.28	2.87	2.67	3.28	3.07	3	2.7	0.6	**NR 90**	4.85	4.7	2.46	2.36	5	96.5	98
60	—	—	—	**95**	91.82	91.31	2.87	2.67	—	—	3	2.7	0.6	**NR 95**	4.85	4.7	2.46	2.36	5	101.6	103
65	55	45	35	**100**	96.8	96.29	2.87	2.67	3.28	3.07	3	2.7	0.6	**NR 100**	4.85	4.7	2.46	2.36	5	106.5	108
70	60	50	40	**110**	106.81	106.3	2.87	2.67	3.28	3.07	3	2.7	0.6	**NR 110**	4.85	4.7	2.46	2.36	5	116.6	118
75	—	—	—	**115**	111.81	111.3	2.87	2.67	—	—	3	2.7	0.6	**NR 115**	4.85	4.7	2.46	2.36	5	121.6	123
—	65	55	45	**120**	115.21	114.71	—	—	4.06	3.86	3.4	3.1	0.6	**NR 120**	7.21	7.06	2.82	2.72	7	129.7	131.5
80	70	—	—	**125**	120.22	119.71	2.87	2.67	4.06	3.86	3.4	3.1	0.6	**NR 125**	7.21	7.06	2.82	2.72	7	134.7	136.5
85	75	60	50	**130**	125.22	124.71	2.87	2.67	4.06	3.86	3.4	3.1	0.6	**NR 130**	7.21	7.06	2.82	2.72	7	139.7	141.5
90	80	65	55	**140**	135.23	134.72	3.71	3.45	4.9	4.65	3.4	3.1	0.6	**NR 140**	7.21	7.06	2.82	2.72	7	149.7	152
95	—	—	—	**145**	140.23	139.73	3.71	3.45	—	—	3.4	3.1	0.6	**NR 145**	7.21	7.06	2.82	2.72	7	154.7	157
100	85	70	60	**150**	145.24	144.73	3.71	3.45	4.9	4.65	3.4	3.1	0.6	**NR 150**	7.21	7.06	2.82	2.72	7	159.7	162
105	90	75	65	**160**	155.22	154.71	3.71	3.45	4.9	4.65	3.4	3.1	0.6	**NR 160**	7.21	7.06	2.82	2.72	7	169.7	172
110	95	80	—	**170**	163.65	163.14	3.71	3.45	5.69	5.44	3.8	3.5	0.6	**NR 170**	9.6	9.45	3.1	3	10	182.9	185
120	100	85	70	**180**	173.66	173.15	3.71	3.45	5.69	5.44	3.8	3.5	0.6	**NR 180**	9.6	9.45	3.1	3	10	192.9	195
—	105	90	75	**190**	183.64	183.13	—	—	5.69	5.44	3.8	3.5	0.6	**NR 190**	9.6	9.45	3.1	3	10	202.9	205
130	110	95	80	**200**	193.65	193.14	5.69	5.44	5.69	5.44	3.8	3.5	0.6	**NR 200**	9.6	9.45	3.1	3	10	212.9	215

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 0.5mm. However, for bearings of diameter series 0 having outside diameters 35mm and below, it is 0.3mm.

6.2 Formulation of Bearing Numbers

Bearing numbers are alphanumeric combinations that indicate the bearing type, boundary dimensions, dimensional and running accuracies, internal clearance, and other related specifications. They consist of basic numbers and supplementary symbols. 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 (Bearing Numbers for Rolling Bearings). Due to a need for more detailed classification, NSK uses auxiliary symbols other than those specified by JIS.

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

(Example 1) 6 3 08 ZZ C3
- C3: Radial Clearance **C3** (Internal Clearance Symbol)
- ZZ: Shields on Both Sides (Shield Symbol)
- 08: Bearing Bore **40mm** (Bore Number)
- 3: Diameter Series **3** } Bearing Series Symbol
- 6: Single-Row Deep Groove Ball Bearing } Bearing Series Symbol

(Example 2) 7 2 20 A DB C3
- C3: Axial Clearance **C3**
- DB: Back-to-Back Arrangement
- A: Contact Angle **30º**
- 20: Bearing Bore **100mm**
- 2: Diameter Series **2**
- 7: Single-Row Angular Contact Ball Bearing

(Example 3) 1 2 06 K +H206X
- +H206X: Adapter with **25mm** Bore
- K: Tapered Bore (Taper **1:12**)
- 06: Bearing Bore **30mm**
- 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: Bearing Bore **90mm**
- 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: Bearing Bore **85mm**
- 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 Cup Raceway and Contact Angle Conform to ISO
- 07: Bearing Bore **35mm**
- 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: Bearing Bore **1000mm**
- 0: Diameter Series **0**
- 4: Width Series **4**
- 2: Spherical Roller Bearing

(Example 8) 5 1 2 15
- 15: Bearing Bore **75mm**
- 2: Diameter Series **2**
- 1: Height Series **1**
- 5: Thrust Ball Bearing

Table 6. 5 Bearing Series Symbols

Bearing Type	Bearing Series Symbols	Type Symbols	Dimension Symbols: Width Symbols	Dimension Symbols: Diameter Symbols
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 Symbols	Type Symbols	Dimension Symbols: Width Symbols or Height Symbols	Dimension Symbols: Diameter Symbols
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 Symbol 213 should logically be 203, but customarily it is numbered 213.
Remark Numbers in ( ) in the column of width symbols are usually omitted from the bearing number.

Table 6. 6 Formulation of Bearing Numbers

Basic Numbers (Symbols and Numbers Conform to JIS(5); Marked on Bearings)

Bearing Series Symbols (1)

Symbol	Meaning
68 69 60 :	Single-Row Deep Groove Ball Bearings
70 72 73 :	Single-Row Angular Contact Ball Bearings
12 13 22 :	Self-Aligning Ball Bearings
NU10 NJ 2 N 3 NN 30 :	Cylindrical Roller Bearings
NA48 NA49 NA69 :	Needle Roller Bearings
320 322 323 :	Tapered Roller Bearings (2)
230 222 223 :	Spherical Roller Bearings
511 512 513 :	Thrust Ball Bearing with Flat Seats
292 293 294 :	Thrust Spherical Roller Bearings
HR(4)	High Capacity Tapered Roller Bearings, and others

Bore Number

Symbol	Meaning
1	Bearing Bore 1mm
2	2
3	3
⋮	⋮
9	9
00	10
01	12
02	15
03	17
/22	22
/28	28
/32	32
04(3)	20
05	25
06	30
⋮	⋮
88	440
92	460
96	480
/500	500
/530	530
/560	560
⋮	⋮
/2 360	2 360
/2 500	2 500

Contact Angle Symbol

Symbol	Meaning
	(Angular Contact Ball Bearings)
A	Standard Contact Angle of 30°
A5	Standard Contact Angle of 25°
B	Standard Contact Angle of 40°
C	Standard Contact Angle of 15°
	(Tapered Roller Bearings)
Omitted	Contact Angle Less than 17°
C	Contact Angle about 20°
D	Contact Angle about 28°

Auxiliary Symbols

Internal Design Symbol (NSK Symbol; Marked on Bearings)

Symbol	Meaning
A	Internal Design Differs from Standard One
J	Smaller Diameter of Outer Ring Raceway, Contact Angle, and Outer Ring Width of Tapered Roller Bearings Conform to ISO 355
	(For High Capacity Bearings)
C CA CD EA	Spherical Roller Bearings
E	Cylindrical Roller Bearings
E	Spherical Thrust Roller Bearings
EA	Angular Contact Ball Bearings

Material Symbol (NSK Symbol; Marked on Bearings)

Symbol	Meaning
g	Case-Hardened Steel Used in Rings, Rolling Elements
h	Stainless Steel Used in Rings, Rolling Elements

Cage Symbol (NSK Symbol; Not Marked on Bearings)

Symbol	Meaning
M	Machined Brass Cage
W	Pressed Steel Cage
T	Synthetic Resin Cage
V	Without Cage

External Features — Seals, Shields Symbol (NSK Symbol)

Symbol	Meaning
Z ZS	Shield on One Side Only
ZZ ZZS	Shields on Both Sides
DU	Contact Rubber Seal on One Side Only
DDU	Contact Rubber Seals on Both Sides
V	Non-Contact Rubber Seal on One Side Only
VV	Non-Contact Rubber Seals on Both Sides

Symbol for Design of Rings (Partially the same as JIS(5); In Principle, Marked on Bearings)

Symbol	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 Symbol (Same as JIS(5); In Principle, Marked on Bearings)

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

Internal Clearance Symbol / Preload Symbol (NSK Symbol; Partially the same as JIS(5)/BAS(6); In Principle, Marked on Bearings)

Symbol	Meaning (radial clearance)
	For All Radial Brgs.
C1	Clearance Less than C2
C2	Clearance Less than CN
Omitted	CN Clearance
C3	Clearance Greater than CN
C4	Clearance Greater than C3
C5	Clearance Greater than C4
	For Non-Interchangeable Cylindrical Roller Brgs.
CC1	Clearance Less than CC2
CC2	Clearance Less than CC
CC	Normal Clearance
CC3	Clearance Greater than CC
CC4	Clearance Greater than CC3
CC5	Clearance Greater than CC4
	For Extra-Small and Miniature Ball Brgs.
MC1	Clearance Less than MC2
MC2	Clearance Less than MC3
MC3	Normal Clearance
MC4	Clearance Greater than MC3
MC5	Clearance Greater than MC4
MC6	Clearance Greater than MC5
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)
EL	Extra light Preload
L	Light Preload
M	Medium Preload
H	Heavy Preload

Tolerance Class Symbol (Same as JIS(5); In Principle, Marked on Bearings)

Symbol	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)
Omitted	Class 4
PN2	Class 2
PN3	Class 3
PN0	Class 0
PN00	Class 00

Special Specification Symbol (NSK Symbol, Partially the same as JIS(5); In Principle, Marked on Bearings)

Symbol	Meaning
	(Bearings treated for Dimensional Stabilization)
X26	Working Temperature Lower than 150 °C
X28	Working Temperature Lower than 200 °C
X29	Working Temperature Lower than 250 °C
	(Spherical Roller Bearings)
S11	Dimensional Stabilizing Treatment Working Temperature Lower than 200°C

Spacer or Sleeve Symbol (NSK Symbol, Partially the same as JIS(5); Not Marked on Bearings)

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

Grease Symbol (NSK Symbol, Partially the same as JIS(5); Not Marked on Bearings)

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

Notes (1) Bearing Series Symbols conform to Table 6.5.
(2) For basic numbers of tapered roller bearings in ISO's new series, refer to Page C182.
(3) For Bearing Bore Numbers 04 through 96, five times the bore number gives the bore size (mm) (except double-direction thrust ball bearings).
(4) HR is prefix to bearing series symbols and it is NSK's original prefix.

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

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 492/199/582 (Accuracies of Rolling Bearings). Tolerances are specified for the following items:

Regarding bearing accuracy classes, besides ISO normal accuracy, as the accuracy improves there are Class 6X (for tapered roller bearings), Class 6, Class 5, Class 4, and Class 2, with Class 2 being the highest in ISO. The applicable accuracy 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 inner ring face runout with bore
  - Permissible outer ring variation of outside surface generatrix inclination with face
  - Permissible raceway to back face thickness variation of thrust bearings

Table 7. 1 Bearing Types and Tolerance Classes

Bearing Types		Applicable Tolerance Classes					Applicable Tables	Reference Pages
Deep Groove Ball Bearings		Normal	Class 6	Class 5	Class 4	Class 2	Table 7.2	A128 to A131
Angular Contact Ball Bearings		Normal	Class 6	Class 5	Class 4	Class 2		
Self-Aligning Ball Bearings		Normal	Class 6 equivalent	Class 5 equivalent	—	—		
Cylindrical Roller Bearings		Normal	Class 6	Class 5	Class 4	Class 2		
Needle Roller Bearings (solid type)		Normal	Class 6	Class 5	Class 4	—		
Spherical Roller Bearings		Normal	Class 6	Class 5	—	—		
Tapered Roller Bearings	Metric Design	Normal Class 6X	—	Class 5	Class 4	—	Table 7.3	A132 to A135
	Inch Design	ANSI/ABMA CLASS 4	ANSI/ABMA CLASS 2	ANSI/ABMA CLASS 3	ANSI/ABMA CLASS 0	ANSI/ABMA CLASS 00	Table 7.4	A136 and A137
Magneto Bearings		Normal	Class 6	Class 5	—	—	Table 7.5	A138 and A139
Thrust Ball Bearings		Normal	Class 6	Class 5	Class 4	—	Table 7.6	A140 to A142
Tapered Roller Thrust Bearings		Normal	—	—	—	—	Table 7.7	A143 and A144
Thrust Spherical Roller Bearings		Normal	—	—	—	—	Table 7.8	A145
Equivalent standards (Reference) JIS(1)		Class 0	Class 6	Class 5	Class 4	Class 2	—	—
DIN(2)		P0	P6	P5	P4	P2	—	—
ANSI/ABMA(3)	Ball Bearings	ABEC 1	ABEC 3	ABEC 5 (CLASS 5P)	ABEC 7 (CLASS 7P)	ABEC 9 (CLASS 9P)	Table 7.2	A128 to A131
	Roller Bearings	RBEC 1	RBEC 3	RBEC 5	—	—	[Table 7.9]	(A146 and A147)
	Tapered Roller Bearings	CLASS 4	CLASS 2	CLASS 3	CLASS 0	CLASS 00	[Table 7.4]	(A136 and A137)

Notes (1) JIS : Japanese Industrial Standards (2) DIN : Deutsch Industrie Norm
(3) ANSI/ABMA : The American Bearing Manufacturers Association

Remark The permissible limit of chamfer dimensions shall conform to Table 7.10 (Pages A148 and A149), and the tolerances and permissible tapered bore diameters shall conform to Table 7.11 (Pages A150 and A151).

(Reference) Rough definitions of the items listed for Running Accuracy and their measuring methods are shown in Fig. 7.1, and they are described in detail in ISO 5593 (Rolling Bearings-Vocabulary) and 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 or housing or central washer is to be rotated.		E

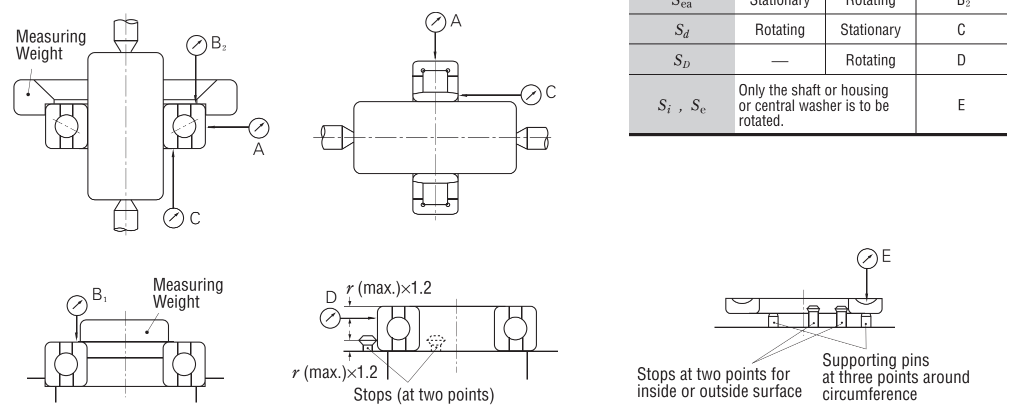


Fig. 7.1 Measuring Methods for Running Accuracy (summarized)

Symbols for Boundary Dimensions and Running Accuracy

d	Brg bore dia., nominal
Δ_{ds}	Deviation of a single bore dia.
Δ_{dmp}	Single plane mean bore dia. deviation
V_{dp}	Bore dia. Variation in a single radial plane
V_{dmp}	Mean bore dia. Variation
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 assembles brg inner ring
S_d	inner ring reference face (backface, where applicable) runout with bore
S_{ia}	Assembled brg inner ring face (back face) runout with raceway
S_i, S_e	Raceway to backface thickness variation of thrust brg
T	Brg width, nominal
Δ_{Ts}	Deviation of the actual brg width
D	Brg outside dia., nominal
Δ_{Ds}	Deviation of a single outside dia.
Δ_{Dmp}	Single plane mean outside dia. Deviation
V_{Dp}	Outside dia. Variation in a single radial plane
V_{Dmp}	Mean outside dia. Variation
C	Outer ring width, nominal
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	Variation of brg outside surface generatrix inclination with outer ring reference face (backface)
S_{ea}	Assembled brg outer ring face (backface) runout with raceway

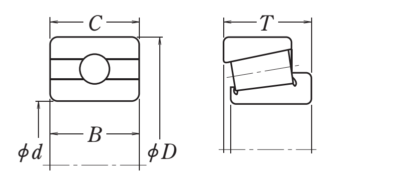


Table 7. 2 Tolerances for Radial Bearings (excluding Tapered Roller Bearings)

Table 7. 2. 1 Tolerances for Inner Rings and Widths of Outer Rings

Nominal Bore Diameter d (mm)		Δ_{dmp} [2]										Δ_{ds} [2]			
		Normal		Class 6		Class 5		Class 4		Class 2		Class 4 Diameter Series 0, 1, 2, 3, 4		Class 2	
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	−	−	−	−	−	−	−	−	−	−	−	−

Nominal Bore Diameter d (mm)		V_{dp} [2]												V_{dmp} [2]				
		Normal			Class 6			Class 5		Class 4		Class 2		Normal	Class 6	Class 5	Class 4	Class 2
		Diameter Series			Diameter Series			Diameter Series		Diameter Series		Diameter Series						
over	incl.	9	0, 1	2, 3, 4	9	0, 1	2, 3, 4	9	0,1,2,3,4	9	0,1,2,3,4	0,1,2,3,4						
		max.			max.			max.		max.		max.		max.	max.	max.	max.	max.
0.6[1]	2.5	10	8	6	9	7	5	5	4	4	3	2.5		6	5	3	2	1.5
2.5	10	10	8	6	9	7	5	5	4	4	3	2.5		6	5	3	2	1.5
10	18	10	8	6	9	7	5	5	4	4	3	2.5		6	5	3	2	1.5
18	30	13	10	8	10	8	6	6	5	5	4	2.5		8	6	3	2.5	1.5
30	50	15	12	9	13	10	8	8	6	6	5	2.5		9	8	4	3	1.5
50	80	19	19	11	15	15	9	9	7	7	5	4		11	9	5	3.5	2
80	120	25	25	15	19	19	11	10	8	8	6	5		15	11	5	4	2.5
120	150	31	31	19	23	23	14	13	10	10	8	7		19	14	7	5	3.5
150	180	31	31	19	23	23	14	13	10	10	8	7		19	14	7	5	3.5
180	250	38	38	23	28	28	17	15	12	12	9	8		23	17	8	6	4
250	315	44	44	26	31	31	19	18	14	−	−	−		26	19	9	−	−
315	400	50	50	30	38	38	23	23	18	−	−	−		30	23	12	−	−
400	500	56	56	34	44	44	26	−	−	−	−	−		34	26	−	−	−
500	630	63	63	38	50	50	30	−	−	−	−	−		38	30	−	−	−
630	800	−	−	−	−	−	−	−	−	−	−	−		−	−	−	−	−
800	1 000	−	−	−	−	−	−	−	−	−	−	−		−	−	−	−	−
1 000	1 250	−	−	−	−	−	−	−	−	−	−	−		−	−	−	−	−
1 250	1 600	−	−	−	−	−	−	−	−	−	−	−		−	−	−	−	−
1 600	2 000	−	−	−	−	−	−	−	−	−	−	−		−	−	−	−	−

Units : μm

Nominal Bore Diameter d (mm)		Δ_{Bs} (or Δ_{Cs})[3]												V_{Bs} (or V_{Cs})				
		Single Bearing						Combined Bearings [4]						Inner Ring (or Outer Ring) [3]		Inner Ring		
		Normal Class 6		Class 5 Class 4		Class 2		Normal Class 6		Class 5 Class 4		Class 2		Normal	Class 6	Class 5	Class 4	Class 2
over	incl.	high	low	high	low	high	low	high	low	high	low	high	low	max.	max.	max.	max.	max.
0.6[1]	2.5	0	−40	0	−40	0	−40	−	−	0	−250	0	−250	12	12	5	2.5	1.5
2.5	10	0	−120	0	−40	0	−40	0	−250	0	−250	0	−250	15	15	5	2.5	1.5
10	18	0	−120	0	−80	0	−80	0	−250	0	−250	0	−250	20	20	5	2.5	1.5
18	30	0	−120	0	−120	0	−120	0	−250	0	−250	0	−250	20	20	5	2.5	1.5
30	50	0	−120	0	−120	0	−120	0	−250	0	−250	0	−250	20	20	5	3	1.5
50	80	0	−150	0	−150	0	−150	0	−380	0	−250	0	−250	25	25	6	4	1.5
80	120	0	−200	0	−200	0	−200	0	−380	0	−380	0	−380	25	25	7	4	2.5
120	150	0	−250	0	−250	0	−250	0	−500	0	−380	0	−380	30	30	8	5	2.5
150	180	0	−250	0	−250	0	−250	0	−500	0	−380	0	−380	30	30	8	5	4
180	250	0	−300	0	−300	0	−300	0	−500	0	−500	0	−500	30	30	10	6	5
250	315	0	−350	0	−350	−	−	0	−500	0	−500	−	−	35	35	13	−	−
315	400	0	−400	0	−400	−	−	0	−630	0	−630	−	−	40	40	15	−	−
400	500	0	−450	−	−	−	−	−	−	−	−	−	−	50	45	−	−	−
500	630	0	−500	−	−	−	−	−	−	−	−	−	−	60	50	−	−	−
630	800	0	−750	−	−	−	−	−	−	−	−	−	−	70	−	−	−	−
800	1 000	0	−1 000	−	−	−	−	−	−	−	−	−	−	80	−	−	−	−
1 000	1 250	0	−1 250	−	−	−	−	−	−	−	−	−	−	100	−	−	−	−
1 250	1 600	0	−1 600	−	−	−	−	−	−	−	−	−	−	120	−	−	−	−
1 600	2 000	0	−2 000	−	−	−	−	−	−	−	−	−	−	140	−	−	−	−

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

Notes (1) 0.6mm is included in the group.
(2) Applicable to bearings with cylindrical bores.
(3) Tolerance for width deviation and tolerance limits for the width variation of the outer ring should be the same bearing. Tolerances for the width variation of the outer ring of Class 5, 4, and 2 are shown in Table 7.2.2.
(4) Applicable to individual rings manufactured for combined bearings.
(5) Applicable to ball bearings such as deep groove ball bearings, angular contact ball bearings, etc.

Remarks 1. The cylindrical bore diameter "no-go side" tolerance limit (high) specified in this table does not necessarily apply within a distance of 1.2 times the chamfer dimension r (max.) from the ring face.
2. 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 (excluding Tapered Roller Bearings)

Table 7. 2. 2 Tolerances for Outer Rings

Nominal Outside Diameter D (mm)		ΔDmp										ΔDs			
		Normal		Class 6		Class 5		Class 4		Class 2		Class 4 (Diameter Series 0, 1, 2, 3, 4)		Class 2	
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	−15	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	−	−	−	−	−	−	−	−	−	−	−	−

Nominal Outside Diameter D (mm)		VDp (2)													VDmp (2)				
		Normal				Class 6				Class 5		Class 4		Class 2	Normal	Class 6	Class 5	Class 4	Class 2
		Open Type			Shielded Sealed	Open Type			Shielded Sealed	Open Type		Open Type		Open Type					
		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	0,1,2,3,4	9	0,1,2,3,4	0,1,2,3,4					
over	incl.	max.				max.				max.		max.		max.	max.	max.	max.	max.	max.
2.5(1)	6	10	8	6	10	9	7	5	9	5	4	4	3	2.5	6	5	3	2	1.5
6	18	10	8	6	10	9	7	5	9	5	4	4	3	2.5	6	5	3	2	1.5
18	30	12	9	7	12	10	8	6	10	6	5	5	4	4	7	6	3	2.5	2
30	50	14	11	8	16	11	9	7	13	7	5	6	5	4	8	7	4	3	2
50	80	16	13	10	20	14	11	8	16	9	7	7	5	4	10	8	5	3.5	2
80	120	19	19	11	26	16	16	10	20	10	8	8	6	5	11	10	5	4	2.5
120	150	23	23	14	30	19	19	11	25	11	8	9	7	5	14	11	6	5	2.5
150	180	31	31	19	38	23	23	14	30	13	10	10	8	7	19	14	7	5	3.5
180	250	38	38	23	−	25	25	15	−	15	11	11	8	8	23	15	8	6	4
250	315	44	44	26	−	31	31	19	−	18	14	13	10	8	26	19	9	7	4
315	400	50	50	30	−	35	35	21	−	20	15	15	11	10	30	21	10	8	5
400	500	56	56	34	−	41	41	25	−	23	17	−	−	−	34	25	12	−	−
500	630	63	63	38	−	48	48	29	−	28	21	−	−	−	38	29	14	−	−
630	800	94	94	55	−	56	56	34	−	35	26	−	−	−	55	34	18	−	−
800	1 000	125	125	75	−	75	75	45	−	−	−	−	−	−	75	45	−	−	−
1 000	1 250	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
1 250	1 600	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
1 600	2 000	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
2 000	2 500	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−

Units : μm

Kea					SD			Sea (3)			VCs (4)			Nominal Outside Diameter D (mm)	
Normal	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 (1)	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

Notes (1) 2.5mm is included in the 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) The tolerances for outer ring width variation of bearings of Classes Normal and 6 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 of 1.2 times the chamfer dimension r (max.) from the ring face.
2. 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. 3 Tolerances for Metric Design Tapered Roller Bearings

Table 7. 3. 1 Tolerances for Inner Ring Bore Diameter and Running Accuracy

Units : μm

Nominal Bore Diameter d (mm)		Δ_{dmp}						Δ_{ds}		V_{dp}				V_{dmp}				K_{ia}				S_d		S_{ia}
		Normal Class 6X		Class 6 Class 5		Class 4		Class 4		Normal Class 6X	Class 6	Class 5	Class 4	Normal Class 6X	Class 6	Class 5	Class 4	Normal Class 6X	Class 6	Class 5	Class 4	Class 5	Class 4	Class 4
over	incl.	high	low	high	low	high	low	high	low	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.
10	18	0	− 8	0	− 7	0	− 5	0	− 5	8	7	5	4	6	5	5	4	15	7	3.5	2.5	7	3	3
18	30	0	−10	0	− 8	0	− 6	0	− 6	10	8	6	5	8	6	5	4	18	8	4	3	8	4	4
30	50	0	−12	0	−10	0	− 8	0	− 8	12	10	8	6	9	8	5	5	20	10	5	4	8	4	4
50	80	0	−15	0	−12	0	− 9	0	− 9	15	12	9	7	11	9	6	5	25	10	5	4	8	5	4
80	120	0	−20	0	−15	0	−10	0	−10	20	15	11	8	15	11	8	5	30	13	6	5	9	5	5
120	180	0	−25	0	−18	0	−13	0	−13	25	18	14	10	19	14	9	7	35	18	8	6	10	6	7
180	250	0	−30	0	−22	0	−15	0	−15	30	22	17	11	23	16	11	8	50	20	10	8	11	7	8
250	315	0	−35	0	−25	0	−18	0	−18	35	−	−	−	26	−	−	−	60	25	13	10	13	8	10
315	400	0	−40	0	−30	0	−23	0	−23	40	−	−	−	30	−	−	−	70	30	15	12	15	10	14
400	500	0	−45	0	−35	0	−27	0	−27	−	−	−	−	−	−	−	−	70	35	18	14	19	13	17
500	630	0	−50	0	−40	−	−	−	−	−	−	−	−	−	−	−	−	85	40	20	−	22	−	−
630	800	0	−75	0	−60	−	−	−	−	−	−	−	−	−	−	−	−	100	45	22	−	27	−	−

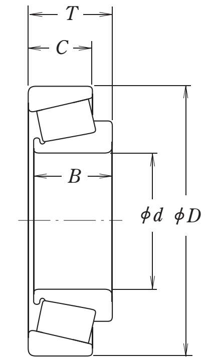
Remarks 1. The bore diameter "no-go side" tolerances (high) specified in this table do not necessarily apply within a distance of 1.2 times the chamfer dimension r (max.) from the ring face.
2. Some of these tolerances conform to the NSK Standard.

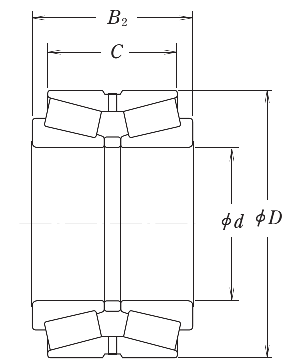
Table 7. 3. 2 Tolerances for Outer Ring Outside Diameter and Running Accuracy

Units : μm

Nominal Outside Diameter D (mm)		Δ_{Dmp}						Δ_{Ds}		V_{Dp}				V_{Dmp}				K_{ea}				S_D		S_{ea}
		Normal Class 6X		Class 6 Class 5		Class 4		Class 4		Normal Class 6X	Class 6	Class 5	Class 4	Normal Class 6X	Class 6	Class 5	Class 4	Normal Class 6X	Class 6	Class 5	Class 4	Class 5	Class 4	Class 4
over	incl.	high	low	high	low	high	low	high	low	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.
18	30	0	− 9	0	− 8	0	− 6	0	− 6	9	8	6	5	7	6	5	4	18	9	6	4	8	4	5
30	50	0	− 11	0	− 9	0	− 7	0	− 7	11	9	7	5	8	7	5	5	20	10	7	5	8	4	5
50	80	0	− 13	0	−11	0	− 9	0	− 9	13	11	8	7	10	8	6	5	25	13	8	5	8	4	5
80	120	0	− 15	0	−13	0	−10	0	−10	15	13	10	8	11	10	7	5	35	18	10	6	9	5	6
120	150	0	− 18	0	−15	0	−11	0	−11	18	15	11	8	14	11	8	6	40	20	11	7	10	5	7
150	180	0	− 25	0	−18	0	−13	0	−13	25	18	14	10	19	14	9	7	45	23	13	8	10	5	8
180	250	0	− 30	0	−20	0	−15	0	−15	30	20	15	11	23	15	10	8	50	25	15	10	11	7	10
250	315	0	− 35	0	−25	0	−18	0	−18	35	25	19	14	26	19	13	9	60	30	18	11	13	8	10
315	400	0	− 40	0	−28	0	−20	0	−20	40	28	22	15	30	21	14	10	70	35	20	13	13	10	13
400	500	0	− 45	0	−33	0	−23	0	−23	45	−	−	−	34	−	−	−	80	40	23	15	15	11	15
500	630	0	− 50	0	−38	0	−28	0	−28	50	−	−	−	38	−	−	−	100	50	25	18	18	13	18
630	800	0	− 75	0	−45	−	−	−	−	−	−	−	−	−	−	−	−	120	60	30	−	20	−	−
800	1 000	0	−100	0	−60	−	−	−	−	−	−	−	−	−	−	−	−	120	75	35	−	23	−	−

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





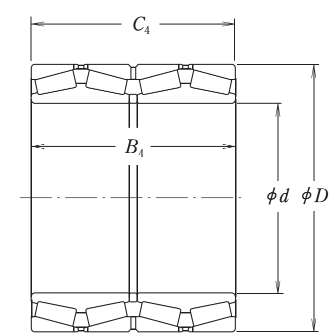


Table 7. 3 Tolerances for Metric Design Tapered Roller Bearings

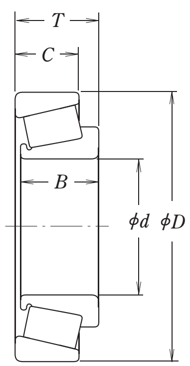
Table 7. 3. 3 Tolerances for Width, Overall Bearing Width, and Combined Bearing Width

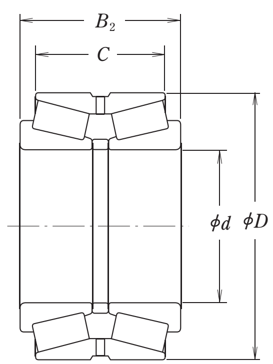
Units : μm

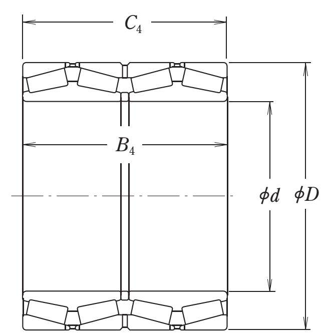
Nominal Bore Diameter d (mm)		Δ_{Bs}						Δ_{Cs}						Δ_{Ts}					
		Normal Class 6		Class 6X		Class 5 Class 4		Normal Class 6		Class 6X		Class 5 Class 4		Normal Class 6		Class 6X		Class 5 Class 4	
over	incl.	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low
10	18	0	−120	0	−50	0	−200	0	−120	0	−100	0	−200	+200	0	+100	0	+200	−200
18	30	0	−120	0	−50	0	−200	0	−120	0	−100	0	−200	+200	0	+100	0	+200	−200
30	50	0	−120	0	−50	0	−240	0	−120	0	−100	0	−240	+200	0	+100	0	+200	−200
50	80	0	−150	0	−50	0	−300	0	−150	0	−100	0	−300	+200	0	+100	0	+200	−200
80	120	0	−200	0	−50	0	−400	0	−200	0	−100	0	−400	+200	−200	+100	0	+200	−200
120	180	0	−250	0	−50	0	−500	0	−250	0	−100	0	−500	+350	−250	+150	0	+350	−250
180	250	0	−300	0	−50	0	−600	0	−300	0	−100	0	−600	+350	−250	+150	0	+350	−250
250	315	0	−350	0	−50	0	−700	0	−350	0	−100	0	−700	+350	−250	+200	0	+350	−250
315	400	0	−400	0	−50	0	−800	0	−400	0	−100	0	−800	+400	−400	+200	0	+400	−400
400	500	0	−450	−	−	0	−800	0	−450	−	−	0	−800	+400	−400	−	−	+400	−400
500	630	0	−500	−	−	0	−800	0	−500	−	−	0	−800	+500	−500	−	−	+500	−500
630	800	0	−750	−	−	0	−800	0	−750	−	−	0	−800	+600	−600	−	−	+600	−600

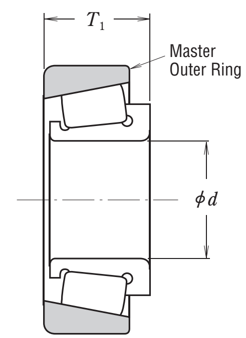
Ring Width with Rollers Δ_{T1s}				Outer Ring Effective Width Deviation Δ_{T2s}				Overall Combined Bearing Width Deviation Δ_{B2s}		Δ_{B4s}, Δ_{C4s}		Nominal Bore Diameter d (mm)	
Normal		Class 6X		Normal		Class 6X		All classes of double-row bearings		All classes of four-row bearings			
high	low	high	low	high	low	high	low	high	low	high	low	over	incl.
+100	0	+50	0	+100	0	+50	0	+200	−200	−	−	10	18
+100	0	+50	0	+100	0	+50	0	+200	−200	−	−	18	30
+100	0	+50	0	+100	0	+50	0	+200	−200	−	−	30	50
+100	0	+50	0	+100	0	+50	0	+300	−300	+300	−300	50	80
+100	−100	+50	0	+100	−100	+50	0	+300	−300	+400	−400	80	120
+150	−150	+50	0	+200	−100	+100	0	+400	−400	+500	−500	120	180
+150	−150	+50	0	+200	−100	+100	0	+450	−450	+600	−600	180	250
+150	−150	+100	0	+200	−100	+100	0	+550	−550	+700	−700	250	315
+200	−200	+100	0	+200	−200	+100	0	+600	−600	+800	−800	315	400
−	−	−	−	−	−	−	−	+700	−700	+900	−900	400	500
−	−	−	−	−	−	−	−	+800	−800	+1 000	−1 000	500	630
−	−	−	−	−	−	−	−	+1 200	−1 200	+1 500	−1 500	630	800

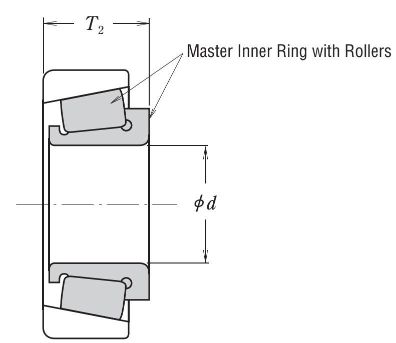
Remarks The effective width of an inner ring with rollers T_1 is defined as the overall bearing width of an inner ring with rollers combined with a master outer ring.
The effective width of an outer ring T_2 is defined as the overall bearing width of an outer ring combined with a master inner ring with rollers.











BEARING TOLERANCES

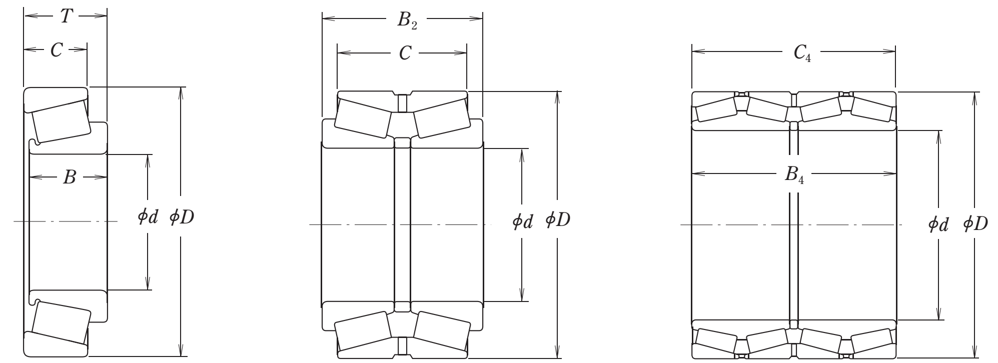
Table 7. 4 Tolerances for Inch Design Tapered Roller Bearings

(Refer to page A126 Table 7. 1 for the tolerance class "CLASS ∗∗" that is the tolerance classes of ANSI/ABMA.)

Table 7. 4. 1 Tolerances for Inner Ring Bore Diameter

Units : μm

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	–	–



KBE KV

Table 7. 4. 2 Tolerances for Outer Ring Outside Diameter and Radial Runout of Inner and Outer Rings

Units : μm

Nominal Outside Diameter D				Δ_{Ds}						K_{ia}, K_{ea}				
over		incl.		CLASS 4, 2		CLASS 3, 0		CLASS 00		CLASS 4	CLASS 2	CLASS 3	CLASS 0	CLASS 00
(mm)	1/25.4	(mm)	1/25.4	high	low	high	low	high	low	max.	max.	max.	max.	max.
–	–	**266.700**	10.5000	+ 25	0	+13	0	+8	0	51	38	8	4	2
266.700	10.5000	**304.800**	12.0000	+ 25	0	+13	0	+8	0	51	38	8	4	2
304.800	12.0000	**609.600**	24.0000	+ 51	0	+25	0	–	–	51	38	18	–	–
609.600	24.0000	**914.400**	36.0000	+ 76	0	+38	0	–	–	76	51	51	–	–
914.400	36.0000	**1 219.200**	48.0000	+102	0	+51	0	–	–	76	–	76	–	–
1 219.200	48.0000	**–**	–	+127	0	+76	0	–	–	76	–	76	–	–

Table 7. 4. 3 Tolerances for Overall Width and Combined Width

Units : μm

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	–	–

Nominal Bore Diameter d				Double-Row Bearings (KBE Type) Δ_{B2s}										Four-Row Bearings (KV Type) Δ_{B4s}, Δ_{C4s}	
over		incl.		CLASS 4		CLASS 2		CLASS 3				CLASS 0,00		CLASS 4, 3	
								$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	high	low
–	–	**101.600**	4.0000	+406	0	+406	0	+406	−406	+406	−406	+406	−406	+1 524	−1 524
101.600	4.0000	**304.800**	12.0000	+711	−508	+406	−203	+406	−406	+406	−406	+406	−406	+1 524	−1 524
304.800	12.0000	**609.600**	24.0000	+762	−762	+762	−762	+406	−406	+762	−762	–	–	+1 524	−1 524
609.600	24.0000	**–**	–	+762	−762	–	–	+762	−762	+762	−762	–	–	+1 524	−1 524

Table 7. 5 Tolerances for Magneto Bearings

Table 7. 5. 1 Tolerances for Inner Rings and Width of Outer Rings

Units : μm

Nominal Bore Diameter d (mm)		Δ_{dmp}						V_{dp}			V_{dmp}			Δ_{Bs} (or Δ_{Cs}) (1)				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	Normal Class 6		Class 5		Normal Class 6	Class 5	Normal Class 6 Class 5		Normal	Class 6	Class 5	Class 5	Class 5
over	incl.	high	low	high	low	high	low	max.	max.	max.	max.	max.	max.	high	low	high	low	max.	max.	high	low	max.	max.	max.	max.	max.
2.5	**10**	0	− 8	0	−7	0	−5	6	5	4	6	5	3	0	−120	0	− 40	15	5	+120	−120	10	6	4	7	7
10	**18**	0	− 8	0	−7	0	−5	6	5	4	6	5	3	0	−120	0	− 80	20	5	+120	−120	10	7	4	7	7
18	**30**	0	−10	0	−8	0	−6	8	6	5	8	6	3	0	−120	0	−120	20	5	+120	−120	13	8	4	8	8

Note (1) The 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 of 1.2 times the chamfer dimension r (max.) from the ring face.

Table 7. 5. 2 Tolerances for Outer Rings

Units : μm

Nominal Outside Diameter D (mm)		Δ_{Dmp} Bearing Series E						Δ_{Dmp} Bearing Series EN						V_{Dp}			V_{Dmp}			K_{ea}			S_{ea}	S_D
		Normal		Class 6		Class 5		Normal		Class 6		Class 5		Normal	Class 6	Class 5	Normal	Class 6	Class 5	Normal	Class 6	Class 5	Class 5	Class 5
over	incl.	high	low	high	low	high	low	high	low	high	low	high	low	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.
6	**18**	+ 8	0	+7	0	+5	0	0	− 8	0	−7	0	−5	6	5	4	6	5	3	15	8	5	8	8
18	**30**	+ 9	0	+8	0	+6	0	0	− 9	0	−8	0	−6	7	6	5	7	6	3	15	9	6	8	8
30	**50**	+11	0	+9	0	+7	0	0	−11	0	−9	0	−7	8	7	5	8	7	4	20	10	7	8	8

Remark The outside diameter "no-go side" tolerances (low) do not necessarily apply within a distance of 1.2 times the chamfer dimension r (max.) from the ring face.

Table 7. 6 Tolerances for Thrust Ball Bearings

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

Units : μm

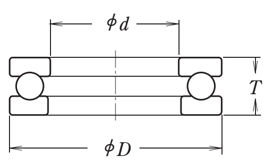
Nominal Bore Diameter d or d_2 (mm)		Δ_{dmp} or Δ_{d2mp}				V_{dp} or V_{d2p}		S_i or S_e (1)			
		Normal Class 6 Class 5		Class 4		Normal Class 6 Class 5	Class 4	Normal	Class 6	Class 5	Class 4
over	incl.	high	low	high	low	max.	max.	max.	max.	max.	max.
–	18	0	− 8	0	− 7	6	5	10	5	3	2
18	30	0	− 10	0	− 8	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	–

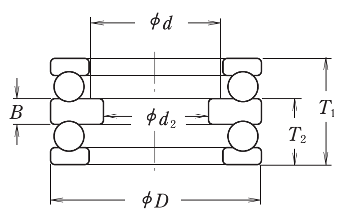
Note (1) For double-direction bearings, the thickness variation doesn't depend on the bore diameter d_2, but on d for single-direction bearings with the same D in the same diameter series.
The thickness variation of housing washers, S_e, applies only to flat-seat thrust bearings.

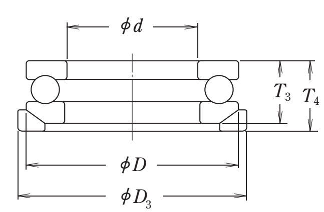
Table 7. 6. 2 Tolerances for Outside Diameter of Housing Washers and Aligning Seat Washers

Units : μm

Nominal Outside Diameter of Bearing or Aligning Seat Washer D or D_3 (mm)		Δ_{Dmp}						V_{Dp}		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	–	–	–	–	–	–	–	–







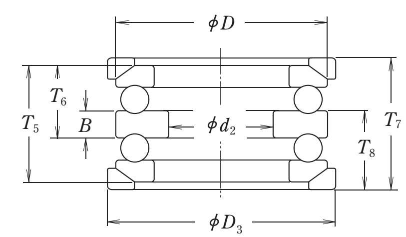


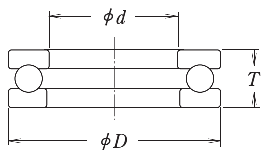
Table 7. 6. 3 Tolerances for Thrust Ball Bearing Height and Central Washer Height

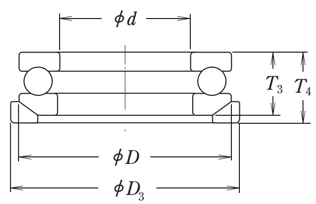
Units : μm

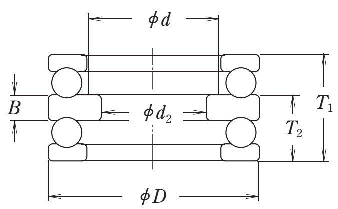
Nominal Bore Diameter d (¹) (mm)		Flat Seat Type				Aligning Seat Washer Type				With Aligning Seat Washer				Height Deviation of Central Washer Δ_{Bs}	
		Δ_{Ts} or Δ_{T2s}		Δ_{T1s}		Δ_{T3s} or Δ_{T6s}		Δ_{T5s}		Δ_{T4s} or Δ_{T8s}		Δ_{T7s}			
		Normal, Class 6 Class 5, Class 4		Normal, Class 6 Class 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, its 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 figures below.







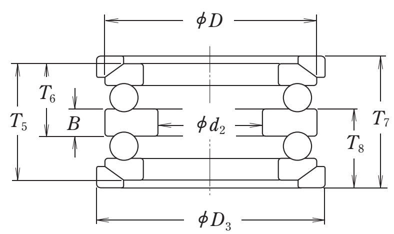


Table 7. 7 Tolerances for Tapered Roller Thrust Bearings

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

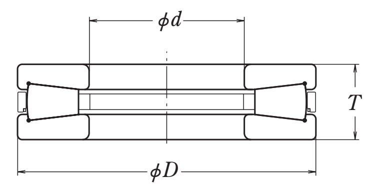
Units : μm

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, Class Normal)

Units : μm

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



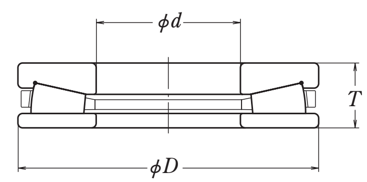


Table 7. 7 Tolerances for Tapered Roller Thrust Bearings

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

Units : μm

Nominal Bore Diameter d				Δ_{dmp}		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

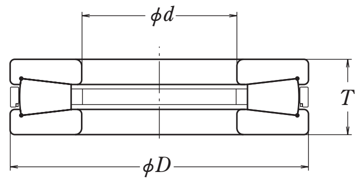


Table 7. 7. 4 Tolerances for Housing Washer Outside Diameters (Inch)

Units : μm

Nominal Outside Diameter D				Δ_{Dmp}	
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

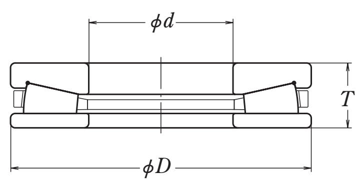


Table 7. 8 Tolerances for Thrust Spherical Roller Bearings

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

Units : μm

Nominal Bore Diameter d (mm)		Δ_{dmp}		V_{dp}	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 of 1.2 times the chamfer dimension r (max.) from the ring face.

Table 7. 8. 2 Tolerances for Housing Ring Diameter (Class Normal)

Units : μm

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 of 1.2 times the chamfer dimension r (max.) from the ring face.

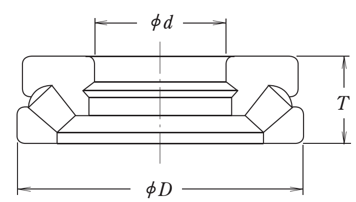


Table 7. 9 Tolerances of Instrument Ball Bearings (Inch design) CLASS 5P, CLASS 7P, and CLASS 9P (ANSI/ABMA Equivalent)

(1) Tolerances for Inner Rings and Width of Outer Rings

Units : μm

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

Nominal Bore Diameter d (mm)		Δ_{Bs} (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
over	incl.	high	low	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.
—	10	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
10	18	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
18	30	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

Note (1) Applicable to bearings for which the axial clearance (preload) is to be adjusted by combining two selected bearings.
Remark For the CLASS 3P and the tolerances of Metric design Instrument Ball Bearings, it is advisable to consult NSK.

(2) Tolerances for Outer Rings

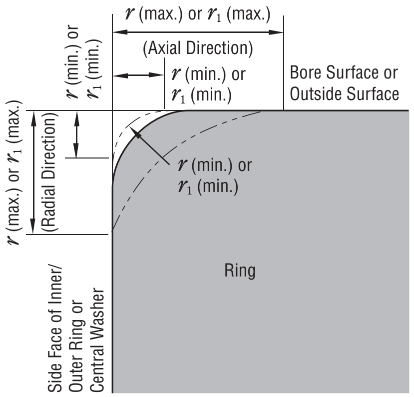
Units : μm

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

Nominal Outside Diameter D (mm)		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
over	incl.	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.	high	low	high	low	max.
—	18	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
18	30	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
30	50	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

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

BEARING TOLERANCES



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 shall not intersect an arc of radius r (min.) or r_1 (min.) touching 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 Design 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	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

Remark For bearings with nominal widths less than 2mm, 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	0.7	1.4	0.3
	40	–	0.9	1.6	
0.6	–	40	1.1	1.7	0.6
	40	–	1.3	2	
1	–	50	1.6	2.5	1
	50	–	1.9	3	
1.5	–	120	2.3	3	1.5
	120	250	2.8	3.5	
	250	–	3.5	4	
2	–	120	2.8	4	2
	120	250	3.5	4.5	
	250	–	4	5	
2.5	–	120	3.5	5	2
	120	250	4	5.5	
	250	–	4.5	6	
3	–	120	4	5.5	2.5
	120	250	4.5	6.5	
	250	400	5	7	
	400	–	5.5	7.5	
4	–	120	5	7	3
	120	250	5.5	7.5	
	250	400	6	8	
	400	–	6.5	8.5	
5	–	180	6.5	8	4
	180	–	7.5	9	
6	–	180	7.5	10	5
	180	–	9	11	

Note ([1]) Inner Rings are classified by d and Outer Rings by D.

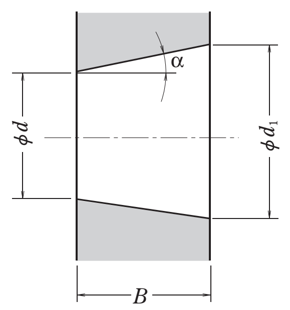
Table 7. 10. 3 Chamfer Dimension Limits for Thrust Bearings

Units : mm

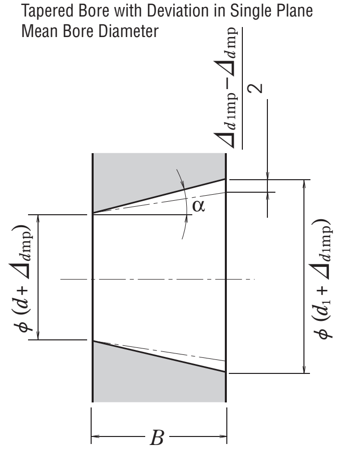
Permissible Chamfer Dimension for Shaft (or Central)/Housing Washers r (min.) or r_1 (min.)	Permissible Chamfer Dimension for Shaft (or Central)/Housing Washers r (max.) or r_1 (max.)	Reference Corner Radius of Shaft or Housing r_a
	Radial or Axial Direction	max.
0.05	0.1	0.05
0.08	0.16	0.08
0.1	0.2	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 (Class Normal)

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 : μm

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

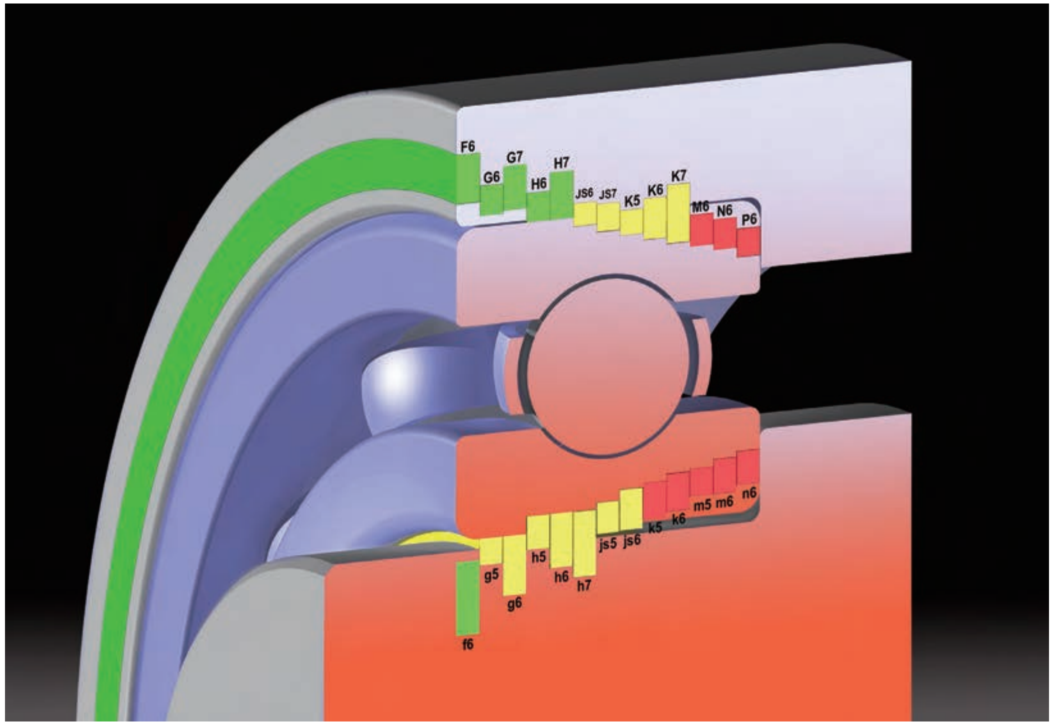
Notes (1) Applicable to all radial planes of tapered bores.
(2) Not applicable to diameter series 7 and 8.
Remark For a value exceeding 630 mm, please contact NSK.

7.2 Selection of Accuracy Classes

For general applications, Class Normal tolerances are adequate in nearly all cases for satisfactory performance, but for the following applications, bearings having an accuracy class of 5,4 or higher are more suitable.
For reference, in Table 7.12, examples of 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 Requirement, Operating Conditions	Examples of Applications	Tolerance Classes
High running accuracy is required	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 is required	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 are required	Gyroscope Gimbals	CLASS 7P, P4
	Servomechanisms	CLASS 7P, CLASS 5P
	Potentiometric Controllers	CLASS 7P



8. FITS AND INTERNAL CLEARANCES

8. FITS AND INTERNAL CLEARANCES

8.1 Fits

8.1.1 Importance of Proper Fits

In the case of a rolling bearing with the inner ring fitted to the shaft with only slight interference, a harmful circumferential slipping 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 that ring which 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, however, 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 this case, to prevent damage to the fitting surfaces due to creep, lubrication of other applicable methods should be considered.

8.1.2 Selection of Fit

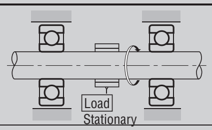
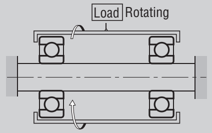
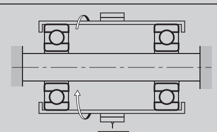
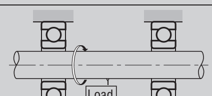
(1) Load Conditions and Fit
The proper fit may be selected from Table 8.1 based on the load and operating conditions.

(2) Magnitude of Load and Interference
The interference of the inner ring is slightly reduced by the bearing load; therefore, the loss of interference should be estimated using the following equations:

$$\Delta d_F = 0.08\sqrt{\frac{d}{B}F_r}\times 10^{-3} \;\ldots\ldots\; \text{(N)}$$
$$\Delta d_F = 0.25\sqrt{\frac{d}{B}F_r}\times 10^{-3} \;\ldots\; \{\text{kgf}\} \qquad \ldots \textbf{(8.1)}$$

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		Load Conditions	Fitting	
	Inner Ring	Outer Ring		Inner Ring	Outer Ring
	Rotating	Stationary	Rotating Inner Ring Load / Stationary Outer Ring Load	Tight Fit	Loose Fit
	Stationary	Rotating	Rotating Inner Ring Load / Stationary Outer Ring Load	Tight Fit	Loose Fit
	Stationary	Rotating	Rotating Outer Ring Load / Stationary Inner Ring Load	Loose Fit	Tight Fit
	Rotating	Stationary	Rotating Outer Ring Load / Stationary Inner Ring Load	Loose Fit	Tight Fit
Direction of load indeterminate 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, in the case of heavy loads where the radial load exceeds 20% of the basic static load rating C_{0r}, under the operating condition, interference often becomes shortage. Therefore, interference should be estimated using Equation (8.2):

$$\Delta d \geqq 0.02\frac{F_r}{B}\times 10^{-3} \;\ldots\ldots\ldots\; \text{(N)}$$
$$\Delta d \geqq 0.2\frac{F_r}{B}\times 10^{-3} \;\ldots\ldots\ldots\; \{\text{kgf}\} \qquad \ldots\ldots \textbf{(8.2)}$$

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).
For NU219, the interference given by Equation (8.1) for loads heavier than 0.25 C_{0r}, the interference 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, sufficient care should be taken to prevent excessive circumferential stress.

Calculation example
For NU219, B=32 (mm) and assume
F_r=98 100 N {10 000 kgf}
C_{0r}=183 000 N {18 600 kgf}

$$\frac{F_r}{C_{0r}} = \frac{98\,100}{183\,000} = 0.536 > 0.2$$

Therefore, the required effective interference is calculated using Equation (8.2).

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

This result agrees well with Fig. 8.1.

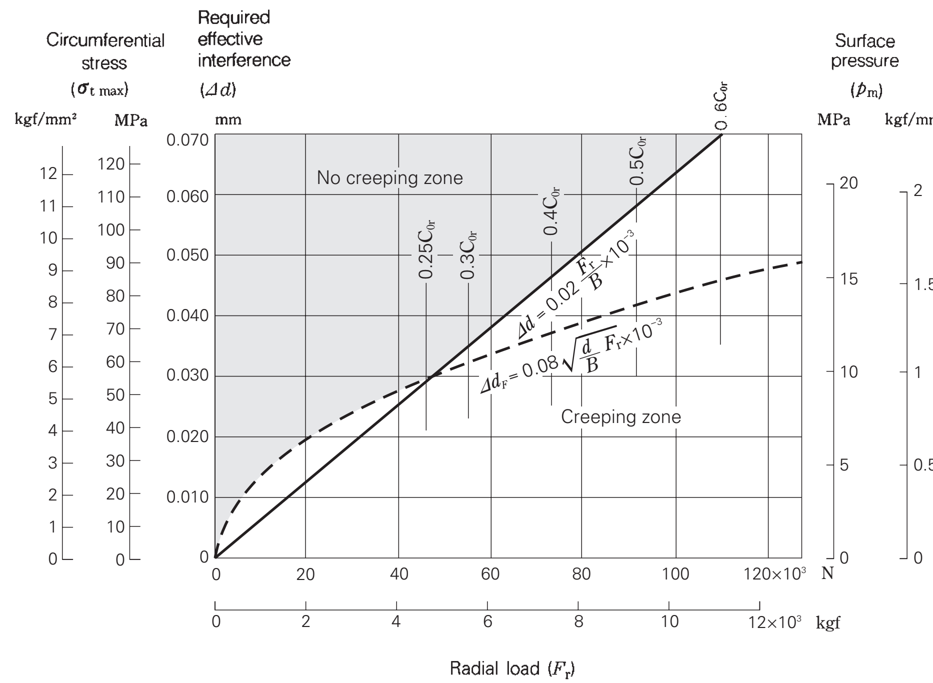


Fig. 8.1 Load and Required Effective Interference for Fit

(3) Interference Variation Caused by Temperature Difference 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 in case that 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):

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

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=12.5×10^{-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, the 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 $$\Delta d = \frac{d}{d+2} \Delta d_a \quad \text{............ } \mathbf{(8.4)}$$

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

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 guide, the maximum interference should be kept under approximately 7/10 000 of 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 $p_m = \frac{\Delta d}{d} \cfrac{1}{\left[\frac{m_s-1}{m_sE_s} - \frac{m_i-1}{m_iE_i}\right] + 2\left[\frac{k_0^2}{E_s(1-k_0^2)} + \frac{1}{E_i(1-k^2)}\right]}$ Solid shaft $p_m = \frac{\Delta d}{d} \cfrac{1}{\left[\frac{m_s-1}{m_sE_s} - \frac{m_i-1}{m_iE_i}\right] + \frac{2}{E_i(1-k^2)}}$	Housing outside diameter $p_m = \frac{\Delta D}{D} \cfrac{1}{\left[\frac{m_e-1}{m_eE_e} - \frac{m_h-1}{m_hE_h}\right] + 2\left[\frac{h^2}{E_e(1-h^2)} + \frac{1}{E_h(1-h_0^2)}\right]}$
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}	Circumferential stress at inner ring bore fitting surface is maximum. $\sigma_{t\,max} = p_m \frac{1+k^2}{1-k^2}$	Circumferential stress at outer ring bore surface is maximum. $\sigma_{t\,max} = p_m \frac{2}{1-h^2}$
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 for an inner ring, which is the rotating ring, an interference fit is chosen, and for a fixed outer ring, a loose fit is used. To select the fit, the magnitude of the load, the temperature differences among the bearing and shaft and housing, the material characteristics of the shaft and housing, the level of finish, the material thickness, and the bearing mounting/dismounting method must all be considered.

If the interference is insufficient for the operating conditions, ring loosening, creep, fretting, heat generation, etc. may occur. If the interference is excessive, the ring may crack. The magnitude of the interference is usually satisfactory if it is set for the size of the shaft or housing listed in the bearing manufacturer's catalog. To determine the surface pressure and stress on the fitting surfaces, calculations can be made assuming a thick-walled cylinder with uniform internal and external pressures. To do this, the necessary equations are summarized in Table 8.2. For convenience in the fitting of bearing inner rings on solid steel shafts, which are the most common, 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 $\sigma_{t\ max}$ variations with shaft diameter when interference results from the mean values of the tolerance grade shaft and bearing bore tolerances. 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 whether $\sigma_{t\ max}$ exceeds the tolerances. 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.

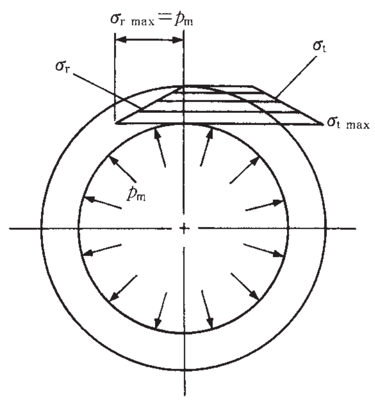


Fig. 8.2 Distribution of Circumferential Stress σ_t and Radial Stress σ_r

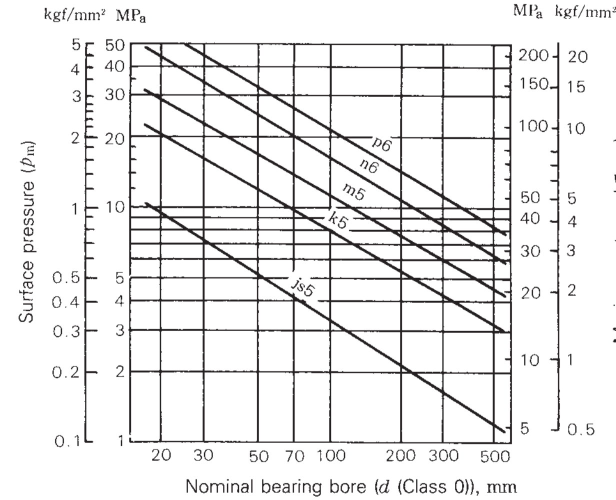


Fig. 8.3 Surface Pressure p_m and Maximum Stress $\sigma_{t\ max}$ for Mean Interference in Various Tolerance Grades

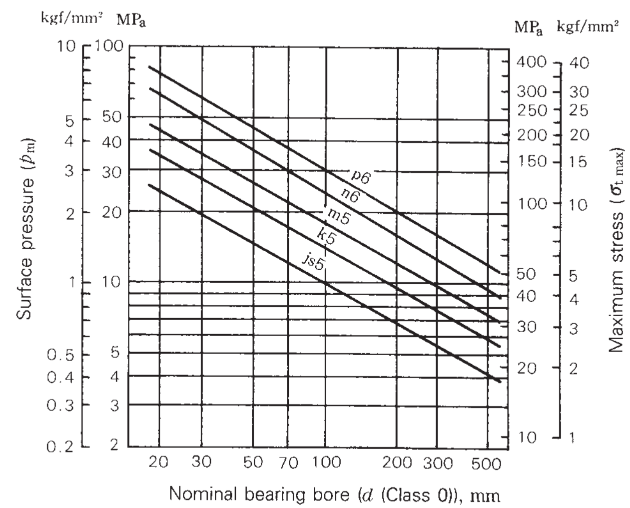


Fig. 8.4 Surface Pressure p_m and Maximum Stress $\sigma_{t\ max}$ for Maximum Interference in Various Tolerance Grades

(7) Mounting and Withdrawal Loads

The push-up load needed to mount bearings on shafts or in a housing hole with interference can be obtained using the thick-walled cylinder theory.

The mounting load (or withdrawal load) depends upon the contact area, surface pressure, and coefficient of friction between the fitting surfaces.

The mounting load (or withdrawal load) K needed to mount inner rings on shafts is given by Equation (8.6).

$$K=\mu\, p_m\, \pi\, d\, B \text{ (N), \{kgf\}} \qquad \textbf{(8.6)}$$

where
- μ: Coefficient of friction between fitting surfaces
  - μ=0.12 (for mounting)
  - 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 the 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) is:

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

Equation (8.7) is shown graphically in Fig. 8.5. The mounting and withdrawal loads for outer rings and housings have been calculated and the results are shown in Fig. 8.6.

The actual mounting and withdrawal loads can become much higher than the calculated values if the bearing ring and shaft (or housing) are slightly misaligned or the load is applied unevenly to the circumference of the bearing ring hole. Consequently, the loads obtained from Figs. 8.5 and 8.6 should be considered only as guides when designing withdrawal tools, their strength should be five to six times higher than that indicated by the figures.

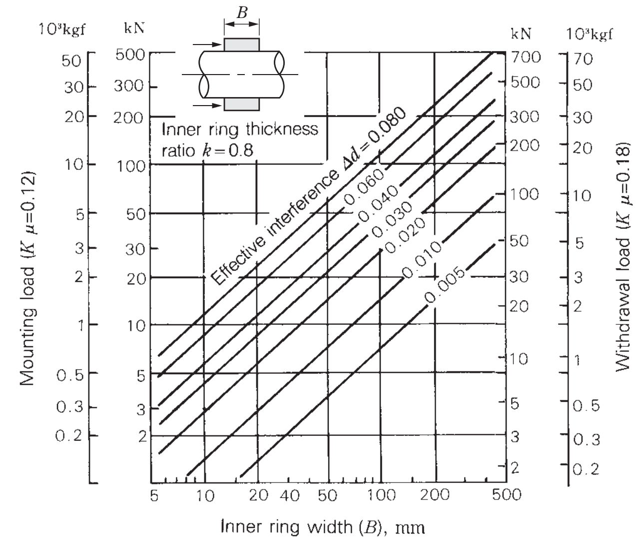


Fig. 8.5 Mounting and Withdrawal Loads for Inner Rings

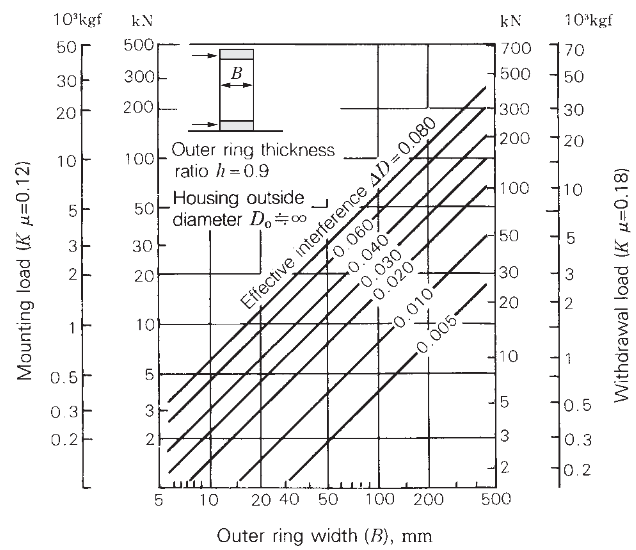


Fig. 8.6 Mounting and Withdrawal Loads for Outer Rings

8.1.3 Recommended Fits

As described previously, many factors, such as the characteristics and magnitude of bearing load, temperature differences, 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 Table 8.3 to 8.8. In the case of unusual operating conditions, it is advisable to consult NSK. For the accuracy and surface finish of shafts and housings, please refer to Section 13.1 (Page A270).

Table 8.3 Fits of Radial Bearings with Shafts

Load Conditions		Examples	Shaft Diameter (mm) Ball Brgs	Shaft Diameter (mm) Cylindrical Roller Brgs, Tapered Roller Brgs	Shaft Diameter (mm) Spherical Roller Brgs	Tolerance of Shaft	Remarks
Radial Bearings with Cylindrical Bores							
Rotating Outer Ring Load	Easy axial displacement of inner ring on shaft desirable.	Wheels on Stationary Axles	All Shaft Diameters			g6	Use g5 and h5 where accuracy is required. In case of large bearings, f6 can be used to allow easy axial movement.
	Easy axial displacement of inner ring on shaft unnecessary	Tension Pulleys Rope Sheaves				h6	
Rotating Inner Ring Load or Direction of Load Indeterminate	Light Loads or Variable Loads (<0.06C_r[1])	Electrical Home Appliances Pumps, Blowers, Transport Vehicles, Precision Machinery, Machine Tools	<18	—	—	js5	
			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)	k6 and m6 can be used for single-row tapered roller bearings and single-row angular contact ball bearings instead of k5 and m5.
			18 to 100	<40	<40	k5 or k6	
			100 to 140	40 to 100	40 to 65	m5 or m6	
			140 to 200	100 to 140	65 to 100	m6	
			200 to 280	140 to 200	100 to 140	n6	
			—	200 to 400	140 to 280	p6	
			—	—	280 to 500	r6	
			—	—	over 500	r7	
	Heavy Loads or Shock Loads (>0.13C_r[1])	Railway Axleboxes, Industrial Vehicles, Traction Motors, Construction Equipment, Crushers	—	50 to 140	50 to 100	n6	More than CN bearing internal clearance is necessary.
			—	140 to 200	100 to 140	p6	
			—	over 200	140 to 200	r6	
			—	—	200 to 500	r7	
Axial Loads Only			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]	IT5 and IT7 mean that the deviation of the shaft from its true geometric form, e. g. roundness and cylindricity should be within the tolerances of IT5 and IT7 respectively.
		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 standard tolerance grades IT.
[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 is applicable 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 Direction of Load Indeterminate	Paper Pulp Refiners, Plastic Extruders	<200	k6	
			200 to 400	m6	
			over 400	n6	

Table 8.5 Fits of Radial Bearings 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		
	Direction of Load Indeterminate	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	Loads of All kinds	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 Desirable under Normal or Light Loads	Grinding Spindle Rear Ball Bearings High Speed Centrifugal Compressor Free Bearings	JS6 (J6)	Possible	—
	Direction of Load Indeterminate		Grinding Spindle Front Ball Bearings High Speed Centrifugal Compressor Fixed Bearings	K6	Generally Impossible	For heavy loads, interference fit tighter than K is used. When high accuracy is required, very strict tolerances should be used for fitting.
	Rotating Inner Ring Load	Accurate Running and High Rigidity Desirable under Variable Loads	Cylindrical Roller Bearings for Machine Tool Main Spindle	M6 or N6	Impossible	
		Minimum 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 those in this table.
2. Refer to the introductory section of the bearing dimension tables (blue pages) for special fits such as 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 Direction of Load Indeterminate		K7	Normal Loads
			M7	Relatively Heavy Radial Loads

Table 8.7 Fits of Inch Design Tapered Roller Bearings with Shafts

(1) Bearings of Precision Classes 4 and 2

Units : μm

Operating Conditions		Nominal Bore Diameters d over (mm)	over 1/25.4	incl. (mm)	incl. 1/25.4	Bore Diameter Tolerances Δ_{ds} high	low	Shaft Diameter Tolerances high	low	Remarks
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. ※ means 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 in the 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 over (mm)	over 1/25.4	incl. (mm)	incl. 1/25.4	Bore Diameter Tolerances Δ_{ds} high	low	Shaft Diameter Tolerances high	low	Remarks
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 Design 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 in rolling bearings in operation greatly influences bearing performance including fatigue life, vibration, noise, heat-generation, etc. Consequently, the selection of the 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 is the combined clearances between the inner/outer rings and rolling elements. The radial and axial 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).

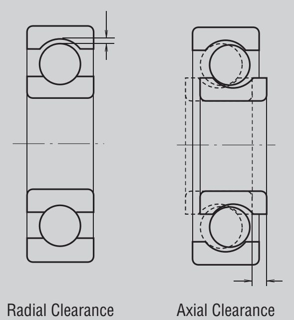


Fig. 8.7 Bearing Internal Clearance

To obtain accurate measurements, the clearance is generally measured by applying a specified measuring load on the bearing; therefore, the measured clearance (sometimes called "measured clearance" to make a distinction) is always slightly larger than the theoretical internal clearance (called "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 the one specified as the theoretical internal clearance.

In Table 8.9, reference table and page numbers are listed by bearing types.

Table 8.9 Index for Radial Internal Clearances by Bearing Types

Bearing Types		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 clearances.

Table 8.10 Radial Internal Clearances in Deep Groove Ball Bearings

Units : μm

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 for radial clearance increase caused by the measuring load 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 : μm

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 : μm

Clear-ance Symbol	MC1		MC2		MC3		MC4		MC5		MC6	
	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
Clear-ance	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 in the table below.

Units : μm

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 their classification, refer to Table 1 on Page C054.

Table 8.12 Radial Internal Clearances in Magneto Bearings

Units : μm

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 clearance increase caused by the measuring load is equal to the correction amount for CN clearance 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-Type Needle Roller Bearings

Units : μm

Nominal Bore Dia. *d* (mm)		Clearances in Bearings with Cylindrical Bores										Clearances in Non-Interchangeable 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 non-Interchangeable cylindrical roller bearings and solid-type needle roller bearings.

Units : μm

Nominal Bore Dia. *d* (mm)		Clearances in Non-Interchangeable 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 non-Interchangeable cylindrical roller bearings and solid-type 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 in Tolerance Classes Normal and 6. For internal axial clearances in bearings in tolerance classes better than 5 and contact angles of 15° and 25°, it is advisable to consult NSK.

Table 8.19 Axial Internal Clearance in Four-Point Contact Ball Bearings (Measured Clearances)

Units : μm

Nominal Bore Dia. d (mm)		Axial Internal Clearance							
		C2		CN		C3		C4	
over	incl.	min.	max.	min.	max.	min.	max.	min.	max.
10	18	15	55	45	85	75	125	115	165
18	40	26	66	56	106	96	146	136	186
40	60	36	86	76	126	116	166	156	206
60	80	46	96	86	136	126	176	166	226
80	100	56	106	96	156	136	196	186	246
100	140	66	126	116	176	156	216	206	266
140	180	76	156	136	196	176	246	226	296
180	220	96	176	156	226	206	276	256	326
220	260	115	196	175	245	225	305	285	365
260	300	135	215	195	275	255	335	315	395
300	350	155	235	215	305	275	365	345	425
350	400	175	265	245	335	315	405	385	475
400	500	205	305	285	385	355	455	435	525

8.2.2 Selection of Bearing Internal Clearances

Among the bearing internal clearances listed in the tables, the CN Clearance is adequate for standard operating conditions. The 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 ($P \fallingdotseq 0.1C_r$), and the bearing is tight-fitted on the shaft.

As a measure to reduce bearing noise for electric motors, the radial 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 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 is tight-fitted 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 and 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, Fits (5), Pages A156 and A157). The internal clearance after subtracting this decrease from the theoretical internal clearance Δ_0 is called the residual clearance, Δ_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 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 is greater. 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:

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

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

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

For roller bearings

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

The clearance after substracting this δ_t from the residual clearance, Δ_f is called the effective clearance, Δ. Theoretically, the longest life of a bearing can be expected 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, it is necessary to provide adequate axial clearance to allow for shaft elongation during operation.

The radial clearances used in some specific applications are given in Table 8.20. Under special operating conditions, it is advisable to consult NSK.

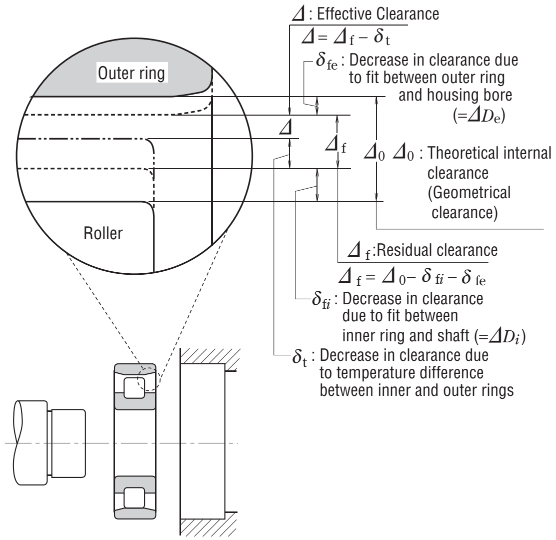


Fig. 8.8 Changes in Radial Internal Clearance of Bearings

Table 8. 20 Examples of 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, it is specified as a rule that measurement of a bearing must be made at 20°C and that the dimensions to be set forth in the standards must be expressed by values at 20°C.

Dimensional change due to temperature change not only affects the dimensional accuracy, but also causes change 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 also possible to achieve shrink fitting with large interference by utilizing dimensional change induced by temperature difference. The dimensional change Δl due to temperature rise can be expressed as in Equation (8.11) below:

$$\Delta l = \Delta T \alpha l \text{ (mm)} \quad \cdots\cdots\cdots (\mathbf{8.11})$$

where, Δl: Dimentional change (mm)

ΔT: temperature rise (°C)

α: Coefficient of linear expansion for bearing steel $\alpha=12.5\times10^{-6}$ (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:

(1) To correct dimensional measurements according to the ambient air temperature
(2) To find the change in bearing internal clearance due to temperature difference between inner and outer rings during operation
(3) To find the relationship between the interference and heating temperature during shrink fitting
(4) To find the change in the interference when a temperature difference exists on the fit surface

Example

To what temperature should the inner ring be heated if an inner ring of 110 mm in bore is to be shrink fitted to a shaft belonging to the n6 tolerance range class?

The maximum interference between the n6 shaft of 110 in diameter and the inner ring is 0.065. To enable insertion of the inner ring with ease on the shaft, there must be a clearance of 0.03 to 0.04. Accordingly, the amount to expand the inner ring must be 0.095 to 0.105.

Intersection of a vertical axis Δl=0.105 and a horizontal axis l=110 is determined on a diagram. ΔT is located in the temperature range between 70°C and 80°C (ΔT≒77°C). Therefore, it is enough to set the inner ring heating temperature to the room temperature +80°C.

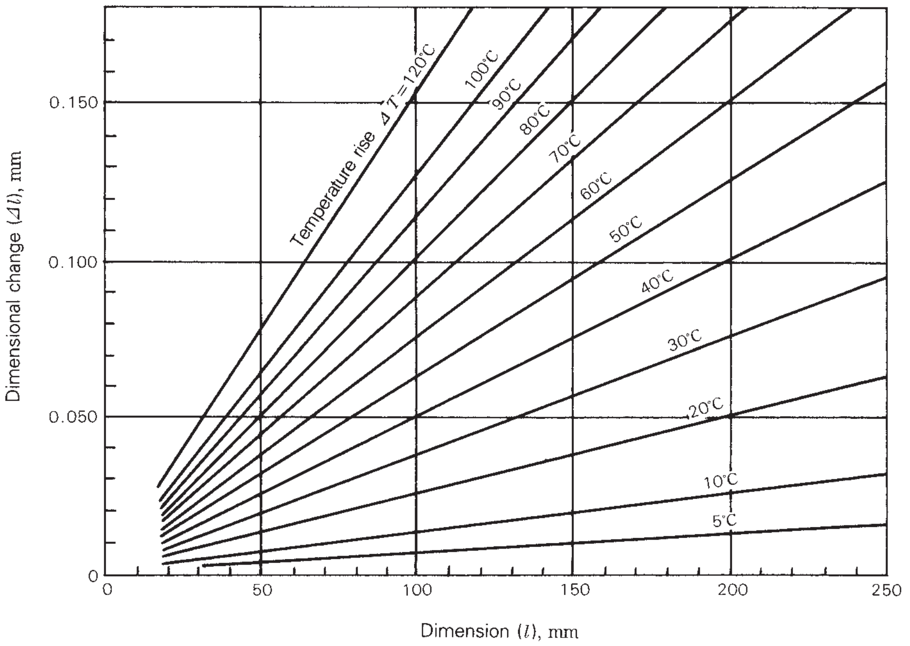


Fig. 8.9 Temperature Rise and Dimensional Change of Bearing Steel

8.3.2 Interference Deviation Due to Temperature Rise (Aluminum Housing, Plastic Housing)

For reducing weight and cost or improving the performance of equipment, bearing housing materials such as aluminum, light alloys, or plastics (polyacetal resin, etc.) are often used.

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 large for plastics which have high coefficients of linear expansion.

The deviation ΔD_T of clearance or interference of a fitting surface of a bearing's outer ring due to temperature rise is expressed by the following equation:

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

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: Bearing outside diameter (mm)

In general, the housing temperature rise and that of the outer ring 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 (8.13) becomes,

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

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

In the case of an aluminum housing (α_1=23.7×10^{-6}), Equation (8.13) can be shown graphically as in Fig. 8.10.

Among the various plastics, polyacetal resin is one that is often used for bearing housings. The coefficients of linear expansion of plastics may vary or show directional characteristics. In the case of polyacetal resin, for molded products, it is approximately 9×10^{-5}. Equation (8.13) can be shown as in Fig. 8.11.

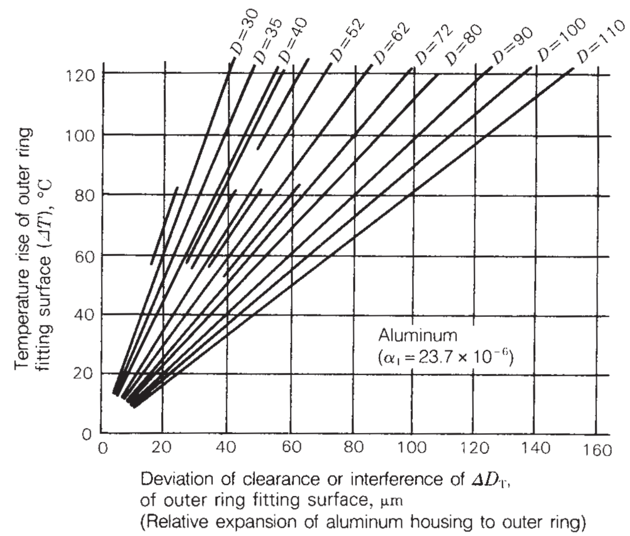


Fig. 8.10 Aluminum Housing

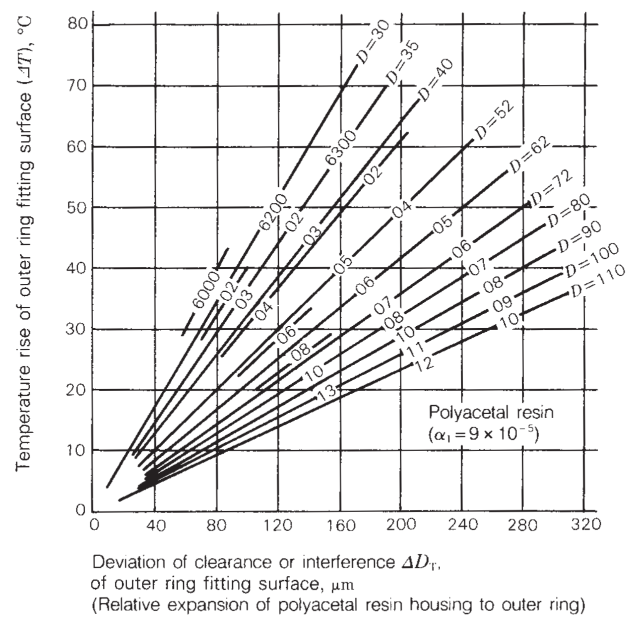


Fig. 8.11 Polyacetal Resin Housing

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. Generally, therefore, 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 at k5, with the housing set at H7. An interference fit is applied only to the inner ring.

Shaft diameter, bore size and radial clearance are the standard bearing measurements. Assuming that 99.7% of the parts are within tolerance, the mean value ($m_{\Delta f}$) and standard deviation ($\sigma_{\Delta f}$) of the internal clearance after mounting (residual clearance) can be calculated. Measurements are given in units of 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, wihtin a 99.7% probability, the variation in internal clearance after mounting ($R_{\Delta f}$), we 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 a 6310 bearing.

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

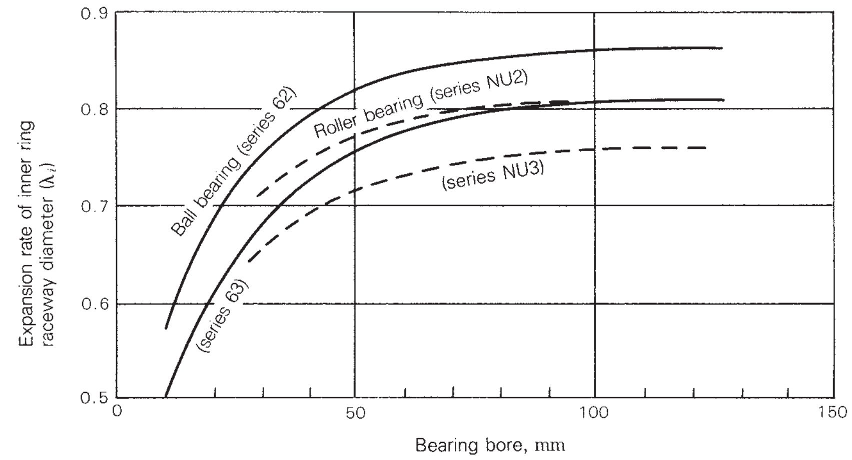


Fig. 8.12 Rate of Inner Ring Raceway Expansion (λ_i) from Apparent Interference

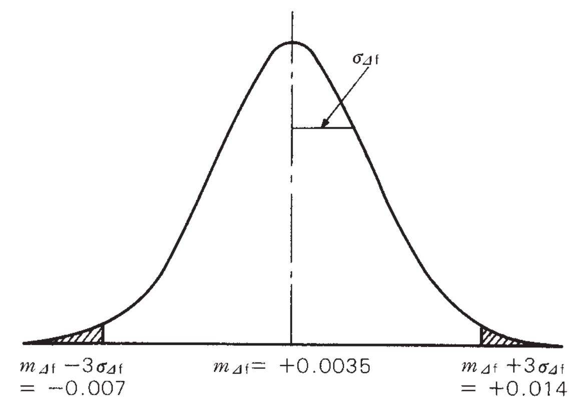


Fig. 8.13 Distribution of Residual Internal Clearance

8.3.4 Effect of Interference Fit on Bearing Raceways (Fit of Inner Ring)

One of the important factors that relates to radial clearance is the reduction in radial clearance resulting from the mounting fit. When 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).

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

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) has been translated into a clearer graphical form in Fig. 8.14.
The vertical axis of Fig. 8.14 represents the inner raceway diameter expansion in relation to the amount of interference. The horizontal axis is the ratio of inside and outside diameter of the hollow shaft (k_0) and uses as its parameter the ratio of bore diameter and raceway diameter of the inner ring (k).
Generally, the decrease in radial clearance is calculated to be approximately 80% of the interference. However, this is for solid shaft mountings only. For hollow shaft mountings the decrease in radial clearance varies with the ratio of inside to outside diameter of the shaft. 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.
Let's take as an example 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 and determine the decrease in radial clearance.
The ratio between bore diameter and raceway diameter, k is 0.87 as shown in Fig. 8.15. The ratio of inside to outside diameter for shaft, 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.

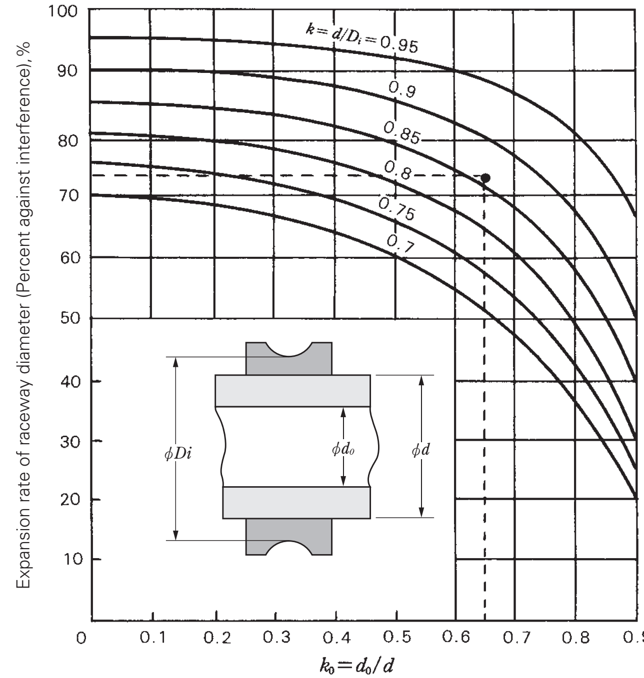


Fig. 8.14 Raceway Expansion in Relation to Bearing Fit (Inner Ring Fit upon Steel Shaft)

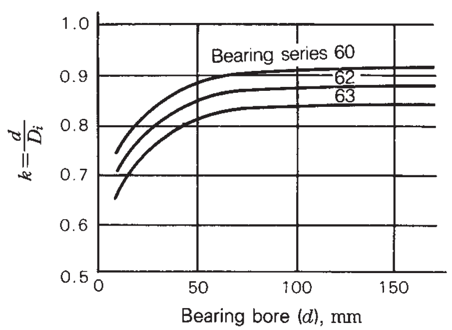


Fig. 8.15 Ratio of Bore Size to Raceway Diameter for Single Row Deep Groove Ball Bearings

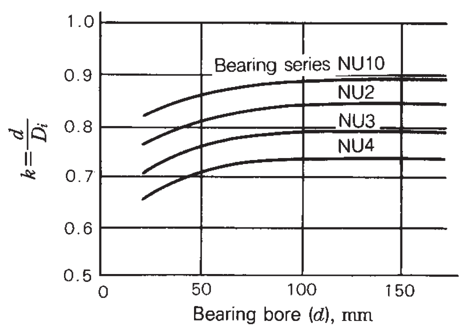


Fig. 8.16 Ratio of Bore Size to Raceway Diameter for Cylindrical Roller Bearings

8.3.5 Effect of Interference Fit on Bearing Raceways (Fit of Outer Ring)

We continue with the calculation of the raceway contraction of the outer ring after fitting.
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 the bearing 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.
Actually, because the amount of interference that can be applied to the outer ring is limited by stress, and because the constraints of most bearing applications make it difficult to apply a large amount of interference to the outer ring, and instances where there is an indeterminate load are quite rare compared to those where a rotating inner ring carries the load, 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 ΔD_e is calculated using Equation (8.15).

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

where, ΔD: 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 in graphic form.
The vertical axis show the outer-ring raceway contraction as a percentage of interference, and the horizontal axis is the housing thickness ratio h_0. The data are plotted for constant values of the outer-ring thickness ratio 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 for 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, we estimate the amount of decrease in radial clearance assuming a 6207 ball bearing is mounted in a steel housing with an N7 fit. The outside diameter of the housing is assumed to be D_0=95, and the bearing outside diameter is D=72. From Fig. 8.18, the outer-ring thickness ratio, h, is 0.9. Because $h_0=D/D_0$=0.76, from Fig. 8.17, the amount of raceway contraction is 71%. Taking the mean value for N7 interference as 18 μm, the amount of contraction of the outer raceway, or the amount of decrease in radial clearance is 0.71×18=13 μm.

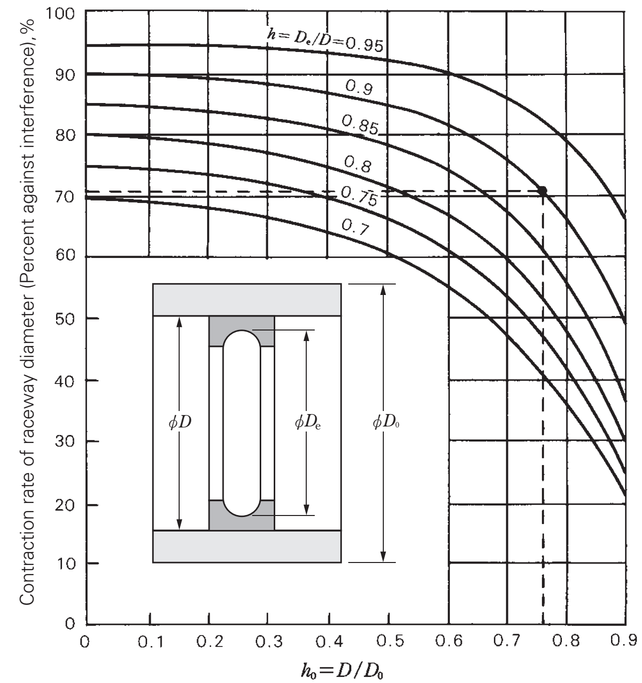


Fig. 8.17 Raceway Contraction in Relation to Bearing Fit (Outer Ring Fit in Steel Housing)

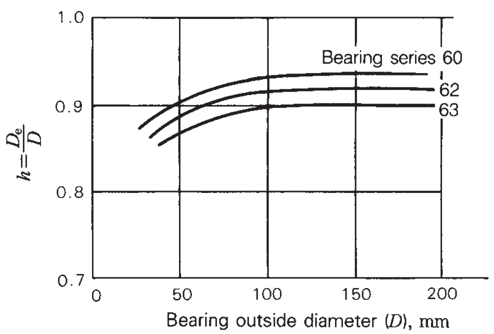


Fig. 8.18 Ratio of Outside Diameter to Raceway Diameter for Single Row Deep Groove Ball Bearings

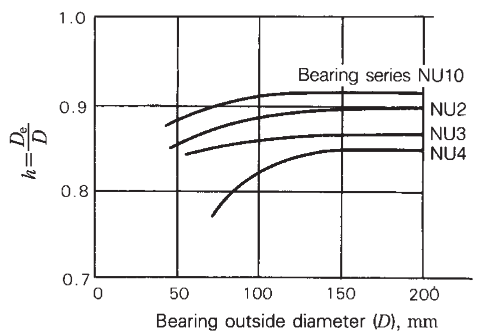


Fig. 8.19 Ratio of Outside Diameter to Raceway Diameter for Cylindrical Roller Bearings

8.3.6 Measuring Method of Internal Clearance of Combined Tapered Roller Bearings (Offset Measuring Method)

Combined tapered roller bearings are available in two types: a back-to-back combination (DB type) and a face-to-face combination (DF type) (see Fig. 8.20 and Fig. 8.21). The advantages of these combinations can be obtained by assembly as one set or combined with other bearings to be a fixed- or free-side bearing.
For the DB type of combined tapered roller bearing, as its cage protrudes from the back side of the outer ring, the outer ring spacer (K spacer in Fig. 8.20) is mounted to prevent mutual contact of cages. For the inner ring, the inner ring spacer (L spacer in Fig. 8.20), having an appropriate width, is provided to secure the clearance. For the DF type, as shown in Fig. 8.21, bearings are used with a K spacer.

In general, to use such a bearing arrangement either an appropriate clearance is required that takes into account the heat generated during operation or an applied preload is required 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.
Hereunder, we introduce you to a clearance measurement method for a DB arrangement.
(1) As shown in Fig. 8.22, put the bearing A on the surface plate and after stabilization of rollers by rotating the outer ring (more than 10 turns), measure the offset $f_A=T_A-B_A$.
(2) Next, as shown in Fig. 8.23, use the same procedure to measure the other bearing B for its offset $f_B=T_B-B_B$.
(3) Next, 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 combined tapered roller bearing can be obtained, with the use of symbols shown in Figs. 8.22 through 8.24 by Equation (8.16):

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

As an example, for the combined tapered roller bearing HR32232JDB+KLR10AC3, confirm the clearance of the actual product conforms to the specifications. First, refer to Table 8.17 and notice that the C3 clearance range is Δ_r=110 to 140 μm.
To compare this specification with the offset measurement results, convert it into an 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 NSK Rolling Bearings Catalog)

refering to the said catalog (Page C205), with use of e=0.44, the following is obtained:

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

It is possible to 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.

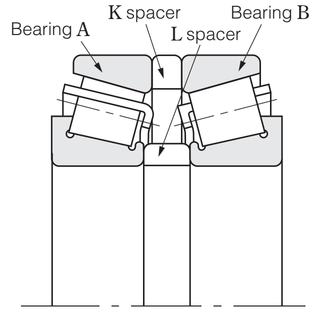


Fig. 8.20 DB Arrangement

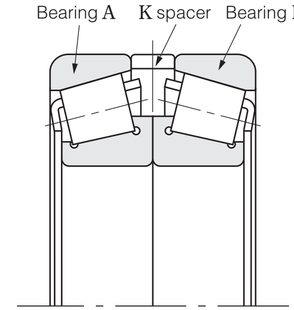


Fig. 8.21 DF Arrangement

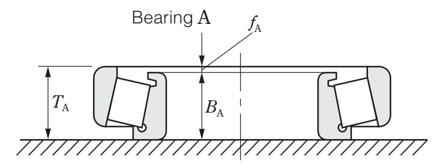


Fig. 8.22

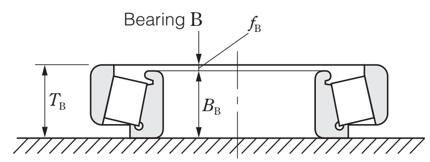


Fig. 8.23

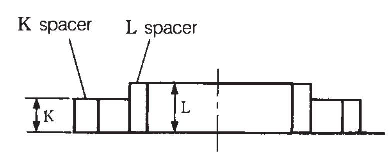


Fig. 8.24

8.3.7 Internal Clearance Adjustment Method when Mounting a Tapered Roller Bearing

The two single row tapered roller bearings are usually arranged in a configuration opposite each other and the clearance is adjusted in the axial direction. There are two types of opposite placement methods: back-to-back arrangement (DB arrangement) and face-to-face arrangement (DF arrangement).

The clearance adjustment of the 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, it is necessary that the fit of the tightening side inner ring with the shaft be a loose fit to allow displacement of the inner ring in the axial direction.

For the face-to-face arrangement, 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 (Fig. 8.26). In this case, it is necessary to use a loose fit between the tightening side of the outer ring and the housing in order to allow appropriate displacement of the outer ring in the axial direction. When the structure is designed to install the outer ring into the retaining cover (Fig. 8.27), the above measure becomes unnecessary and both mounting and dismounting become easy.

Theoretically when the bearing clearance is slightly negative during operation, the fatigue life becomes the longest, but if the negative clearance becomes much bigger, then the fatigue life becomes very short and heat generation quickly increases. Thus, it is generally arranged that the clearance be slightly positive (a little bigger than zero) while operating. In consideration of the clearance reduction caused by temperature difference of inner and outer rings during operation and difference of thermal expansion of the shaft and housing in the axial direction, the bearing clearance after mounting should be decided.

In practice, the clearance C1 or C2 is frequently adopted which is listed in Table 8.17.

In addition, the relationship between the radial clearance Δ_r and axial clearance Δ_a is as follows:

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

where, α: Contact angle
e: Constant determined for each bearing No. (Listed in the Bearing Tables of NSK Rolling Bearing 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. Such a method is called a preload method. There are two different modes of preloading: position preload and constant pressure preload. The position preload is used most often.

For the position preload, there are two methods: one method is to use an already adjusted arrangement of bearings and the other method is to apply the specified preload by tightening an adjustment nut or using an adjustment shim.

The constant pressure preload is a method to apply an appropriate preload to the bearing by means of spring or hydraulic pressure, etc. Next we introduce several examples that use these methods:

Fig. 8.28 shows the automotive final reduction gear. For pinion gears, the preload is adjusted by use of an inner ring spacer and shim. For large gears on the other hand, the preload is controlled by tightening the torque of the outer ring retaining screw.

Fig. 8.29 shows the rear wheel of a truck. This is an example of a preload application by tightening the inner ring in the axial direction with a shaft nut. In this case, the preload is controlled by measuring the starting friction moment of the bearing.

Fig. 8.30 shows an example of the head spindle of the lathe, the preload is adjusted by tightening the shaft nut.

Fig. 8.31 shows an example of a constant pressure preload for which the preload is adjusted by the displacement of the spring. In this case, first find a relationship between the spring's preload and displacement, then use this information to establish a constant pressure preload.

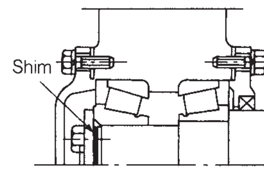


Fig. 8.25 DB Arrangement whose Clearance is Adjusted by Inner Rings.

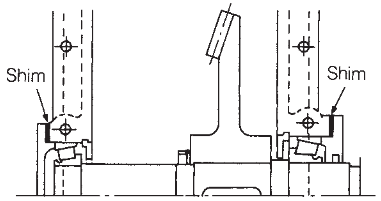


Fig. 8.26 DF Arrangement whose Clearance is Adjusted by Outer Rings.

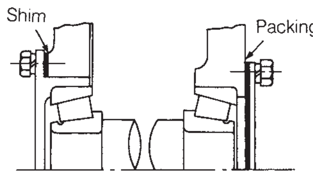


Fig. 8.27 Examples of Clearance Adjusted by Shim Thickness of Outer Ring Cover

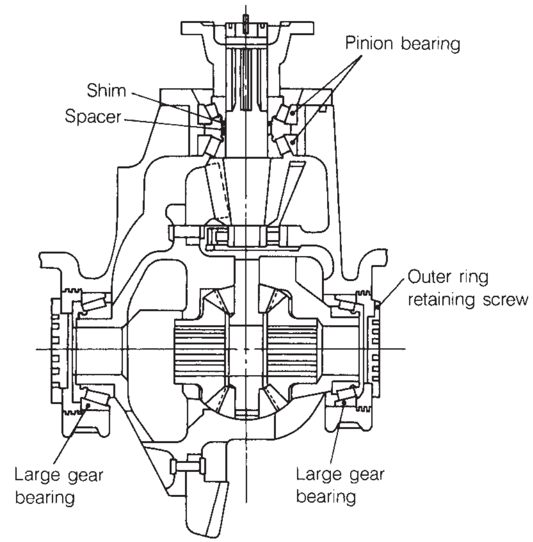


Fig. 8.28 Automotive Final Reduction Gear

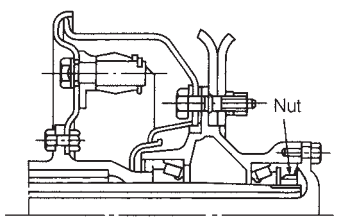


Fig. 8.29 Rear Wheel of Truck

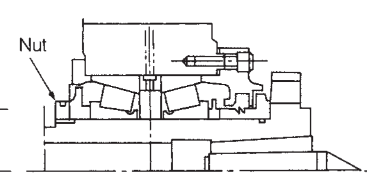


Fig. 8.30 Head Spindle of Lathe

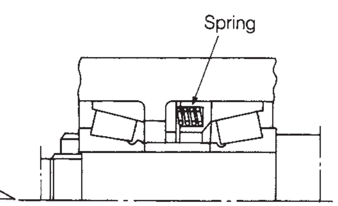
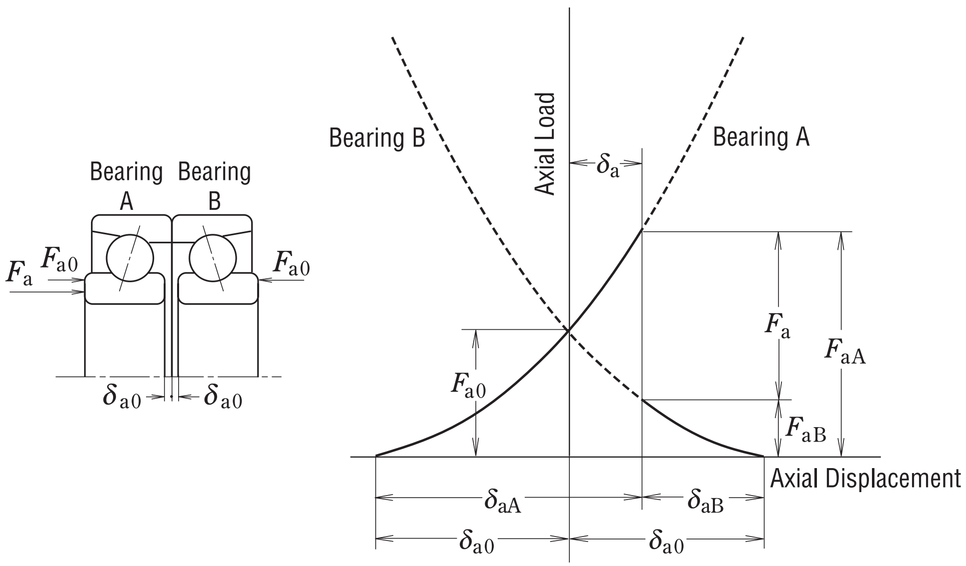


Fig. 8.31 Constant Pressure Preload Applied by Spring



Bearing A
Bearing B
F_a
F_{a0}
F_{a0}
δ_{a0}
δ_{a0}
Bearing B
Axial Load
δ_a
Bearing 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, it is desirable to provide a negative clearance to keep them internally stressed. This is called "preloading". A preload is usually applied to bearings in which the 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 duplex set 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 exact position both radially and axially and to maintain the running accuracy of the shaft.
…Main shafts of machine tools, precision instruments, etc.
(2) To increase bearing rigidity
…Main shafts of machine tools, pinion shafts of final drive gears of automobiles, etc.
(3) To minimize noise due to axial vibration and resonance
…Small electric motors, etc.
(4) To prevent sliding between the rolling elements and raceways due to gyroscopic moments
…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
…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, remain unchanged while in operation.
In practice, the following three methods are generally used to obtain a position preload.

(1) By installing a duplex bearing set with previously adjusted stand-out dimensions (see Page A007, Fig. 1.1) and axial clearance.
(2) By using a spacer or shim of proper size to obtain the required spacing and preload. (Refer to Fig. 9.1)
(3) By 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 using a coil or leaf spring to impose a constant preload. Even if the relative position of the bearings changes during operation, the magnitude of the preload remains relatively constant (refer to Fig. 9.2)

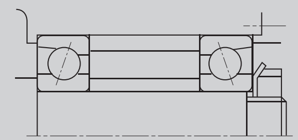


Fig. 9.1 Position Preload

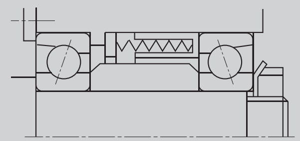


Fig. 9.2 Constant-Pressure Preload

9.3 Preload and Rigidity

9.3.1 Position Preload and Rigidity

When the inner rings of the duplex bearings shown in Fig.9.3 are fixed axially, bearings A and B are displaced δ_{a0} and axial space $2\delta_{a0}$ between the inner rings is eliminated. With this condition, a preload F_{a0} is imposed on each bearing. A preload diagram showing bearing rigidity, that is the relation between load and displacement with a given axial load F_a imposed on a duplex set, is shown in Fig. 9.4.

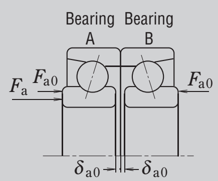


Fig. 9.3 Back-to-Back Duplex Bearing Preload

9.3.2 Constant-Pressure Preload and Rigidity

A preload diagram for duplex bearings under a 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 springs is lower than that of the bearing. As a result, the rigidity under a constant-pressure preload is approximately equal to that for a single bearing with a preload F_{a0} applied to it. Fig. 9.6 presents a comparison of the rigidity of 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 using 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, the deflection due to external loads is less for bearings with a position preload.
(2) In the case of a position preload, the preload varies depending on such factors as a difference in axial expansion due to a temperature difference between the shaft and housing, a difference in radial expansion due to a temperature difference between the inner and outer rings, deflection due to load, etc.

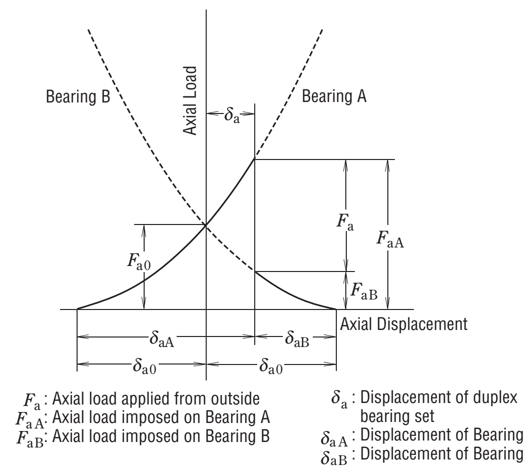


Fig. 9.4 Axial Displacement with Position Preload

In the case of a constant-pressure preload, it is possible to minimize any change in the preload because the variation of the spring load with shaft expansion and contraction is negligible. From the foregoing explanation, it is seen that position preloads are generally preferred for increasing rigidity and constant-pressure preloads are more suitable for high speed applications, for prevention of axial vibration, for use with thrust bearings on horizontal shafts, etc.

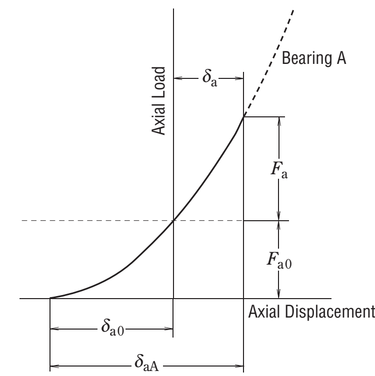


Fig. 9.5 Axial Displacement with Constant-Pressure Preload

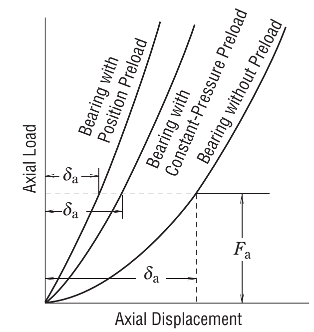


Fig. 9.6 Comparison of Rigidities and Preloading Methods

9.5 Amount of Preload

If the preload is larger than necessary, abnormal heart generation, increased frictional torque, reduced fatigue life, etc. 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, etc. At NSK, preloads are divided into four graduated classifications — Extra light (EL), Light (L), Medium (M), and Heavy (H) — to allow the customer to freely choose the appropriate preload for the specific application. These four preload classes are expressed in symbols, EL, L, M, and H, respectively, when applied to DB and DF bearing sets.

The average preload and axial clearance (measured) for duplex angular contact ball bearing sets with contact angles 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 the 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. The housing fits should be selected in the lower part of the standard clearance for bearings in fixed-end applications and the higher part of the standard clearance for bearings in free-end applications.

As general rules when selecting preloads, grinding machine spindles or machining center spindles require extra light to light preloads, whereas lathe spindles, which need rigidity, require medium preloads.
The bearing preloads, if the bearing set is mounted with tight fit, are larger than those shown in Tables 9.3 to 9.5. Since excessive preloads cause bearing temperature rise and seizure, etc., it is necessary to pay attention to fitting.
When speeds result in a value of $D_{pw}\times n$ ($d_m n$ value) higher than 500000, the preload should be very carefully studied and selected. In such a case, please consult with NSK beforehand.

Table 9.1 Measuring Load of Axial Clearance

Nominal bearing outside diameter D (mm) over	incl	Measuring load (N)
10*	50	24.5
50	120	49
120	200	98
200	—	196

*10 mm is included in this range.

Table 9.2 Target of Fitting

Units : μm

Bore or outside diameter d or D (mm) over	incl	Shaft and inner ring: Target interference	Housing and outer ring: 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 Preloads and Axial Clearance for Bearing Series 79C

Bearing No.	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	105	−11
7903C	11	3	25	0	56	−5	120	−12
7904C	20	1	42	−3	80	−8	150	−15
7905C	19	1	37	−2	99	−9	205	−17
7906C	25	0	46	−3	95	−8	205	−16
7907C	33	2	67	−2	150	−9	295	−18
7908C	41	1	78	−3	195	−12	385	−22
7909C	50	0	105	−5	190	−11	390	−21
7910C	50	0	94	−4	240	−13	500	−24
7911C	60	−1	110	−5	295	−15	595	−26
7912C	60	−1	115	−5	305	−15	580	−25
7913C	74	−2	150	−7	350	−16	690	−27
7914C	100	−4	205	−10	505	−22	1 000	−36
7915C	105	−4	190	−9	490	−21	995	−35
7916C	105	−4	195	−9	505	−21	985	−34
7917C	140	−6	305	−14	630	−25	1 280	−41
7918C	155	−3	290	−9	740	−23	1 490	−39
7919C	155	−3	295	−9	800	−24	1 590	−40
7920C	190	−5	385	−13	905	−28	1 790	−46

Remark In the axial clearance column, the measured value is given.

Table 9.4 Average Preloads and Axial Clearance for Bearing Series 70C

Bearing No.	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)
7000C	13	3	24	0	49	−5	96	−12
7001C	13	3	25	0	57	−6	120	−14
7002C	12	3	29	−1	66	−7	145	−16
7003C	15	2	30	−1	69	−7	155	−16
7004C	25	0	49	−4	120	−12	245	−22
7005C	30	−1	58	−5	150	−14	290	−24
7006C	41	1	75	−3	195	−13	385	−24
7007C	58	−1	120	−7	250	−16	495	−28
7008C	58	−1	115	−6	290	−17	595	−30
7009C	80	−3	145	−8	340	−19	695	−33
7010C	70	−2	150	−8	390	−20	790	−34
7011C	95	−4	200	−11	480	−24	970	−40
7012C	96	−4	190	−10	525	−25	1 090	−42
7013C	130	−6	260	−13	535	−24	1 060	−39
7014C	150	−7	285	−14	730	−30	1 460	−48
7015C	150	−7	295	−14	795	−31	1 570	−49
7016C	200	−6	380	−14	920	−31	1 880	−52
7017C	205	−6	395	−14	995	−32	1 960	−52
7018C	245	−8	500	−18	1 190	−37	2 370	−60
7019C	275	−9	550	−19	1 190	−36	2 350	−58
7020C	280	−9	535	−18	1 280	−37	2 570	−60

Remark In the axial clearance column, the measured value is given.

Table 9.5 Average Preloads and Axial Clearance for Bearing Series 72C

Bearing No.	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	195	−22
7202C	20	1	40	−3	97	−11	200	−21
7203C	25	0	46	−4	145	−16	295	−28
7204C	35	−2	68	−7	195	−20	385	−33
7205C	42	1	82	−4	195	−14	400	−27
7206C	57	−1	115	−7	290	−20	590	−35
7207C	75	−3	150	−10	385	−25	795	−43
7208C	98	−5	200	−13	500	−29	985	−47
7209C	125	−7	255	−16	535	−30	1 070	−49
7210C	125	−7	250	−15	590	−31	1 170	−50
7211C	140	−8	290	−17	790	−38	1 550	−60
7212C	190	−11	395	−22	925	−42	1 880	−67
7213C	220	−12	450	−23	1 070	−44	2 170	−70
7214C	245	−9	485	−20	1 160	−42	2 370	−69
7215C	270	−10	530	−21	1 220	−42	2 440	−68
7216C	305	−12	595	−24	1 370	−47	2 750	−76
7217C	355	−14	695	−27	1 660	−53	3 360	−85
7218C	385	−15	770	−29	1 870	−57	3 710	−90
7219C	450	−18	875	−33	2 080	−63	4 150	−99
7220C	505	−20	985	−36	2 340	−68	4 700	−107

Remark In the axial clearance column, the measured value is given.

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

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

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

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

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

9.6 Technical Data

9.6.1 Load and Displacement of Position-Preloaded Bearings

Two (or more) ball or tapered roller bearings mounted side by side as a set are termed duplex (or multiple) bearing sets. The bearings most often used in multiple arrangements are single-row angular contact ball bearings for machine tool spindles, since there is a requirement to reduce the bearing displacement under load as much as possible.

There are various ways of assembling sets depending on the effect desired. Duplex angular contact bearings fall into three types of arrangements, Back-to-Back, with lines of force convergent on the bearing back faces, Face-to-Face, with lines of force convergent on the bearing front faces, and Tandem, with lines of force being parallel. The symbols for these are DB, DF, and DT arrangements respectively (Fig. 9.7).

DB and DF arrangement sets can take axial loads in either direction. Since the distance of the load centers of DB bearing set is longer than that of DF bearing set, they are widely used in applications where there is a moment. DT type sets can only take axial loads in one direction. However, because the two bearings share some load equally between them, a set can be used where the load in one direction is large.

By selecting the DB or DF bearing sets with the proper preloads which have already been adjusted to an appropriate range by the bearing manufacturer, the radial and axial displacements of the bearing inner and outer ring can be reduced as much as allowed by certain limits. However, the DT bearing set cannot be preloaded.

The amount of preload can be adjusted by changing clearance between bearings, δ_{a0}, as shown in Figs. 9.9 to 9.11. Preloads are divided into four graduated classification — Extra light (EL), Light (L), Medium (M), and Heavy (H). Therefore, DB and DF bearing sets are often used for applications where shaft misalignments and displacements due to loads must be minimized.

Triplex sets are also available in three types (symbols: DBD, DFD, and DTD) of arrangements as shown in Fig. 9.8. Sets of four or five bearings can also be used depending on the application requirements.

Duplex bearings are often used with a preload applied. Since the preload affects the rise in bearing temperature during operation, torque, bearing noise, and especially bearing life, it is extremely important to avoid applying an excessive preload.

Generally, the axial displacement δ_a under an axial load F_a for single-row angular contact ball bearings is calculated as follows,

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

where, c: Constant depending on the bearing type and dimensions.

Fig. 9.9 shows the preload curves of duplex DB arrangement, and Figs. 9.10 and 9.11 show those for triplex DBD arrangement.

If the inner rings of the duplex bearing set in Fig. 9.9 are pressed axially, A-side and B-side bearings are deformed δ_{a0A} and δ_{a0B} respectively and the clearance (between the inner rings), δ_{a0}, becomes zero. This condition means that the preload F_{a0} is applied on the bearing set. If an external axial load F_a is applied on the preloaded bearing set from the A-side, then the A-side bearing will be deformed δ_{a1} additionally 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. That is, the load on A-side bearing including the preload is ($F_{a0}+F_a-F_a'$) and the B-side bearing is ($F_{a0}-F_a'$).

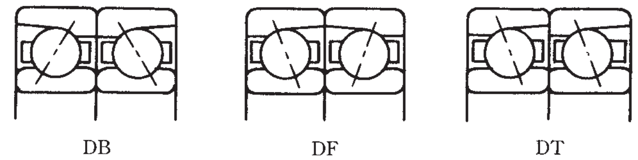


Fig. 9.7 Duplex Bearing Arrangements

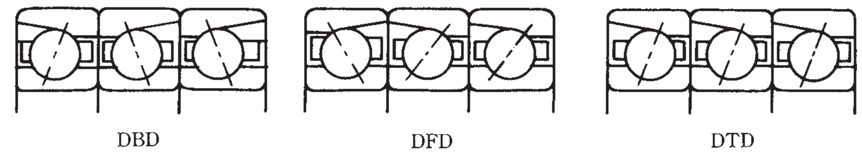


Fig. 9.8 Triplex Bearing Arrangements

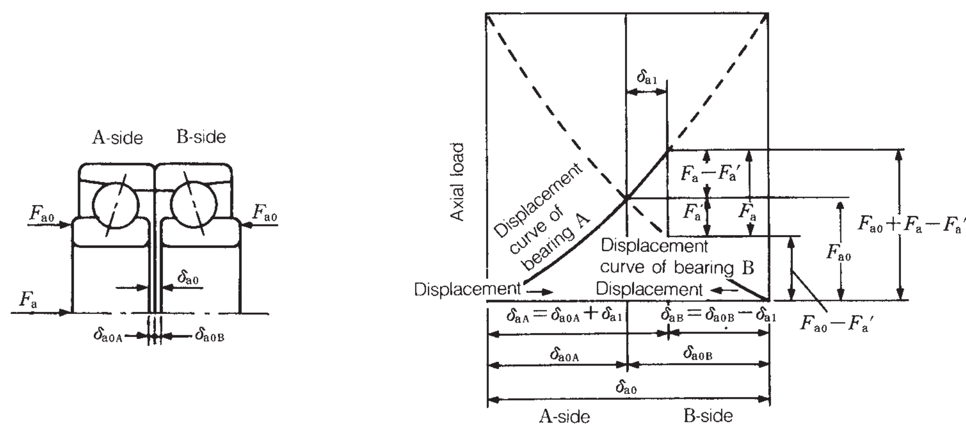


Fig. 9.9 Preload Graph of DB Arrangement Duplex Bearings

If the bearing set has an applied preload, the A-side bearing should have a sufficient life and load capacity for an axial load ($F_{a0}+F_a-F_a'$) under the speed condition. The axial clearance δ_{a0} is shown in Tables 9.3 to 9.5 of Section 9.5.1 (Pages A195 to A197).

In Fig. 9.10, with an external axial load F_a applied on the AA-side bearings, the axial loads and displacements of AA- and B-side bearings are summarized in Table 9.6.

In Fig. 9.11, with an external axial load F_a applied on the A-side bearing, the axial loads and displacements of A- and BB-side bearings are summarized in Table 9.7.

The examples, Figs. 9.12 to 9.17, show the relation of the axial loads and axial displacements using duplex DB and triplex 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	$\delta_{a0B}-\delta_{a1}$	$F_{a0}-F_a'$

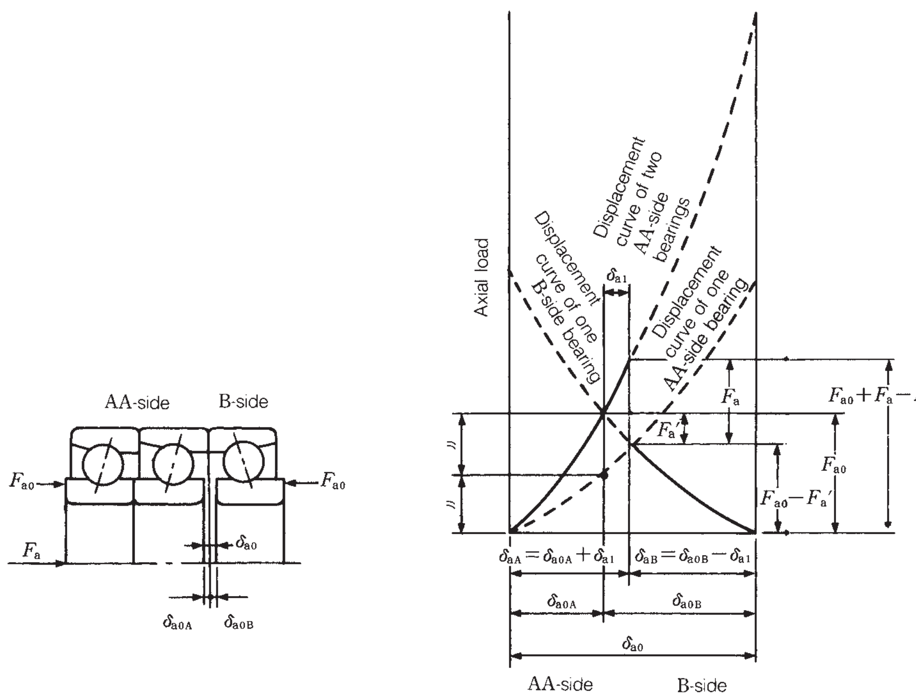


Fig. 9.10 Preload Graph of Triplex DBD Bearing Set (Axial load is applied from AA-side)

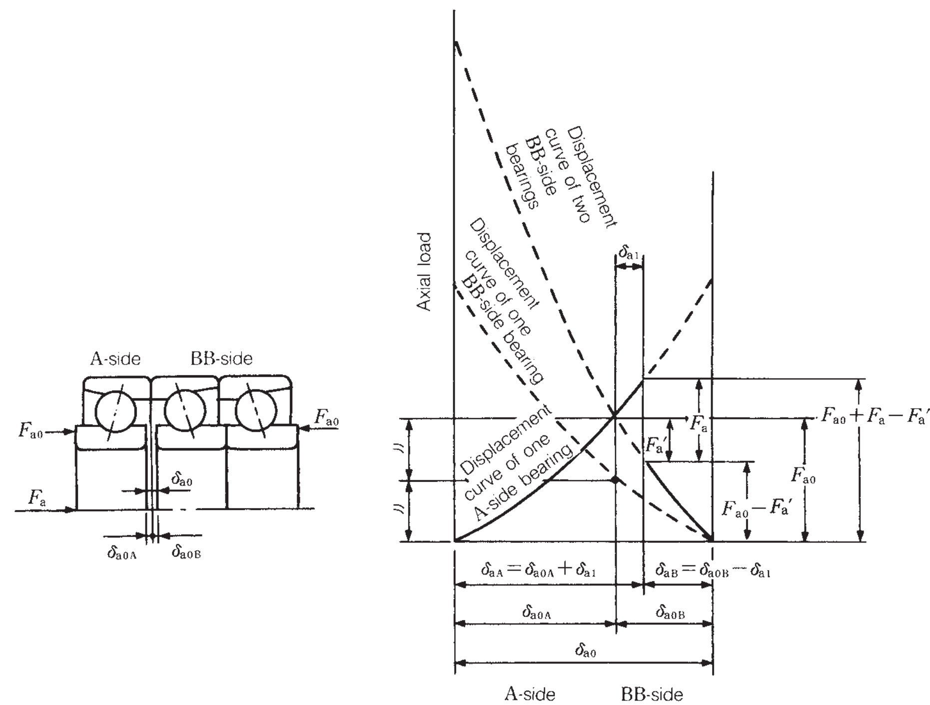


Fig. 9.11 Preload Graph of Triplex DBD Bearing set (Axial load is applied from A-side)

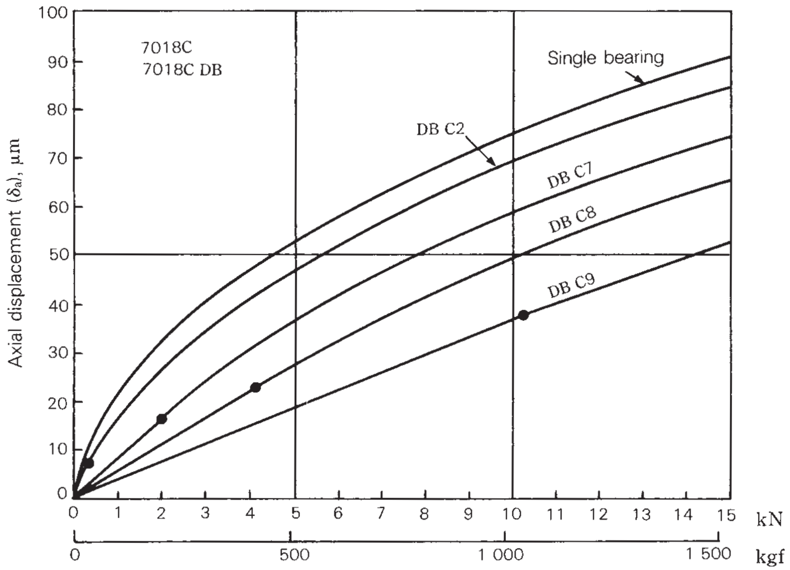


Fig. 9.12

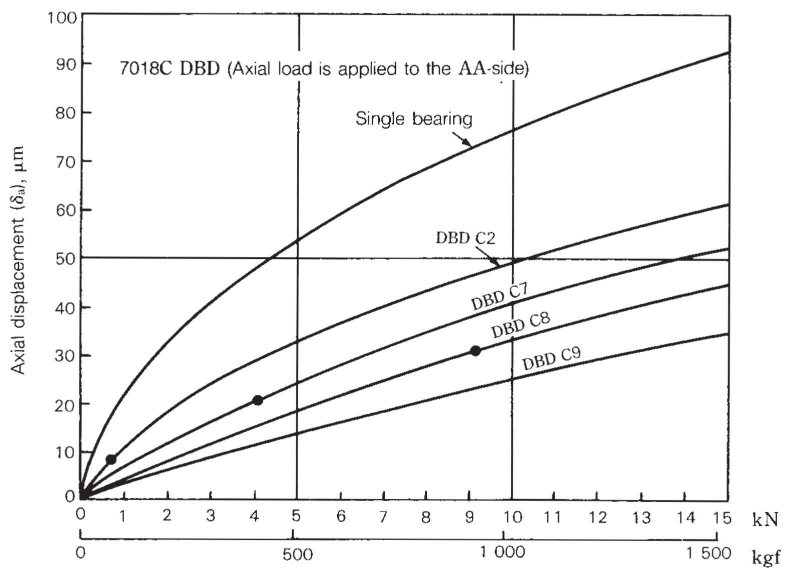


Fig. 9.13

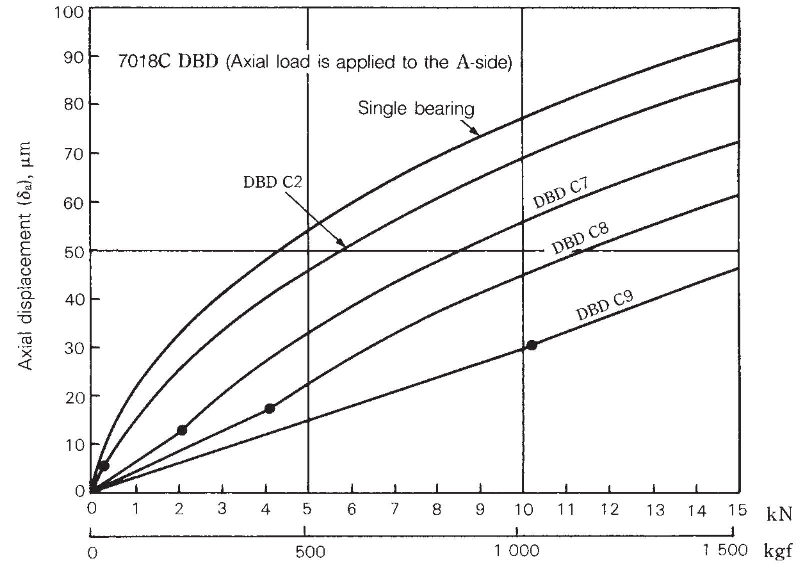


Fig. 9.14

Remark A (•) 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.

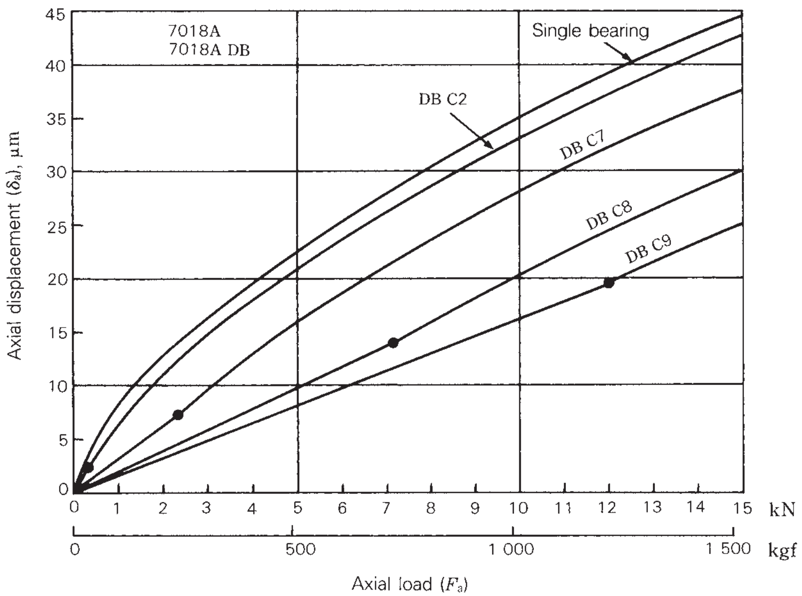


Fig. 9.15

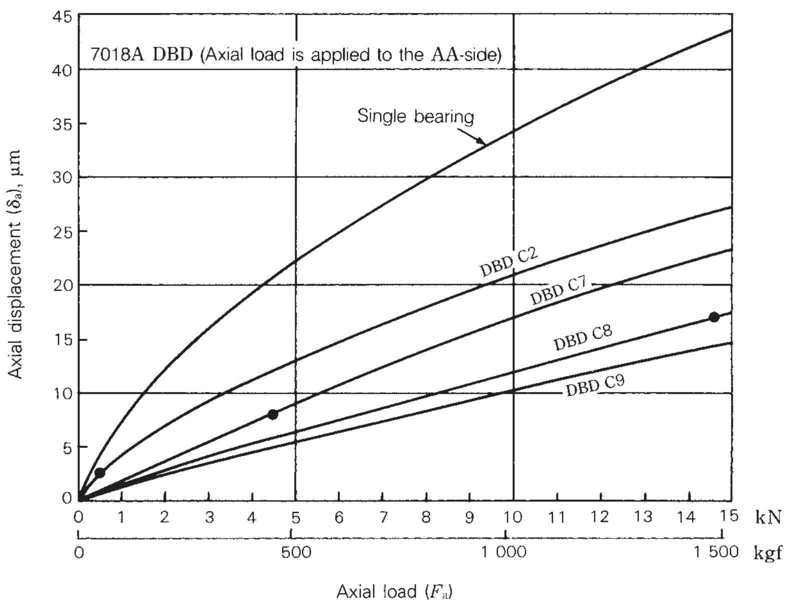


Fig. 9.16

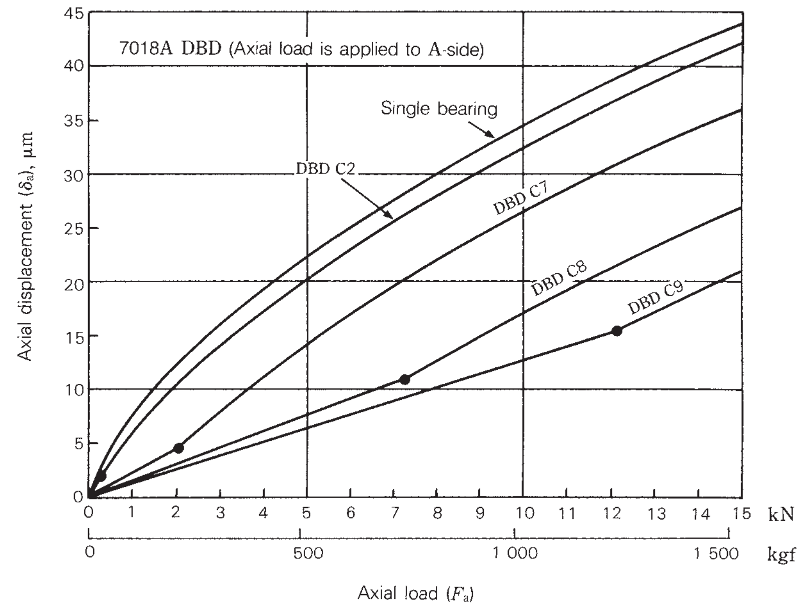


Fig. 9.17

Remark A (•) 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 a contact angle α_0 and the inner ring is displaced δ_a, the center Oi of the inner ring raceway radius is also moved to Oi' resulting in the 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.

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

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

Also there is the following relationship between the rolling element load Q and elastic deformation δ_N.

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

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

$\therefore$ 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 $K_N=K\cdot\dfrac{\sqrt{D_w}}{B^{3/2}}$

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

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

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

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),

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

That is, 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).

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

where, K: Constant depending on the bearing material and design
D_w: Ball diameter
Z: Number of balls
α_0: Initial contact angle
In case of single-row deep groove ball bearings, the initial contact angle can be obtained using Equation (5) of Page C084

Actual axial deformation varies depending on the bearing mounting conditions, such as the material and thickness of the shaft and housing, and bearing fitting. For details, consult with NSK regarding the axial deformation after mounting.

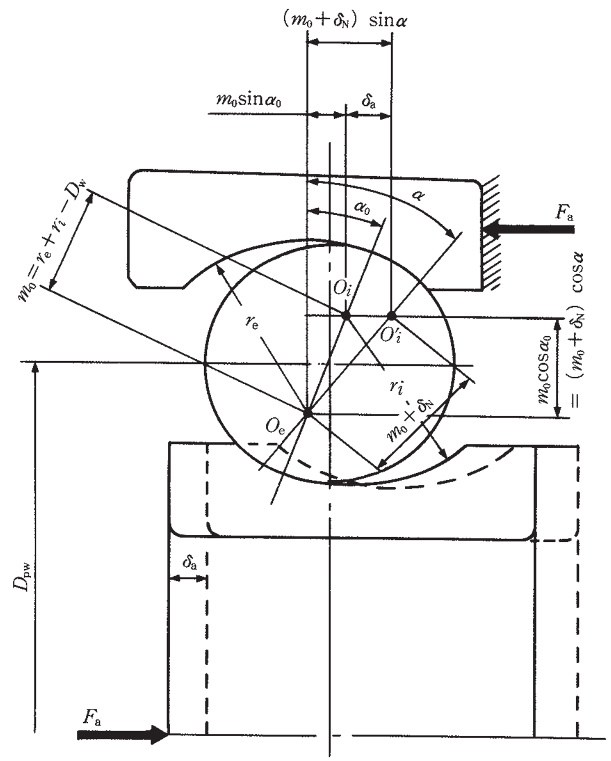


Fig. 9.18

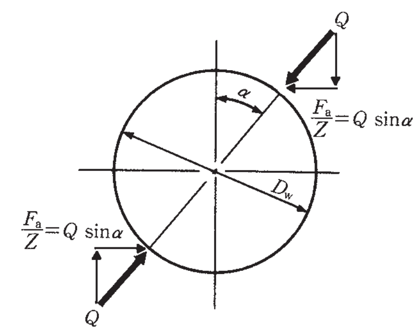


Fig. 9.19

Fig. 9.20 gives the relation between axial load and axial displacement for 6210 and 6310 single-row deep groove ball bearings with initial contact angles of α_0=0°, 10°, 15°. The larger the initial contact angle α_0, the more rigid the bearing will be in the axial direction and also the smaller the difference between the axial displacements of 6210 and 6310 under the same axial load. The angle α_0 depends upon the groove radius and the radial clearance.

Fig. 9.21 gives the relation between axial load and axial displacement for 72 series angular contact ball bearings with initial contact angles of 15° (C), 30° (A), and 40° (B). Because 70 and 73 series bearings with identical contact angles and bore diameters can be considered to have almost the same values as 72 series bearings.
Angular contact ball bearings that sustain loads in the axial direction must maintain their running accuracy and reduce the bearing elastic deformation from applied loads when used as multiple bearing sets with a preload applied.

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 $\delta_a \propto F_a^{3/2}$. That is, the axial displacement δ_a is proportional to the axial load F_a to the 2/3 power. When this axial load index is less than one, it indicates the relative axial displacement will be small with only a small increase in the axial load. (Fig. 9.21) The underlying reason for applying a preload is to reduce the amount of displacement.

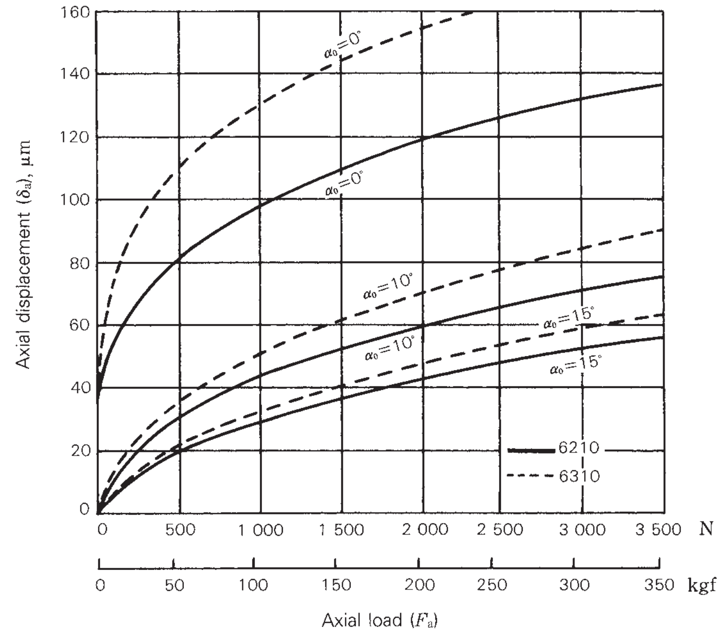


Fig. 9.20 Axial Load and Axial Displacement of Deep Groove Ball Bearings

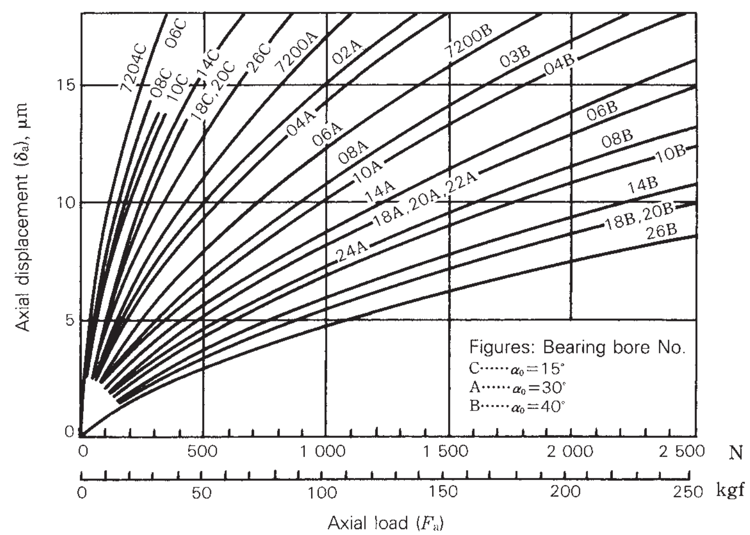


Fig. 9.21 Axial Load and Axial Displacement of Angular Contact Ball Bearings

9.6.3 Axial Displacement of Tapered Roller Bearings

Tapered roller bearings are widely used in pairs like angular contact ball bearings. Care should be taken to select 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 in an application, 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, 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 bearing fitting. For details, consult with NSK regarding the axial deformation after mounting.

$$\delta_a = \frac{0.000077}{\sin\alpha}\cdot\frac{Q^{0.9}}{L_{we}^{\ 0.8}} \quad (\mathrm{N})$$
$$= \frac{0.0006}{\sin\alpha}\cdot\frac{Q^{0.9}}{L_{we}^{\ 0.8}} \quad \{\mathrm{kgf}\} \quad \cdots\cdots \ (\mathbf{9.11})$$

where, δ_a: Axial displacement of inner, outer ring (mm)
α: Contact angle...1/2 the cup 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).

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

where,

$$K_a = \frac{0.000077}{(\sin\alpha)^{1.9}\, Z^{0.9}\, L_{we}^{\ 0.8}} \quad \cdots\cdots \ (\mathrm{N})$$
$$= \frac{0.0006}{(\sin\alpha)^{1.9}\, Z^{0.9}\, L_{we}^{\ 0.8}} \quad \cdots\cdots \ \{\mathrm{kgf}\}$$

Here, K_a: Coefficient determined by the 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.
Caution should be taken not to make the preload indiscriminately large on tapered roller bearings, since too large of a preload can cause excessive heat, seizure, and reduced bearing life.

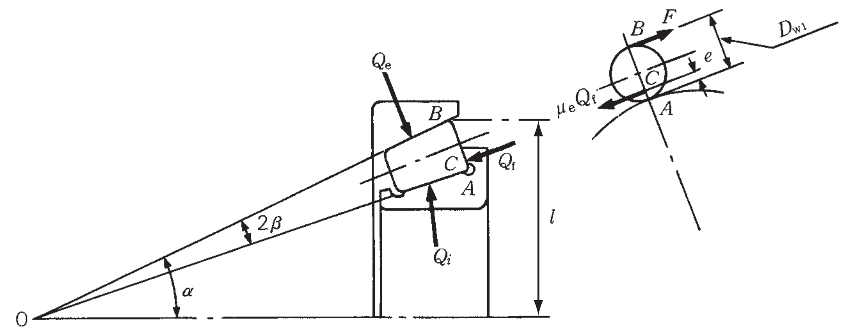


Fig. 9.22

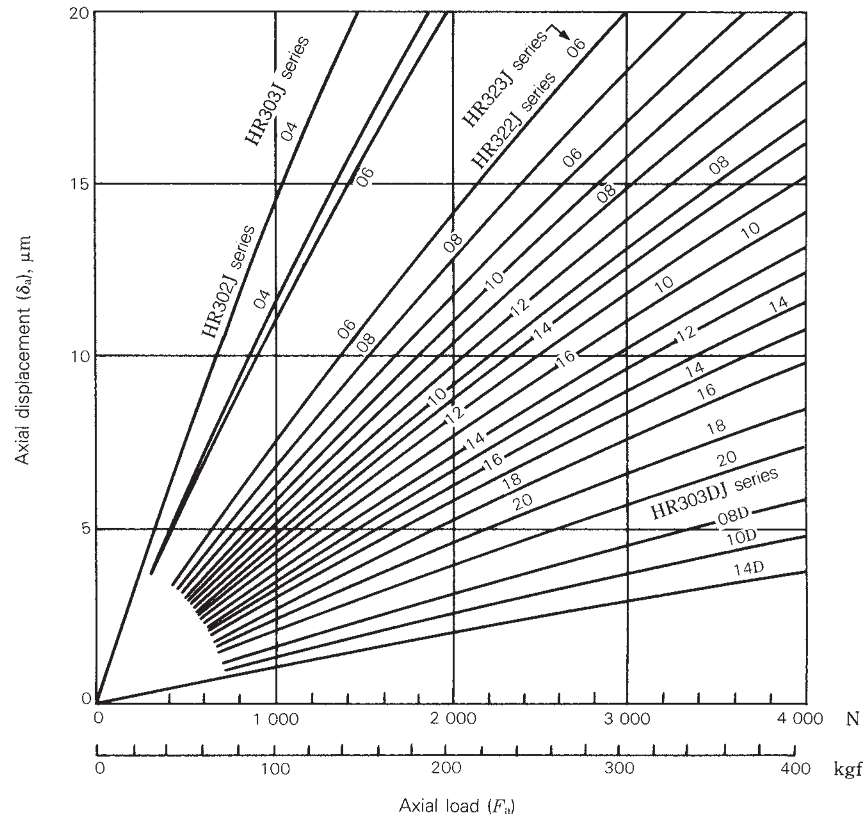
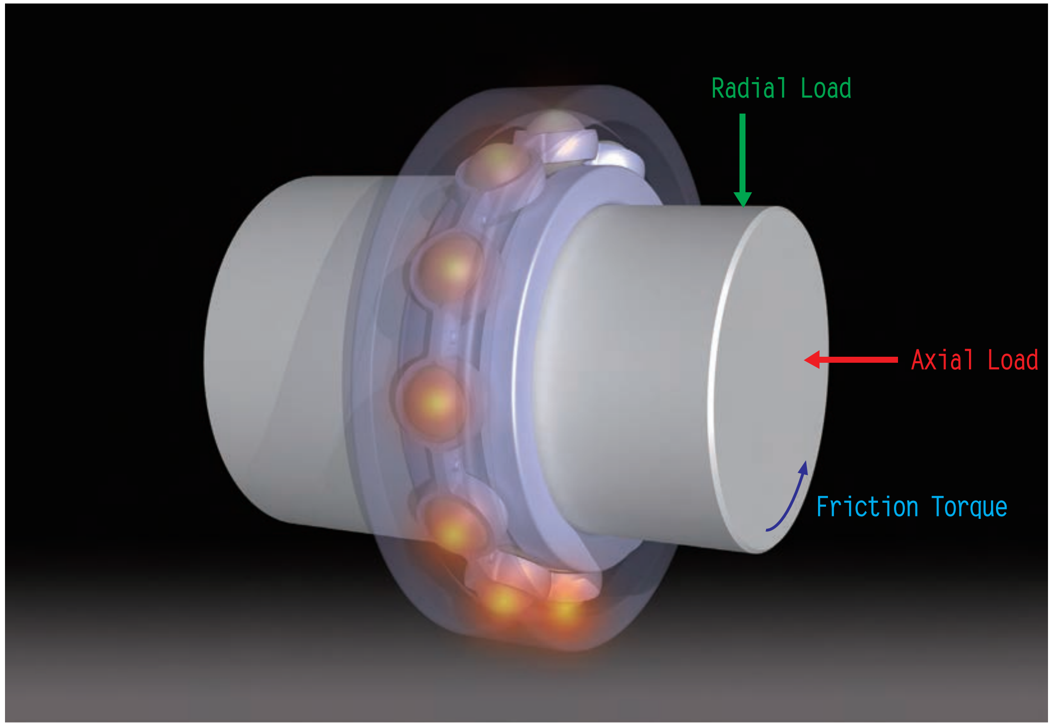


Fig. 9.23 Axial Load and Axial Displacement for Tapered Roller Bearings



10. FRICTION

10. FRICTION

10.1 Coefficients of Dynamic Friction

10.1.1 Bearing Types and Their Coefficients of Dynamic Friction μ

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

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 torque of bearing (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 for the bearing will increase in direct proportion to the preload.

The starting torque of angular contact ball bearings is mainly the torque 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,

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

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

$$M_s = \frac{3}{8} \mu_s \cdot Q \cdot a\, E(k) \quad \text{(mN·m), {kgf·mm}}$$

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 70C and 72C series bearings.

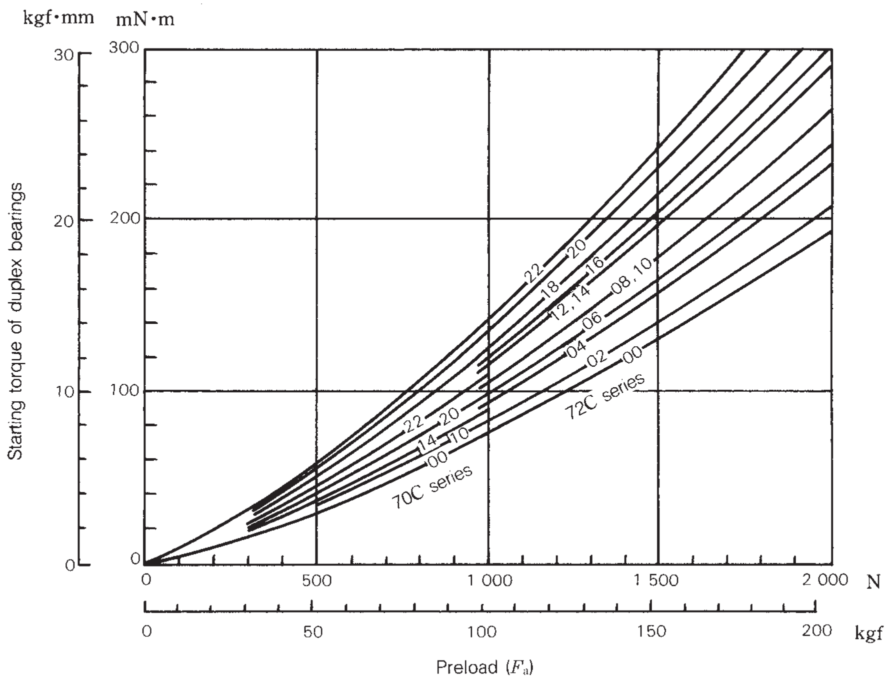


Fig. 10.1 Preload and Starting Torque for Angular Contact Ball Bearings (α=15°) of DF and DB Duplex Sets

10.3.2 Empirical Equation of Running Torque of High-Speed Ball Bearings

We present here empirical equations 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 bigger bearings.

The running torque M can be obtained as the sum of a load term M_l and speed term M_v as follows:

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

The load term M_l is the term for friction, which has no relation with speed or fluid friction, and is expressed by Equation (10.4) which is based on experiments.

$$\left.\begin{aligned} M_l &= 0.672\times10^{-3} D_{pw}^{0.7} F_a^{1.2} \ (\text{mN}\cdot\text{m}) \\ &= 1.06\times10^{-3} D_{pw}^{0.7} F_a^{1.2} \ \{\text{kgf}\cdot\text{mm}\} \end{aligned}\right\} \cdots\cdots\cdots \ (\mathbf{10.4})$$

where, D_{pw}: Pitch diameter of rolling elements (mm)
F_a: Axial load (N), {kgf}

The speed term M_v is that for fluid friction, which depends on angular speed, and is expressed by Equation (10.5).

$$\begin{aligned} M_v &= 3.47\times10^{-10} D_{pw}^{3} n_i^{1.4} Z_B^{a} Q^{b} \ (\text{mN}\cdot\text{m}) \\ &= 3.54\times10^{-11} D_{pw}^{3} n_i^{1.4} Z_B^{a} Q^{b} \ \{\text{kgf}\cdot\text{mm}\} \end{aligned} \quad \cdots\cdots\cdots \ (\mathbf{10.5})$$

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)

The exponents a and b, that affect the oil viscosity and flow rate factors, depend only on the angular speed and are given by Equations (10.6) and (10.7) as follows:

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

$$b = 4\times10^{-9} n_i^{1.6} + 0.03 \quad \cdots\cdots\cdots\cdots \ (\mathbf{10.7})$$

An example of the estimation of 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 big, 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 (ϕ20×ϕ47×14) 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),

$$\begin{aligned} M_l &= 0.672\times10^{-3} D_{pw}^{0.7} F_a^{1.2} \\ &= 0.672\times10^{-3}\times33.5^{0.7}\times590^{1.2} \\ &= 16.6 \ (\text{mN}\cdot\text{m}) \\ M_l &= 1.06\times10^{-3}\times33.5^{0.7}\times60^{1.2} \\ &= 1.7 \ \{\text{kgf}\cdot\text{mm}\} \end{aligned}$$

From Equations (10.6) and (10.7),

$$\begin{aligned} a &= 24 n_i^{-0.37} \\ &= 24\times70\,000^{-0.37} = 0.39 \\ b &= 4\times10^{-9} n_i^{1.6} + 0.03 \\ &= 4\times10^{-9}\times70\,000^{1.6} + 0.03 = 0.26 \end{aligned}$$

From Equation (10.5),

$$\begin{aligned} M_v &= 3.47\times10^{-10} D_{pw}^{3} n_i^{1.4} Z_B^{a} Q^{b} \\ &= 3.47\times10^{-10}\times33.5^{3}\times70\,000^{1.4}\times10^{0.39}\times1.5^{0.26} \\ &= 216 \ (\text{mN}\cdot\text{m}) \end{aligned}$$

$$\begin{aligned} M_v &= 3.54\times10^{-11}\times33.5^{3}\times70\,000^{1.4}\times10^{0.39}\times1.5^{0.26} \\ &= 22.0 \ \{\text{kgf}\cdot\text{mm}\} \end{aligned}$$

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

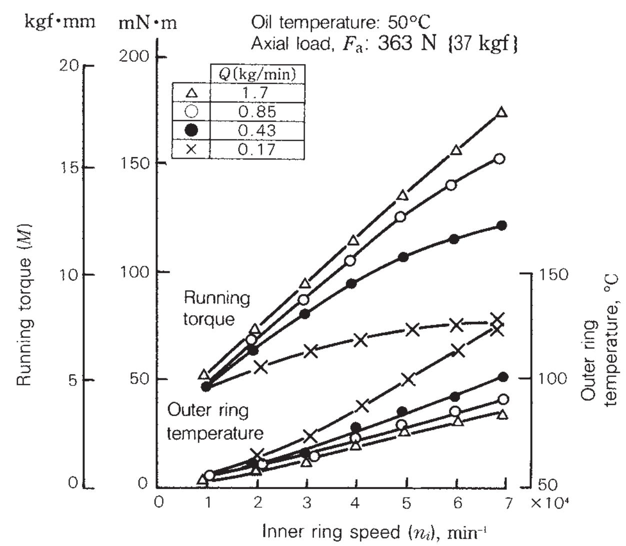


Fig. 10.2 Typical Test Example

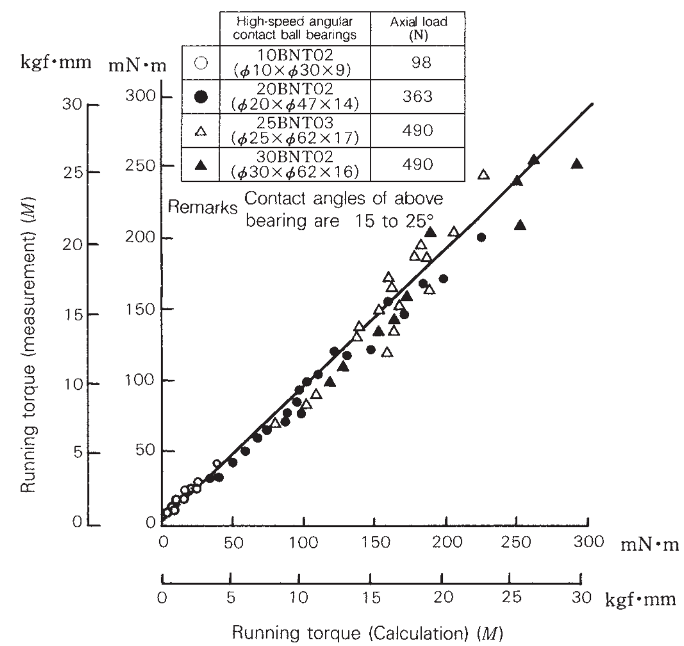


Fig. 10.3 Comparison of Actual Measurements and Calculated Values

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 (10.8), (10.9), and (10.10):

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

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

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

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...(1/2) of the cup angle (°)
- β : (1/2) of 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,

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

where, μ_e: Friction coefficient between inner ring large rib and roller endface

The starting torque M for one bearing is given by,

$$M = F Z l$$

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

because, $D_{w1} = 2\,\overline{OB} \sin\beta$, and $l = \overline{OB} \sin\alpha$.
If we substitute these into Equation (10.12) we obtain,

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

The 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. The torque caused by other factors can be ignored. Values for e and β in Equation (10.12) are determined by the bearing design. Consequently, assuming a value for μ_e, the starting torque can be calculated.
The values for μ_e and for e have to be thought of as a dispersion, thus, even for bearings with the same number, the individual starting torques can be quite diverse. When using a value for e determined by the bearing design, the average value for the bearing starting torque can be estimated using μ_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.

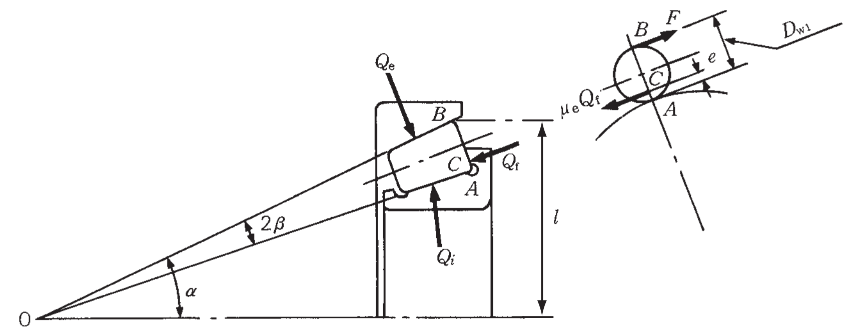


Fig. 10.4

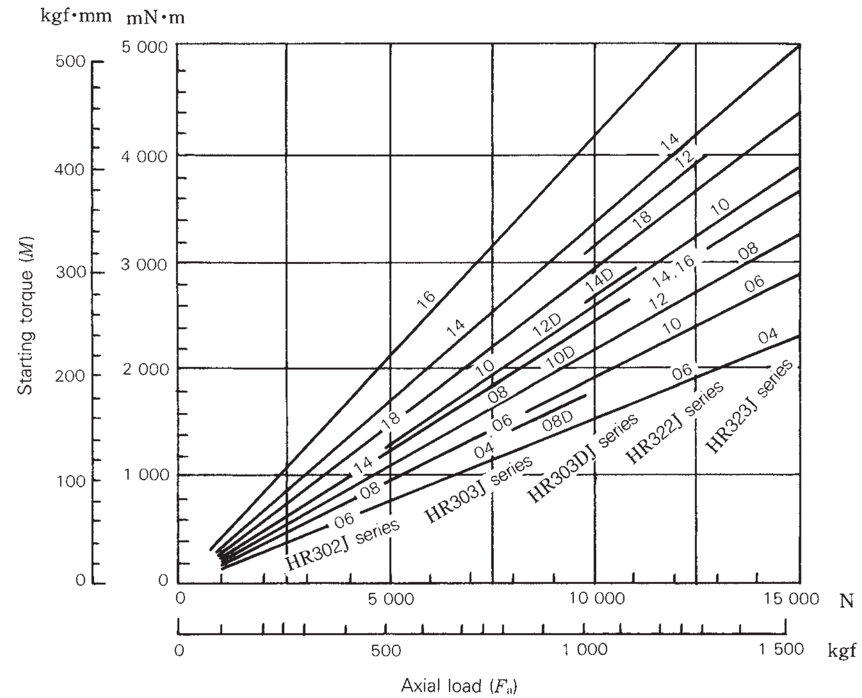


Fig. 10.5 Axial Load and Starting Torque for Tapered Roller Bearings

10.3.4 Empirical Equations for Running Torque of Tapered Roller Bearings

When tapered roller bearings operate under axial load, we reanalyzed the torque of tapered roller bearings 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.

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

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

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…(1/2) of the cup angle
β: (1/2) of tapered roller angle

For simplification, a model using the average diameter D_{we} as shows in Fig. 10.7 can be used.

Where, 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

In Fig. 10.7, when the balance of sliding friction and moments on the rollers are considered, the following equations are obtained:

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

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

When the running torque M applied on the outer (inner) ring is calculated using Equations (10.16) and (10.17) and multiplying by Z, which is the number of rollers:

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

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

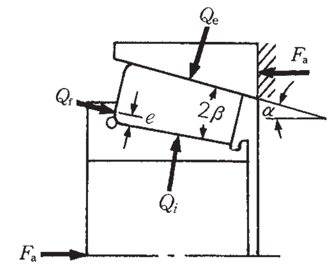


Fig. 10.6 Loads Applied on Roller

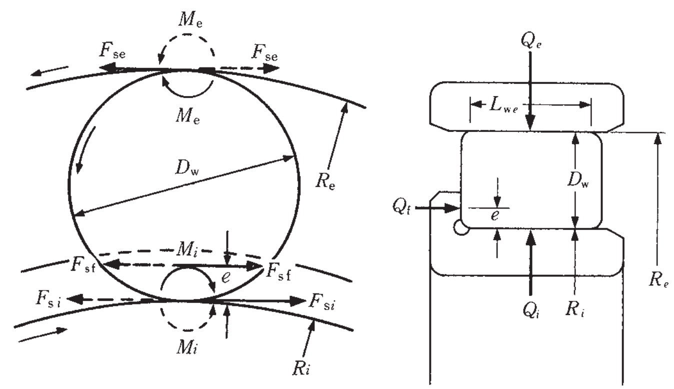


Fig. 10.7 Model of Parts where Friction is Generated

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.

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

Sliding Friction on Rib M_S

As a part of M_S, F_{sf} is the tangential load caused by sliding, so we can write $F_{sf}=\mu Q_f$ using the coefficient of dynamic friction μ. Further, by substitution of the axial load F_a,
the following equation is obtained:

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

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

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

Where μ_0 is approximately 0.2 and $f'(\Lambda, t, \sigma)$ is a function which decreases with running in and oil film formation, but it is set equal to one when starting.

Rolling Friction on Raceway Surface M_R

Most of the rolling friction on the raceway is viscous oil resistance (EHL rolling resistance). M_i and M_e in Equation (10.18) correspond to it. A theoretical equation exists, but it should be corrected as a result of experiments. We obtained the following equation that includes corrective terms:

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

$$f(w)=\left(\frac{kF_a}{E'\,D_w L_{we} Z\sin\alpha}\right)^{0.3} \quad \text{(10.22)}$$

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)

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

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. When needed, please consult NSK.

[Explanation of Symbols]

- 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 (Half of cup angle)
- R_i, R_e: Inner and outer ring raceway radii (center)
- β: Half angle of roller
- i, e: Indicate inner ring or outer ring respectively
- L_{we}: Effective roller length

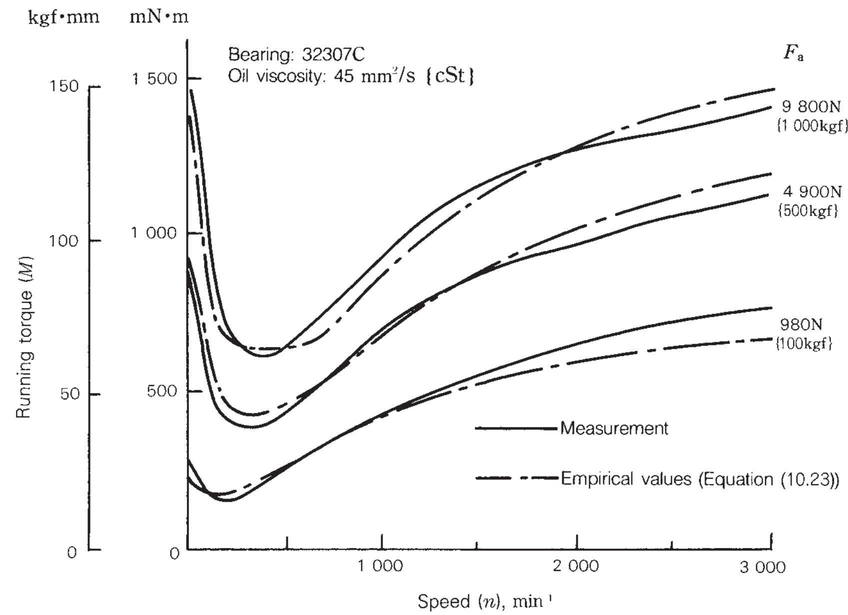


Fig. 10.8 Comparison of Empirical Values with Actual Measurements

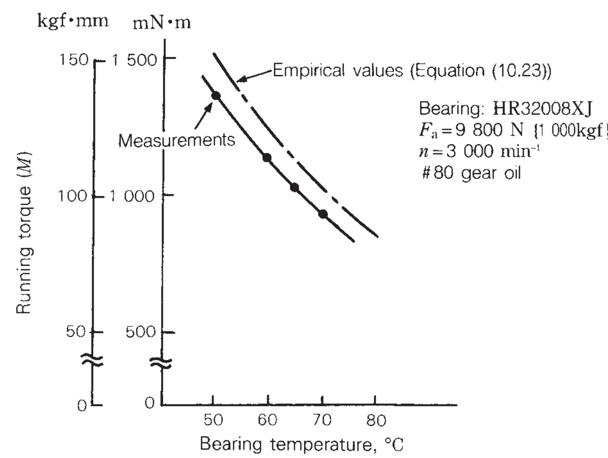


Fig. 10.9 Viscosity Variation and Running Torque

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 bearing rings, rolling elements and cage, which are the basic components of a bearing, is prevented by an oil film which reduces the friction and wear in the 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 the fatigue life, but it is shortened if the viscosity of the oil is too low so the film thickness is insufficient.

(3) Dissipation of Frictional Heat and Cooling
Circulation lubrication may be used to carry away frictional heat or heat transferred from the outside to prevent the bearing from overheating and the oil from deteriorating.

(4) Others
Adequate lubrication also helps to prevent foreign material from entering the bearings and guards against corrosion or rusting.

11.2 Lubricating Methods

The various lubricating methods are first divided into either grease or oil lubrication. Satisfactory bearing performance can be achieved by adopting the lubricating method which is most suitable for the particular application and operating condition.
In general, oil offers superior lubrication; however, grease lubrication allows 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 is 65% to 80% of that with oil lubrication.	Higher limiting speed.
Cooling Effect	Poor	Heat transter is possible using forced oil circulation.
Fluidity	Poor	Good
Full Lubricant Replacement	Sometimes difficult	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, the bearings for the main shafts of machine tools, where the accuracy may be impaired by a small temperature rise, require only a small amount of grease. The quantity of grease for ordinary bearings is determined as follows.
Sufficient grease must be packed inside the bearing including the cage guide face. The available space inside the housing to be packed with grease depends on the speed as follows:

1/2 to 2/3 of the space … When the speed is less than 50% of the limiting speed.
1/3 to 1/2 of the space … When the speed is more than 50% of the limiting speed.

(2) Replacement of Grease

Grease, once packed, usually need not be replenished for a long time; however, for 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 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 is made larger than the partitioned side so it can retain the old grease, which is removed periodically by removing the cover.

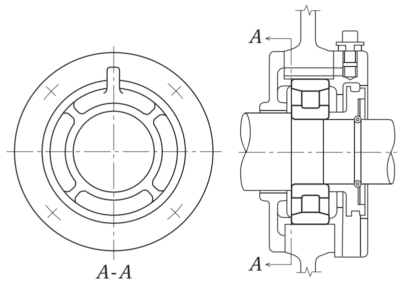


Fig. 11.1 Combination of Partitioned Grease Reservoir and Grease Valve

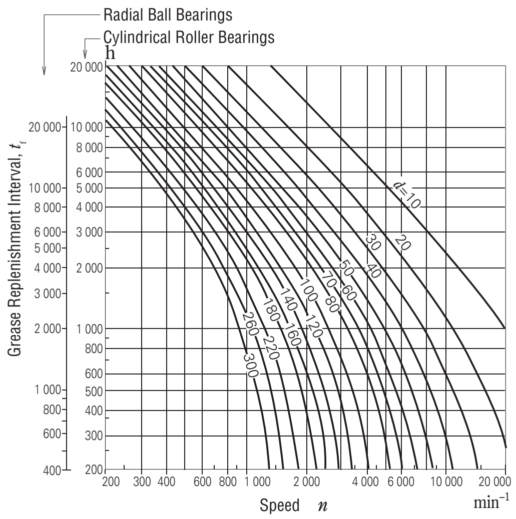
(3) Replenishing Interval

Even if high-quality grease is used, there is deterioration of its properties with time; therefore, periodic replenishment is required. Figs 11.2 (1) and (2) show the replenishment time intervals for various bearing types running at different speeds. Figs.11.2 (1) and (2) apply for the condition of high-quality lithium soap-mineral oil grease, bearing temperature of 70°C, and normal load (P/C=0.1).

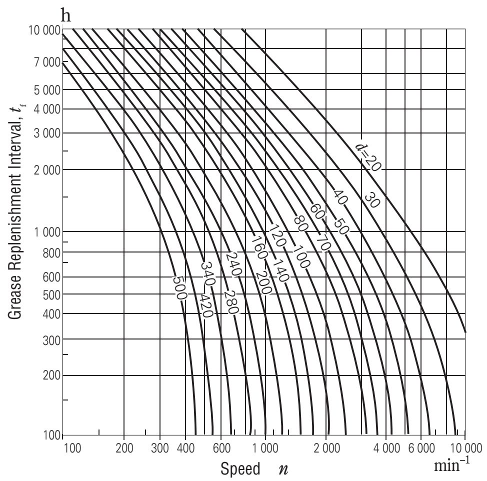
· Temperature
If the bearing temperature exceeds 70°C, the replenishment time interval must be reduced by half for every 15°C temperature rise of the bearings.

· Grease
In case of ball bearings especially, the replenishing time interval can be extended depending on used grease type. (For example, high-quality lithium soap-synthetic oil grease may extend about two times of replenishing time 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.)
It is advisable to consult NSK.

· Load
The replenishing time interval depends on the magnitude of the bearing load.
Please refer to Fig.11.2 (3).
If P/C exceeds 0.16, it is advisable to 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) or (11.2) or Fig. 11.3:

(General purpose grease ([1]))

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

(Wide-range grease ([2]))

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

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 listed in the bearing tables)
T : Operating temperature °C

Equations (11.1) and (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 $\frac{n}{N_{max}} = 0.25$

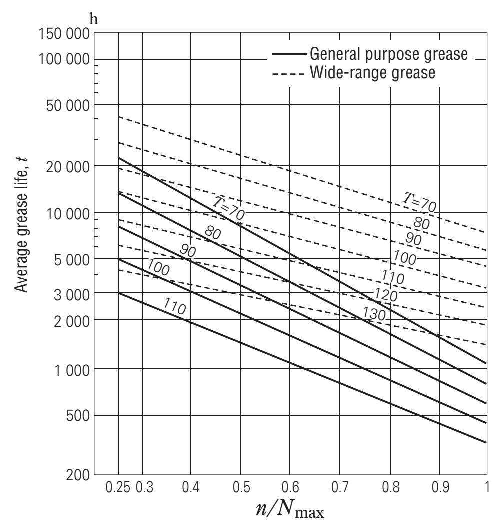


Fig. 11.3 Grease Life of Sealed Ball Bearings

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

$70\ °C \leqq T \leqq 110\ °C$

For wide-range grease ([2])

$70\ °C \leqq T \leqq 130\ °C$

When $T < 70$ °C assume $T = 70$ °C

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

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

11.2.2 Oil Lubrication

(1) Oil Bath Lubrication

Oil bath lubrication is a widely used with low or medium speeds. The oil level should be at the center of the lowest rolling element. It is desirable to 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 the screw in the top.

(3) Splash Lubrication

With this lubricating 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.

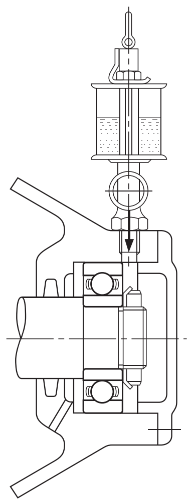


Fig. 11.5 Drip Feed Lubrication

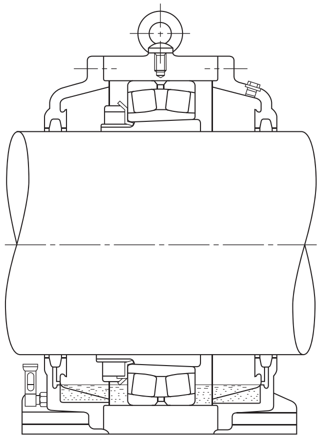


Fig. 11.4 Oil Bath Lubrication

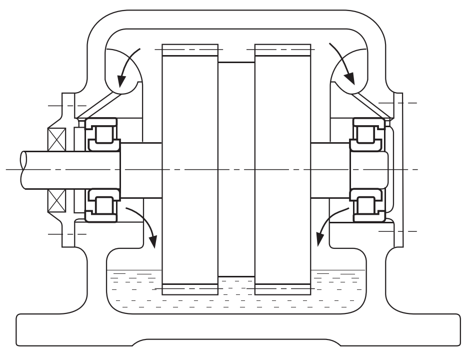
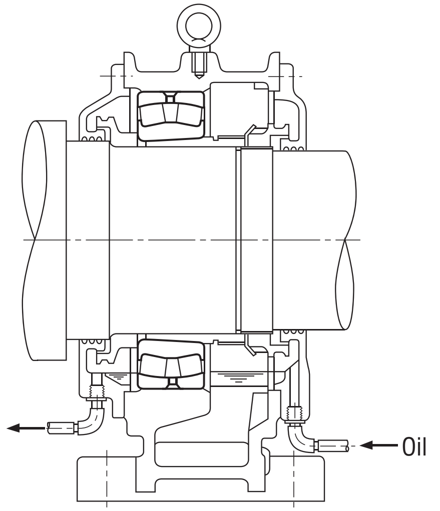


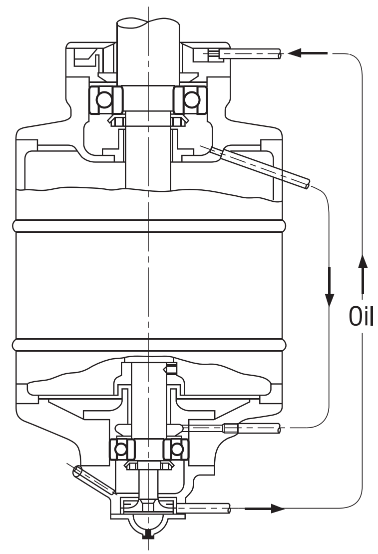
Fig. 11.6 Splash Lubrication

(4) Circulating Lubrication

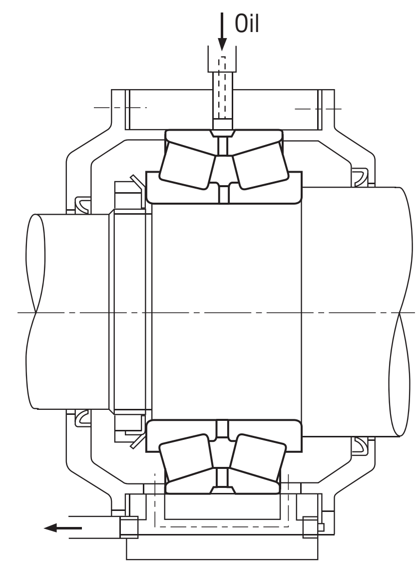
Circulating lubrication is commonly used for high speed operation requiring bearing cooling and for bearings used at high temperatures. As shown in Fig. 11.7 (a), oil is supplied by the pipe on the right side, it travels through the bearing, and drains out through the pipe on the left. After being cooled in a reservoir, it returns to the bearing through a pump and filter.
The oil discharge pipe should be larger than the supply pipe so an excessive amount of oil will not back up in the housing.



(a)



(b)

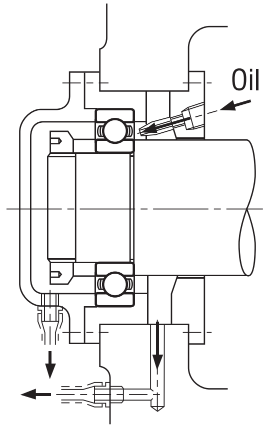


(c)

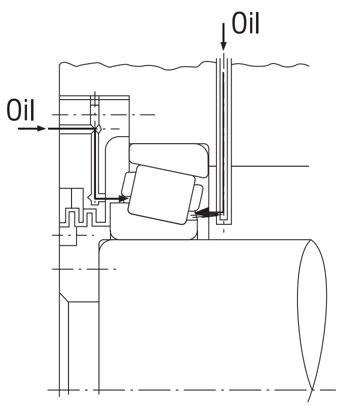
Fig. 11.7 Circulating Lubrication

(5) Jet Lubrication

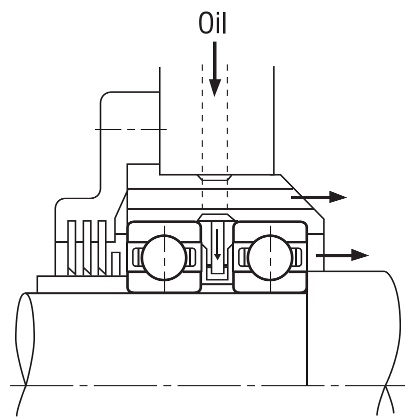
Jet lubrication is often used for ultra high speed bearings, such as the bearings in jet engines with a $d_m n$ valve (d_m: pitch diameter of rolling element set in mm; n: rotational speed in min^{-1}) exceeding one million. Lubricating oil is sprayed under pressure from one or more nozzles directly 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 the case of 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 (which is also the guide face for the cage).
More uniform cooling and a better temperature distribution is achieved using more nozzles for a given amount of oil. It is desirable for the oil to be forcibly discharged so 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, also called 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 slight because the oil leakage is small.
(c) It is relatively easy to continuously supply fresh oil; therefore, the bearing life is extended.
This lubricating method is used in bearings for the high speed spindles of machine tools, high speed pumps, roll necks of rolling mills, etc (Fig. 11.9).
For oil mist lubrication of large bearings, it is advisable to consult NSK.

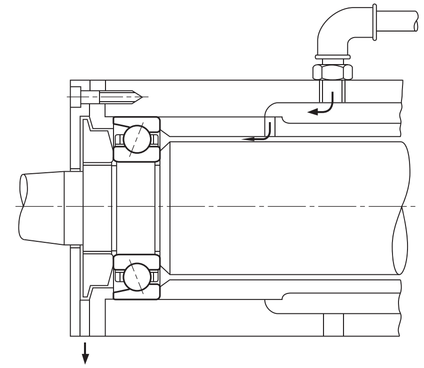


Fig. 11.9 Oil Mist Lubrication

(7) Oil/Air Lubricating Method

Using 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:
(a) Since the minimum necessary amount of oil is supplied, this method is suitable for high speeds because less heat is generated.
(b) Since the minimum amount of oil is fed continuously, bearing temperature remains stable. Also, because of the small amount of oil, there is almost no atmospheric pollution.
(c) Since only fresh oil is fed to the bearings, oil deterioration need not be considered.
(d) Since compressed air is always fed to the bearings, the internal pressure is high, so dust, cutting fluid, etc. cannot enter.
For these reasons, this method is used in the main spindles of machine tools and other high speed applications (Fig. 11.10).

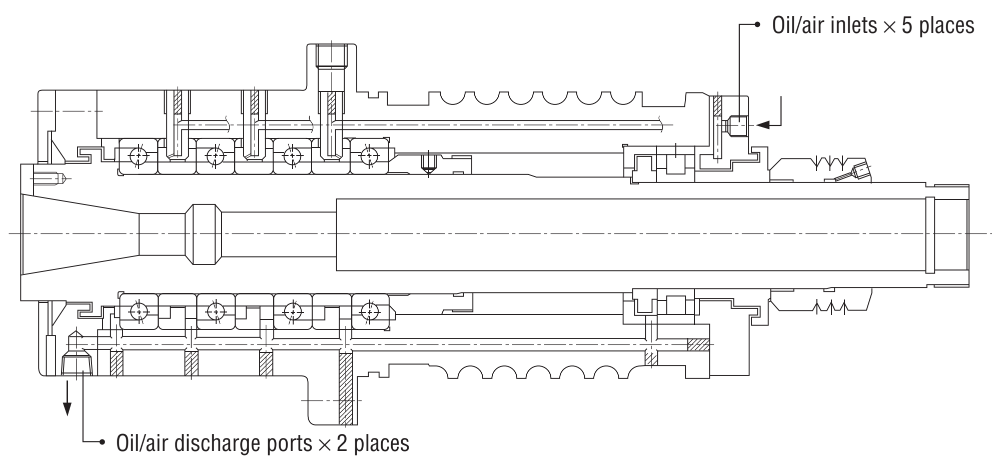


Fig. 11.10 Oil/Air Lubrication

11.3 Lubricants

11.3.1 Lubricating Grease

Grease is a semi-solid lubricant consisting of base oil, a thickener and additives. The main types and general properties of grease are shown in Table 11.2. It should be remembered 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 mainly 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 greases made with high viscosity base oils are 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

As thickeners for lubricating grease, there are 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, please be aware 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 Grease Properties

Name (Popular name)	Lithium Grease			Sodium Grease (Fiber Grease)	Calcium Grease (Cup Grease)	Mixed Base Grease	Complex Base Grease (Complex Grease)	Non-Soap Base Grease (Non-Soap Grease)	
Thickener	Li Soap			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.	
Base Oil / Properties	Mineral Oil	Diester Oil, Polyatomic Ester Oil	Silicone Oil	Mineral Oil	Mineral Oil	Mineral Oil	Mineral Oil	Mineral Oil	Synthetic Oil (Ester Oil, Polyatomic Ester Oil, Synthetic Hydrocarbon Oil, Silicone Oil, Fluoric Based Oil)
Dropping Point, ℃	170 to 195	170 to 195	200 to 210	170 to 210	70 to 90	160 to 190	180 to 300	> 230	> 230
Working Temperatures, ℃	−20 to +110	−50 to +130	−50 to +160	−20 to +130	−20 to +60	−20 to +80	−20 to +130	−10 to +130	< +220
Working Speed, %([1])	70	100	60	70	40	70	70	70	40 to 100
Mechanical Stability	Good	Good	Good	Good	Poor	Good	Good	Good	Good
Pressure Resistance	Fair	Fair	Poor	Fair	Poor	Fair to Good	Fair to Good	Fair	Fair
Water Resistance	Good	Good	Good	Poor	Good	Poor for Na Soap Grease	Good	Good	Good
Rust Prevention	Good	Good	Poor	Poor to Good	Good	Fair to Good	Fair to Good	Fair to Good	Fair to Good
Remarks	General purpose grease used for numerous applications	Good low temperature and torque characteristics. Often used for small motors and instrument bearings. Pay attention to rust caused by insulation varnish.	Mainly for high temperature applications. Unsuitable for bearings for high and low speeds or heavy loads or those having numerous sliding-contact areas (roller bearings, etc.)	Long and short fiber types are available. Long fiber grease is unsuitable for high speeds. Attention to water and high temperature is requred.	Extreme pressure grease containing high viscosity mineral oil and extreme pressure additive (Pb soap, etc.) has high pressure resistance.	Often used for roller bearings and large ball bearing.	Suitable for extreme pressures mechanically stable	Mineral oil base grease is middle and high temperature purpose lubricant. Synthetic oil base grease is recommended for low or high temperature. Some silicone and fluoric oil based grease have poor rust prevention and noise.	

Note ([1]) The values listed are percentages of the limiting speeds given in the bearing tables.

Remark The grease properties shown here can vary between brands.

(3) Additives

Grease often contains various additives such as antioxidants, corrosion inhibitors, and extreme pressure additives to give it special properties. It is recommended that extreme pressure additives be used in 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 working conditions.

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 1/10mm. 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 the 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 oil or synthetic oil that have a high oil film strength and superior oxidation and corrosion resistance. When selecting a lubricating oil, the viscosity at the operating conditions is important. If the viscosity is too low, a proper oil film is not formed and abnormal wear and seizure may occur. On the other hand, if the viscosity is too high, excessive viscous resistance may cause heating or large power 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.

For use when selecting the proper lubricating oil, Fig. 11.11 shows the relationship between oil temperature and viscosity, and examples of selection 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)

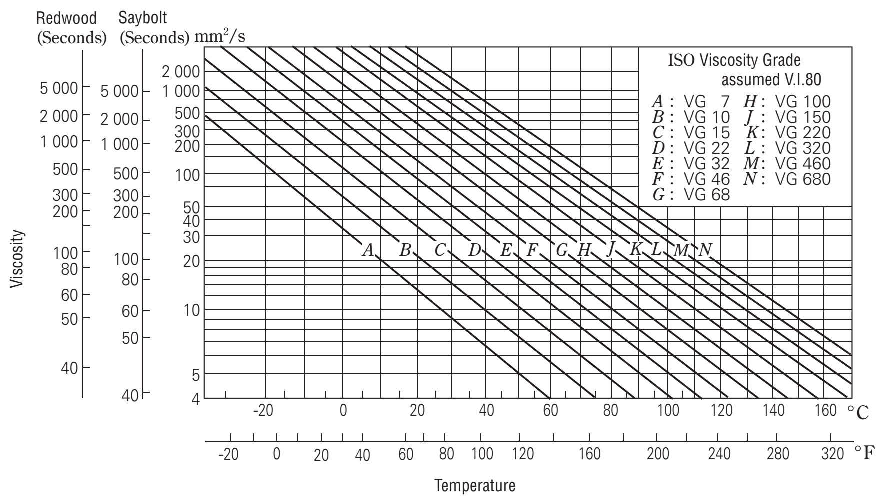


Fig. 11.11 Temperature-Viscosity Chart

Oil Replacement Intervals

Oil replacement intervals depend on the operating conditions and oil quantity.

In those cases where the operating temperature is less than 50°C, and the environmental conditions are good with little dust, the oil should be replaced approximately once a year. However, in cases where the oil temperature is about 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.

Mixing different brands of oil must be prevented for the same reason given previously for grease.

Table 11. 5 Examples of Selection Lubricating Oils

Operating Temperature	Speed	Light or normal Load	Heavy or Shock Load
−30 to 0 ℃	Less than limiting speed	ISO VG 15, 22, 32 (refrigerating machine oil)	–
0 to 50 ℃	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 ℃	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 ℃	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. For the limiting speed, use the values listed in the bearing tables.
2. Refer to Refrigerating Machine Oils (JIS K 2211), Bearing Oils (JIS K 2239), Turbine Oils (JIS K 2213), Gear Oils (JIS K 2219).
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℃ or higher than 110℃ , it is advisable to consult NSK.

11.4 Technical Data

11. 4. 1 Brands and Properties of Lubricating Greases

Table 11. 6 Brands of Lubricating Greases

Brands	Thickeners	Base Oils	Dropping Point (Å@)	Consistency	Working Temperature Range(1)(°C)	Pressure Resistance	Usable Limit Compared to Listed Limiting Speed(Grease)(2)(%)
EA3 GREASE	Urea (3)	Poly-α-olefin oil	≧260	230	−40 to +150	Fair	100
EA5 GREASE	Urea (3)	Poly-α-olefin oil	≧260	251	−40 to +160	Good	60
EA6 GREASE	Urea (3)	Poly-α-olefin oil	≧260	220	−40 to + 160	Fair	70
EA7 GREASE	Urea (3)	Poly-α-olefin oil	≧260	243	−40 to +160	Fair	100
EA9 GREASE	Urea (3)	Poly-α-olefin oil	≧260	314	−40 to +140	Fair	100
ENS GREASE	Urea (3)	Polyol ester oil (4)	≧260	264	−40 to +160	Poor	100
ECE GREASE	Lithium	Poly-α-olefin oil	≧260	235	−10 to +120	Poor	100
DOW CORNING(R) SH 44 M GREASE	Lithium	Silicone oil (5)	210	260	−30 to +130	Poor	60
NS HI-LUBE	Lithium	Ester oil + Diester oil (4)	192	250	−40 to +130	poor	100
LG2 GREASE	Lithium	Poly-α-olefin oil + Mineral oil	201	199	−20 to +70	Poor	100
LGU GREASE	Urea (3)	Poly-α-olefin oil	≧260	201	−40 to +120	Fair	70
EMALUBE 8030	Urea (3)	Mineral oil	≧260	280	0 to +130	Good	60
KP1 GREASE	PTFE	Perfluoropolyether oil	Not applicable	290	−30 to +200	Fair	60
SHELL ALVANIA GREASE S2	Lithium	Mineral oil	181	275	−10 to +110	Fair	70
SHELL ALVANIA GREASE S3	Lithium	Mineral oil	182	242	−10 to +110	Fair	70
SHELL SUNLIGHT GREASE 2	Lithium	Mineral oil	200	274	−10 to +110	Fair	70
WPH GREASE	Urea (3)	Poly-α-olefin oil	259	240	−40 to +150	Fair	70
NIGLUBE RSH	Sodium Complex	Glycol oil	≧260	270	−20 to +140	Fair	60
PALMAX RBG	Lithium Complex	Mineral oil	216	300	−10 to +130	Good	70
MULTEMP PS No.2	Lithium	Poly-α-olefin oil + Diester oil	190	275	−50 to +110	Poor	100
MOLYKOTE(R) FS-3451GREASE	PTFE	Fluorosilicone oil	Not applicable	285	0 to +180	Fair	70
UME GREASE	Urea (3)	Mineral oil	≧260	272	−10 to +130	Fair	70
RW1 GREASE	Urea (3)	Mineral oil	≧260	300	−10 to +130	Fair	70
HA1 GREASE	Urea (3)	Ether oil	≧260	290	−40 to +160	Fair	70
HA2 GREASE	Urea (3)	Ether + Poly-α-olefin oil	≧260	295	−30 to +170	Fair	70
KLUBERSYNTH HB 72-52	Urea (3)	Ester oil	250	295	−30 to +160	Fair	70
NOXLUB KF0921	PTFE	Perfluoropolyether oil	Not applicable	280	−40 to +200	Fair	70
ECH GREASE	Carbon Brack	Perfluoropolyether oil	Not applicable	205	−30 to +260	Fair	60
FWG GREASE	Urea (3)	Mineral oil + Poly-α-olefin oil	≧260	268	−30 to +150	Fair	70
HT1 GREASE	Urea (3)	Poly-α-olefin oil	≧260	236	−40 to +150	Fair	100
ARAPEN RB320	Lithium-Calcium	Mineral oil	177	305	−10 to +80	Fair	70
SHELL GADUSRAIL S4 HIGH SPEED EUFR	Lithium	Mineral oil	188	266	−10 to +110	Fair	100

Notes
(1) If grease will be used at the upper or lower limit sufficient of the temperature range or in a special environment such as vacuum, it is advisable to consult NSK.
(2) For short-term operation or when cooling is 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.

12. BEARING MATERIALS

12. BEARING MATERIALS

12.1 Materials for Bearing Rings and Rolling Elements

SUJ2
JIS
SUJ3
SUJ2
AISI 5210 DIN 100 Cr6
BS 535A99

Table 12.1 Chemical Composition of High-Carbon Chromium Bearing Steel (Major Elements)

		(%)						
		C	Si	Mn	P	S	Cr	Mo
JIS G 4805	SUJ 2	0.95 to 1.10	0.15 to 0.35	0.50	0.025	0.025	1.30 to 1.60	
	SUJ 3	0.95 to 1.10	0.40 to 0.70	0.90 to 1.15	0.025	0.025	0.90 to 1.20	
	SUJ 4	0.95 to 1.10	0.15 to 0.35	0.50	0.025	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	0.025	0.015	1.35 to 1.60	0.10

Table 12.2 Chemical Composition of Carburizing Bearing Steels (Major Elements)

		(%)							
		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	0.030	0.030	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	0.030	0.030	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	0.030	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	0.030	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	0.030	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	0.025	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	0.025	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	0.025	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

		(%)										
		C	Si	Mn	P	S	Cr	Mo	V	Ni	Cu	Co	W
AISI	M50	0.77 to 0.85	0.25	0.35	0.015	0.015	3.75 to 4.25	4.00 to 4.50	0.90 to 1.10	0.10	0.10	0.25	0.25

12.2 Cage Materials

Table 12.4 Chemical Composition of Stainless Steel for Rolling Bearing (Major Elements)

		(%)						
		C	Si	Mn	P	S	Cr	Mo
JIS G 4303	SUS 440 C	0.95 to 1.20	1.00	1.00	0.040	0.030	16.00 to 18.00	0.75
SAE J 405	51440 C	0.95 to 1.20	1.00	1.00	0.040	0.030	16.00 to 18.00	0.75

Table 12.5 Chemical Composition of Steel sheet and Carbon Steel for Cages (Major Elements)

			(%)				
			C	Si	Mn	P	S
	JIS G 3141	SPCC	0.12		0.50	0.04	0.045
	BAS 361	SPB 2	0.13 to 0.20	0.30	0.25 to 0.60	0.03	0.030
	JIS G 3311	S 50 CM	0.47 to 0.53	0.15 to 0.35	0.60 to 0.90	0.03	0.035
	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

Table 12.6 Chemical Composition of High Strength Brass for Machined Cages

		(%)								
		Cu	Zn	Mn	Fe	Al	Sn	Ni		
									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	1.0	1.0	0.4	0.1
JIS H 3250	C 6782	56.0 to 60.5		0.5 to 2.5	0.1 to 1.0	0.2 to 2.0			0.5	

Remark HBsC 1

12.3 Characteristics of Bearing and Shaft/ Housing Materials

Table 12.7 Physical and Mechanical Properties of Bearing and Shaft/Housing Materials

			g cm³	kJ kg·K	W m·K	μΩ·cm	Linear expansion coeff. ℃ × ⁻⁶ ℃	MPa kgf mm²	MPa kgf mm²	MPa kgf mm²		HB	
	SUJ												
	SUJ												
	SCr												
	SAE SNCM												
	SNCM						—		—				
	SUS C										—		
	SPCC								—			—	
	S C												
	CAC HB₅C	—							—			—	
	S C	℃											
	SCr	℃											
	SCr	℃											
	SCM	℃							—				
	SNCM	℃											
	SC		—	—	—	—	—						
	SUS J	℃ ℃											
	FC					—			—		—		
	FCD					—							
	A											—	
	AC C											—	
	ADC											—	
	SUS												

Note JIS

Remark C SUJ SCr MPa kgf mm² MPa kgf mm²

12.4 Technical Data

12.4.1 Comparison of National Standards of Rolling Bearing Steel

ISO

Part

Table 12.8 Applicable National Standards and Chemical Composition of High-Carbon Chrome Bearing Steel

JIS G	ASTM		C	Si	Mn	Cr	Mo			
SUJ	—	—			≦		—			
—		—					≦			
SUJ	—	—			≦		—			
—	A	—					≦	P≦ S≦		
—	—	r DIN					—	—		
—	—	C NF					≦	P≦ S≦		
—	—	A BS					—			
SUJ	—	—					—			SUJ Grade Grade
—	A Grade	—					≦	P≦ S≦		
—	A Grade	—					≦	P≦ S≦		
SUJ	—	—			≦					SUJ
SUJ	—	—								Grade SUJ Grade SUJ
—	A Grade	—						P≦ S≦		

Note P≦ S≦
Remark ASTM DIN NF BS

Table 12.9 JIS and ASTM **Standards and Chemical Composition of Carburizing Bearing Steel**

JIS G G	ASTM A	C	Si	Mn	Ni	Cr	Mo		
SCr H	—				≦		—		
—	H				—		—		
SCM H	—				≦				
—	H				—				H SCM H
SNCM H	—								
—	H								
SNCM H	—								
—	H								
SNCM	—								
—	H								

Note P≦ S≦ P≦ S≦

12.4.2 Long Life Bearing Steel (NSK Z Steel)

SUJ SAE

Z

Ti S

Z

Z

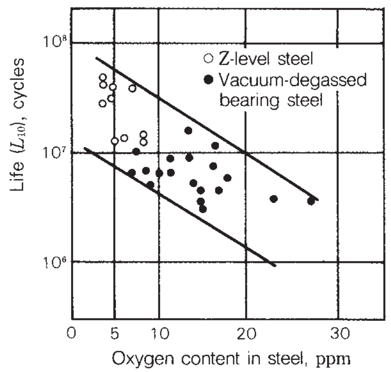


Fig. 12.1 Oxygen Content in Steel and Life of Bearing Steel

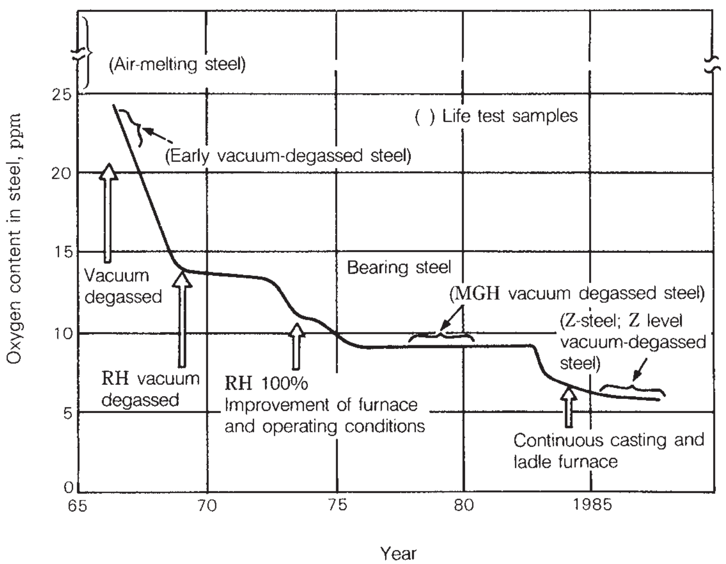
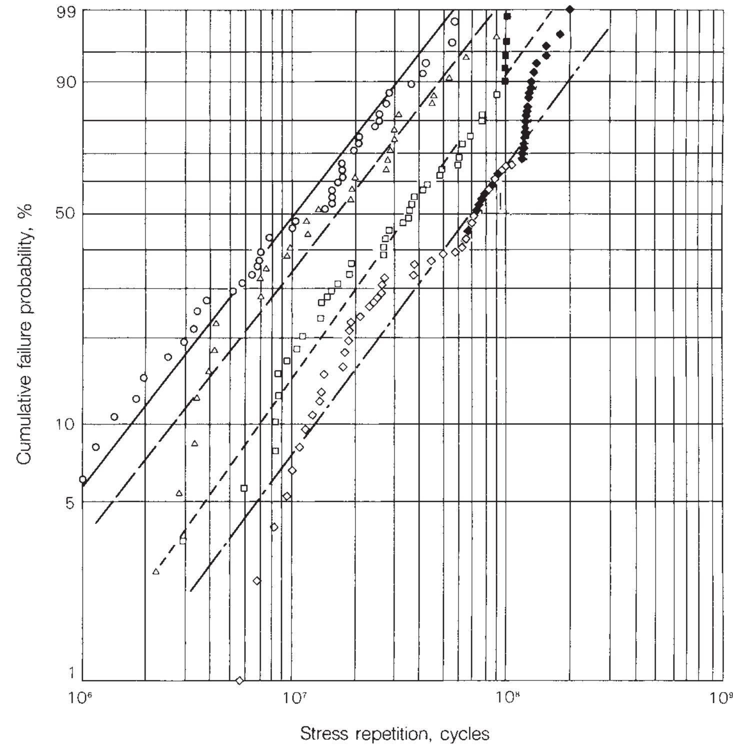


Fig. 12.2 Transition of Oxygen Content in NSK Bearing Steels



				L_{10}	L_{50}
○				× ^{6}	× ^{7}
△				× ^{6}	× ^{7}
□ MGH				× ^{6}	× ^{7}
◇ Z				× ^{7}	× ^{7}

Remark ■ ◆

Fig. 12.3 Result of Thrust Life Test of Bearing Steel

12.4.3 Dimensional Stability of Bearing Steel

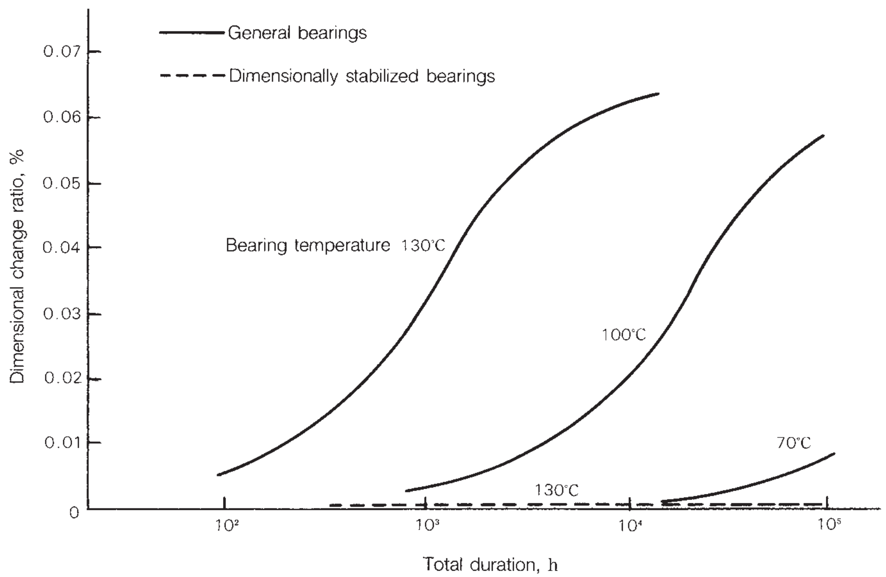
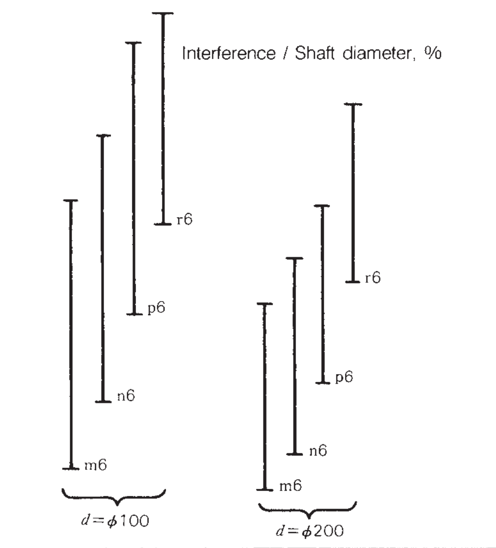


Fig. 12.4 Bearing Temperature and Dimensional Change Ratio



12.4.4 Fatigue Analysis

(1) Measurement of Fatigue Degree

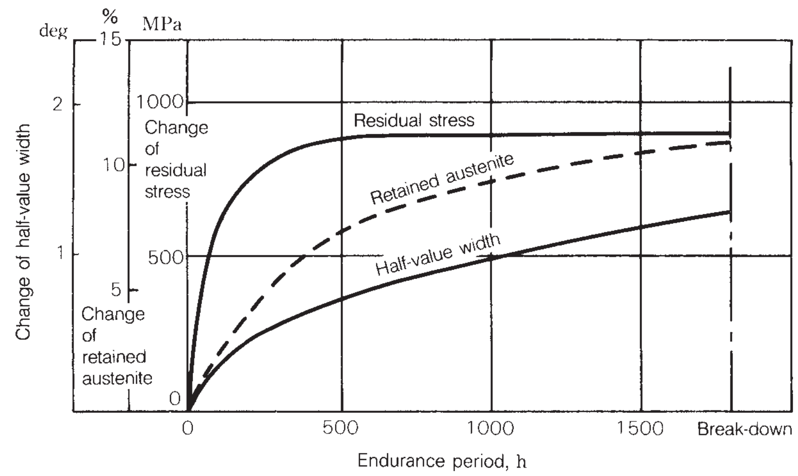


Fig. 12.5 Change in X-ray Measurements

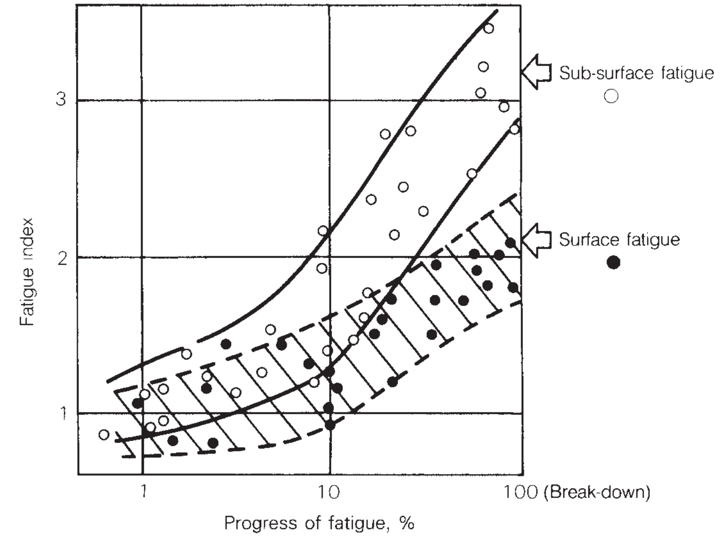


Fig. 12.6 Fatigue Progress and Fatigue Index

(2) Surface and Sub-Surface Fatigues

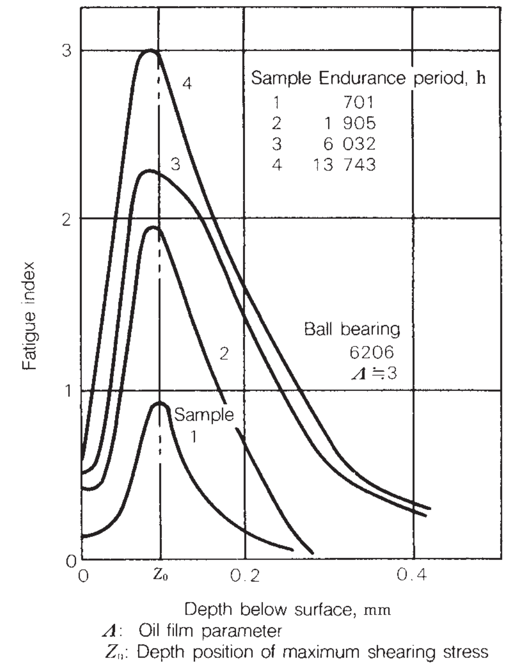


Fig. 12.7 Progress of Sub-Surface Fatigue

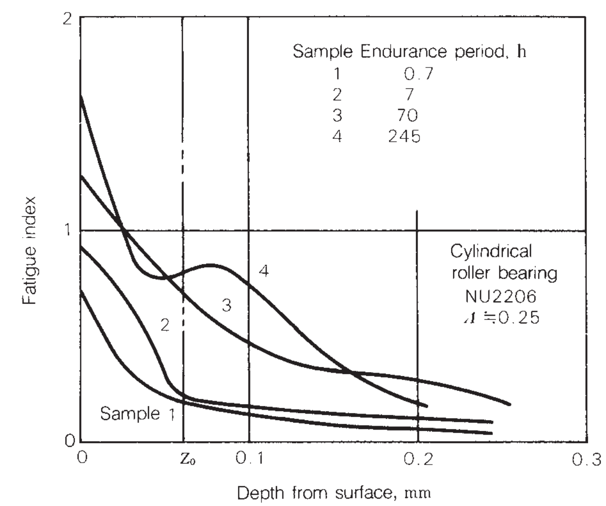


Fig. 12.8 Progress of Surface Fatigue

12.4.5 Hi-TF Bearings and Super-TF Bearings

(1) Hi-TF Bearings, Super-TF Bearings, and TF Technology

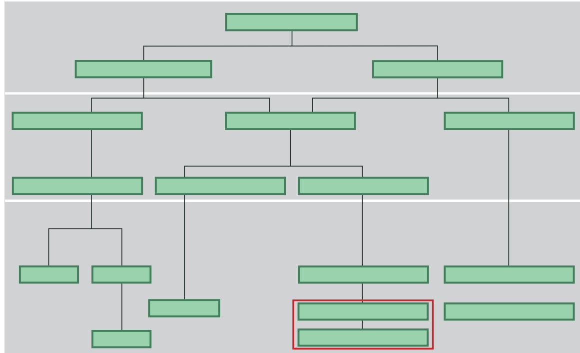


Fig. 12.9 Approaches to Achieving Longer Service Life in Bearings

(2) TF Technology

$[P/P_0 \propto (r/c)^{-0.24}]$ r c

r c

r c

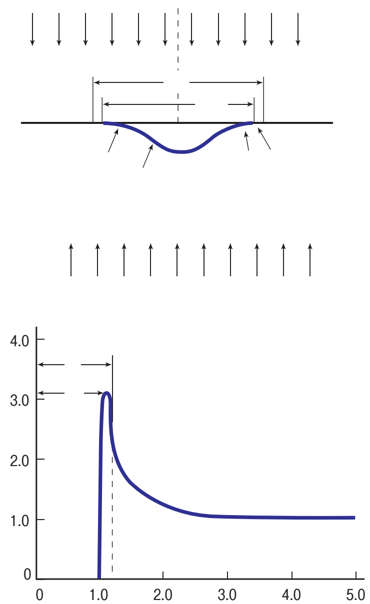


Fig. 12.10 Concentration of Stress around a Surface Dent

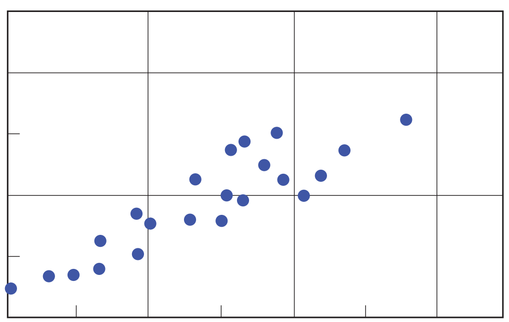


Fig. 12.11 Relationship of r/c Value to Retained Austenite Level

(3) Material Properties of Hi-TF Bearings and Super-TF Bearings

r c

r c

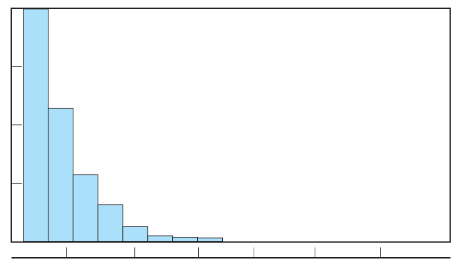


Fig. 12.12 Average Diameter of Carbide and Carbonitride Particles in a Super-TF Bearing

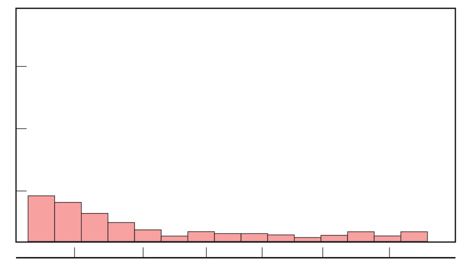


Fig. 12.13 Average Diameter of Carbide Particles in an Ordinary Carburized Steel Bearing

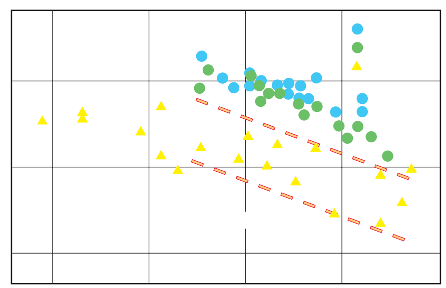


Fig. 12.14 Relationship of Material Hardness and Retained Austenite Level

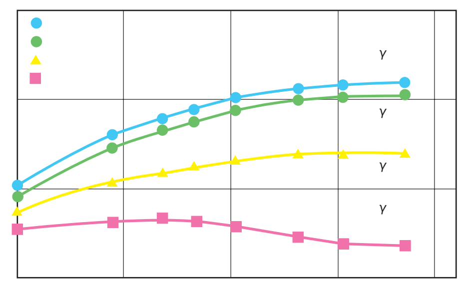


Fig. 12.15 Change of r/c Value under Repeated Stress

(4) Service Life under Contaminated Lubrication Conditions

10

Table 12.10 Comparison of Service Life of L44649/10 Tapered Roller Bearings

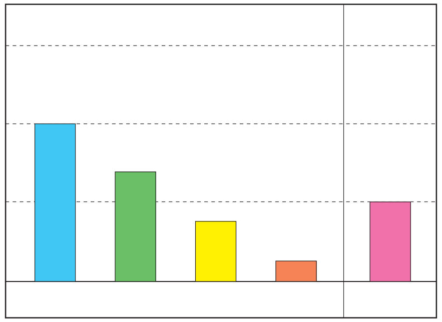


Fig. 12.16 Comparison of Service Life under Contaminated Lubrication

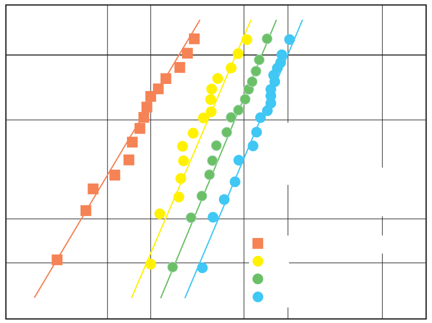


Fig. 12.17 Service Life of L44649/10 Bearings under Contaminated Lubrication

(5) Service Life under Clean Lubrication Conditions

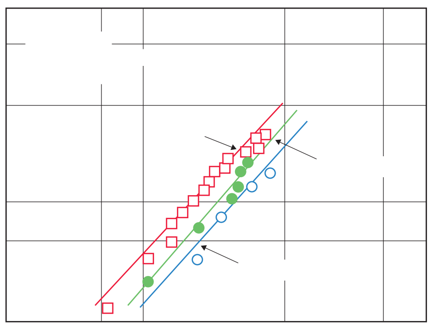


Fig. 12.18 Service Life Tests of 6206 Bearings under Clean Lubrication

(6) Service Life under Boundary Lubrication Conditions

Λ

Λ Λ

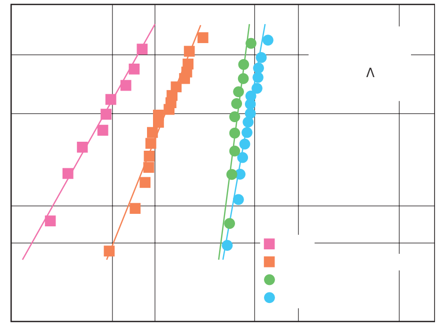


Fig. 12.19 Service Life Tests under Boundary Lubrication Conditions

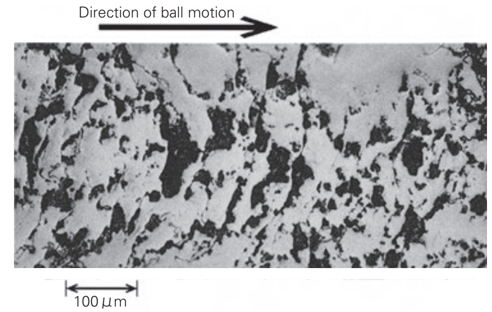


Fig. 12.20 Peeling Damage

(7) Wear and Seizure Resistance

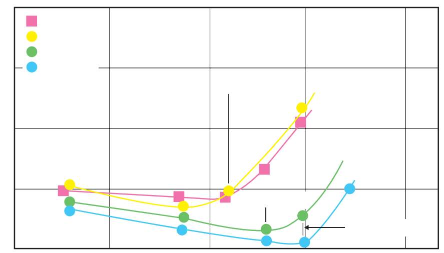


Fig. 12.21 Comparison of Wear Resistance

(8) Heat Resistance

℃

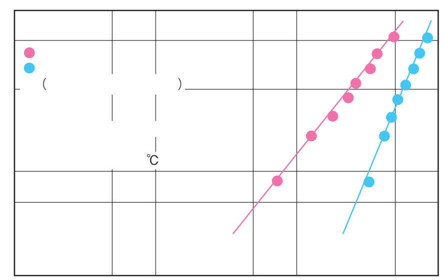


Fig. 12.22 Service Life Test of 6206 under High Temperature Clean Lubrication

12.4.6 Physical Properties of Representative Polymers Used as Bearing Material

PV

Table 12.11 Characteristics of Representative Polymers

	GPa [1]	GPa [1]	g cm^3	× ^{4}mm	× ^{4}mm	℃	℃	℃ [2]	℃	
HDPE UHMWPE							— —		— —	
							—			
PTFE								—		℃
PBT										
POM							— —		—	
PES						—				℃
PSf						—				
							— —			PTFE ℃
PPS GF								>		℃
PEEK										
							> >			
									[3]	℃
PI										℃
PAI						—				℃
PI					—	—				
	—			—		—	—	[3]		

Notes [1] GPa≒ ^{4} kgf cm^2= ^{2} kgf mm^2
[2] " " " " kPa MPa
[3]

12.4.7 Characteristics of Nylon Material for Cages

C

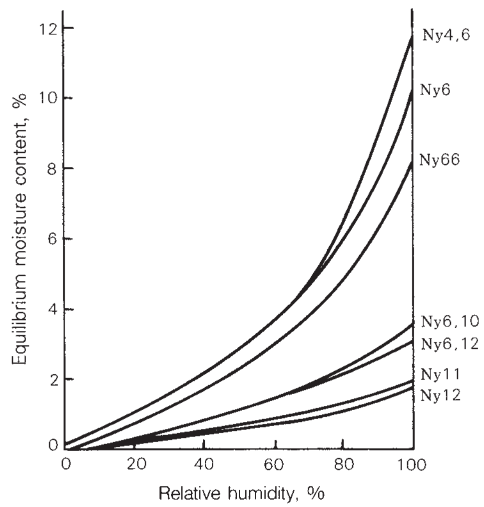


Fig. 12.23 Equilibrium Moisture Content and Relative Humidity of Various Nylons

Table 12.12 Examples of Applications with Fiber Reinforced Nylon Cages

		VCR IC	
	ET H		

Table 12.13 Environmental Resistance of Nylon 66 Resin

		℃		h	
			D		
			A D		
			A		
			A		
			A C		
			B D		
			D		
			D		
			D		
			D		
			A D		
			D		
			D		
			D		
			A D		
			A C		
			B		

A<B<C<D

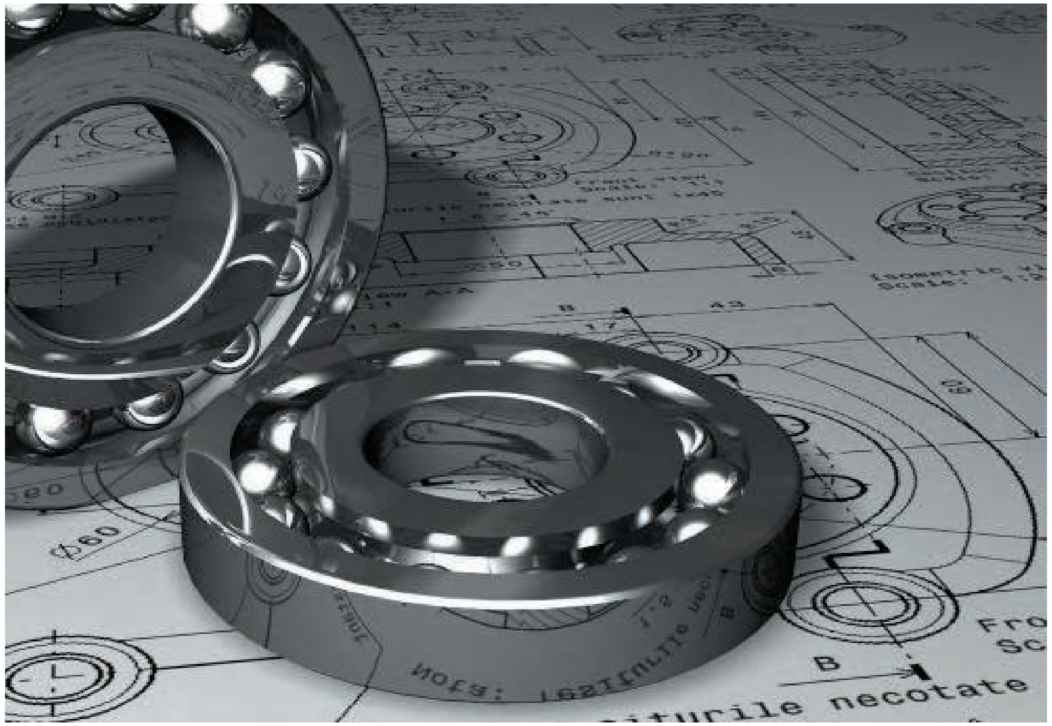
12.4.8 Heat-Resistant Resin Materials for Cages

C

C

Table 12.14 Properties of Typical Super-Engineering Plastic Materials for Cages

	PES	PEI	PAI	PEEK	PPS	L PPS
	℃	℃	℃	℃	℃	℃
	• • •	• • •	• • •	• •	• •	• • •
	• • •	• •	•	•	•	•
	• •	• •	• •	• •	• •	•



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 provide 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 same reason. Housings should be rigid in order to provide firm bearing support. High rigidity housings are advantageous also from he standpoint of 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 one single-piece housing, the fitting surfaces of the housing bore should be designed so both bearing seats may be finished together with one operation such as in -line boring. In the case of split housings, care must be taken in the fabrication of the housing so the outer ring will not become deformed during installation. The accuracy and surface finish of shafts and housings are listed in Table 13.1 for normal operating conditions.

Table 13. 1 Accuracy 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 is for general recommendation using radius measuring method, the basic tolerance (IT) class should be selected in accordance with the bearing precision class. Regarding the figures of IT, please refer to the Appendix Table 11 (page E016).
In cases that the outer ring is mounted in the housing bore with interference or that a thin cross-section bearing is mounted on a shaft and housing, the accuracy of the shaft and housing should be higher 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.

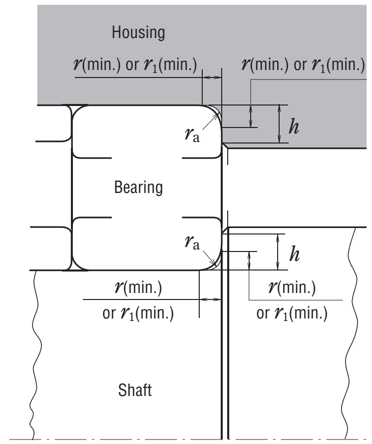


Fig. 13.1 Chamfer Dimensions, Fillet Radius of Shaft and Housing, and Shoulder Height

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 are listed in the bearing tables including the proper shoulder diameters. Sufficient shoulder height is particularly important for supporting the side ribs of tapered roller bearings and cylindrical roller bearings subjected to high axial loads.

The values of h and r_a in Table 13.3 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, Self-Aligning Ball Bearings, Cylindrical Roller Bearings, Solid Needle Roller Bearings	Angular Contact Ball Bearings, Tapered Roller Bearings, 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

Remarks
1. When heavy axial loads are applied, the shoulder height must be sufficiently higher than the values listed.
2. The fillet radius of the corner is also applicable to thrust bearings.
3. The shoulder diameter is listed instead of shoulder height in the bearing tables.

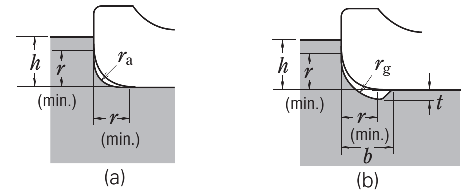


Fig. 13. 2 Chamfer Dimensions, Fillet Radius, and Shoulder Height

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, it is advisable for the full contact length between rollers and rings to be supported by the shaft and housing shoulder (Fig. 13.4).
These diameters d_a and D_a are listed in the bearing tables.

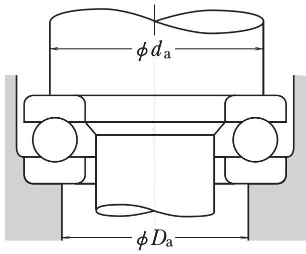


Fig. 13.3 Face Supporting Diameters for Thrust Ball Bearings

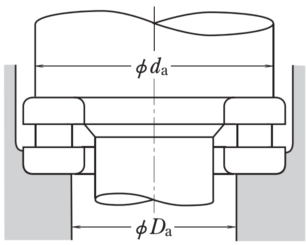


Fig. 13.4 Face Supporting Diameters for Thrust Roller Bearings

13.3 Bearing Seals

To insure the longest possible life of a bearing, it may be necessary to provide seals to prevent leakage of lubricant and entry of dust, water and other harmful material like metallic particles. The seals must be free from excessive running friction and the probability of seizure. They should also be easy to assemble and disassemble. It is necessary to select a suitable seal for each application considering the lubricating method.

13.3.1 Non-Contact Type Seals

Various sealing devices that do not contact the shaft, such as oil grooves, flingers, and labyrinths, are available. 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

The effectiveness of oil groove seals is obtained by means of the small gap between the shaft and housing bore and by multiple grooves on either or both of the housing bore and 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 type seal is often combined with an oil groove seal (Fig. 13.5 (c)). The entry of dust is impeded by packing grease with a consistency of about 200 into the grooves.
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 5mm, with a depth of about 4 to 5mm. In the case of sealing methods using grooves only, there should be three or more grooves.

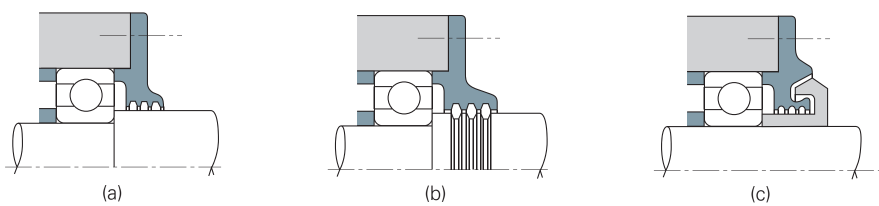


Fig. 13.5 Examples of Oil Grooves

(2) Flinger (Slinger) Type Seals

A flinger is designed to force water and dust away by means of the centrifugal force acting on any contaminants on the shaft. Sealing mechanisms with flingers inside the housing as shown in Fig. 13.6 (a), (b) are mainly intended to prevent oil leakage, and are used in environments with relatively little dust. Dust and moisture are prevented from entering by the centrifugal force of flingers shown in Figs 13.6 (c), (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), (c) have better seal effectiveness.

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

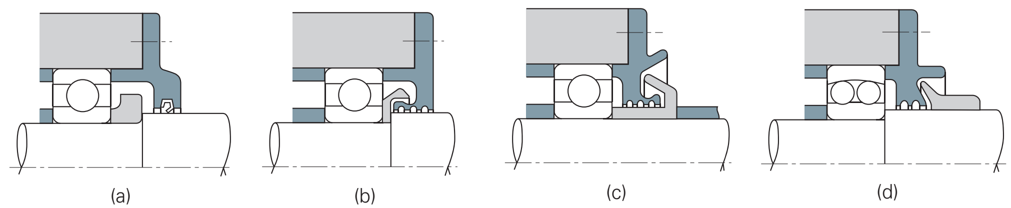


Fig. 13.6 Examples of Flinger Configurations

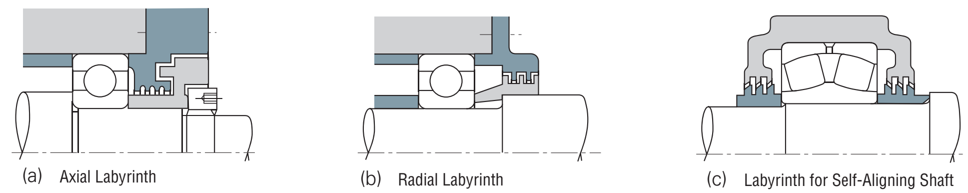


Fig. 13.7 Examples of Labyrinth Designs

13.3.2 Contact Type Seals

The effectiveness of contact seals is achieved by the 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 out as well as to prevent dust, water, and other foreign matter from entering (Figs. 13.8 and 13.9)
In Japan, such oil seals are standardized (Refer to JIS B 2402) on the basis of type and size. 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.
Seal lip materials are usually synthetic rubber including nitrile, acrylate, silicone, and fluorine. Tetrafluoride ethylene is also used. The maximum allowable operating temperature for each material increases in this same order.
Synthetic rubber oil seals may cause trouble 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. It is also desirable for the lubricant inside the housing to spread a little between the sliding surfaces. However, please be aware that ester-based grease will cause acrylic rubber material to swell. Also, 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 the type, the 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 temperature permitted 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 the shaft eccentricity should be less than 0.02 to 0.05 mm.
The hardness of the shaft's contact surface should be made higher than HRC40 by means of heat treatment or hard chrome plating in order to gain abrasion resistance. If possible, a hardness of more than HRC 55 is recommended.
The approximate level of contact surface finish required for several shaft circumferential surface speeds is given in Table 13.7.

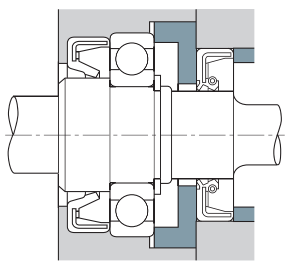


Fig. 13.8 Example of Application of Oil Seal (1)

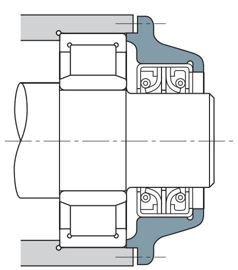


Fig. 13.9 Example of Application of Oil Seal (2)

Table 13. 6 Permissible Circumferential Surface Speeds and Temperature Range 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 for 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 being used for transmission shafts, etc.
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 entering. Felt seals are not suitable for circumferential surface speeds exceeding 4m/sec; therefore, it is preferable to replace them with synthetic rubber seals depending on the application.

Part B

BEARING HANDLING AND MAINTENANCE

1. BEARING HANDLING

1. BEARING HANDLING

1.1 Precautions for Proper Handling of Bearings

(1) Keep Bearings and Surrounding Area Clean

(2) Careful Handling

(3) Use Proper Tools

(4) Prevent Corrosion

1.2 Bearing Storage

1.2.1 Bearing Storage Location

1.2.2 How to Store Bearings

1.3 Mounting

1.3.1 Mounting of Bearings with Cylindrical Bores

(1) Press Fits

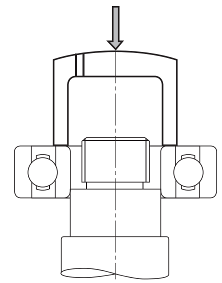


Fig. 1.1 Press Fitting Inner Ring

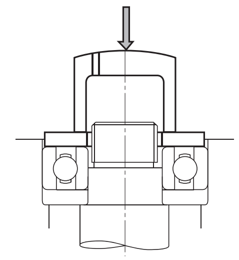


Fig. 1.2 Simultaneous Press Fitting of Inner and Outer Rings

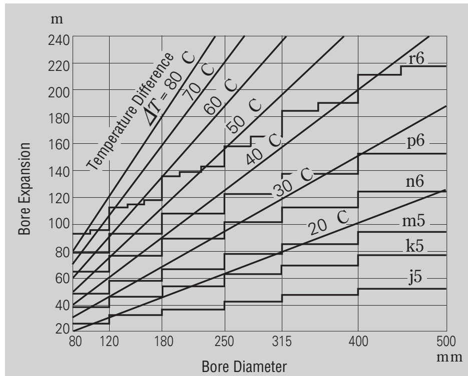


Fig. 1.3 Temperature and Thermal Expansion of Inner Ring

(2) Shrink Fits

C

C

Bearing Induction Heaters

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 another mounting method. Holes are drilled in the sleeve which 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-clearance reduction and referring to the push-in amounts 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 bigger 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 and (which are on a horizontal line passing through the bearing center) and (which is at the lowest position of the bearing) may be used as the residual clearance.
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. Sufficient clearance for easy alignment of the outer ring must be allowed.

1.4 Operation Inspection

After the 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 assure that they rotate smoothly. Items to be checked include sticking due to foreign matter or visible flaws, uneven torque caused by improper mounting or an improper mounting surface, and excessive torque caused by an inadequate clearance, mounting error, or seal friction. If there are no abnormalities, powered operation may be started.

Table 1.1 Mounting of Spherical Roller Bearings with Tapered Bores

Units :

Bearing Bore Diameter		Reduction in Radial Clearance		Push-in amount in axial direction				Minimum Permissible Residual Clearance	
				Taper 1 : 12		Taper 1 : 30			
over	incl.	min.	max.	min.	max.	min.	max.		
		0.025	0.030	0.40	0.45	—	—	0.010	0.025
		0.030	0.035	0.45	0.55	—	—	0.015	0.030
		0.030	0.035	0.45	0.55	—	—	0.025	0.035
		0.040	0.045	0.60	0.70	—	—	0.030	0.040
		0.045	0.055	0.70	0.85	1.75	2.15	0.035	0.050
		0.050	0.060	0.75	0.90	1.9	2.25	0.045	0.065
		0.060	0.070	0.90	1.10	2.25	2.75	0.055	0.080
		0.065	0.080	1.0	1.3	2.5	3.25	0.060	0.100
		0.070	0.090	1.1	1.4	2.75	3.5	0.070	0.110
		0.080	0.100	1.3	1.6	3.25	4.0	0.070	0.110
		0.090	0.110	1.4	1.7	3.5	4.25	0.080	0.130
		0.100	0.120	1.6	1.9	4	4.75	0.090	0.140
		0.110	0.140	1.7	2.2	4.25	5.5	0.100	0.150
		0.120	0.150	1.9	2.4	4.75	6.0	0.110	0.160
		0.140	0.170	2.2	2.7	5.5	6.75	0.120	0.180
		0.150	0.190	2.4	3.0	6	7.5	0.130	0.200
		0.170	0.210	2.7	3.3	6.75	8.25	0.140	0.220
		0.190	0.240	3.0	3.7	7.5	9.25	0.160	0.240
		0.210	0.270	3.4	4.3	8.5	11.0	0.170	0.270
		0.230	0.300	3.7	4.8	9.25	12.0	0.200	0.310
		0.260	0.330	4.2	5.3	10.5	130	0.220	0.330
		0.280	0.370	4.5	5.9	11.5	15.0	0.240	0.390
		0.310	0.410	5.0	6.6	12.5	16.5	0.280	0.430
		0.340	0.460	5.5	7.4	14.0	18.5	0.310	0.470
		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 clearance. For bearing with 3 Clearance,the maximum values listed should be used for the reduction in radial internal clearance.

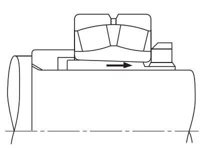


Fig. 1.4 Mounting with Adapter

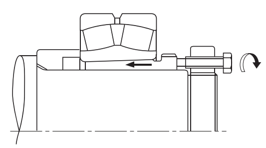


Fig. 1.5 Mounting with Withdrawal Sleeve

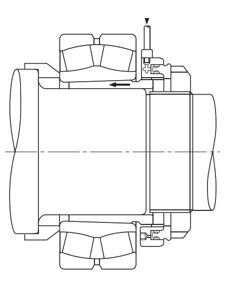


Fig. 1.6 Mounting with Hydraulic Nut

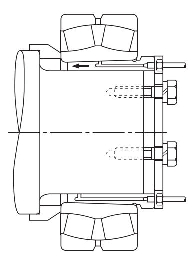


Fig. 1.7 Mounting with Special Sleeve and Hydraulic Pressure

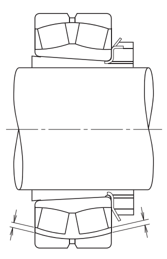


Fig. 1.8 Clearance Measurement of Spherical Roller Bearing

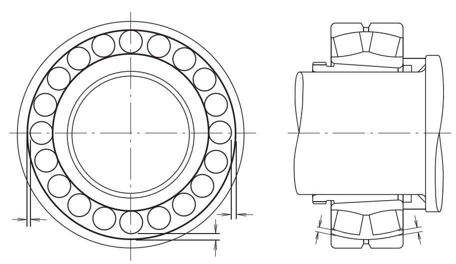


Fig. 1.9 Measuring Clearance in Large Spherical Roller Bearing

Large machines, which cannot be turned by hand, can be started after examination with no load, and the power immediately cutoff and the machine allowed to coast to a stop. Confirm that there is no abnormality such as vibration, noise, contact of rotating parts, etc.
Powered operation should be started slowly without load and the operation should be observed carefully until it is determined that no abnormalities exist, then gradually increase the speed, load, etc. to their normal levels. Items to be checked during the test operation include the existence of abnormal noise, excessive rise of bearing temperature, leakage and contamination of lubricants, etc. If any abnormality is found during the test operation, it must be stopped immediately and the machine should be inspected. If necessary, the bearing should be dismounted for examination.

Although the bearing temperature can generally be estimated by the temperature of the outside surface of the housing, it is more desirable to directly measure the temperature of the outer ring using oil holes for access.

The bearing temperature should rise gradually to the steady state level within one to two hours after the operation starts. If the bearing or its mounting is improper, the bearing temperature may increase rapidly and become abnormally high. The cause of this abnormal temperature may be an excessive amount of lubricant, insufficient bearing clearance, incorrect mounting, or excessive friction of the seals.

In the case of high speed operation, an incorrect selection of bearing type or lubricating method may also cause an abnormal temperature rise.

The sound of a bearing may be checked with a noise locater or other instruments. Abnormal conditions are indicated by a loud metallic sound, or other irregular noise, and the possible cause may include incorrect lubrication, poor alignment of the shaft and housing, or the entry of foreign matter into the bearing. The possible causes and measures for irregularities are listed in Table 1.2.

Table 1. 2 Causes of and Measures for Operating Irregularities

Irregularities		Possible Causes	Measures
Noise	Loud Metallic Sound ( )	Abnormal Load	Improve the fit, internal clearance, preload, position of housing shoulder, etc.
		Incorrect mounting	Improve the machining accuracy and alignment of shaft and housing, accuracy of mounting method.
		Insufficient or improper Lubricant	Replenish the lubricant or select another lubricant.
		Contact of rotating parts	Modify the labyrinth seal, etc.
	Loud Regular Sound	Flaws,corrosion,or scratches on raceways	Replace or clean 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.
		Penetration of foreign particles	Replace or clean the bearing, improve the seals, and use clean lubricant.
		Flaws or flaking on balls	Replace the bearing.
Abnormal Temperature Rise		Excessive amount of lubricant	Reduce amount of lubricant, select stiffer grease.
		Insufficient or improper lubricant	Replenish lubricant or select a better one.
		Abnormal load	Improve the fit, internal clearance, preload, position of housing shoulder.
		Incorrect mounting	Improve the machining accuracy and alignment of shaft and housing, accuracy of mounting, or mounting method.
		Creep on fitted surface, excessive seal friction	Correct the seals, replace the bearing, correct the fitting or mounting.
Vibration (Axial 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.
		Penetration of foreign particles	Replace or clean the bearing, improve the seals.
Leakage or Discoloration of Lubricant		Too much lubricant, Penetration by foreign matter or abrasion chips	Reduce the amount of lubricant, select a stiffer grease. Replace the bearing or lubricant. Clean the housing and adjacent parts.

Note ( ) Intermittent squeal or high-pitch noise may be heard in medium- to large-sized cylindrical roller bearings or ball bearings that are operating under grease lubrication in low-temperature environments. Under such low-temperature conditions, bearing temperature will not rise resulting in fatigue nor is grease performance affected. Although intermittent squeal or high-pitch noise may occur under these conditions, the bearing is fully functional and can continue to be used. In the event that greater noise reduction or quieter running 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 it is removed only for inspection, it should be dismounted as carefully as when it was mounted. If the bearing has a tight fit, its 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 drawing and 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, first place bolts in the push-out holes in the housing at several locations on its 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. In the case of 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 the outer ring may be pressed out using a dismounting tool or by tapping it.

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, the 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.

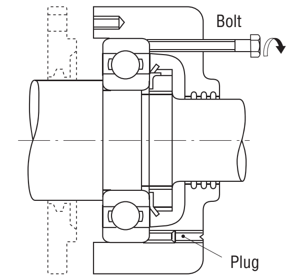


Fig. 1.10 Removal of Outer Ring with Dismounting Bolts

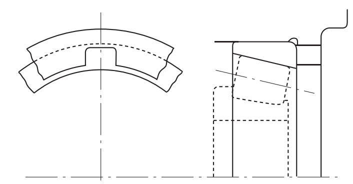


Fig. 1.11 Removal Notches

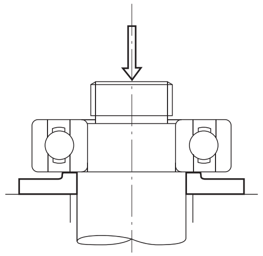


Fig. 1.12 Removal of Inner Ring Using a Press

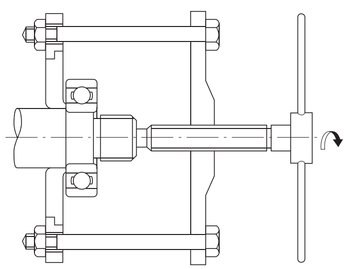


Fig. 1.13 Removal of Inner Ring Using Withdrawal Tool (1)

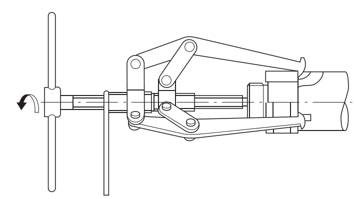


Fig. 1.14 Removal of Inner Ring Using Withdrawal Tool (2)

In both cases, the claws of the tools must substantially engage the face of the inner ring; therefore, it is advisable to consider the size of the shaft shoulder or to cut grooves in the shoulder to accommodate the withdrawal tools (Fig. 1.14).
The oil injection method is usually used for the withdrawal of large bearings. The withdrawal is achieved easily by mean of oil pressure applied through holes in the shaft. In the case of 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 types of cylindrical roller bearings. The inner rings are expanded by brief local heating, and then withdrawn (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. This is followed by hammering on the sleeve using a suitable tool as shown in Fig. 1.18. 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 withdraw the sleeve by tightening the bolts as shown in Fig. 1.17.
Large bearings may be withdrawn 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 withdrawal using a hydraulic nut.

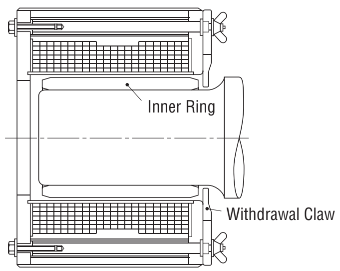


Fig. 1.15 Removal of Inner Ring Using Induction Heater

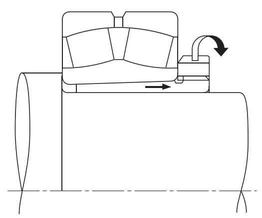


Fig. 1.16 Removal of Withdrawal Sleeve Using Withdrawal Nut (1)

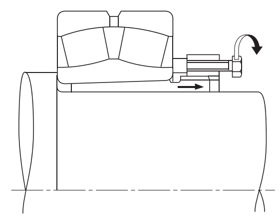


Fig. 1.17 Removal of Withdrawal Sleeve Using Withdrawal Nut (2)

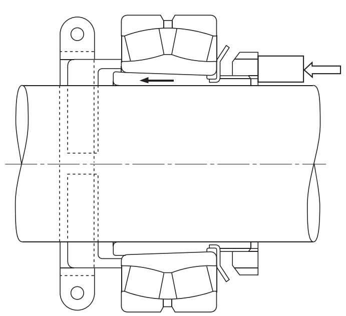


Fig. 1.18 Removal of Adapter with Stop and Axial Pressure

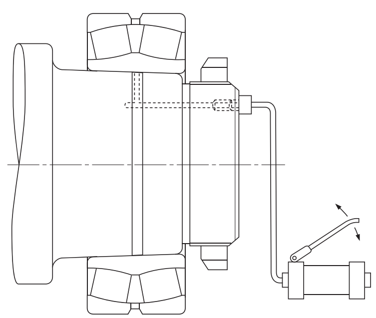


Fig. 1.19 Removal Using Oil Injection Hydraulic Pump

1.6 Inspection of Bearings

1.6.1 Bearing Cleaning

When bearings are inspected, the appearance of the bearings should first be recorded and the amount and condition of the residual lubricant should be checked.
After the lubricant has been sampled for examination, 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 be provided with a metal net to support the bearings in the 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. The lubricant and other deposits should be removed in the oil bath during the initial rough cleaning with a brush or other means. After the bearing is relatively clean, it is given the finishing rinse. The finishing rinse should be done carefully with the bearing being rotated while immersed in the rinsing oil. It is necessary to always keep the rinsing oil clean.

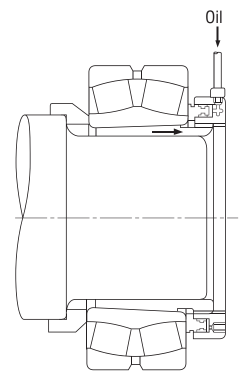


Fig. 1.20 Removal Using Hydraulic Nut

1.6.2 Inspection and Evaluation of Bearings

After being thoroughly cleaned, bearings should be examined for the condition of their raceways and external surfaces, the amount of cage wear, the increase in internal clearance, and degradation of tolerances. These should be carefully checked, in addition to examination for possible damage or other abnormalities, in order to determine the possibility for its reuse.
In the case of 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 bearings in the machine, operating conditions, and the time until the next inspection. However, if any of the following defects exist, reuse is impossible and replacement is necessary.

(a) When there are cracks in the inner or outer rings, rolling elements, or cage.
(b) When there is flaking of the raceway or rolling elements.
(c) When there is significant smearing of the raceway surfaces, ribs, or rolling elements.
(d) When the cage is significantly worn or rivets are loose.
(e) When there is rust or scoring on the raceway surfaces or rolling elements.
(f) When there are any significant impact or brinell traces on the raceway surfaces or rolling elements.
(g) When there is significant evidence of creep on the bore or the periphery of the outer ring.
(h) When discoloration by heat is evident.
(i) When significant damage to the seals or shields of grease sealed bearings has occurred.

1.7 Checking of Shaft and Housing

1.7.1 Checking of Shaft

(a) Cylindrical Shaft

(1) Dimensional check of shaft
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. Use an outside micrometer.

(2) Observation of the shaft outside surface
Observe the surface of shaft where the bearing was mounted to check whether there are scratches, dents, rust or stepped wearing.

- When there are scratches, dents
  Round edge with oil stone and/or sand paper to smoothen the surface.
- When there is rust
  Remove rust with oil stone and/or sand paper to smoothen the surface.
- When there is stepped wearing
  After the dimensional measurement of the shaft, decide whether correction is possible.

(3) Anticorrosive agent
After completion of check, apply an anticorrosive agent.

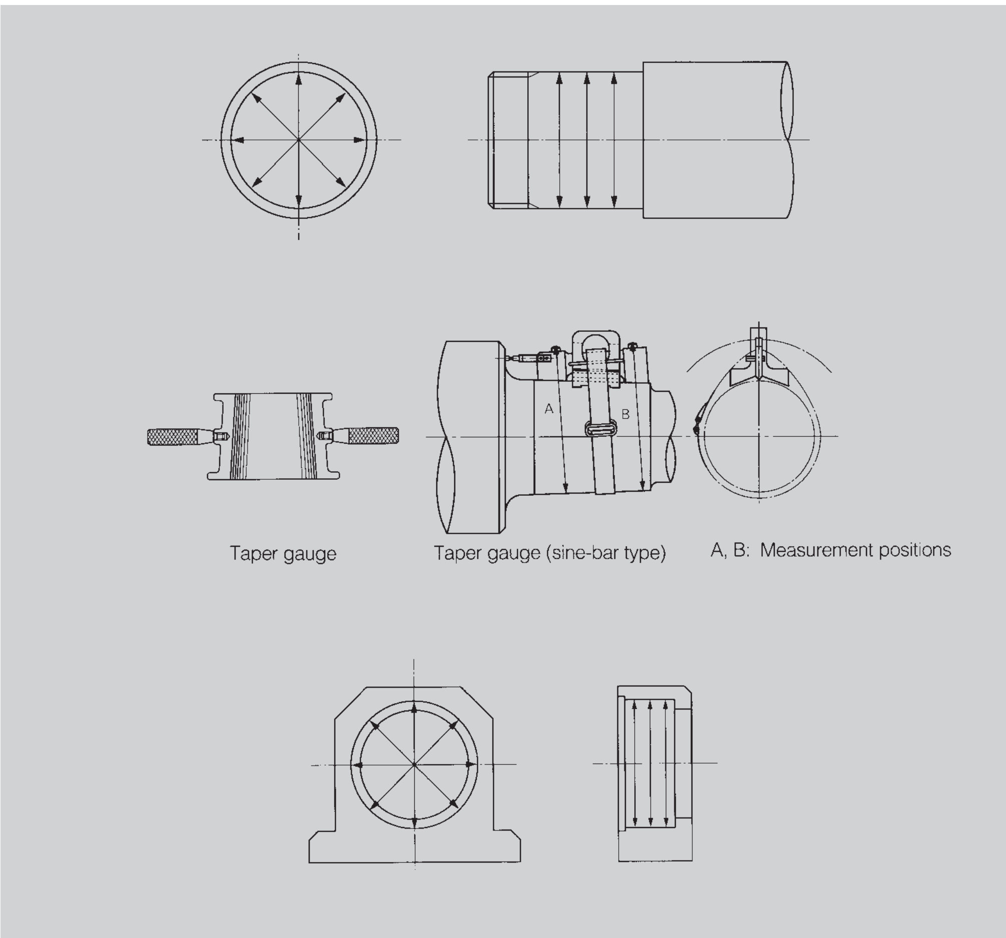
(b) Tapered Shaft

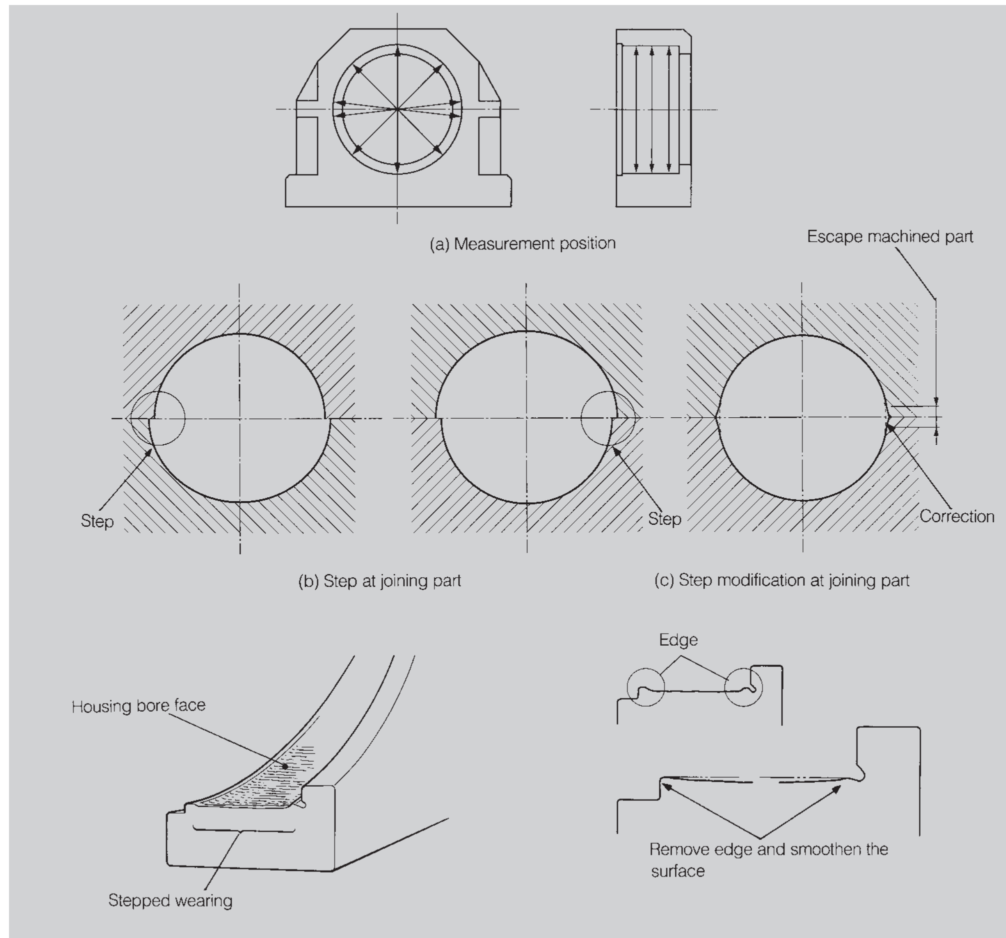
(1) Check of shaft shape
Measure the shape of shaft where the bearing will be mounted to confirm that its shape is correct. The measurement positions are shown in Fig. 1.22. As for the measurement instrument, use a taper gauge (sine bar system). (Fig. 2.2 and Fig. 1.22)

(2) Observation of the shaft outside surface
Observe the shaft surface where the bearing was mounted to check whether there are scratches, dents, rust or stepped wearing.

- When there are scratches, dents
  Round edge with oil stone and/or sand paper to smoothen the surface.
- When there is rust
  Remove rust with oil stone and/or sand paper to smoothen the surface.
  (In this case if the zone to be corrected is wide, it is necessary to inspect the shape of the tapered part by using a taper gauge. The inspection method is: apply a thin coat of bluing over the entire surface of taper gauge bore face, insert it slowly after adjusting the taper gauge to the shaft center tapered shaft, then, do a run-in by moving back-and-forth. Then, pull the taper gauge out slowly when adjusting to the shaft center. Observe where blue dye is attached to the surface of tapered shaft.
  If the blue ares is bigger than 80%, the shaft may be reused. When using a taper gauge (sine-bar type), follow the instructions given in the Operation Manual issued by the manufacturer).
- When there is stepped wearing
  After the dimensional measurement of the shaft, decide whether correction is possible.

(3) Anticorrosive agent
After completion of check, apply an anticorrosive agent.





1.7.2 Checking of Housing

(a) Integrated Type Housing

(1) Check of bore size of housing
Measure the housing bore size where the bearing will be mounted to confirm that the size is correct. The measurement position is shown in Fig. 1.23. As for the measurement instrument, use an inside micrometer.

(2) Observation of housing bore face
Observe the surface of the housing bore where the bearing was mounted to check whether there are scratches, dents, rust or stepped wearing.

- When there are scratches, dents
Round edge with oil stone and/or sand paper to smoothen the surface.
- When there is rust
Remove rust with oil stone and/or sand paper to smoothen the surface.
- When there is stepped wearing (Fig. 1.25)
After the dimensional measurement of the housing bore, decide whether correction and reuse is possible. In this case, if the measured value of the housing bore is within its tolerance, remove the stepped worn part with oil stone and/or sand paper, etc. and smoothen the surface, then, reuse. If the stepped wearing is severe, either plate or apply thermal spraying to reconstitute to the correct housing size before reusing.

(3) Anticorrosive agent
After completion of check, apply an anticorrosive agent.

(b) Split Housing

(1) Check of the housing bore size
In case of a split housing, assemble correctly the housing without bearing, and measure its bore dimension at the place where the bearing will be mounted to confirm that the dimension is correct. The measurement position is shown in Fig. 1.24 (a). As for the measurement instrument, an inside micrometer shall be used.

(2) Observation of housing bore face
Observe the surface of the housing bore where the bearing was mounted to check whether there are scratches, dents, rust or stepped wearing.

- When there are scratches, dents
Round edge with oil stone and/or sand paper to smoothen the surface.
- When there is rust
Remove rust with oil stone and/or sand paper to smoothen the surface.
- When there is stepped wearing (Fig. 1.25)
After the dimensional measurement of the housing bore, decide whether correction is possible.
In this case, if the measured value of housing bore is within its tolerance, remove the stepped worn portion with oil stone and/or sand paper, etc. and smoothen the surface, then, reuse.
- When the stepped wearing is severe
If the stepped wearing is severe, either plate or apply thermal spraying to reconstitute to the correct housing size and reuse.
- When there is a step
As step may occur at the joining part of the split halves housing, confirm whether there is a step.
If a step is found, correct it in the way as shown in Fig. 1.24 (c).

(3) Anticorrosive agent
After completion of 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 should 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. It is suggested that periodic maintenance be done following the procedure specified. 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 the proper corrective actions should be taken after referring to Table 1.2.

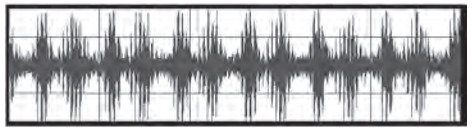
If necessary, the bearing should be dismounted and examined in detail. As for the procedure for dismounting and inspection, refer to Section 1.6, Inspection of Bearings.

1.8.2 Diagnosis with Sound and Vibration

Classification of sounds and vibrations

Sound and vibration accompany the rotation of rolling bearings. The tone and amplitude of such sound and vibration vary depending on the type of bearing, mounting conditions, operational conditions, etc. The sound and vibration of a rolling bearing can be classified under the following four chief categories and each category can be further classified into several sub-categories, as described in Table 1.3 below. Boundaries between groups are, however, not definite. Even if some types of sounds or vibrations are inherent in the bearings, the volume might be related to the manufacturing process, while some types of sounds or vibrations, even if they arise due to manufacturing, cannot be eliminated even in normal conditions.

By recording sounds and vibrations of a rotating machine and analyzing them, it is possible to infer the cause. As can be seen from figures on the next page, a mechanically normal bearing shows a stable waveform. However, a bearing with a scratch, for example, shows a waveform with wide swings indicating large-amplitude sounds at regular intervals. (Refer to Figs.1.26 and 1.27)



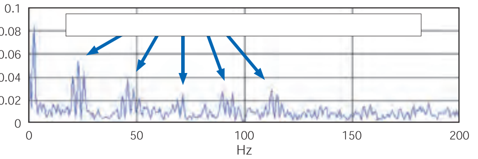


Table 1.3 Classification of Sounds and Vibrations in a Rolling Bearing

2. BEARING DAMAGE AND MEASURES (Bearing Doctor)

2. BEARING DAMAGE AND MEASURES (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 is caused by improper mounting, handling, or lubrication, entry of foreign matter, or abnormal heat generation.
For instance, the causes of rib scoring, as one example of premature failure, may include insufficient lubrication, use of improper lubricant, 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 previous to the time of failure are known, including the application, the 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 make contact with the rolling elements. This results in a wear path on both the rolling elements and raceways. Running traces are useful, since they indicate the loading conditions, and should be carefully observed when the bearing is disassembled.
If the running traces are clearly defined, it is possible to determine whether the bearing is carrying a radial load, axial load or moment load. Also, the roundness condition of the bearing can be determined. Check whether unexpected bearing loads or large mounting errors occurred. Also, determine the probable cause of the bearing damage.

Fig. 2.2 shows the 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 result in a shortened life due to their adverse effect on the bearings.
Similarly, Fig. 2.2 shows different roller bearing running traces: Fig. 2.2 (i) shows the outer ring running trace when a radial load is properly applied to a cylindrical roller bearing which has a load on a rotating inner ring. Fig. 2.2 (j) shows the running trace in the case of 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. For double-row tapered roller bearings where a single load is applied to the rotating inner ring, Fig. 2.2 (k) shows the running trace on the outer ring under radial load 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, then the application of a radial load causes running traces to appear on the outer ring as shown in Fig. 2.2 (m).

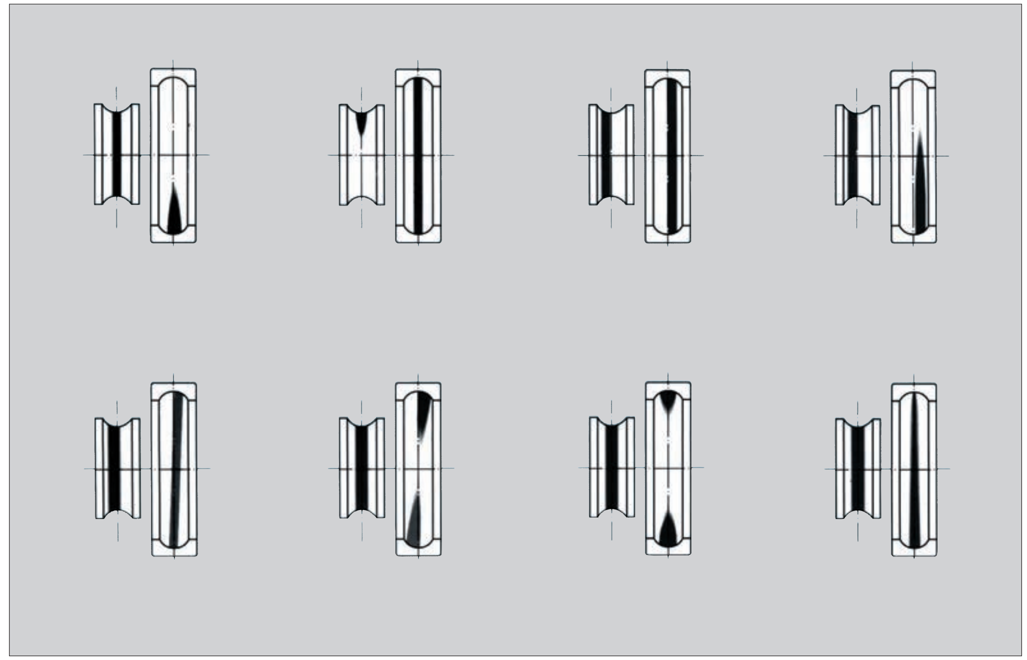


Fig. 2.2 Typical Running Traces of Deep Groove Ball Bearings

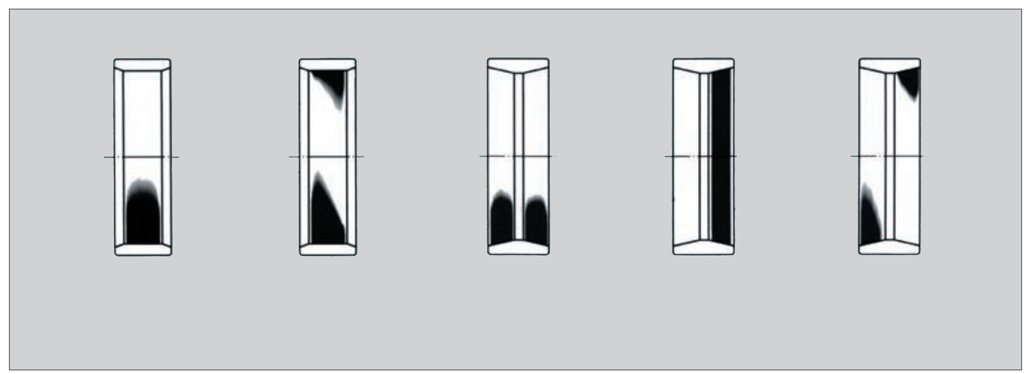


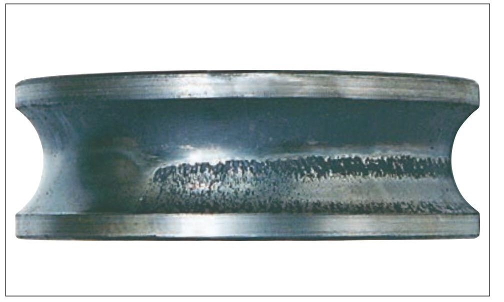
Fig. 2.2 Typical Running Traces on Roller Bearings

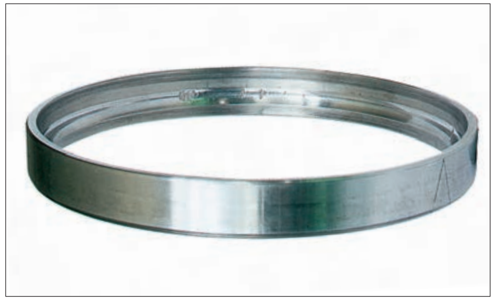
2.3 Bearing Damage and Measures

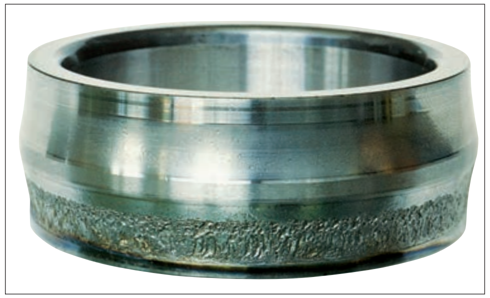
In general, if rolling bearings are used correctly, they will survive to their predicted fatigue life. Bearings, however, often fail prematurely due to avoidable mistakes. In contrast to fatigue life, this premature failure is caused by improper mounting, mishandling, poor lubrication, entry of foreign matter or abnormal heat generation.
For example, one cause of premature failure is rib scoring which is due to insufficient lubrication, use of improper lubricant, faulty lubrication system, entry of foreign matter, bearing mounting error, excessive deflection of the shaft or some combination of these. If all conditions are known for the times both before and after the failure, including the application, the operating conditions, and environment, then a measure can be determined by studying the nature of the failure and its probable causes. A successful measure will reduce similar failures or prevent them from happening again.
Sections 2.3.1 through 2.3.15 give various type of bearing damage and measures. Please consult these sections when trying to determine the cause of bearing damage. By the way, the bearing diagnostic chart in the Appendix may be useful as a quick reference guide.

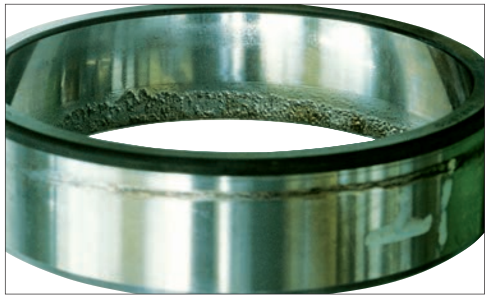
2.3.1 Flaking

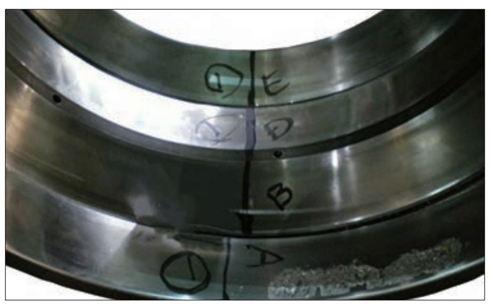
Damage Condition	Possible Cause	Measures
Flaking occurs when small pieces of bearing material are split off from the smooth surface of the raceway or rolling elements due to rolling fatigue, thereby creating regions having rough and coarse texture.	Excessive load Poor mounting (misalignment) Moment load Entry of foreign debris, water penetration Poor lubrication, Improper lubricant Unsuitable bearing clearance Improper precision for shaft or housing, unevenness in housing rigidity, large shaft bending Progression from rust, corrosion pits, smearing, dents (Brinelling)	● Reconfirm the bearing application and check the load conditions ● Improve the mounting method ● Improve the sealing mechanism, prevent rusting during non-running ● Use a lubricant with a proper viscosity, improve the lubrication method ● Check the precision of shaft and housing ● Check the bearing internal clearance

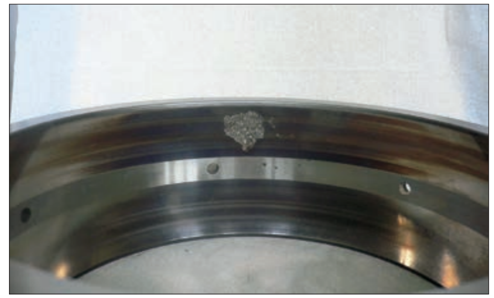


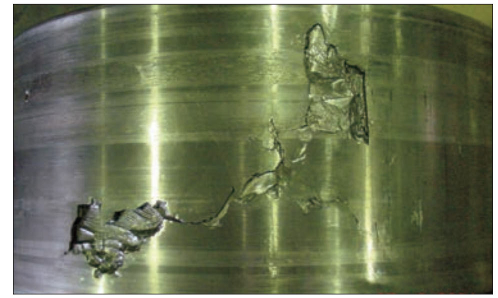


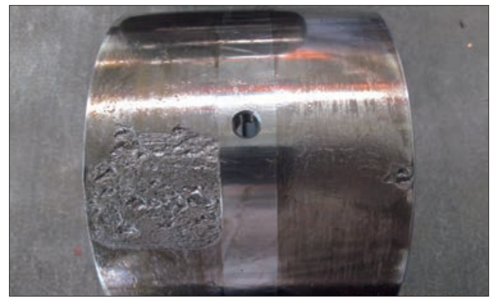


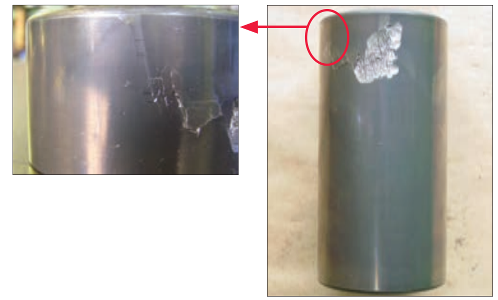












BEARING DOCTOR

—Example of flaking and other damage combined 1—

⇒

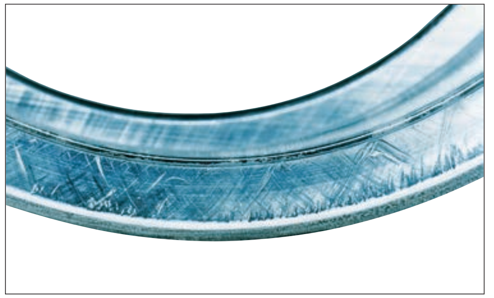
—Example of flaking and other damage combined 2—

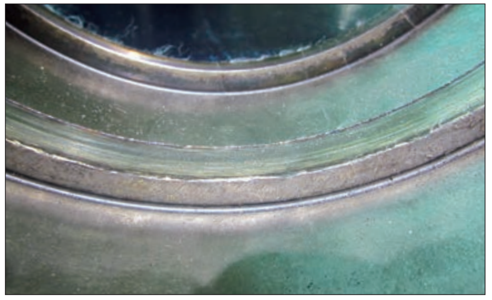
2.3.2 Peeling

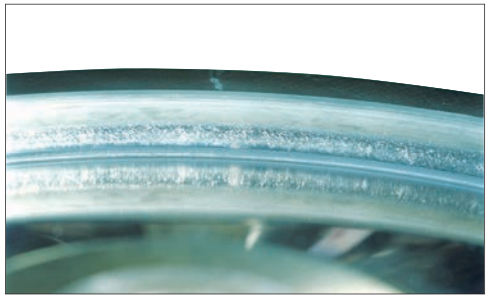
Damage Condition	Possible Cause	Measures
		● ● ●

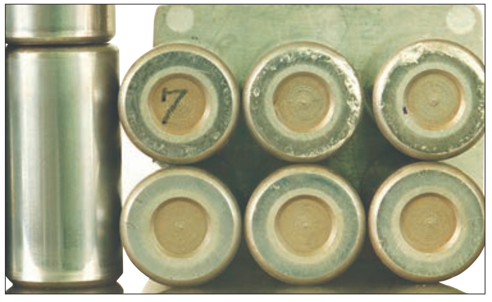
2.3.3 Scoring

Damage Condition	Possible Cause	Measures
Scoring is 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 on the roller end. Scoring on rib surface contacting roller end.	Excessive load, excessive preload Poor lubrication Particles are 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





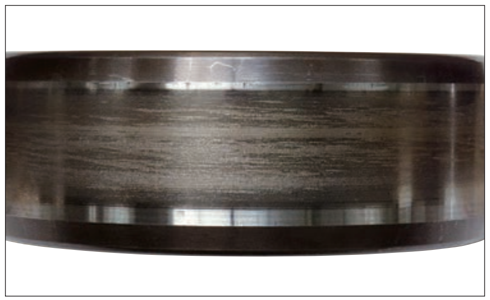


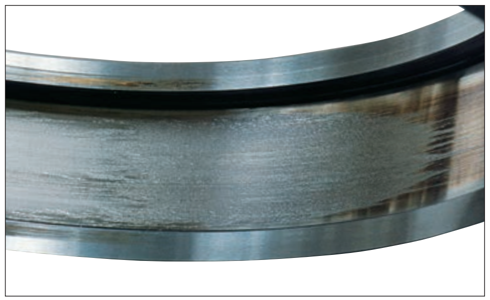


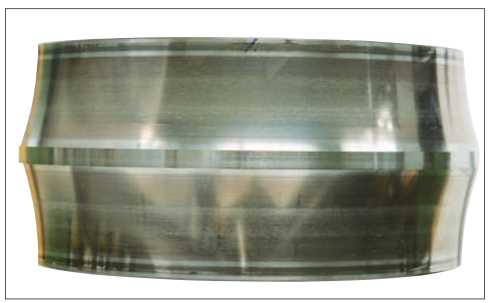
BEARING DOCTOR

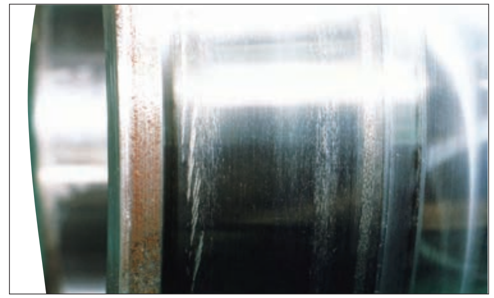
2.3.4 Smearing

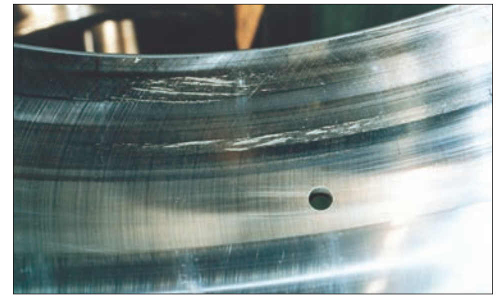
Damage Condition	Possible Cause	Measures
Smearing is surface damage which occurs from a collection of small seizures between bearing components caused by oil film rupture and/or sliding. Surface roughening occurs along with melting.	High speed and light load Sudden acceleration/deceleration Improper lubricant Entry of water	● Improve the preload ● Improve the bearing clearance ● Use a lubricant with good oil film formation ability ● Improve the lubrication method ● Improve the sealing mechanism







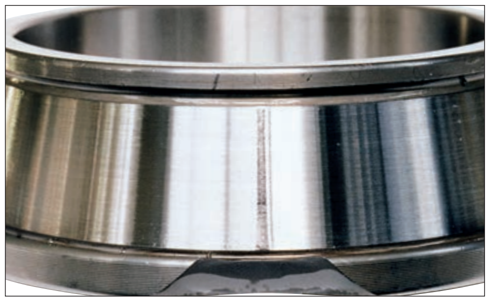


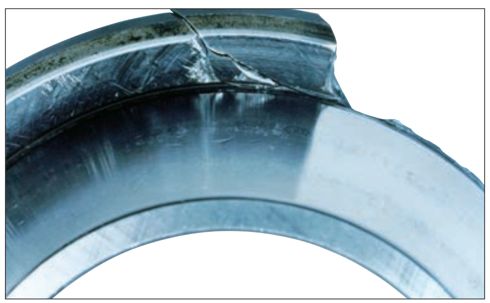


BEARING DOCTOR

2.3.5 Fracture

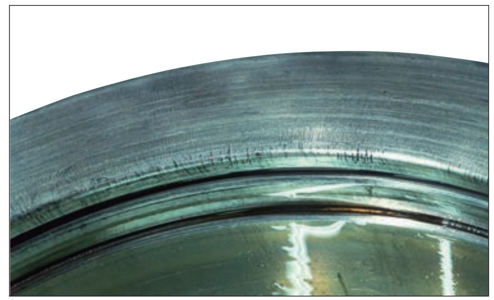
Damage Condition	Possible Cause	Measures
		● ● ●

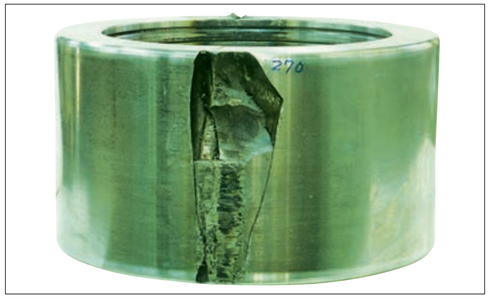


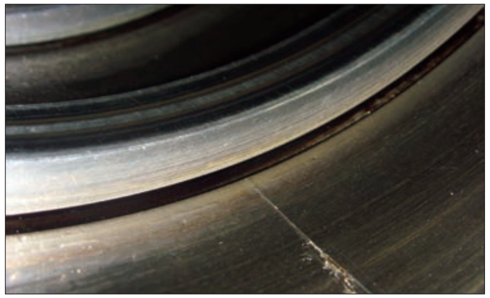


2.3.6 Cracks

Damage Condition	Possible Cause	Measures
		● ● ● ●







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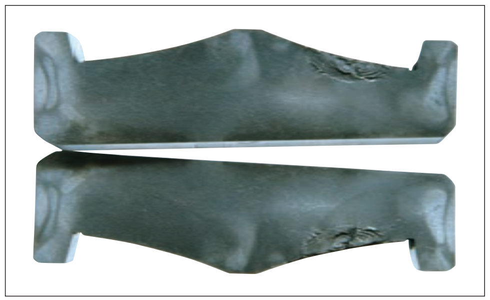
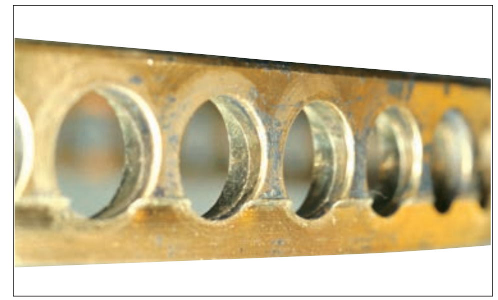
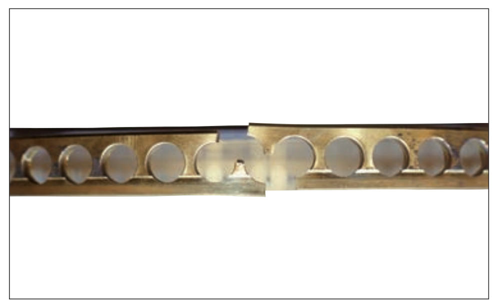


2.3.7 Cage Damage

Damage Condition	Possible Cause	Measures
Cage damage includes cage deformation, fracture, and wear Fracture of cage pillar Deformation of side face Wear of pocket surface Wear of guide surface	Poor mounting (Bearing misalignment) Poor handling Large moment load Shock and large vibration Excessive rotation speed, sudden acceleration and deceleration Poor lubrication Temperature rise	● Check the mounting method ● Check the temperature, rotation, and load conditions ● Reduce the vibration ● Select a cage type ● Select a lubrication method and lubricant



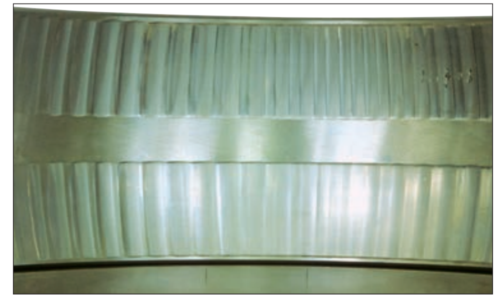


2.3.8 Denting

Damage Condition	Possible Cause	Measures
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 the mounting (Brinell dents).	Debris such as metallic particles are 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

2.3.9 Wear

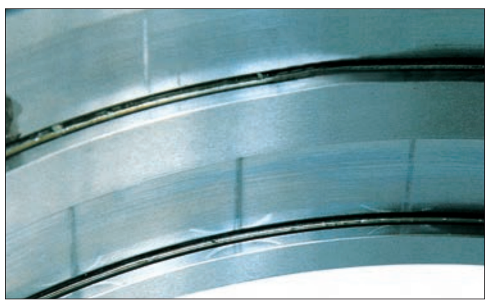
Damage Condition	Possible Cause	Measures
Wear is surface deterioration due to sliding friction at the surface of the raceway, rolling elements, roller end faces, rib face, cage pockets, etc.	Entry of debris Progression from rust and electrical corrosion Poor lubrication Sliding due to irregular motion of rolling elements	● Improve the sealing mechanism ● Clean the housing ● Filter the lubrication oil thoroughly ● Check the lubricant and lubrication method ● Prevent misalignment



BEARING DOCTOR

2.3.10 Fretting

Damage Condition	Possible Cause	Measures
Wear occurs due to repeated sliding between the two surfaces. Fretting occurs at fitting surface and also at contact area between raceway ring and rolling elements. Fretting corrosion is another term used to describe the 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



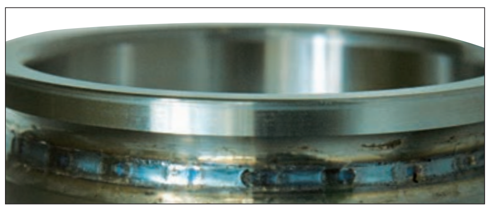
2.3.11 False Brinelling

Damage Condition	Possible Cause	Measures
Among the different types of fretting, false brinelling is the occurrence of hollow spots that resemble brinell dents, and 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 such times as transporting Oscillating motion with a small amplitude Poor lubrication	● Secure the shaft and housing during transporting ● Transport with the inner and outer rings packed separately ● Reduce the vibration by preloading ● Use a proper lubricant

BEARING DOCTOR

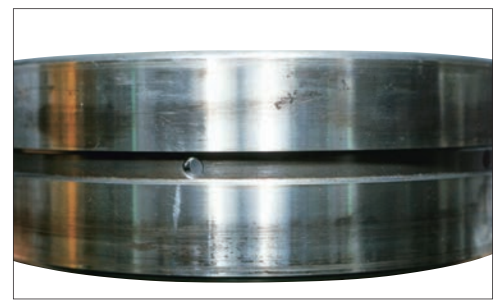
2.3.12 Seizure

Damage Condition	Possible Cause	Measures
When sudden overheating occurs during rotation, the bearing becomes discolored. Next, 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	● Study the lubricant and lubrication method ● Reinvestigate the suitability of the bearing type selected ● Study the preload, bearing clearance, and fitting ● Improve the sealing mechanism ● Check the precision of the shaft and housing ● Improve the mounting method



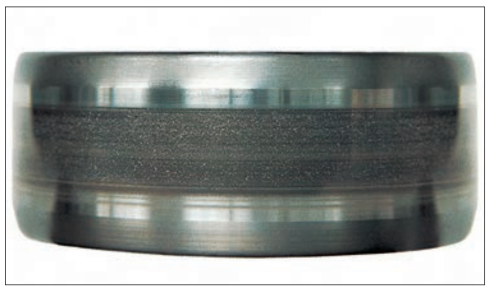
2.3.13 Creep

Damage Condition	Possible Cause	Measures
Creep is the phenomenon in bearings where relative slipping occurs at the fitting surfaces and thereby creates a clearance at the fitting surface. Creep causes a shiny appearance, occasionally with scoring or wear.	Insufficient interference or loose fit Insufficient sleeve tightening	● Check the interference, and prevent rotation ● Correct the sleeve tightening ● Study the shaft and housing precision ● Preload in the axial direction ● Tighten the raceway ring side face ● Apply adhesive to the fitting surface ● Apply a film of lubricant to the fitting surafce



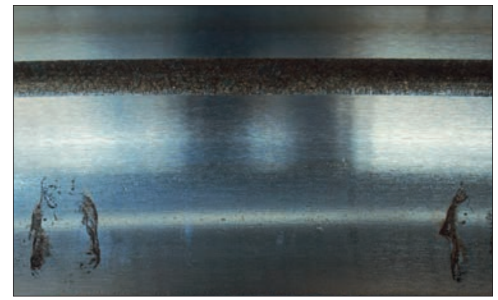
2.3.14 Electrical Corrosion

Damage Condition	Possible Cause	Measures
		● ●



2.3.15 Rust and Corrosion

Damage Condition	Possible Cause	Measures
		● ● ● ● ●



Appendix Bearing Diagnostic Chart

Damage name	Location (Phenomenon)	Cause: Handling		Bearing surrounding			Lubri-cation		Load			Speed			Remarks
		Stock·Shipping	Mounting	Shaft Housing	Sealed device Water·Debris	Temperature	Lubricant	Lubrication method	Excessive load Impact load	Moment	Ultra small load	High speed, High acceleration & deceleration	Shaking·Vibration Stationary	Bearing Selection	
2.3.1 Flaking	Raceway, Rolling surface		○	○	○		○	○	○	○				○	
2.3.2 Peeling	Raceway, Rolling surface				○		○	○			○	○			
	Bearing outside surface (Rolling contact)			○*	○		○	○							*Mating rolling 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, (Innumerable small dents)				○			○							
	Raceway (Debris on the rolling element pitch)	○	○						○				○		
2.3.9 Wear	Raceway, Rolling surface, Rib surface, Roller end face		○		○		○								
2.3.10 Fretting	Raceway, Rolling surface	○	○	○			○	○	○			○	○		
	Bearing outside & bore, side surface (Contact with housing and shaft)		○	○					○						
2.3.11 False brinelling	Raceway, Rolling surface	○					○	○					○		
2.3.12 Seizure	Raceway ring, Rolling element, Cage		○	○	○		○	○	○	○		○		○	
2.3.13 Creep	Fitting surface		○	○		○	○*	○*	○			○			*Clearance fit
2.3.14 Electrical corrosion	Raceway, Rolling surface		○*	○*											*Electricity passing through the rolling element
2.3.15 Rust and corrosion	Raceway ring, Rolling element, Cage	○	○		○	○	○	○							

Remark This chart is not comprehensive. It lists only the more commonly occurring damages, causes, and locations.

Part C

BEARINGS TABLE

1. DEEP GROOVE BALL BEARINGS

DESIGN, TYPES, AND FEATURES

SINGLE-ROW DEEP GROOVE BALL BEARINGS

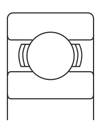
Single-Row Deep Groove Ball Bearings are classified into the types shown below.

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.

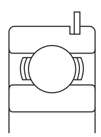
Table 1 Features of Sealed Ball Bearings

Type	Shielded Type (ZZ Type)	Non-Contact Rubber Sealed Type (VV Type)	Contact Rubber Sealed Type (DDU Type)
Torque	Low	Low	Higher than ZZ, VV types due to contact seal
Speed capability	Good	Good	Limited by contact seals
Grease sealing effectiveness	Good	Better than ZZ type	A little better than VV type
Dust resistance	Good	Better than ZZ type (usable in moderately dusty environment)	Best (usable even in very dusty environment)
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

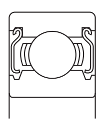
Note ([1]) The above temperature range applies to standard bearings. By using cold or heat resistant grease and changing the type of rubber, the operating temperature range can be extended. For such applications, please contact NSK.



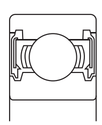
Open Type



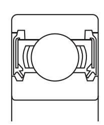
With Snap Ring



Shielded Type (ZZ Type)



Non-Contact Rubber Sealed Type (VV Type)



Contact Rubber Sealed Type (DDU Type)

For deep groove ball bearings, pressed cages are usually used. For big bearings, machined brass cages are used. (Refer to Table 2)

Machined cages are also used for high speed applications.

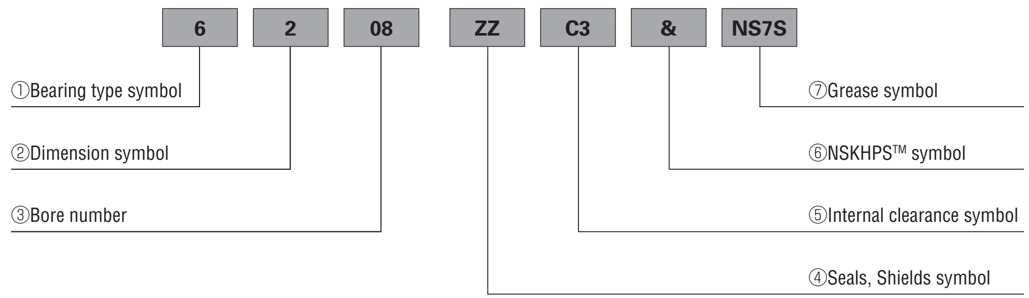
Table 2 Standard Cages for Deep Groove Ball Bearings

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 Numbers

Single-Row Deep Groove Ball Bearings

Bearing number example :



①Bearing type symbol	6 : Single-Row Deep Groove Ball Bearings
②Dimension symbol	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 symbol	ZZ : Shield on Both Side , DDU : Contact Rubber Seal on Both Side, VV: Non-Contact Rubber Sealed on Both Side
⑤Internal clearance symbol	Omitted : CN clearance*1, C3 : Clearance greater than CN, C4 : Clearance greater than C3, CM : For Electric Motors*1
⑥NSKHPS™ symbol	& : NSKHPS™ Bearings
⑦Grease symbol	NS7 : NS HI-LUBE

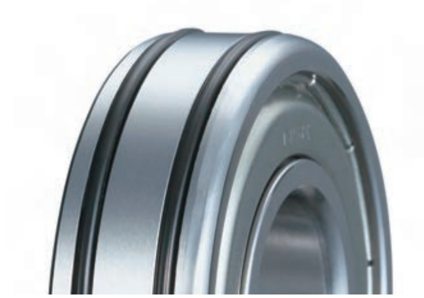
*1 The CM clearance can be used in substitute of the CN clearance. (The opposite is not available.)

Creep-Free Bearings™

Creep-Free Bearings, which come with two O-rings mounted in the outer ring, help to prevent the occurrence of creep by restricting the amount of clearance between the outer ring and housing.

No special machining is required; 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 improvement in creep prevention, due to the tension of the O-ring mounted in the outer ring.



Features

■Prevents creep

O-rings help prevent creep.

■Reusable housing

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

■Easy to assemble

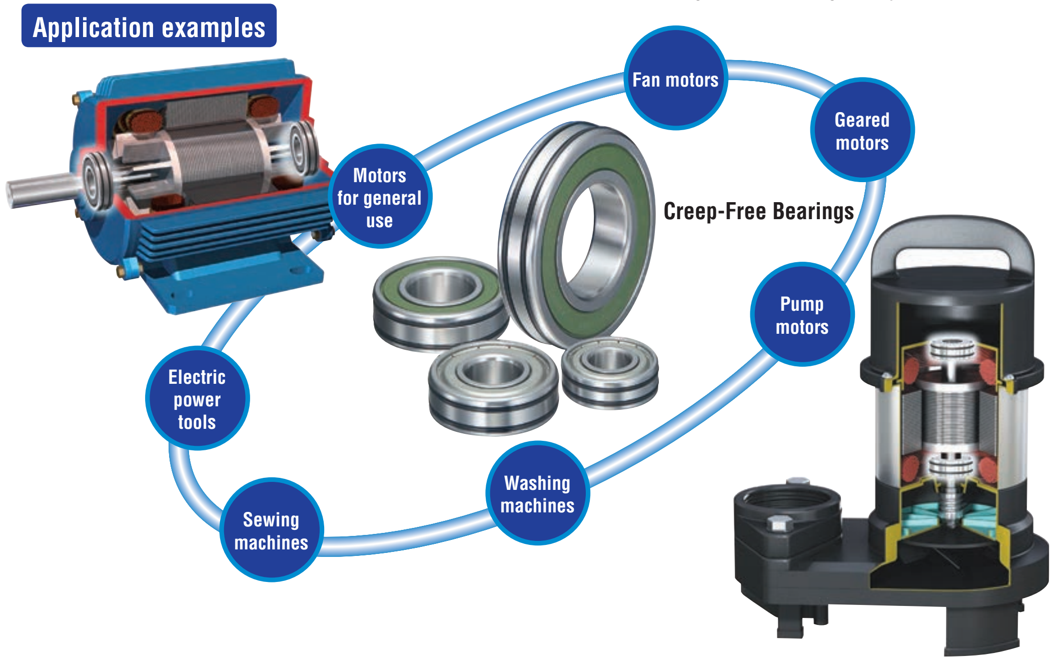
Assembly is easy since bearings can be fitted with a loose tolerance.

■No special machining of the housing is required

Bearings can be replaced since boundary dimensions are identical to standard bearings.

No reworking of the housing is required.

Application examples



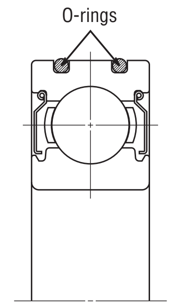


Fig. 1 Structure of Creep-Free Bearings

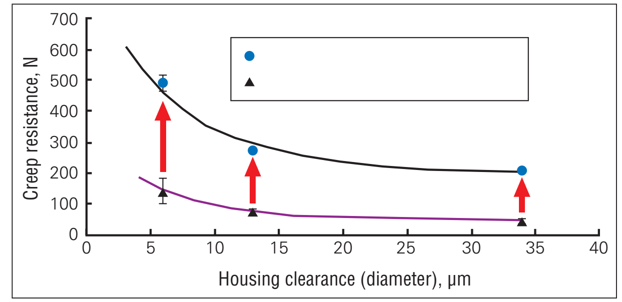


Fig. 2 Creep limit load test (example: 6204)

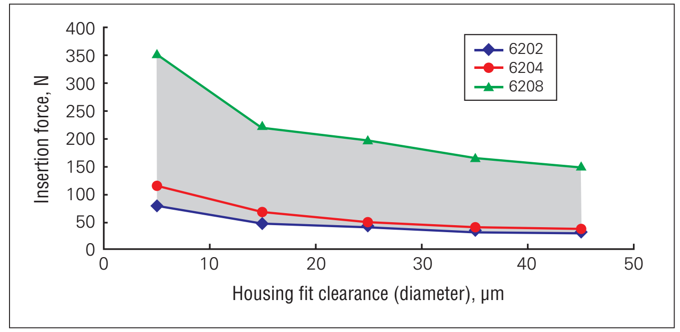


Fig. 3 Fit and insertion force

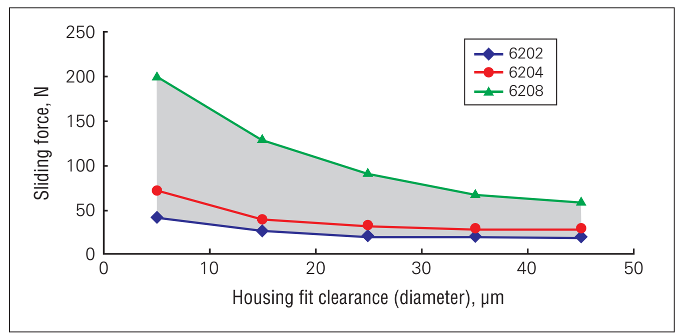


Fig. 4 Fit and sliding force

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.).
- O-ring material is nitrile rubber (operating temperature range: −30 to 120°C) as a standard specification. Please contact NSK for use under special environments such as high temperatures.

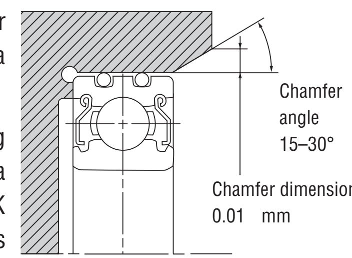
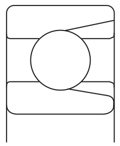


Fig. 5 Housing shape and dimension

Note on the product name “Creep-Free Bearings”: The term “free” should not be construed to mean that creep is nonexistent.



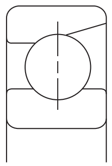
MAXIMUM TYPE BALL BEARINGS

Maximum Type 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 single-row deep groove ball bearings of Series 62 and 63 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.

Their cages are pressed steel.



MAGNETO BEARINGS

The groove in the inner ring is a little shallower than that of deep groove ball bearings and one side of the outer ring is relieved. Consequently, the outer ring is separable, which makes it 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

For deep groove ball bearings, if the bearing load is too small during operation, slippage occurs between the balls and raceways, which may result in smearing. The higher the weight of balls and cage, the higher this tendency becomes, 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)
MAXIMUM TYPE 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 TYPE 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)
MAXIMUM TYPE BALL BEARINGS .... Table 8.10 (Page A169)
MAGNETO BEARINGS .... Table 8.12 (Page A169)

LIMITING SPEEDS (GREASE/OIL)

The limiting speeds (grease) and limiting speeds (oil) listed in the bearing tables should be adjusted depending on the bearing load condition. Also, higher speeds are attainable by making changes in 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 has been 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 direction of the bearing radius is called the radial clearance, and the amount along the direction of the axis is called the axial clearance.

The geometric relation between the radial and axial clearance is shown in Fig. 1.

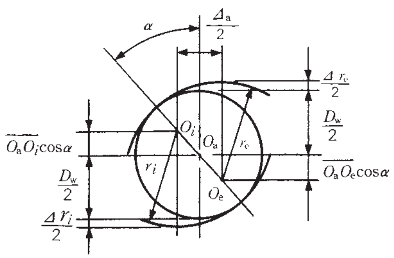


Fig. 1 Relationship Between Δ_r and Δ_a

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 $\Delta_r = \Delta r_e + \Delta r_i$.

From geometric relationships, various equations for clearance, contact angle, etc. can be derived.

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

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

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

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

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

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

Because $(r_e+r_i-D_w)$ is a constant, it is apparent why fixed relationships between Δ_r, Δ_a and α exist for all the various bearing types.

As was previously mentioned, the clearances for deep groove ball bearings are given as radial clearances, but there are specific applications where it is desirable to have an axial clearance 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,

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

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 a 6312 bearing, for a sample calculation, which has a radial clearance of 0.017 mm. From Table 1, K=2.09. Therefore, the axial clearance Δ_a is:
$\Delta = 2.09 \times \sqrt{0.017} = 2.09 \times 0.13 = 0.27$ (mm)

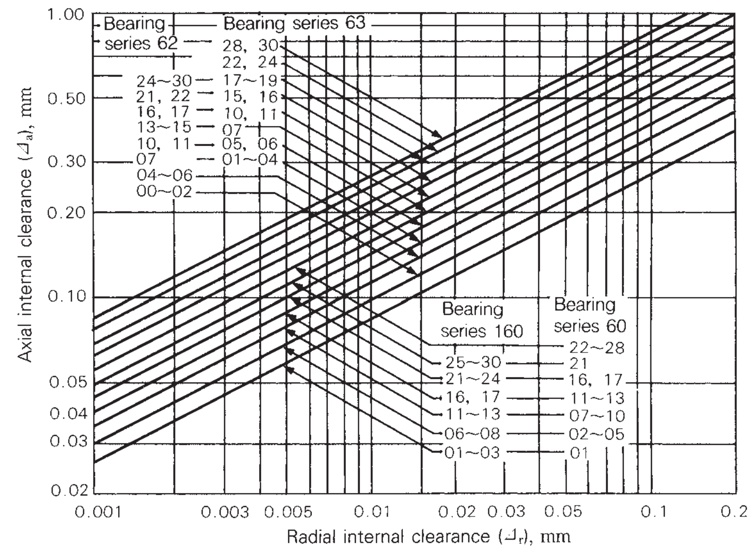


Fig. 2 Radial Clearance, Δ_r and Axial Clearance, Δ_a of Deep Groove Ball Bearings

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, it is recommended to make the contact angle as large as possible.

The contact angle for ball bearings is determined by the geometric relationship between the radial clearance and the 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 62 and 63 series bearings. The initial contact angle, α_0, is the initial contact angle when the 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°, it is necessary to check whether or not the contact area of the ball and raceway touch the edge of raceway shoulder. (Refer to Section 8.1.2)

For applications when 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 anlgle 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 No.	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°

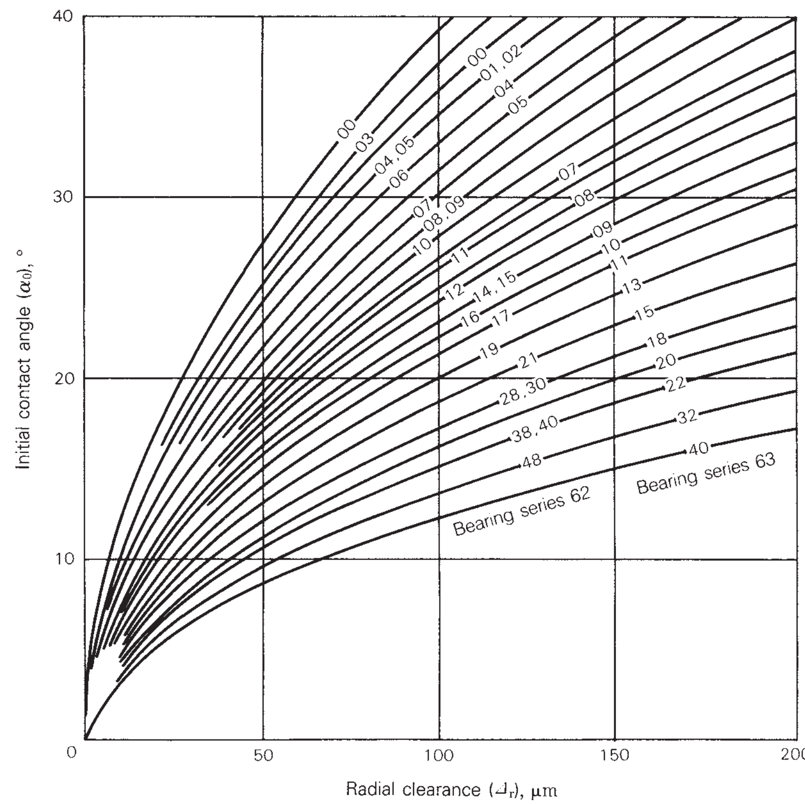


Fig. 3 Radial Clearance and Contact Angle

Features and Operating Temperature Range of Ball Bearing Seal Material

The sealed ball bearing is a ball bearing with seals as shown in Figs. 1 and 2. There are two seal types: non-contact seal type and contact seal type. For rubber seal material, nitrile rubber is used for general purpose and poly-acrylic rubber, silicon rubber, and fluoric rubber are used depending on temperature conditions.

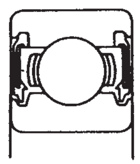
These rubbers have their own unique nature and appropriate rubber must be selected by considering the particular application environment and running conditions.

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 the temperature and time. Rubber may be used in a much wider range of operating temperatures depending on the operating time and frequency.

In the non-contact seal, heat generation due to friction on the lip can be ignored. And thermal factors, which cause aging of the rubber, are 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 the seal performance. A rubber non-contact seal can thus be used in an expanded range of operating temperatures greater than that for a contact seal.

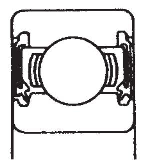
But there are some disadvantages. The contact seal has a problem with wear occurring at the seal lip due to friction, thermal plastic deformation, and hardening. When friction or plastic deformation occurs, the contact pressure between the lip and slide surface decreases, resulting in a clearance. This clearance is minimum and does not cause excessive degradation of sealing performance (for instance, it does not allow dust entry or grease leakage). In most cases, this minor plastic deformation or slightly increased hardness presents no practical problems.

However, in external environments with dust and water in large quantity, the bearing seal is used as an auxiliary seal and a principal seal should be provided separately. As so far described, the operating temperature range of rubber material is only a guideline for selection. Since heat resistant rubber is expensive, it is important to understand the temperature conditions so that an economical selection can be made. Due attention should also be paid not only to heat resistance, but also to the distinctive features of each rubber.



Non-contact rubber seal (VV)

Fig. 1



Contact rubber 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 in oil and wear resistances and mechanical properties ○Readily ages under direct sun-rays ○Less expensive than other rubbers	○Superior in heat and oil resistances ○Large compression causes permanent deformation ○Inferior in cold resistance ○One of the less expensive materials among the high temperature materials ○Attention is necessary because it swells the ester oil based grease	○High heat and cold resistances ○Inferior in mechanical properties other than permanent deformation by compression. Pay attention to tear strength ○Pay attention so as to avoid swell caused by low aniline point mineral oil, silicone grease, and silicone oil	○High heat resistance ○Superior in oil and chemical resistances ○Cold resistance similar to nitrile rubber ○Attention is necessary because it deteriorates the 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 is the temperature of seal rubber materials.

Free Space and Grease Filling Amount for Deep Groove Ball Bearings

Grease lubrication can simplify the bearing's peripheral construction. In place of oil lubrication, grease lubrication is now employed along with enhancement of the grease quality for applications in many fields. It is important to select a grease appropriate to the operating conditions. Due care is also necessary as to 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. A general guideline is described next.

First, the bearing is filled with an appropriate amount of grease. In this case, it is essential to push grease onto the cage guide surface. Then, the free space, whic excludes the spindle and bearing inside the housing, is filled with an amount of grease as shown next:

1/2 to 2/3 when the bearing speed is 50% or less of the allowable speed specified in the catalog.
1/3 to 1/2 when the bearing speed is 50% or more.

Roughly, 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 to prevent heat generation. When the bearing speed is extremely low, on the other hand, grease may be packed almost full to prevent dust and water entry. Accordingly, it is necessary to know the extent of the housing's free space for the specific bearing to determine the correct filling amount. As a reference, the volume of free space is shown in Table 1 for an open type deep groove ball bearing.

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.

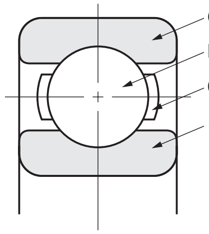


Table 1 Free Space of Open Type Deep Groove Ball Bearing

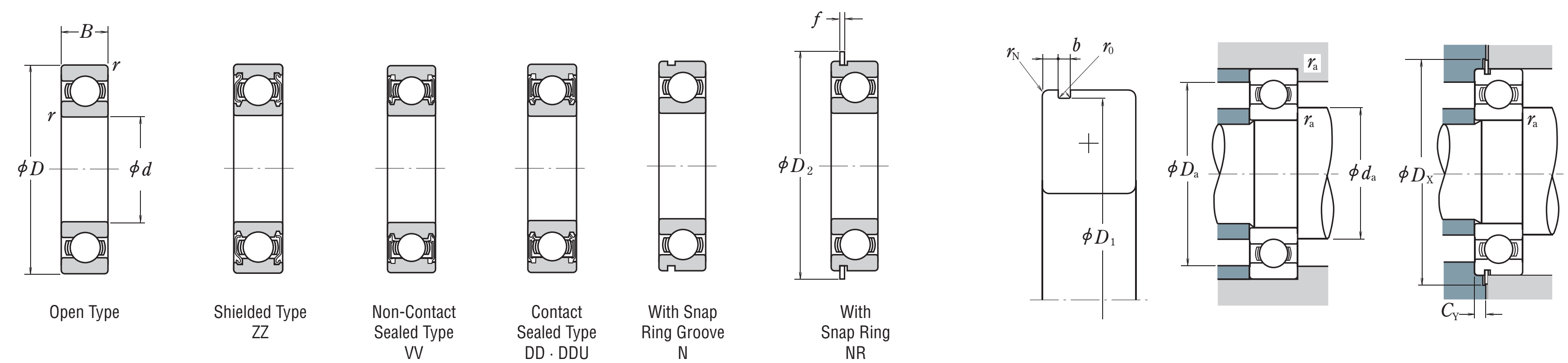
Units : cm^3

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 a bearing using a pressed steel cage. The free space of a bearing using a high-tension brass machined cage is about 50 to 60% of the value in the table.

SINGLE-ROW DEEP GROOVE BALL BEARINGS

Bore Diameter 10 – 17 mm



Dynamic Equivalent Load

$P = XF_r + YF_a$

$\frac{f_0F_a}{C_{0r}}$	e	$\frac{F_a}{F_r} \leq e$ X	Y	$\frac{F_a}{F_r} > e$ 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

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

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

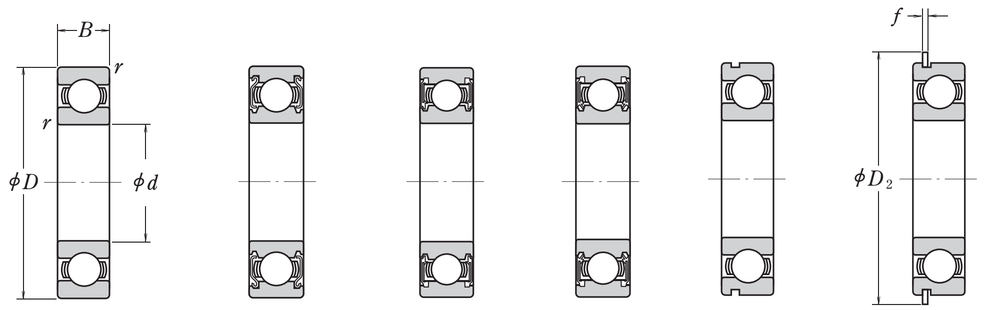
Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min⁻¹) Grease		Oil	Bearing Numbers						Snap Ring Groove Dimensions (1) (mm)					Snap Ring (1) Dimensions (mm)		Abutment and Fillet Dimensions (mm)						Mass (kg)
d	D	B	r min.	C_r	C_{0r}	f_0	Open Z · ZZ V · VV	DU DDU	Open Z	Open	Shielded	Sealed		With Snap Ring Groove	With Snap Ring	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.
10	19	5	0.3	1 720	840	14.8	34 000	24 000	40 000	**6800**	**ZZ**	**VV**	**DD**	—	—	—	—	—	—	—	—	—	12	12	17	0.3	—	—	0.005
	22	6	0.3	2 700	1 270	14.0	32 000	22 000	38 000	**6900**	**ZZ**	**VV**	**DD**	**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
	26	8	0.3	4 550	1 970	12.4	30 000	22 000	36 000	**6000**	**ZZ**	**VV**	**DDU**	**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
	30	9	0.6	5 350	2 390	13.2	28 000	18 000	34 000	**6200**	**ZZ**	**VV**	**DDU**	**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
	30	9	0.6	5 100	2 390	13.2	24 000	18 000	30 000	**6200**	**ZZ**	**VV**	**DDU**	**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
	35	11	0.6	8 500	3 450	11.2	26 000	17 000	30 000	**6300**	**ZZ**	**VV**	**DDU**	**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
	35	11	0.6	8 100	3 450	11.2	22 000	17 000	26 000	**6300**	**ZZ**	**VV**	**DDU**	**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
12	21	5	0.3	1 920	1 040	15.3	32 000	20 000	38 000	**6801**	**ZZ**	**VV**	**DD**	—	—	—	—	—	—	—	—	—	14	14	19	0.3	—	—	0.006
	24	6	0.3	2 890	1 460	14.5	30 000	20 000	36 000	**6901**	**ZZ**	**VV**	**DD**	**N**	**NR**	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
	28	7	0.3	5 100	2 370	13.0	28 000	—	32 000	**16001**	—	—	—	—	—	—	—	—	—	—	—	—	14	—	26	0.3	—	—	0.019
	28	8	0.3	5 350	2 370	13.0	32 000	18 000	38 000	**6001**	**ZZ**	**VV**	**DDU**	**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
	28	8	0.3	5 100	2 370	13.0	28 000	18 000	32 000	**6001**	**ZZ**	**VV**	**DDU**	**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
	32	10	0.6	7 150	3 050	12.3	26 000	17 000	32 000	**6201**	**ZZ**	**VV**	**DDU**	**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
	32	10	0.6	6 800	3 050	12.3	22 000	17 000	28 000	**6201**	**ZZ**	**VV**	**DDU**	**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
	37	12	1	10 200	4 200	11.1	24 000	16 000	28 000	**6301**	**ZZ**	**VV**	**DDU**	**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
	37	12	1	9 700	4 200	11.1	20 000	16 000	24 000	**6301**	**ZZ**	**VV**	**DDU**	**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
15	24	5	0.3	2 070	1 260	15.8	28 000	17 000	34 000	**6802**	**ZZ**	**VV**	**DD**	—	—	—	—	—	—	—	—	—	17	17	22	0.3	—	—	0.007
	28	7	0.3	4 350	2 260	14.3	26 000	17 000	30 000	**6902**	**ZZ**	**VV**	**DD**	**N**	**NR**	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
	32	8	0.3	5 600	2 830	13.9	24 000	—	28 000	**16002**	—	—	—	—	—	—	—	—	—	—	—	—	17	—	30	0.3	—	—	0.027
	32	9	0.3	5 850	2 830	13.9	26 000	15 000	32 000	**6002**	**ZZ**	**VV**	**DDU**	**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
	32	9	0.3	5 600	2 830	13.9	24 000	15 000	28 000	**6002**	**ZZ**	**VV**	**DDU**	**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
	35	11	0.6	8 000	3 750	13.2	22 000	14 000	28 000	**6202**	**ZZ**	**VV**	**DDU**	**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
	35	11	0.6	7 650	3 750	13.2	20 000	14 000	24 000	**6202**	**ZZ**	**VV**	**DDU**	**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
	42	13	1	12 000	5 450	12.3	19 000	13 000	24 000	**6302**	**ZZ**	**VV**	**DDU**	**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
	42	13	1	11 400	5 450	12.3	17 000	13 000	20 000	**6302**	**ZZ**	**VV**	**DDU**	**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
17	26	5	0.3	2 630	1 570	15.7	26 000	15 000	30 000	**6803**	**ZZ**	**VV**	**DD**	—	—	—	—	—	—	—	—	—	19	19	24	0.3	—	—	0.007
	30	7	0.3	4 600	2 550	14.7	24 000	15 000	28 000	**6903**	**ZZ**	**VV**	**DDU**	**N**	**NR**	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
	35	8	0.3	6 000	3 250	14.4	22 000	—	26 000	**16003**	—	—	—	—	—	—	—	—	—	—	—	—	19	—	33	0.3	—	—	0.033
	35	10	0.3	6 300	3 250	14.4	24 000	13 000	28 000	**6003**	**ZZ**	**VV**	**DDU**	**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
	35	10	0.3	6 000	3 250	14.4	22 000	13 000	26 000	**6003**	**ZZ**	**VV**	**DDU**	**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
	40	12	0.6	10 100	4 800	13.2	20 000	12 000	24 000	**6203**	**ZZ**	**VV**	**DDU**	**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
	40	12	0.6	9 550	4 800	13.2	17 000	12 000	20 000	**6203**	**ZZ**	**VV**	**DDU**	**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
	47	14	1	14 300	6 650	12.4	17 000	11 000	20 000	**6303**	**ZZ**	**VV**	**DDU**	**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
	47	14	1	13 600	6 650	12.4	15 000	11 000	18 000	**6303**	**ZZ**	**VV**	**DDU**	**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

Notes
(1) For tolerances for the snap ring grooves and snap ring dimensions, refer to Pages A116 to A119.
(2) When heavy axial loads are applied, increase d_a and decrease D_a from the above values.
(3) Ring types N and NR applicable only to open-type bearings. Please consult NSK about the snap ring groove dimensions of sealed or shielded bearings.
(4) Snap ring groove dimensions and snap ring dimensions are not conformed to ISO15.

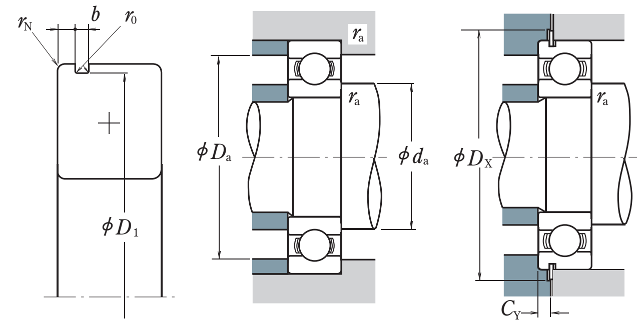
Remarks
1. Diameter Series 7 (extra thin section bearings) are also available, please contact NSK.
2. When using bearings with rotating outer rings, contact NSK if they are sealed, shielded, or have snap rings.
3. The bearings denoted by an asterisk( ) are NSKHPS™ Deep groove ball bearings.

SINGLE-ROW DEEP GROOVE BALL BEARINGS

Bore Diameter 20 – 30 mm



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



Dynamic Equivalent Load

$P = XF_r + YF_a$

$\frac{f_0 F_a}{C_{0r}}$	e	$\frac{F_a}{F_r}$ e X	Y	$\frac{F_a}{F_r}$ e 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, $P_0 = 0.6F_r + 0.5F_a$

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

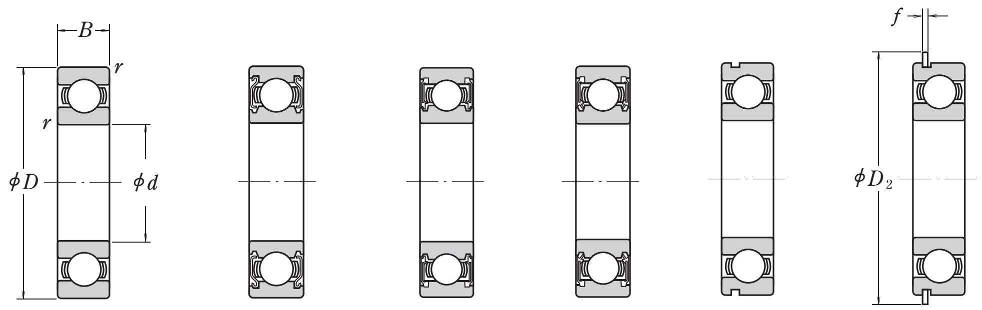
Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min⁻¹) Grease		Oil	Bearing Numbers						Snap Ring Groove Dimensions (¹) (mm)					Snap Ring (¹) Dimensions (mm)		Abutment and Fillet Dimensions (mm)						Mass (kg)
d	D	B	r min.	C_r	C_{0r}	f_0	Open Z · ZZ V · VV	DU DDU	Open Z	Open	Shielded	Sealed		With Snap Ring Groove	With Snap Ring	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.
20	32	7	0.3	4 000	2 470	15.5	22 000	13 000	26 000	**6804**	**ZZ**	**VV**	**DD**	**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
	37	9	0.3	6 400	3 700	14.7	19 000	12 000	22 000	**6904**	**ZZ**	**VV**	**DDU**	**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
	42	8	0.3	7 900	4 450	14.5	18 000	—	20 000	**16004**	—	—	—	—	—	—	—	—	—	—	—	—	22	—	40	0.3	—	—	0.048
	42	12	0.6	9 400	5 000	13.8	18 000	11 000	20 000	**6004**	**ZZ**	**VV**	**DDU**	**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
	42	12	0.6	9 400	5 000	13.8	18 000	11 000	20 000	**6004**	**ZZ**	**VV**	**DDU**	**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
	47	14	1	12 800	6 600	13.1	15 000	11 000	18 000	**6204**	**ZZ**	**VV**	**DDU**	**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
	47	14	1	12 800	6 600	13.1	15 000	11 000	18 000	**6204**	**ZZ**	**VV**	**DDU**	**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
	52	15	1.1	15 900	7 900	12.4	14 000	10 000	17 000	**6304**	**ZZ**	**VV**	**DDU**	**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
	52	15	1.1	15 900	7 900	12.4	14 000	10 000	17 000	**6304**	**ZZ**	**VV**	**DDU**	**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
22	44	12	0.6	9 400	5 050	14.0	17 000	11 000	20 000	**60/22**	**ZZ**	**VV**	**DDU**	**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
	50	14	1	12 900	6 800	13.5	14 000	9 500	16 000	**62/22**	**ZZ**	**VV**	**DDU**	**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
	56	16	1.1	18 400	9 250	12.4	13 000	9 500	16 000	**63/22**	**ZZ**	**VV**	**DDU**	**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
25	37	7	0.3	4 500	3 150	16.1	18 000	10 000	22 000	**6805**	**ZZ**	**VV**	**DD**	**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
	42	9	0.3	7 050	4 550	15.4	16 000	10 000	19 000	**6905**	**ZZ**	**VV**	**DDU**	**N**	**NR**	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
	47	8	0.3	8 850	5 600	15.1	15 000	—	18 000	**16005**	—	—	—	—	—	—	—	—	—	—	—	—	27	—	45	0.3	—	—	0.059
	47	12	0.6	10 600	5 850	14.5	18 000	9 500	22 000	**6005**	**ZZ**	**VV**	**DDU**	**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
	47	12	0.6	10 100	5 850	14.5	15 000	9 500	18 000	**6005**	**ZZ**	**VV**	**DDU**	**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
	52	15	1	14 700	7 850	13.9	15 000	9 000	18 000	**6205**	**ZZ**	**VV**	**DDU**	**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
	52	15	1	14 000	7 850	13.9	13 000	9 000	15 000	**6205**	**ZZ**	**VV**	**DDU**	**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
	62	17	1.1	21 600	11 200	13.2	13 000	8 000	16 000	**6305**	**ZZ**	**VV**	**DDU**	**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
	62	17	1.1	20 600	11 200	13.2	11 000	8 000	13 000	**6305**	**ZZ**	**VV**	**DDU**	**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
28	52	12	0.6	12 500	7 400	14.5	14 000	8 500	16 000	**60/28**	**ZZ**	**VV**	**DDU**	**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
	58	16	1	16 600	9 500	13.9	12 000	8 000	14 000	**62/28**	**ZZ**	**VV**	**DDU**	**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
	68	18	1.1	26 700	14 000	12.4	10 000	7 500	13 000	**63/28**	**ZZ**	**VV**	**DDU**	**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
30	42	7	0.3	4 700	3 650	16.4	15 000	9 000	18 000	**6806**	**ZZ**	**VV**	**DD**	**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
	47	9	0.3	7 250	5 000	15.8	14 000	8 500	17 000	**6906**	**ZZ**	**VV**	**DDU**	**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
	55	9	0.3	11 200	7 350	15.2	13 000	—	15 000	**16006**	—	—	—	—	—	—	—	—	—	—	—	—	32	—	53	0.3	—	—	0.087
	55	13	1	13 900	8 300	14.7	15 000	8 000	18 000	**6006**	**ZZ**	**VV**	**DDU**	**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
	55	13	1	13 200	8 300	14.7	13 000	8 000	15 000	**6006**	**ZZ**	**VV**	**DDU**	**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
	62	16	1	20 400	11 300	13.8	12 000	7 500	15 000	**6206**	**ZZ**	**VV**	**DDU**	**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
	62	16	1	19 500	11 300	13.8	11 000	7 500	13 000	**6206**	**ZZ**	**VV**	**DDU**	**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
	72	19	1.1	28 000	15 000	13.3	11 000	6 700	13 000	**6306**	**ZZ**	**VV**	**DDU**	**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
	72	19	1.1	26 700	15 000	13.3	9 500	6 700	12 000	**6306**	**ZZ**	**VV**	**DDU**	**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

Notes
(¹) For tolerances for the snap ring grooves and snap ring dimensions, refer to Pages A116 to A119.
(²) When heavy axial loads are applied, increase d_a and decrease D_a from the above values.
(³) Ring types N and NR applicable only to open-type bearings. Please consult NSK about the snap ring groove dimensions of sealed or shielded bearings.
(⁴) Snap ring groove dimensions and snap ring dimensions are not conformed to ISO15.

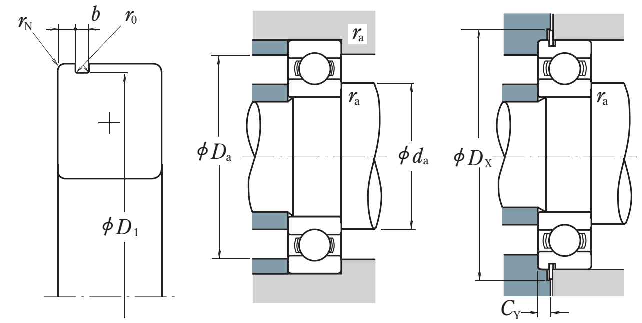
Remarks
1. Diameter Series 7 (extra thin section bearings) are also available, please contact NSK.
2. When using bearings with rotating outer rings, contact NSK if they are sealed, shielded, or have snap rings.
3. The bearings denoted by an asterisk( ) are NSKHPS™ Deep groove ball bearings.

SINGLE-ROW DEEP GROOVE BALL BEARINGS

Bore Diameter 32 – 45 mm



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



Dynamic Equivalent Load

$P = XF_r + YF_a$

$\frac{f_0F_a}{C_{0r}}$	e	$\frac{F_a}{F_r} \leq e$ X	Y	$\frac{F_a}{F_r} > e$ 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

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

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

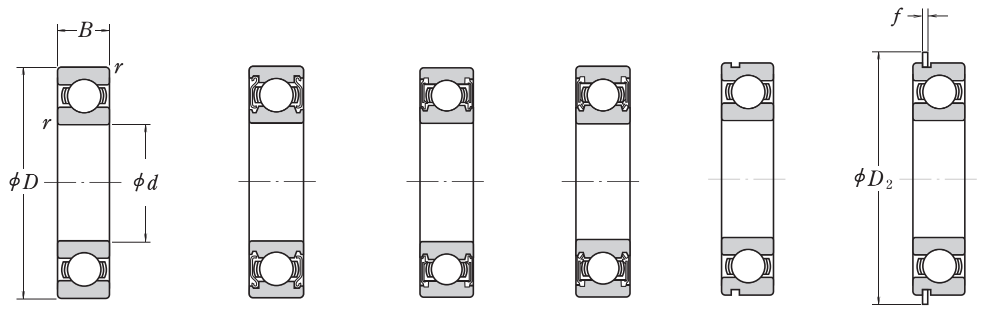
Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min⁻¹)			Bearing Numbers						Snap Ring Groove Dimensions ([1]) (mm)					Snap Ring ([1]) Dimensions (mm)		Abutment and Fillet Dimensions (mm)						Mass (kg)
							Grease		Oil																				
d	D	B	r min.	C_r	C_{0r}	f_0	Open Z · ZZ V · VV	DU DDU	Open Z	Open	Shielded	Sealed		With Snap Ring Groove	With Snap Ring	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.
32	58	13	1	15 100	9 150	14.5	12 000	7 500	14 000	**60/32**	**ZZ**	**VV**	**DDU**	**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
	65	17	1	20 700	11 600	13.6	10 000	7 100	12 000	**62/32**	**ZZ**	**VV**	**DDU**	**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
	75	20	1.1	29 900	17 000	13.2	9 000	6 300	11 000	**63/32**	**ZZ**	**VV**	**DDU**	**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
35	47	7	0.3	4 900	4 100	16.7	14 000	7 500	16 000	**6807**	**ZZ**	**VV**	**DD**	**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
	55	10	0.6	10 600	7 250	15.5	12 000	7 500	15 000	**6907**	**ZZ**	**VV**	**DDU**	**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
	62	9	0.3	11 700	8 200	15.6	11 000	—	13 000	**16007**	—	—	—	—	—	—	—	—	—	—	—	—	37	—	60	0.3	—	—	0.107
	62	14	1	16 800	10 300	14.8	13 000	6 700	15 000	**6007**	**ZZ**	**VV**	**DDU**	**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
	62	14	1	16 000	10 300	14.8	11 000	6 700	13 000	**6007**	**ZZ**	**VV**	**DDU**	**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
	72	17	1.1	27 000	15 300	13.8	11 000	6 300	13 000	**6207**	**ZZ**	**VV**	**DDU**	**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
	72	17	1.1	25 700	15 300	13.8	9 500	6 300	11 000	**6207**	**ZZ**	**VV**	**DDU**	**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
	80	21	1.5	35 000	19 200	13.2	10 000	6 000	12 000	**6307**	**ZZ**	**VV**	**DDU**	**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
	80	21	1.5	33 500	19 200	13.2	8 500	6 000	10 000	**6307**	**ZZ**	**VV**	**DDU**	**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
40	52	7	0.3	6 350	5 550	17.0	12 000	6 700	14 000	**6808**	**ZZ**	**VV**	**DD**	**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
	62	12	0.6	13 700	10 000	15.7	11 000	6 300	13 000	**6908**	**ZZ**	**VV**	**DDU**	**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
	68	9	0.3	12 600	9 650	16.0	10 000	—	12 000	**16008**	—	—	—	—	—	—	—	—	—	—	—	—	42	—	66	0.3	—	—	0.13
	68	15	1	17 600	11 500	15.3	12 000	6 000	14 000	**6008**	**ZZ**	**VV**	**DDU**	**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
	68	15	1	16 800	11 500	15.3	10 000	6 000	12 000	**6008**	**ZZ**	**VV**	**DDU**	**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
	80	18	1.1	30 500	17 900	14.0	9 500	5 600	12 000	**6208**	**ZZ**	**VV**	**DDU**	**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
	80	18	1.1	29 100	17 900	14.0	8 500	5 600	10 000	**6208**	**ZZ**	**VV**	**DDU**	**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
	90	23	1.5	43 000	24 000	13.2	9 000	5 300	11 000	**6308**	**ZZ**	**VV**	**DDU**	**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
	90	23	1.5	40 500	24 000	13.2	7 500	5 300	9 000	**6308**	**ZZ**	**VV**	**DDU**	**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
45	58	7	0.3	6 600	6 150	17.2	11 000	6 000	13 000	**6809**	**ZZ**	**VV**	**DD**	**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
	68	12	0.6	14 100	10 900	15.9	9 500	5 600	12 000	**6909**	**ZZ**	**VV**	**DDU**	**N**	**NR**	1.70	0.95	66.7	0.25	0.5	70.8	0.85	49	50	64	0.6	72	2.3	0.126
	75	10	0.6	14 900	11 400	15.9	9 000	—	11 000	**16009**	—	—	—	—	—	—	—	—	—	—	—	—	49	—	71	0.6	—	—	0.167
	75	16	1	22 000	15 200	15.3	10 000	5 300	12 000	**6009**	**ZZ**	**VV**	**DDU**	**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
	75	16	1	20 900	15 200	15.3	9 000	5 300	11 000	**6009**	**ZZ**	**VV**	**DDU**	**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
	85	19	1.1	33 000	20 400	14.4	9 000	5 300	11 000	**6209**	**ZZ**	**VV**	**DDU**	**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
	85	19	1.1	31 500	20 400	14.4	7 500	5 300	9 000	**6209**	**ZZ**	**VV**	**DDU**	**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
	100	25	1.5	55 500	32 000	13.1	7 500	4 800	9 500	**6309**	**ZZ**	**VV**	**DDU**	**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
	100	25	1.5	53 000	32 000	13.1	6 700	4 800	8 000	**6309**	**ZZ**	**VV**	**DDU**	**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

Notes
(1) For tolerances for the snap ring grooves and snap ring dimensions, refer to Pages A116 to A119.
(2) When heavy axial loads are applied, increase d_a and decrease D_a from the above values.
(3) Ring types N and NR applicable only to open-type bearings. Please consult NSK about the snap ring groove dimensions of sealed or shielded bearings.
(4) Snap ring groove dimensions and snap ring dimensions are not conformed to ISO15.

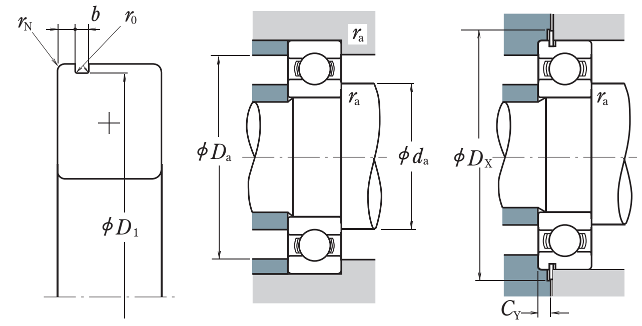
Remarks
1. Diameter Series 7 (extra thin section bearings) are also available, please contact NSK.
2. When using bearings with rotating outer rings, contact NSK if they are sealed, shielded, or have snap rings.
3. The bearings denoted by an asterisk( ) are NSKHPS™ Deep groove ball bearings.

SINGLE-ROW DEEP GROOVE BALL BEARINGS

Bore Diameter 50 – 60 mm



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



Dynamic Equivalent Load

$P = XF_r + YF_a$

$\frac{f_0 F_a}{C_{0r}}$	e	$\frac{F_a}{F_r} \le e$ X	$\frac{F_a}{F_r} \le e$ Y	$\frac{F_a}{F_r} > e$ X	$\frac{F_a}{F_r} > e$ 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

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

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

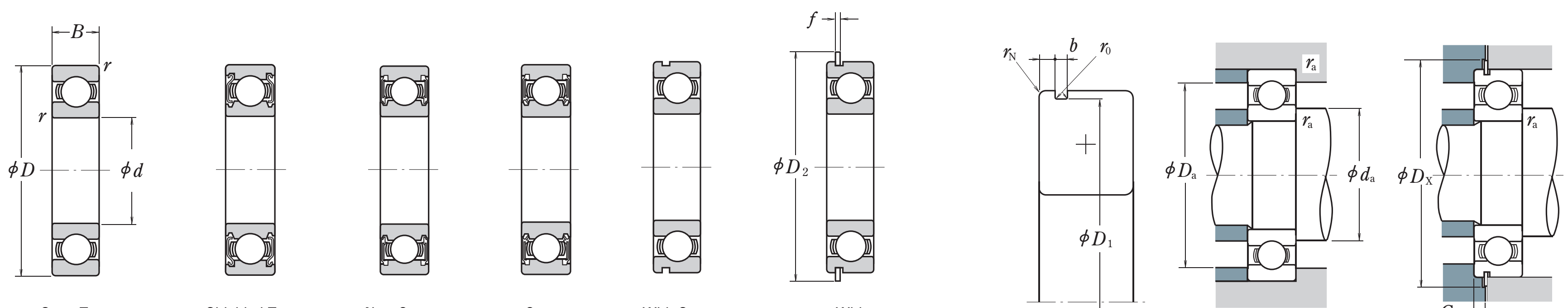
Boundary Dimensions (mm) d	D	B	r min.	Basic Load Ratings (N) C_r	C_{0r}	Factor f_0	Limiting Speeds (min⁻¹) Grease Open Z · ZZ V · VV	Grease DU DDU	Oil Open Z	Bearing Numbers Open	Shielded	Sealed	Sealed	With Snap Ring Groove	With Snap Ring	Snap Ring Groove Dimensions (1) (mm) max.	b min.	D_1 max.	r_0 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.
50	65	7	0.3	6 400	6 200	17.2	9 500	5 300	11 000	6810	ZZ	VV	DDU	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
	72	12	0.6	14 500	11 700	16.1	9 000	5 300	11 000	6910	ZZ	VV	DDU	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
	80	10	0.6	15 400	12 400	16.1	8 500	—	10 000	16010	—	—	—	—	—	—	—	—	—	—	—	—	54	—	76	0.6	—	—	0.175
	80	16	1	22 900	16 600	15.6	9 500	4 800	11 000	6010	ZZ	VV	DDU	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
	80	16	1	21 800	16 600	15.6	8 500	4 800	10 000	6010	ZZ	VV	DDU	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
	90	20	1.1	37 000	23 200	14.4	8 000	4 800	10 000	6210	ZZ	VV	DDU	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
	90	20	1.1	35 000	23 200	14.4	7 100	4 800	8 500	6210	ZZ	VV	DDU	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
	110	27	2	65 000	38 500	13.2	7 100	4 300	8 500	6310	ZZ	VV	DDU	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
	110	27	2	62 000	38 500	13.2	6 000	4 300	7 500	6310	ZZ	VV	DDU	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
55	72	9	0.3	8 800	8 500	17.0	8 500	4 800	10 000	6811	ZZ	VV	DDU	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
	80	13	1	16 000	13 300	16.2	8 000	4 500	9 500	6911	ZZ	VV	DDU	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
	90	11	0.6	19 400	16 300	16.2	7 500	—	9 000	16011	—	—	—	—	—	—	—	—	—	—	—	—	59	—	86	0.6	—	—	0.257
	90	18	1.1	29 700	21 200	15.3	8 500	4 500	10 000	6011	ZZ	VV	DDU	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
	90	18	1.1	28 300	21 200	15.3	7 500	4 500	9 000	6011	ZZ	VV	DDU	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
	100	21	1.5	45 500	29 300	14.3	7 500	4 300	9 000	6211	ZZ	VV	DDU	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
	100	21	1.5	43 500	29 300	14.3	6 300	4 300	7 500	6211	ZZ	VV	DDU	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
	120	29	2	75 000	44 500	13.1	6 700	4 000	8 000	6311	ZZ	VV	DDU	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
	120	29	2	71 500	44 500	13.1	5 600	4 000	6 700	6311	ZZ	VV	DDU	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
60	78	10	0.3	11 500	10 900	16.9	8 000	4 500	9 500	6812	ZZ	VV	DD	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
	85	13	1	19 400	16 300	16.2	7 500	4 300	9 000	6912	ZZ	VV	DDU	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
	95	11	0.6	20 000	17 500	16.3	7 100	—	8 500	16012	—	—	—	—	—	—	—	—	—	—	—	—	64	—	91	0.6	—	—	0.281
	95	18	1.1	31 000	23 200	15.6	8 000	4 000	9 500	6012	ZZ	VV	DDU	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
	95	18	1.1	29 500	23 200	15.6	7 100	4 000	8 500	6012	ZZ	VV	DDU	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
	110	22	1.5	55 000	36 000	14.3	6 700	3 800	8 000	6212	ZZ	VV	DDU	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
	110	22	1.5	52 500	36 000	14.3	5 600	3 800	7 100	6212	ZZ	VV	DDU	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
	130	31	2.1	86 000	52 000	13.1	6 000	3 600	7 100	6312	ZZ	VV	DDU	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
	130	31	2.1	82 000	52 000	13.1	5 300	3 600	6 300	6312	ZZ	VV	DDU	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

Notes (1) For tolerances for the snap ring grooves and snap ring dimensions, refer to Pages A116 to A119.
(2) When heavy axial loads are applied, increase d_a and decrease D_a from the above values.
(3) Ring types N and NR applicable only to open-type bearings. Please consult NSK about the snap ring groove dimensions of sealed or shielded bearings.
(4) Not conformed to ISO15.

Remarks
1. Diameter Series 7 (extra thin section bearings) are also available, please contact NSK.
2. When using bearings with rotating outer rings, contact NSK if they are sealed, shielded, or have snap rings.
3. The bearings denoted by an asterisk( ) are NSKHPS™ Deep groove ball bearings.

SINGLE-ROW DEEP GROOVE BALL BEARINGS

Bore Diameter 65 – 75 mm



Dynamic Equivalent Load

$P = XF_r + YF_a$

$\frac{f_0F_a}{C_{0r}}$	e	$\frac{F_a}{F_r} \le e$ X	Y	$\frac{F_a}{F_r} > e$ 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

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

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

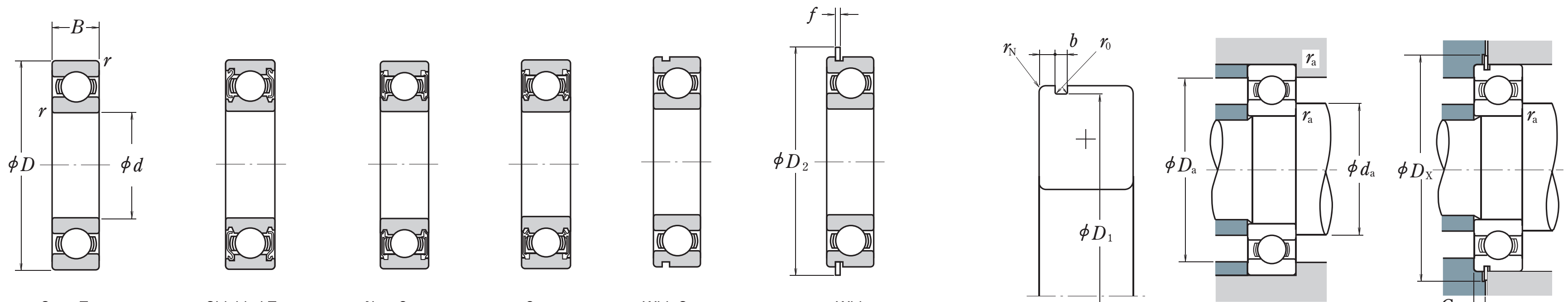
Boundary Dimensions (mm) d	D	B	r min.	Basic Load Ratings (N) C_r	C_{0r}	Factor f_0	Limiting Speeds (min⁻¹) Grease Open Z · ZZ V · VV	Grease DU DDU	Oil Open Z	Bearing Numbers Open	Shielded	Sealed	Sealed	With Snap Ring Groove	With Snap Ring	Snap Ring Groove Dimensions ([1]) (mm) max.	b min.	D_1 max.	r_0 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.
65	85	10	0.6	11 900	12 100	17.0	7 500	4 000	8 500	6813	ZZ	VV	DD	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
	90	13	1	17 400	16 100	16.6	7 100	4 000	8 500	6913	ZZ	VV	DDU	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
	100	11	0.6	20 500	18 700	16.5	6 700	—	8 000	16013	—	—	—	—	—	—	—	—	—	—	—	—	69	—	96	0.6	—	—	0.30
	100	18	1.1	32 000	25 200	15.8	7 500	4 000	9 000	6013	ZZ	VV	DDU	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
	100	18	1.1	30 500	25 200	15.8	6 700	4 000	8 000	6013	ZZ	VV	DDU	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
	120	23	1.5	60 000	40 000	14.4	6 300	3 600	7 500	6213	ZZ	VV	DDU	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
	120	23	1.5	57 500	40 000	14.4	5 300	3 600	6 300	6213	ZZ	VV	DDU	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
	140	33	2.1	97 500	60 000	13.2	5 600	3 400	6 700	6313	ZZ	VV	DDU	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
	140	33	2.1	92 500	60 000	13.2	4 800	3 400	6 000	6313	ZZ	VV	DDU	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
70	90	10	0.6	12 100	12 700	17.2	6 700	3 800	8 000	6814	ZZ	VV	DD	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
	100	16	1	23 700	21 200	16.3	6 300	3 600	7 500	6914	ZZ	VV	DDU	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
	110	13	0.6	26 800	23 600	16.3	6 000	—	7 100	16014	—	—	—	—	—	—	—	—	—	—	—	—	74	—	106	0.6	—	—	0.441
	110	20	1.1	40 000	31 000	15.6	7 100	3 600	8 500	6014	ZZ	VV	DDU	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
	110	20	1.1	38 000	31 000	15.6	6 000	3 600	7 100	6014	ZZ	VV	DDU	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
	125	24	1.5	65 500	44 000	14.5	6 000	3 400	7 100	6214	ZZ	VV	DDU	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
	125	24	1.5	62 000	44 000	14.5	5 000	3 400	6 300	6214	ZZ	VV	DDU	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
	150	35	2.1	109 000	68 000	13.2	5 300	3 200	6 300	6314	ZZ	VV	DDU	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
	150	35	2.1	104 000	68 000	13.2	4 500	3 200	5 300	6314	ZZ	VV	DDU	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
75	95	10	0.6	12 500	13 900	17.3	6 300	3 600	7 500	6815	ZZ	VV	DDU	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
	105	16	1	24 400	22 600	16.5	6 000	3 400	7 100	6915	ZZ	VV	DDU	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
	115	13	0.6	27 600	25 300	16.4	5 600	—	6 700	16015	—	—	—	—	—	—	—	—	—	—	—	—	79	—	111	0.6	—	—	0.463
	115	20	1.1	41 500	33 500	15.8	6 700	3 400	8 000	6015	ZZ	VV	DDU	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
	115	20	1.1	39 500	33 500	15.8	5 600	3 400	6 700	6015	ZZ	VV	DDU	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
	130	25	1.5	69 500	49 500	14.7	5 600	3 200	6 700	6215	ZZ	VV	DDU	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
	130	25	1.5	66 000	49 500	14.7	4 800	3 200	5 600	6215	ZZ	VV	DDU	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
	160	37	2.1	119 000	77 000	13.2	4 800	2 800	6 000	6315	ZZ	VV	DDU	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
	160	37	2.1	113 000	77 000	13.2	4 300	2 800	5 000	6315	ZZ	VV	DDU	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

Notes
([1]) For tolerances for the snap ring grooves and snap ring dimensions, refer to Pages A116 to A119.
([2]) When heavy axial loads are applied, increase d_a and decrease D_a from the above values.
([3]) Ring types N and NR applicable only to open-type bearings. Please consult NSK about the snap ring groove dimensions of sealed or shielded bearings.
([4]) Not conformed to ISO15.

Remarks
1. Diameter Series 7 (extra thin section bearings) are also available, please contact NSK.
2. When using bearings with rotating outer rings, contact NSK if they are sealed, shielded, or have snap rings.
3. The bearings denoted by an asterisk( ) are NSKHPS™ Deep groove ball bearings.

SINGLE-ROW DEEP GROOVE BALL BEARINGS

Bore Diameter 80 – 90 mm



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

Dynamic Equivalent Load

$P = XF_r + YF_a$

$\frac{f_0F_a}{C_{0r}}$	e	$\frac{F_a}{F_r} \le e$ X	Y	$\frac{F_a}{F_r} > e$ 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

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

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

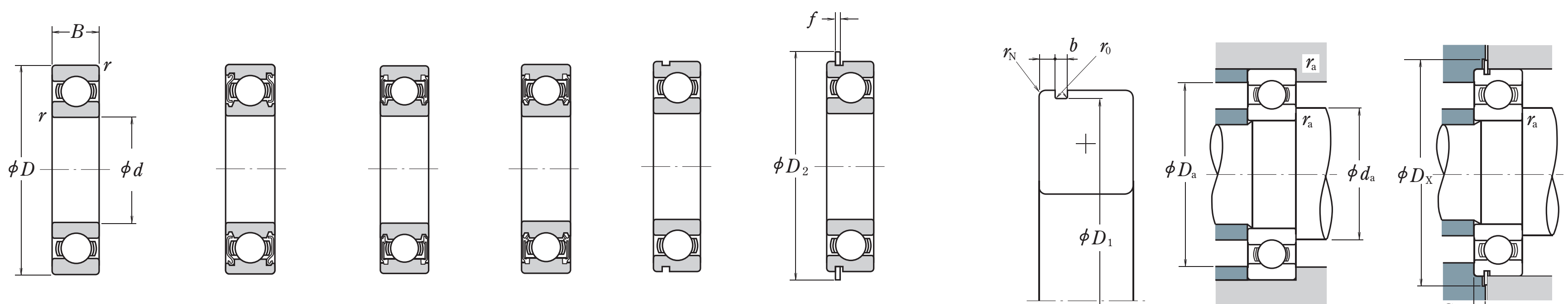
Boundary Dimensions (mm) d	D	B	r min.	Basic Load Ratings (N) C_r	C_{0r}	Factor f_0	Limiting Speeds (min⁻¹) Grease Open Z · ZZ V · VV	Grease DU DDU	Oil Open Z	Bearing Numbers Open	Shielded	Sealed	Sealed	With Snap Ring Groove	With Snap Ring	Snap Ring Groove Dimensions ([1]) (mm) max.	b min.	D_1 max.	r_0 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 max.	D_a([2]) max.	r_a max.	D_x min.	C_Y max.	Mass (kg) approx.
80	100	10	0.6	12 700	14 500	17.4	6 000	3 400	7 100	6816	ZZ	VV	DDU	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
	110	16	1	25 000	24 000	16.6	5 600	3 200	6 700	6916	ZZ	VV	DDU	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
	125	14	0.6	32 000	29 600	16.4	5 300	—	6 300	16016	—	—	—	—	—	—	—	—	—	—	—	—	84	—	121	0.6	—	—	0.621
	125	22	1.1	50 000	40 000	15.6	6 300	3 200	7 100	6016	ZZ	VV	DDU	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
	125	22	1.1	47 500	40 000	15.6	5 300	3 200	6 300	6016	ZZ	VV	DDU	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
	140	26	2	76 500	53 000	14.6	5 300	3 000	6 300	6216	ZZ	VV	DDU	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
	140	26	2	72 500	53 000	14.6	4 500	3 000	5 300	6216	ZZ	VV	DDU	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
	170	39	2.1	129 000	86 500	13.3	4 500	2 800	5 600	6316	ZZ	VV	DDU	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
	170	39	2.1	123 000	86 500	13.3	4 000	2 800	4 800	6316	ZZ	VV	DDU	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
85	110	13	1	18 700	20 000	17.1	5 600	3 200	6 700	6817	ZZ	VV	DDU	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
	120	18	1.1	32 000	29 600	16.4	5 300	3 000	6 300	6917	ZZ	VV	DDU	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
	130	14	0.6	33 000	31 500	16.5	5 000	—	6 000	16017	—	—	—	—	—	—	—	—	—	—	—	—	89	—	126	0.6	—	—	0.652
	130	22	1.1	52 000	43 000	15.8	6 000	3 000	7 100	6017	ZZ	VV	DDU	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
	130	22	1.1	49 500	43 000	15.8	5 000	3 000	6 000	6017	ZZ	VV	DDU	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
	150	28	2	88 000	62 000	14.5	4 800	2 800	6 000	6217	ZZ	VV	DDU	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
	150	28	2	84 000	62 000	14.5	4 300	2 800	5 000	6217	ZZ	VV	DDU	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
	180	41	3	139 000	97 000	13.3	4 300	2 600	5 000	6317	ZZ	VV	DDU	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
	180	41	3	133 000	97 000	13.3	3 800	2 600	4 500	6317	ZZ	VV	DDU	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
90	115	13	1	19 000	21 000	17.2	5 300	3 000	6 300	6818	ZZ	VV	DDU	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
	125	18	1.1	33 000	31 500	16.5	5 000	2 800	6 000	6918	ZZ	VV	DDU	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
	140	16	1	41 500	39 500	16.3	4 800	—	5 600	16018	—	—	—	—	—	—	—	—	—	—	—	—	95	—	135	1	—	—	0.873
	140	24	1.5	61 000	50 000	15.6	5 600	2 800	6 300	6018	ZZ	VV	DDU	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
	140	24	1.5	58 000	50 000	15.6	4 800	2 800	5 600	6018	ZZ	VV	DDU	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
	160	30	2	101 000	71 500	14.5	4 500	2 600	5 600	6218	ZZ	VV	DDU	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
	160	30	2	96 000	71 500	14.5	4 000	2 600	4 800	6218	ZZ	VV	DDU	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
	190	43	3	150 000	107 000	13.3	4 000	2 400	4 800	6318	ZZ	VV	DDU	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
	190	43	3	143 000	107 000	13.3	3 600	2 400	4 300	6318	ZZ	VV	DDU	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

Notes
(1) For tolerances for the snap ring grooves and snap ring dimensions, refer to Pages A116 to A119.
(2) When heavy axial loads are applied, increase d_a and decrease D_a from the above values.
(3) Ring types N and NR applicable only to open-type bearings. Please consult NSK about the snap ring groove dimensions of sealed or shielded bearings.
(4) Not conformed to ISO15.

Remarks
1. Diameter Series 7 (extra thin section bearings) are also available, please contact NSK.
2. When using bearings with rotating outer rings, contact NSK if they are sealed, shielded, or have snap rings.
3. The bearings denoted by an asterisk( ) are NSKHPS™ Deep groove ball bearings.

SINGLE-ROW DEEP GROOVE BALL BEARINGS

Bore Diameter 95 – 105 mm



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

Dynamic Equivalent Load

$P = XF_r + YF_a$

$\frac{f_0F_a}{C_{0r}}$	e	$\frac{F_a}{F_r} \le e$: X	Y	$\frac{F_a}{F_r} > e$: 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

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

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

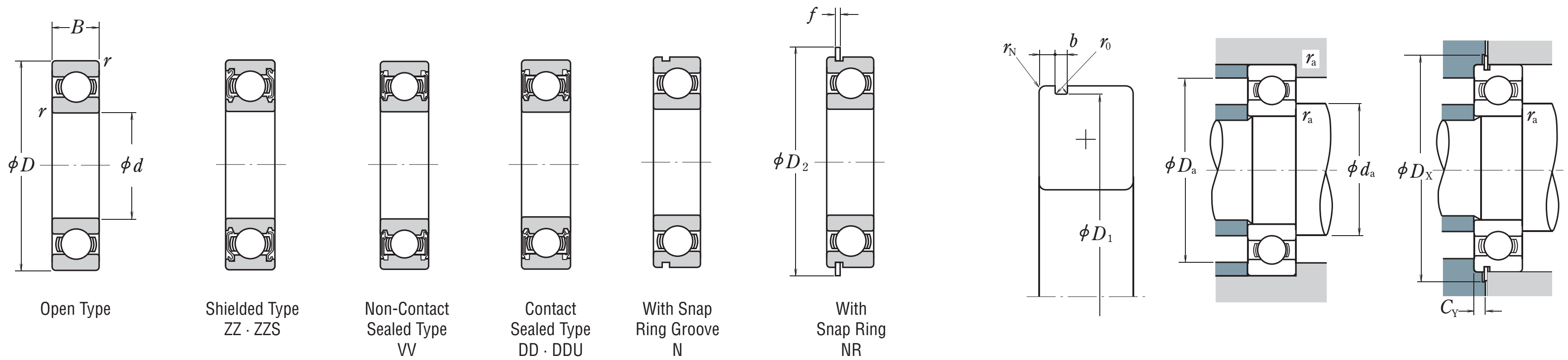
Boundary Dimensions (mm) d	D	B	r min.	Basic Load Ratings (N) C_r	C_{0r}	Factor f_0	Limiting Speeds (min⁻¹) Grease Open Z · ZZ V · VV	Grease DU DDU	Oil Open Z	Bearing Numbers Open	Shielded	Sealed	Sealed	With Snap Ring Groove	With Snap Ring	Snap Ring Groove Dimensions ([1]) (mm) max.	b min.	D_1 max.	r_0 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.
95	120	13	1	19 300	22 000	17.2	5 000	2 800	6 000	**6819**	**ZZ**	**VV**	**DD**	**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
	130	18	1.1	33 500	33 500	16.6	4 800	2 800	5 600	**6919**	**ZZ**	**VV**	**DDU**	**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
	145	16	1	43 000	42 000	16.4	4 500	—	5 300	**16019**	—	—	—	—	—	—	—	—	—	—	—	—	100	—	140	1	—	—	0.904
	145	24	1.5	63 500	54 000	15.8	5 300	2 600	6 000	**6019**	**ZZ**	**VV**	**DDU**	**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
	145	24	1.5	60 500	54 000	15.8	4 500	2 600	5 300	**6019**	**ZZ**	**VV**	**DDU**	**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
	170	32	2.1	114 000	82 000	14.4	4 300	2 600	5 000	**6219**	**ZZ**	**VV**	**DDU**	**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
	170	32	2.1	109 000	82 000	14.4	3 800	2 600	4 500	**6219**	**ZZ**	**VV**	**DDU**	**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
	200	45	3	160 000	119 000	13.3	3 400	2 400	4 300	**6319**	**ZZ**	**VV**	**DDU**	**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
	200	45	3	153 000	119 000	13.3	3 000	2 400	3 600	**6319**	**ZZ**	**VV**	**DDU**	**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
100	125	13	1	19 600	23 000	17.3	4 800	2 800	5 600	**6820**	**ZZ**	**VV**	**DD**	**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
	140	20	1.1	43 000	42 000	16.4	4 500	2 600	5 300	**6920**	**ZZ**	**VV**	**DDU**	**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
	150	16	1	42 500	42 000	16.5	4 300	—	5 300	**16020**	—	—	—	—	—	—	—	—	—	—	—	—	105	—	145	1	—	—	0.945
	150	24	1.5	63 000	54 000	15.9	5 000	2 600	6 000	**6020**	**ZZ**	**VV**	**DDU**	**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
	150	24	1.5	60 000	54 000	15.9	4 300	2 600	5 300	**6020**	**ZZ**	**VV**	**DDU**	**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
	180	34	2.1	128 000	93 000	14.4	4 000	2 400	4 800	**6220**	**ZZ**	**VV**	**DDU**	**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
	180	34	2.1	122 000	93 000	14.4	3 600	2 400	4 300	**6220**	**ZZ**	**VV**	**DDU**	**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
	215	47	3	173 000	141 000	13.2	2 800	2 200	3 400	**6320**	**ZZ**	**VV**	**DDU**	—	—	—	—	—	—	—	—	—	113	133	202	2.5	—	—	7.04
105	130	13	1	19 800	23 900	17.4	4 800	2 600	5 600	**6821**	**ZZ**	**VV**	**DDU**	**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
	145	20	1.1	42 500	42 000	16.5	4 300	—	5 300	**6921**	**ZZ**	**VV**	—	**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
	160	18	1	52 000	50 500	16.3	4 000	—	4 800	**16021**	—	—	—	—	—	—	—	—	—	—	—	—	110	—	155	1	—	—	1.24
	160	26	2	76 000	66 000	15.8	4 500	2 400	5 600	**6021**	**ZZ**	**VV**	**DDU**	**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
	160	26	2	72 500	66 000	15.8	4 000	2 400	4 800	**6021**	**ZZ**	**VV**	**DDU**	**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
	190	36	2.1	140 000	105 000	14.4	3 800	2 200	4 500	**6221**	**ZZ**	**VV**	**DDU**	**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
	190	36	2.1	133 000	105 000	14.4	3 400	2 200	4 000	**6221**	**ZZ**	**VV**	**DDU**	**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
	225	49	3	184 000	154 000	13.2	2 600	2 000	3 200	**6321**	**ZZ**	—	**DDU**	—	—	—	—	—	—	—	—	—	118	138	212	2.5	—	—	8.09

Notes
([1]) For tolerances for the snap ring grooves and snap ring dimensions, refer to Pages A116 to A119.
([2]) When heavy axial loads are applied, increase d_a and decrease D_a from the above values.
([3]) Ring types N and NR applicable only to open-type bearings. Please consult NSK about the snap ring groove dimensions of sealed or shielded bearings.
([4]) Not conformed to ISO15.

Remarks
1. Diameter Series 7 (extra thin section bearings) are also available, please contact NSK.
2. When using bearings with rotating outer rings, contact NSK if they are sealed, shielded, or have snap rings.
3. The bearings denoted by an asterisk( ) are NSKHPS™ Deep groove ball bearings.

SINGLE-ROW DEEP GROOVE BALL BEARINGS

Bore Diameter 110 – 150 mm



Dynamic Equivalent Load

$P = XF_r + YF_a$

$\frac{f_0F_a}{C_{0r}}$	e	$\frac{F_a}{F_r} \le e$ X	Y	$\frac{F_a}{F_r} > e$ 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

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

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

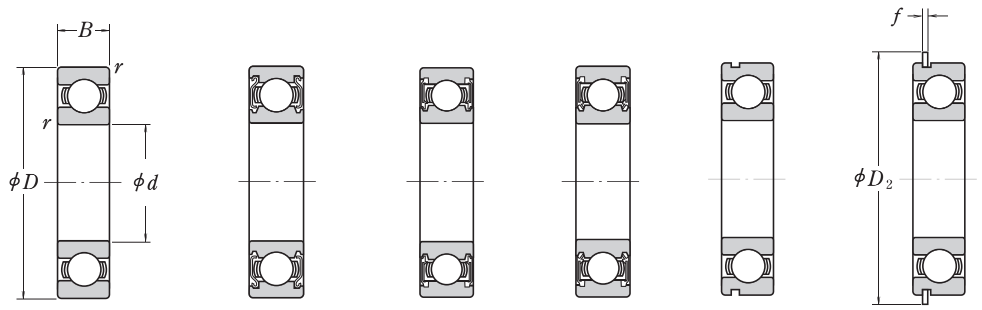
Boundary Dimensions (mm) d	D	B	r min.	Basic Load Ratings (N) C_r	C_{0r}	Factor f_0	Limiting Speeds (min⁻¹) Grease Open Z · ZZ V · VV	Grease DU DDU	Oil Open Z	Bearing Numbers Open	Shielded	Sealed	Sealed	With Snap Ring Groove	With Snap Ring	Snap Ring Groove Dimensions (1) (mm) max.	b min.	D_1 max.	r_0 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 max.	D_a(2) max.	r_a max.	D_x min.	C_Y max.	Mass (kg) approx.
110	140	16	1	28 100	32 500	17.1	4 300	2 400	5 300	6822	ZZ	VV	DDU	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
	150	20	1.1	43 500	44 500	16.6	4 300	2 400	5 000	6922	ZZ	VV	DDU	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
	170	19	1	57 500	56 500	16.3	3 800	—	4 500	16022	—	—	—	—	—	—	—	—	—	—	—	—	115	—	165	1	—	—	1.51
	170	28	2	89 000	73 000	15.5	4 500	2 200	5 300	6022	ZZ	VV	DDU	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
	170	28	2	85 000	73 000	15.5	3 800	2 200	4 500	6022	ZZ	VV	DDU	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
	200	38	2.1	144 000	117 000	14.3	2 800	2 200	3 400	6222	ZZ	VV	DDU	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
	240	50	3	205 000	179 000	13.2	2 400	—	3 000	6322	ZZ	—	—	—	—	—	—	—	—	—	—	—	123	147	227	2.5	—	—	9.51
120	150	16	1	28 900	35 500	17.3	4 000	2 200	4 800	6824	ZZ	VV	DD	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
	165	22	1.1	53 000	54 000	16.5	3 800	—	4 500	6924	ZZ	—	—	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
	180	19	1	56 500	57 500	16.5	3 600	—	4 300	16024	—	—	—	—	—	—	—	—	—	—	—	—	125	—	175	1	—	—	1.6
	180	28	2	92 500	80 000	15.7	4 000	2 200	4 800	6024	ZZ	VV	DDU	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
	180	28	2	88 000	80 000	15.7	3 600	2 200	4 300	6024	ZZ	VV	DDU	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
	215	40	2.1	155 000	131 000	14.4	2 600	2 000	3 200	6224	ZZ	VV	DDU	—	—	—	—	—	—	—	—	—	131	146	204	2	—	—	5.29
	260	55	3	207 000	185 000	13.5	2 200	1 800	2 800	6324	ZZS	—	DDU	—	—	—	—	—	—	—	—	—	133	161	247	2.5	—	—	12.5
130	165	18	1.1	37 000	44 000	17.1	3 600	2 000	4 300	6826	ZZS	VV	DD	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
	180	24	1.5	65 000	67 500	16.5	3 400	—	4 000	6926	ZZ	—	—	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
	200	22	1.1	75 500	77 500	16.4	3 000	—	3 600	16026	—	—	—	—	—	—	—	—	—	—	—	—	136.5	—	193.5	1	—	—	2.4
	200	33	2	106 000	101 000	15.8	3 000	1 900	3 600	6026	ZZ	—	DDU	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
	230	40	3	167 000	146 000	14.5	2 400	—	3 000	6226	ZZ	—	—	—	—	—	—	—	—	—	—	—	143	157	217	2.5	—	—	5.96
	280	58	4	229 000	214 000	13.6	2 200	—	2 600	6326	ZZS	—	—	—	—	—	—	—	—	—	—	—	146	175	264	3	—	—	15.2
140	175	18	1.1	38 500	48 000	17.3	3 400	1 900	4 000	6828	ZZ	VV	DDU	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
	190	24	1.5	66 500	72 000	16.6	3 200	—	3 800	6928	ZZS	VV	—	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
	210	22	1.1	77 500	82 500	16.5	2 800	—	3 400	16028	—	—	—	—	—	—	—	—	—	—	—	—	146.5	—	203.5	1	—	—	2.84
	210	33	2	110 000	109 000	16.0	2 800	1 800	3 400	6028	ZZ	—	DDU	—	—	—	—	—	—	—	—	—	149	158.5	201	2	—	—	3.48
	250	42	3	166 000	150 000	14.9	2 200	1 700	2 800	6228	ZZS	—	DDU	—	—	—	—	—	—	—	—	—	153	171.5	237	2.5	—	—	7.68
	300	62	4	253 000	246 000	13.6	2 000	—	2 400	6328	ZZS	—	—	—	—	—	—	—	—	—	—	—	156	187	284	3	—	—	18.5
150	190	20	1.1	47 500	58 500	17.1	3 200	1 800	3 800	6830	ZZ	VV	DDU	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
	210	28	2	85 000	90 500	16.5	2 600	1 700	3 200	6930	ZZS	—	DDU	—	—	—	—	—	—	—	—	—	159	166	201	2	—	—	3.01
	225	24	1.1	84 000	91 000	16.6	2 600	—	3 000	16030	—	—	—	—	—	—	—	—	—	—	—	—	156.5	—	218.5	1	—	—	3.62
	225	35	2.1	126 000	126 000	15.9	2 600	1 700	3 000	6030	ZZ	VV	DDU	—	—	—	—	—	—	—	—	—	161	170	214	2	—	—	4.24
	270	45	3	176 000	168 000	15.1	2 000	—	2 600	6230	ZZS	—	—	—	—	—	—	—	—	—	—	—	163	186	257	2.5	—	—	10
	320	65	4	274 000	284 000	13.9	1 800	—	2 200	6330	ZZS	—	—	—	—	—	—	—	—	—	—	—	166	203	304	3	—	—	22.7

Notes (1) For tolerances for the snap ring grooves and snap ring dimensions, refer to Pages A116 to A119.
(2) When heavy axial loads are applied, increase d_a and decrease D_a from the above values.

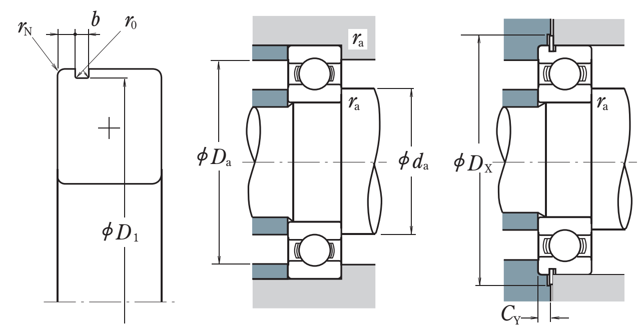
Remarks
1. When using bearings with rotating outer rings, contact NSK if they are sealed, shielded, or have snap rings.
2. Please consult NSK about the snap ring groove dimensions of sealed and shielded bearings when the diameter of dimension series 18 and 19 is 50 mm or more.
3. The bearings denoted by an asterisk( ) are NSKHPS™ Deep groove ball bearings.

SINGLE-ROW DEEP GROOVE BALL BEARINGS

Bore Diameter 160 mm



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



Dynamic Equivalent Load

$P = XF_r + YF_a$

$\frac{f_0 F_a}{C_{0r}}$	e	$\frac{F_a}{F_r} \le e$ X	$\frac{F_a}{F_r} \le e$ Y	$\frac{F_a}{F_r} > e$ X	$\frac{F_a}{F_r} > e$ 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, $P_0 = 0.6F_r + 0.5F_a$

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

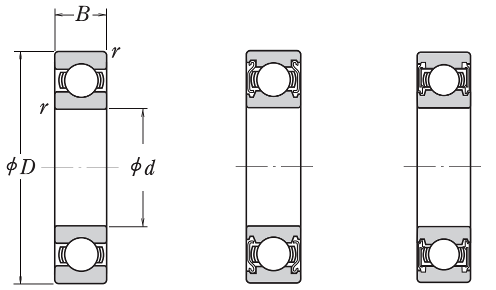
Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min⁻¹) Grease		Oil	Bearing Numbers				With Snap Ring Groove	With Snap Ring	Snap Ring Groove Dimensions (1) (mm)					Snap Ring (1) Dimensions (mm)		Abutment and Fillet Dimensions (mm)						Mass (kg)
d	D	B	r min.	C_r	C_{0r}	f_0	Open Z · ZZ V · VV	DU DDU	Open Z	Open	Shielded	Sealed				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.
160	200	20	1.1	48 500	61 000	17.2	2 600	1 700	3 200	**6832**	**ZZS**	**VV**	**DDU**	**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
	220	28	2	87 000	96 000	16.6	2 600	1 600	3 000	**6932**	**ZZS**	—	**DDU**	—	—	—	—	—	—	—	—	—	169	176	211	2	—	—	2.71
	240	25	1.5	99 000	108 000	16.5	2 400	—	2 800	**16032**	—	—	—	—	—	—	—	—	—	—	—	—	168	—	232	1.5	—	—	4.2
	240	38	2.1	137 000	135 000	15.9	2 400	1 600	2 800	**6032**	**ZZ**	—	**DDU**	—	—	—	—	—	—	—	—	—	171	181.5	229	2	—	—	5.15
	290	48	3	185 000	186 000	15.4	1 900	—	2 400	**6232**	**ZZS**	—	—	—	—	—	—	—	—	—	—	—	173	202	277	2.5	—	—	12.8
	340	68	4	278 000	287 000	13.9	1 700	—	2 000	**6332**	**ZZS**	—	—	—	—	—	—	—	—	—	—	—	176	215.5	324	3	—	—	26.2

Notes (1) For tolerances for the snap ring grooves and snap ring dimensions, refer to Pages A116 to A119.
(2) When heavy axial loads are applied, increase d_a and decrease D_a from the above values.

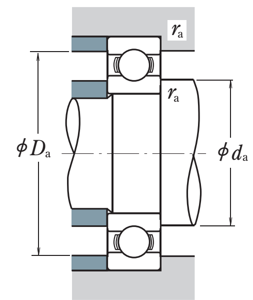
Remarks
1. When using bearings with rotating outer rings, contact NSK if they are sealed, shielded, or have snap rings.
2. Please consult NSK about the snap ring groove dimensions of sealed and shielded bearings when the diameter of dimension series 18 and 19 is 50 mm or more.

SINGLE-ROW DEEP GROOVE BALL BEARINGS

Bore Diameter 170 – 240 mm



Open Type | Shielded Type ZZS | Non-Contact Sealed Type VV



Dynamic Equivalent Load

$P = XF_r + YF_a$

$\frac{f_0F_a}{C_{0r}}$	e	$\frac{F_a}{F_r} \leq e$ X	Y	$\frac{F_a}{F_r} > e$ 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, $P_0 = 0.6F_r + 0.5F_a$

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

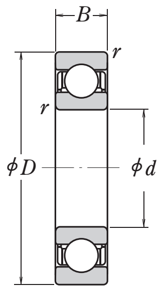
Boundary Dimensions (mm) d	D	B	r min.	Basic Load Ratings (N) C_r	C_{0r}	Factor f_0	Limiting Speeds (min⁻¹) Grease Open Z · ZZ V · VV	Grease DU DDU	Oil Open Z	Bearing Numbers Open	Shielded	Sealed	Sealed	Abutment and Fillet Dimensions (mm) d_a(1) min.	d_a(1) max.	D_a(1) max.	r_a max.	Mass (kg) approx.
170	215	22	1.1	60 000	75 000	17.1	2 600	1 600	3 000	**6834**	**ZZS**	**VV**	**DDU**	176.5	182	208.5	1	1.86
	230	28	2	86 000	97 000	16.7	2 400	—	2 800	**6934**	**ZZS**	—	—	179	186	221	2	3.34
	260	28	1.5	114 000	126 000	16.5	2 200	—	2 600	**16034**	—	—	—	178	—	252	1.5	5.71
	260	42	2.1	161 000	161 000	15.8	2 200	—	2 600	**6034**	**ZZS**	**VV**	—	181	194.5	249	2	6.89
	310	52	4	212 000	224 000	15.3	1 800	—	2 200	**6234**	**ZZS**	—	—	186	215	294	3	15.8
	360	72	4	325 000	355 000	13.6	1 600	—	2 000	**6334**	—	—	—	186	—	344	3	36.6
180	225	22	1.1	60 500	78 500	17.2	2 400	—	2 800	**6836**	—	**VV**	—	186.5	192	218.5	1	1.98
	250	33	2	119 000	128 000	16.4	2 200	—	2 600	**6936**	**ZZS**	—	—	189	198.5	241	2	4.16
	280	31	2	145 000	157 000	16.3	2 000	—	2 400	**16036**	—	—	—	189	—	271	2	7.5
	280	46	2.1	180 000	185 000	15.6	2 000	—	2 400	**6036**	**ZZS**	**VV**	—	191	208	269	2	8.88
	320	52	4	227 000	241 000	15.1	1 700	—	2 000	**6236**	**ZZS**	—	—	196	223	304	3	15.9
	380	75	4	355 000	405 000	13.9	1 500	—	1 800	**6336**	—	—	—	196	—	364	3	43.1
190	240	24	1.5	73 000	93 500	17.1	2 200	—	2 600	**6838**	—	**VV**	—	198	202.5	232	1.5	2.53
	260	33	2	113 000	127 000	16.6	2 200	—	2 600	**6938**	—	—	—	199	—	251	2	5.18
	290	31	2	149 000	168 000	16.4	2 000	—	2 400	**16038**	—	—	—	199	—	281	2	7.78
	290	46	2.1	188 000	201 000	15.8	2 000	—	2 400	**6038**	**ZZS**	—	—	201	218	279	2	9.39
	340	55	4	255 000	282 000	15.0	1 600	—	2 000	**6238**	**ZZS**	—	—	206	236	324	3	22.3
	400	78	5	355 000	415 000	14.1	1 400	—	1 700	**6338**	—	—	—	210	—	380	4	49.7
200	250	24	1.5	74 000	98 000	17.2	2 200	—	2 600	**6840**	—	—	—	208	—	242	1.5	2.67
	280	38	2.1	143 000	158 000	16.4	2 000	—	2 400	**6940**	**ZZS**	—	—	211	222	269	2	7.28
	310	34	2	161 000	180 000	16.4	1 900	—	2 200	**16040**	—	—	—	209	—	301	2	10
	310	51	2.1	207 000	226 000	15.6	1 900	—	2 200	**6040**	**ZZS**	—	—	211	231.5	299	2	12
	360	58	4	269 000	310 000	15.2	1 500	—	1 800	**6240**	**ZZS**	—	—	216	252	344	3	26.7
	420	80	5	380 000	445 000	13.8	1 300	—	1 600	**6340**	—	—	—	220	—	400	4	55.3
220	270	24	1.5	76 500	107 000	17.4	1 900	—	2 400	**6844**	**ZZS**	—	—	228	233.5	262	1.5	2.9
	300	38	2.1	146 000	169 000	16.6	1 800	—	2 200	**6944**	**ZZS**	—	—	231	242	289	2	7.88
	340	37	2.1	180 000	217 000	16.5	1 600	—	2 000	**16044**	—	—	—	231	—	329	2	13.1
	340	56	3	235 000	271 000	15.6	1 700	—	2 000	**6044**	**ZZS**	—	—	233	254.5	327	2.5	18.6
	400	65	4	310 000	375 000	15.1	1 300	—	1 600	**6244**	—	—	—	236	—	384	3	37.4
	460	88	5	410 000	520 000	14.3	1 200	—	1 500	**6344**	—	—	—	240	—	440	4	73.9
240	300	28	2	98 500	137 000	17.3	1 700	—	2 000	**6848**	—	—	—	249	—	291	2	4.48
	320	38	2.1	154 000	190 000	16.8	1 700	—	2 000	**6948**	**ZZS**	—	—	251	262	309	2	8.49
	360	37	2.1	196 000	243 000	16.5	1 500	—	1 900	**16048**	—	—	—	251	—	349	2	13.9
	360	56	3	244 000	296 000	15.9	1 500	—	1 900	**6048**	—	—	—	253	—	347	2.5	19.9
	440	72	4	340 000	430 000	15.2	1 200	—	1 500	**6248**	—	—	—	256	—	424	3	50.5
	500	95	5	470 000	625 000	14.2	1 100	—	1 300	**6348**	—	—	—	260	—	480	4	94.4

Note (1) When heavy axial loads are applied, increase d_a and decrease D_a from the above values.

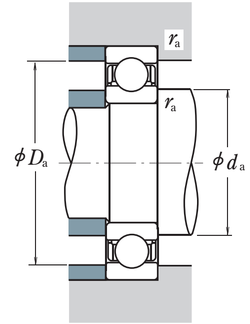
Remark When using bearings with rotating outer rings, contact NSK if they are sealed or shielded.

SINGLE-ROW DEEP GROOVE BALL BEARINGS

Bore Diameter 260 – 360 mm



Open Type



Dynamic Equivalent Load

$P = XF_r + YF_a$

$\frac{f_0F_a}{C_{0r}}$	e	$\frac{F_a}{F_r}$ 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, $P_0 = 0.6F_r + 0.5F_a$

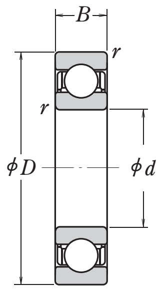
$\frac{F_a}{F_r}$ 0.8, $P_0 = F_r$

Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min^{-1})		Bearing Numbers	Abutment and Fillet Dimensions (mm)			Mass (kg)
d	D	B	r min.	C_r	C_{0r}	f_0	Grease	Oil	Open	d_a(1) min.	D_a(1) max.	r_a max.	approx.
260	320	28	2	101 000	148 000	17.4	1 600	1 900	**6852**	269	311	2	4.84
	360	46	2.1	204 000	255 000	16.5	1 500	1 800	**6952**	271	349	2	14
	400	44	3	237 000	310 000	16.4	1 400	1 700	**16052**	273	387	2.5	21.1
	400	65	4	291 000	375 000	15.8	1 400	1 700	**6052**	276	384	3	29.4
	480	80	5	400 000	540 000	15.1	1 100	1 300	**6252**	280	460	4	67
	540	102	6	505 000	710 000	14.6	1 000	1 200	**6352**	286	514	5	118
280	350	33	2	133 000	191 000	17.3	1 500	1 700	**6856**	289	341	2	7.2
	380	46	2.1	209 000	272 000	16.6	1 400	1 700	**6956**	291	369	2	15.1
	420	44	3	243 000	330 000	16.5	1 300	1 600	**16056**	293	407	2.5	22.7
	420	65	4	300 000	410 000	16.0	1 300	1 600	**6056**	296	404	3	31.2
	500	80	5	400 000	550 000	15.2	1 000	1 300	**6256**	300	480	4	70.4
	580	108	6	570 000	840 000	14.5	900	1 100	**6356**	306	554	5	144
300	380	38	2.1	166 000	233 000	17.1	1 300	1 600	**6860**	311	369	2	10.3
	420	56	3	269 000	370 000	16.4	1 300	1 500	**6960**	313	407	2.5	23.9
	460	50	4	285 000	405 000	16.4	1 200	1 400	**16060**	316	444	3	31.5
	460	74	4	355 000	500 000	15.8	1 200	1 400	**6060**	316	444	3	44.2
	540	85	5	465 000	670 000	15.1	950	1 200	**6260**	320	520	4	87.8
320	400	38	2.1	168 000	244 000	17.2	1 300	1 500	**6864**	331	389	2	10.8
	440	56	3	266 000	375 000	16.5	1 200	1 400	**6964**	333	427	2.5	25.3
	480	50	4	293 000	430 000	16.5	1 100	1 300	**16064**	336	464	3	33.2
	480	74	4	390 000	570 000	15.7	1 100	1 300	**6064**	336	464	3	46.5
	580	92	5	530 000	805 000	15.0	850	1 100	**6264**	340	560	4	111
340	420	38	2.1	175 000	265 000	17.3	1 200	1 400	**6868**	351	409	2	11.5
	460	56	3	273 000	400 000	16.6	1 100	1 300	**6968**	353	447	2.5	26.6
	520	82	5	440 000	660 000	15.6	1 000	1 200	**6068**	360	500	4	62.3
	620	92	6	530 000	820 000	15.3	800	1 000	**6268**	366	594	5	129
360	440	38	2.1	192 000	290 000	17.3	1 100	1 300	**6872**	371	429	2	11.8
	480	56	3	280 000	425 000	16.7	1 100	1 300	**6972**	373	467	2.5	27.9
	540	82	5	460 000	720 000	15.7	950	1 200	**6072**	380	520	4	65.3
	650	95	6	555 000	905 000	15.4	750	950	**6272**	386	624	5	145

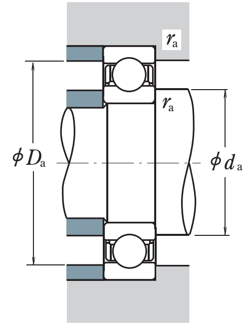
Note (1) When heavy axial loads are applied, increase d_a and decrease D_a from the above values.

SINGLE-ROW DEEP GROOVE BALL BEARINGS

Bore Diameter 380 – 600 mm



Open Type



Dynamic Equivalent Load

$P = XF_r + YF_a$

$\frac{f_0 F_a}{C_{0r}}$	e	$\frac{F_a}{F_r}$ e X	Y	$\frac{F_a}{F_r}$ e 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, $P_0 = 0.6F_r + 0.5F_a$

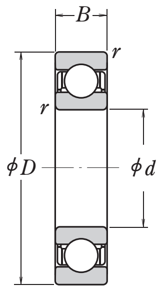
$\frac{F_a}{F_r}$ 0.8, $P_0 = F_r$

Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min⁻¹)		Bearing Numbers	Abutment and Fillet Dimensions (mm)			Mass (kg)
d	D	B	r min.	C_r	C_{0r}	f_0	Grease	Oil	Open	d_a(1) min.	D_a(1) max.	r_a max.	approx.
380	480	46	2.1	238 000	375 000	17.1	1 000	1 200	**6876**	391	469	2	19.5
	520	65	4	325 000	510 000	16.6	950	1 200	**6976**	396	504	3	40
	560	82	5	455 000	725 000	15.9	900	1 100	**6076**	400	540	4	68
400	500	46	2.1	241 000	390 000	17.2	950	1 200	**6880**	411	489	2	20.5
	540	65	4	335 000	540 000	16.7	900	1 100	**6980**	416	524	3	42
	600	90	5	510 000	825 000	15.7	850	1 000	**6080**	420	580	4	88.4
420	520	46	2.1	245 000	410 000	17.3	900	1 100	**6884**	431	509	2	21.4
	560	65	4	340 000	570 000	16.8	900	1 100	**6984**	436	544	3	43.6
	620	90	5	530 000	895 000	15.8	800	1 000	**6084**	440	600	4	92.2
440	540	46	2.1	248 000	425 000	17.4	900	1 100	**6888**	451	529	2	22.3
	600	74	4	395 000	680 000	16.6	800	1 000	**6988**	456	584	3	60.2
	650	94	6	550 000	965 000	16.0	750	900	**6088**	466	624	5	106
460	580	56	3	310 000	550 000	17.1	800	1 000	**6892**	473	567	2.5	34.3
	620	74	4	405 000	720 000	16.7	800	950	**6992**	476	604	3	62.6
	680	100	6	605 000	1 080 000	15.8	710	850	**6092**	486	654	5	123
480	600	56	3	315 000	575 000	17.2	800	950	**6896**	493	587	2.5	35.4
	650	78	5	450 000	815 000	16.6	750	900	**6996**	500	630	4	73.5
	700	100	6	605 000	1 090 000	15.9	710	850	**6096**	506	674	5	127
500	620	56	3	320 000	600 000	17.3	750	900	**68/500**	513	607	2.5	37.2
	670	78	5	460 000	865 000	16.7	710	850	**69/500**	520	650	4	82
	720	100	6	630 000	1 170 000	16.0	670	800	**60/500**	526	694	5	131
530	650	56	3	325 000	625 000	17.4	710	850	**68/530**	543	637	2.5	39.8
	710	82	5	455 000	870 000	16.8	670	800	**69/530**	550	690	4	89.8
	780	112	6	680 000	1 300 000	16.0	600	750	**60/530**	556	754	5	184
560	680	56	3	330 000	650 000	17.4	670	800	**68/560**	573	667	2.5	41.5
	750	85	5	525 000	1 040 000	16.7	600	750	**69/560**	580	730	4	105
	820	115	6	735 000	1 500 000	16.2	560	670	**60/560**	586	793.5	5	203
600	730	60	3	355 000	735 000	17.5	600	710	**68/600**	613	717	2.5	50.9
	800	90	5	550 000	1 160 000	16.9	560	670	**69/600**	620	780	4	120
	870	118	6	790 000	1 640 000	16.1	530	630	**60/600**	626	844	5	236

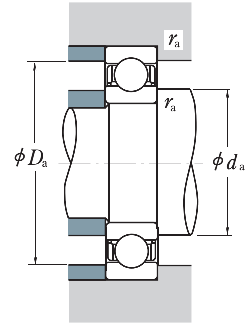
Note (1) When heavy axial loads are applied, increase d_a and decrease D_a from the above values.

SINGLE-ROW DEEP GROOVE BALL BEARINGS

Bore Diameter 630 – 800 mm



Open Type



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, $P_0 = 0.6F_r + 0.5F_a$

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

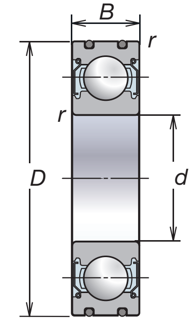
Boundary Dimensions (mm)				Basic Load Ratings (N)		Factor	Limiting Speeds (min⁻¹)		Bearing Numbers	Abutment and Fillet Dimensions (mm)			Mass (kg)
d	D	B	r min.	C_r	C_{0r}	f_0	Grease	Oil	Open	d_a(1) min.	D_a(1) max.	r_a max.	approx.
630	780	69	4	420 000	890 000	17.3	560	670	**68/630**	646	764	3	71.3
	850	100	6	625 000	1 350 000	16.7	530	630	**69/630**	656	824	5	163
	920	128	7.5	750 000	1 620 000	16.4	480	600	**60/630**	662	888	6	285
670	820	69	4	435 000	965 000	17.4	500	630	**68/670**	686	804	3	75.4
	900	103	6	675 000	1 460 000	16.7	480	560	**69/670**	696	874	5	181
	980	136	7.5	765 000	1 730 000	16.6	450	530	**60/670**	702	948	6	351
710	870	74	4	480 000	1 100 000	17.4	480	560	**68/710**	726	854	3	92.6
	950	106	6	715 000	1 640 000	16.8	450	530	**69/710**	736	924	5	208
750	920	78	5	525 000	1 260 000	17.4	430	530	**68/750**	770	900	4	110
	1 000	112	6	785 000	1 840 000	16.7	400	500	**69/750**	776	974	5	245
800	980	82	5	530 000	1 310 000	17.5	400	480	**68/800**	820	960	4	132
	1 060	115	6	825 000	2 050 000	16.8	380	450	**69/800**	826	1 034	5	275

Note (1) When heavy axial loads are applied, increase d_a and decrease D_a from the above values.

CREEP-FREE BEARINGS™

Bore Diameter 10 – 100 mm

Bearing bore diameter d (mm)	Bearing outer diameter D (mm)	Bearing width B (mm)	Basic load ratings C_r (N)	Basic load ratings C_{0r} (N)	Recommended fits (1)	Bearing number: Basic number (Open type)	Shield type	Contact seal type (2)	Non-contact seal type
10	26	8	4 550	1 970	H7 or G6	6000	ZZ	DDU	VV
	30	9	5 100	2 390		6200			
	35	11	8 100	3 450		6300			
12	28	8	5 100	2 370		6001	ZZ	DDU	VV
	32	10	6 800	3 050		6201			
	37	12	9 700	4 200		6301			
15	32	9	5 600	2 830		6002	ZZ	DDU	VV
	35	11	7 650	3 750		6202			
	42	13	11 400	5 450		6302			
17	35	10	6 000	3 250		6003	ZZ	DDU	VV
	40	12	9 550	4 800		6203			
	47	14	13 600	6 650		6303			
20	42	12	9 400	5 000		6004	ZZ	DDU	VV
	47	14	12 800	6 600		6204			
	52	15	15 900	7 900		6304			
25	47	12	10 100	5 850		6005	ZZ	DDU	VV
	52	15	14 000	7 850		6205			
	62	17	20 600	11 200		6305			
30	55	13	13 200	8 300		6006	ZZ	DDU	VV
	62	16	19 500	11 300		6206			
	72	19	26 700	15 000		6306			
35	62	14	16 000	10 300		6007	ZZ	DDU	VV
	72	17	25 700	15 300		6207			
	80	21	33 500	19 200		6307			
40	68	15	16 800	11 500		6008	ZZ	DDU	VV
	80	18	29 100	17 900		6208			
	90	23	40 500	24 000		6308			
45	75	16	20 900	15 200		6009	ZZ	DDU	VV
	85	19	31 500	20 400		6209			
	100	25	53 000	32 000		6309			
50	80	16	21 800	16 600		6010	ZZ	DDU	VV
	90	20	35 000	23 200		6210			
	110	27	62 000	38 500		6310			
55	90	18	28 300	21 200		6011	ZZ	DDU	VV
	100	21	43 500	29 300		6211			
	120	29	71 500	44 500		6311			
60	95	18	29 500	23 200		6012	ZZ	DDU	VV
	110	22	52 500	36 000		6212			
	130	31	82 000	52 000		6312			
65	100	18	30 500	25 200		6013	ZZ	DDU	VV
	120	23	57 500	40 000		6213			
	140	33	92 500	60 000		6313			
70	110	20	38 000	31 000		6014	ZZ	DDU	VV
	125	24	62 000	44 000		6214			
	150	35	104 000	68 000		6314			
75	115	20	39 500	33 500		6015	ZZ	DDU	VV
	130	25	66 000	49 500		6215			
80	125	22	47 500	40 000		6016	ZZ	DDU	VV
	140	26	72 500	53 000		6216			
85	130	22	49 500	43 000		6017	ZZ	DDU	VV
	150	28	84 000	62 000		6217			
90	140	24	58 000	50 000		6018	ZZ	DDU	VV
95	145	24	60 500	54 000		6019	ZZ	DDU	VV
100	150	24	60 000	54 000		6020	ZZ	DDU	VV

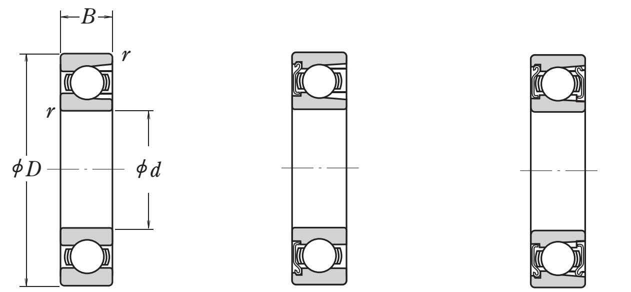


Notes (1) Although recommended fits are H7 or G6, G6 is recommended when used under conditions that prioritize insertion under light pre-load.

(2) Low-contact seal available for seal type bearings, Contact NSK for details.

MAXIMUM TYPE BALL BEARINGS

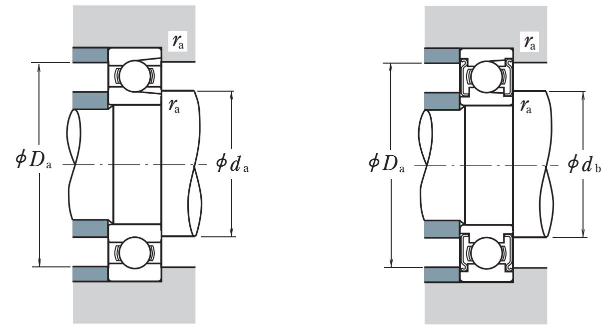
Bore Diameter 25 – 110 mm



Open Type

Shielded Type (One Shield) Z

Shielded Type (Two Shields) ZZ

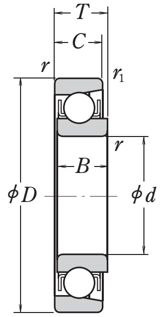


Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers			Abutment and Fillet Dimensions (mm)				Mass (kg)
d	D	B	r min.	C_r	C_{0r}	Grease Open Z · ZZ	Oil Open Z	Open	With One Shielded	With Two Shields	d_a min.	d_b max.	D_a max.	r_a max.	approx.
25	52	15	1	14 400	10 500	12 000	15 000	**BL 205**	**BL 205 Z**	**BL 205 ZZ**	30	32	47	1	0.133
	62	17	1.1	21 500	15 500	11 000	13 000	**BL 305**	**BL 305 Z**	**BL 305 ZZ**	31.5	36	55.5	1	0.246
30	62	16	1	21 000	16 300	10 000	12 000	**BL 206**	**BL 206 Z**	**BL 206 ZZ**	35	38.5	57	1	0.215
	72	19	1.1	27 900	20 700	9 000	11 000	**BL 306**	**BL 306 Z**	**BL 306 ZZ**	36.5	42	65.5	1	0.364
35	72	17	1.1	27 800	22 100	9 000	11 000	**BL 207**	**BL 207 Z**	**BL 207 ZZ**	41.5	44.5	65.5	1	0.307
	80	21	1.5	37 000	29 100	8 000	9 500	**BL 307**	**BL 307 Z**	**BL 307 ZZ**	43	44.5	72	1.5	0.486
40	80	18	1.1	35 500	28 800	8 000	9 500	**BL 208**	**BL 208 Z**	**BL 208 ZZ**	46.5	50	73.5	1	0.394
	90	23	1.5	46 500	36 000	7 500	9 000	**BL 308**	**BL 308 Z**	**BL 308 ZZ**	48	52.5	82	1.5	0.685
45	85	19	1.1	37 000	32 000	7 500	9 000	**BL 209**	**BL 209 Z**	**BL 209 ZZ**	51.5	55.5	78.5	1	0.449
	100	25	1.5	55 500	44 000	6 300	8 000	**BL 309**	**BL 309 Z**	**BL 309 ZZ**	53	61.5	92	1.5	0.883
50	90	20	1.1	39 000	35 000	6 700	8 500	**BL 210**	**BL 210 Z**	**BL 210 ZZ**	56.5	60	83.5	1	0.504
	110	27	2	65 000	52 500	6 000	7 100	**BL 310**	**BL 310 Z**	**BL 310 ZZ**	59	68	101	2	1.16
55	100	21	1.5	48 000	44 000	6 300	7 500	**BL 211**	**BL 211 Z**	**BL 211 ZZ**	63	66.5	92	1.5	0.667
	120	29	2	75 000	61 500	5 600	6 700	**BL 311**	**BL 311 Z**	**BL 311 ZZ**	64	72.5	111	2	1.49
60	110	22	1.5	58 000	54 000	5 600	6 700	**BL 212**	**BL 212 Z**	**BL 212 ZZ**	68	74.5	102	1.5	0.856
	130	31	2.1	85 500	71 500	5 000	6 000	**BL 312**	**BL 312 Z**	**BL 312 ZZ**	71	79	119	2	1.88
65	120	23	1.5	63 500	60 000	5 300	6 300	**BL 213**	**BL 213 Z**	**BL 213 ZZ**	73	80	112	1.5	1.09
	140	33	2.1	103 000	89 500	4 800	5 600	**BL 313**	**BL 313 Z**	**BL 313 ZZ**	76	85.5	129	2	2.36
70	125	24	1.5	69 000	66 000	5 000	6 000	**BL 214**	**BL 214 Z**	**BL 214 ZZ**	78	84	117	1.5	1.19
	150	35	2.1	115 000	102 000	4 300	5 300	**BL 314**	**BL 314 Z**	**BL 314 ZZ**	81	92	139	2	2.87
75	130	25	1.5	72 000	72 000	4 500	5 600	**BL 215**	**BL 215 Z**	**BL 215 ZZ**	83	90	122	1.5	1.29
	160	37	2.1	126 000	116 000	4 000	5 000	**BL 315**	**BL 315 Z**	**BL 315 ZZ**	86	98.5	149	2	3.43
80	140	26	2	84 000	85 000	4 300	5 300	**BL 216**	**BL 216 Z**	**BL 216 ZZ**	89	95.5	131	2	1.61
	170	39	2.1	136 000	130 000	3 800	4 500	**BL 316**	**BL 316 Z**	**BL 316 ZZ**	91	104.5	159	2	4.08
85	150	28	2	93 000	93 000	4 000	5 000	**BL 217**	**BL 217 Z**	**BL 217 ZZ**	94	102	141	2	1.97
	180	41	3	147 000	145 000	3 600	4 300	**BL 317**	**BL 317 Z**	**BL 317 ZZ**	98	110.5	167	2.5	4.77
90	160	30	2	107 000	107 000	3 800	4 500	**BL 218**	**BL 218 Z**	**BL 218 ZZ**	99	107.5	151	2	2.43
	190	43	3	158 000	161 000	3 400	4 000	**BL 318**	**BL 318 Z**	**BL 318 ZZ**	103	117	177	2.5	5.45
95	170	32	2.1	121 000	123 000	3 600	4 300	**BL 219**	**BL 219 Z**	**BL 219 ZZ**	106	114	159	2	2.95
	200	45	3	169 000	178 000	2 800	3 600	**BL 319**	**BL 319 Z**	**BL 319 ZZ**	108	124	187	2.5	6.4
100	180	34	2.1	136 000	140 000	3 400	4 000	**BL 220**	**BL 220 Z**	**BL 220 ZZ**	111	121.5	169	2	3.54
105	190	36	2.1	148 000	157 000	3 200	3 800	**BL 221**	**BL 221 Z**	**BL 221 ZZ**	116	127.5	179	2	4.23
110	200	38	2.1	160 000	176 000	2 800	3 400	**BL 222**	—	—	121	—	189	2	4.84

Remark When using Maximum Type Ball Bearings, please contact NSK.

MAGNETO BEARINGS

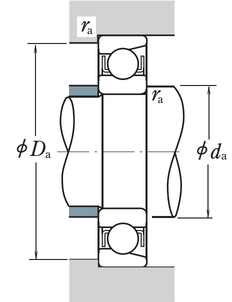
Bore Diameter 4 – 20 mm



Outside Diameter Tolerance (Class N)

Units : μm

Nominal Outside Diameter D (mm)		Single Plane Mean Outside Diameter D_{mp}			
		E Series		EN Series	
Over	Incl.	High	Low	High	Low
—	10	+ 8	0	0	− 8
10	18	+ 8	0	0	− 8
18	30	+ 9	0	0	− 9
30	50	+11	0	0	−11



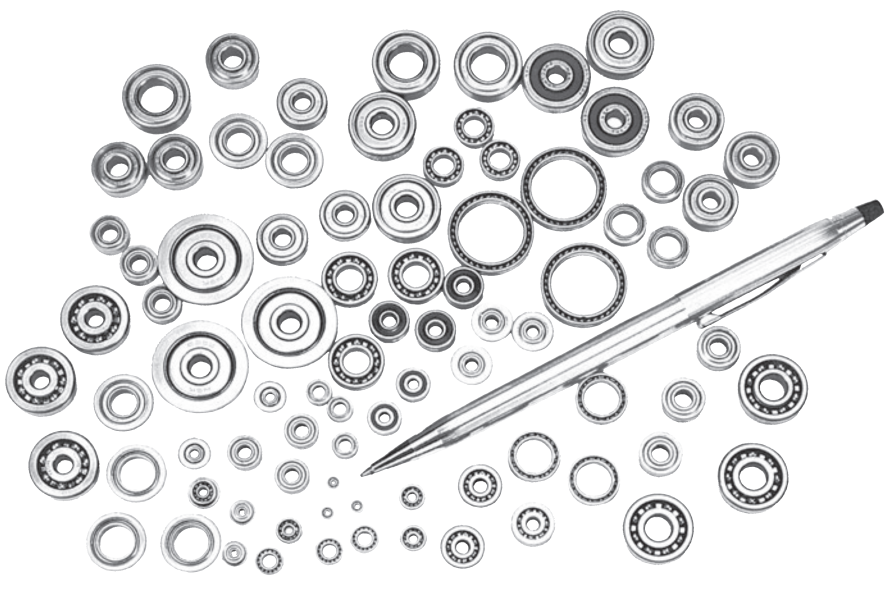
Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leq e$		$F_a/F_r > e$		e
X	Y	X	Y	
1	0	0.5	2.5	0.2

Boundary Dimensions (mm)					Basic Load Ratings (N)		Limiting Speeds (min^{-1})		Bearing Numbers		Abutment and Fillet Dimensions (mm)			Mass (kg)
d	D	B,C,T	r min.	r_1 min.	C_r	C_{0r}	Grease	Oil	E Series	EN Series	d_a min.	D_a max.	r_a max.	approx.
4	16	5	0.15	0.1	1 650	288	34 000	40 000	**E 4**	**EN 4**	5.2	14.8	0.15	0.005
5	16	5	0.15	0.1	1 650	288	34 000	40 000	**E 5**	**EN 5**	6.2	14.8	0.15	0.004
6	21	7	0.3	0.15	2 490	445	30 000	36 000	**E 6**	**EN 6**	8	19	0.3	0.011
7	22	7	0.3	0.15	2 490	445	30 000	36 000	**E 7**	**EN 7**	9	20	0.3	0.013
8	24	7	0.3	0.15	3 450	650	28 000	34 000	**E 8**	**EN 8**	10	22	0.3	0.014
9	28	8	0.3	0.15	4 550	880	24 000	30 000	**E 9**	**EN 9**	11	26	0.3	0.022
10	28	8	0.3	0.15	4 550	880	24 000	30 000	**E 10**	**EN 10**	12	26	0.3	0.021
11	32	7	0.3	0.15	4 400	845	22 000	26 000	**E 11**	**EN 11**	13	30	0.3	0.029
12	32	7	0.3	0.15	4 400	845	22 000	26 000	**E 12**	**EN 12**	14	30	0.3	0.028
13	30	7	0.3	0.15	4 400	845	22 000	26 000	**E 13**	**EN 13**	15	28	0.3	0.021
14	35	8	0.3	0.15	5 800	1 150	19 000	22 000	—	**EN 14**	16	33	0.3	0.035
15	35	8	0.3	0.15	5 800	1 150	19 000	22 000	**E 15**	**EN 15**	17	33	0.3	0.034
	40	10	0.6	0.3	7 400	1 500	17 000	20 000	**BO 15**	—	19	36	0.6	0.055
16	38	10	0.6	0.2	6 900	1 380	17 000	22 000	—	**EN 16**	20	34	0.6	0.049
17	40	10	0.6	0.3	7 400	1 500	17 000	20 000	**L 17**	—	21	36	0.6	0.051
	44	11	0.6	0.3	7 350	1 500	16 000	19 000	—	**EN 17**	21	40	0.6	0.080
	44	11	0.6	0.3	7 350	1 500	16 000	19 000	**BO 17**	—	21	40	0.6	0.080
18	40	9	0.6	0.2	5 050	1 030	17 000	20 000	—	**EN 18**	22	36	0.6	0.051
19	40	9	0.6	0.2	5 050	1 030	17 000	20 000	**E 19**	**EN 19**	23	36	0.6	0.049
20	47	12	1	0.6	11 000	2 380	14 000	17 000	**E 20**	**EN 20**	25	42	1	0.089
	47	14	1	0.6	11 000	2 380	14 000	17 000	**L 20**	—	25	42	1	0.101

Remarks 1. The outside diameters of Magneto Bearings Series E always have plus tolerances.
2. When using Magneto Bearings other than E, please contact NSK.



2. EXTRA SMALL BALL BEARINGS AND MINIATURE BALL BEARINGS

DESIGN AND TYPES

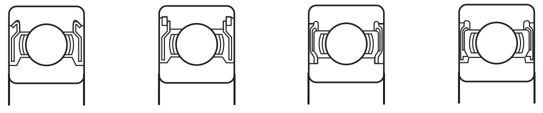
The size ranges of extra small and miniature ball bearings are shown in Table 1. The design, types, and type symbols are shown in Table 2. Those types among them that are listed in the bearing tables are indicated by the shading ▬ in Table 2.

Table 1 Size Ranges of Bearings

Units : mm

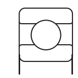
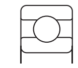
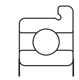
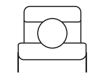
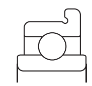
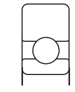
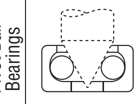
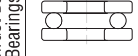
Design	Extra Small Ball Bearings	Miniature Ball Bearings
Metric	Outside diameter D 9 Bore diameter d 10	Outside diameter D 9
Inch	Outside diameter D 9.525 Bore diameter d 10	Outside diameter D 9.525

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



ZZ ZZS DD VV

Table 2 Design, Types, and Type Symbols

Design · Types		Type Symbols				Remarks
		Metric	Inch	Special		
				Metric	Inch	
Single-Row Deep Groove Ball Bearings		6	R	MR	—	Shielded · sealed bearings are available.
	 Thin section	—	—	SMT	—	
	 With flange	F6	FR	MF	—	Shielded · 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 Single-row angular contact ball bearings are available besides those shown above.

TOLERANCES AND RUNNING ACCURACY

METRIC DESIGN BEARINGS ....Table 7.2(Pages A128 to A131)

The flange tolerances for metric design bearings are listed in Table 3.

Table 3 Flange Tolerances for Metric Flanged Bearings

(1) Tolerances of Flange Outside Diameter Units : m

Nominal Flange Outside Diameter D_1(mm)		Deviation of Flange Outside Diameter D_{1S}			
over	incl.	high	low	high	low
	10	+220	–36	0	–36
10	18	+270	–43	0	–43
18	30	+330	–52	0	–52

Remarks is applied when the flange outside diameter is used for positioning.

(2) Flange Width Tolerances and Running Accuracies Related to Flange Units : m

Nominal Bearing Outside Diameter D (mm)		Deviation of Flange Width C_{1S}	Variation of Flange Width C_{1S} VC_{1S}				Variation of Bearing Outside Surface Generatrix Inclination with Flange Backface S_{D1}			Flange Backface Runout with Raceway 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 B_S tolerance for d of the same bearing of the same class	Use the V_{BS} tolerance for d of the same bearing of 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) 2.5 mm is included

INCH DESIGN 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).

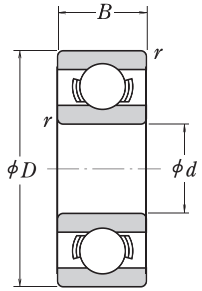
INTERNAL CLEARANCES ....Table 8.11 (Page A169)

LIMITING SPEEDS

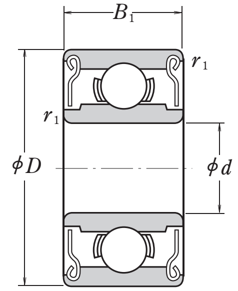
The limiting speeds listed in the bearing tables should be adjusted depending on the bearing toad conditions. Also, higher speeds are attainable by making changes in the lubrication method, cage design, etc. Refer to Page A098 for detailed information.

EXTRA SMALL BALL BEARINGS · MINIATURE BALL BEARINGS

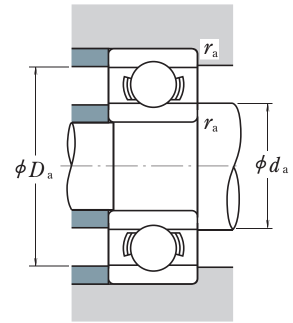
Metric Design
Bore Diameter 1 – 4 mm

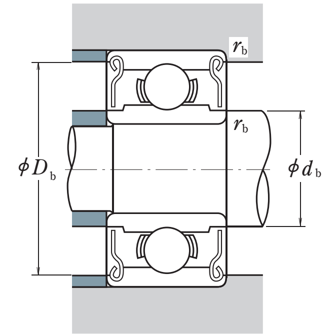


Open Type



Shielded Type
ZZ · ZZ1





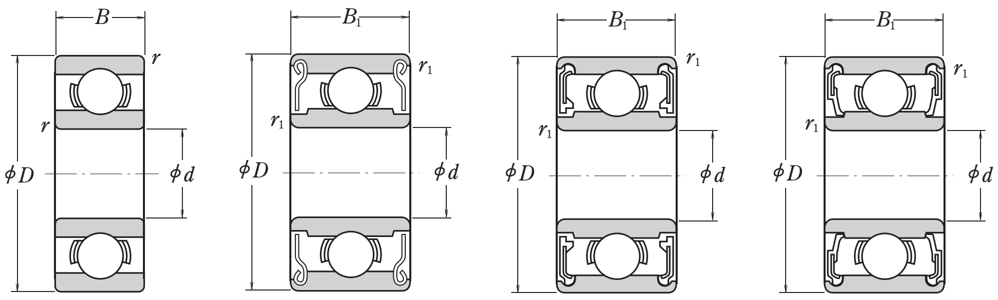
Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers				Abutment and Fillet Dimensions (mm)						Mass (g)	
d	D	B	B_1	r [1] min.	r_1 [1] min.	C_r	C_{0r}	Grease Open Z · ZZ	Oil Open Z	Open	Shielded	Sealed		d_a min.	d_b max.	D_a max.	D_b min.	r_a max.	r_b max.	approx. Open	Shielded
1	3	1	—	0.05	—	80	23	130 000	150 000	**681**	—	—	—	1.4	—	2.6	—	0.05	—	0.03	—
	3	1.5	—	0.05	—	80	23	130 000	150 000	**MR 31**	—	—	—	1.4	—	2.6	—	0.05	—	0.04	—
	4	1.6	—	0.1	—	138	35	100 000	120 000	**691**	—	—	—	1.8	—	3.2	—	0.1	—	0.09	—
1.2	4	1.8	2.5	0.1	0.1	138	35	110 000	130 000	**MR 41 X**	**MR 41 XZZ**	—	—	2.0	1.9	3.2	3.5	0.1	0.1	0.10	0.14
1.5	4	1.2	2	0.05	0.05	112	33	100 000	120 000	**681 X**	**681 XZZ**	—	—	1.9	2.1	3.6	3.6	0.05	0.05	0.07	0.11
	5	2	2.6	0.15	0.15	237	69	85 000	100 000	**691 X**	**691 XZZ**	—	—	2.7	2.5	3.8	4.3	0.15	0.15	0.17	0.20
	6	2.5	3	0.15	0.15	330	98	75 000	90 000	**601 X**	**601 XZZ**	—	—	2.7	3.0	4.8	5.4	0.15	0.15	0.33	0.38
2	5	1.5	2.3	0.08	0.08	169	50	85 000	100 000	**682**	**682 ZZ**	—	—	2.6	2.7	4.4	4.2	0.08	0.08	0.12	0.17
	5	2	2.5	0.1	0.1	187	58	85 000	100 000	**MR 52 B**	**MR 52 BZZ**	—	—	2.8	2.7	4.2	4.4	0.1	0.1	0.16	0.23
	6	2.3	3	0.15	0.15	330	98	75 000	90 000	**692**	**692 ZZ**	—	—	3.2	3.0	4.8	5.4	0.15	0.15	0.28	0.38
	6	2.5	2.5	0.15	0.15	330	98	75 000	90 000	**MR 62**	**MR 62 ZZ**	—	—	3.2	3.0	4.8	5.2	0.15	0.15	0.30	0.29
	7	2.5	3	0.15	0.15	385	127	63 000	75 000	**MR 72**	**MR 72 ZZ**	—	—	3.2	3.8	5.8	6.2	0.15	0.15	0.45	0.49
	7	2.8	3.5	0.15	0.15	385	127	63 000	75 000	**602**	**602 ZZ**	—	—	3.2	3.8	5.8	6.2	0.15	0.15	0.51	0.58
2.5	6	1.8	2.6	0.08	0.08	208	74	71 000	80 000	**682 X**	**682 XZZ**	—	—	3.1	3.7	5.4	5.4	0.08	0.08	0.23	0.29
	7	2.5	3.5	0.15	0.15	385	127	63 000	75 000	**692 X**	**692 XZZ**	—	—	3.7	3.8	5.8	6.2	0.15	0.15	0.41	0.55
	8	2.5	—	0.2	—	560	179	60 000	67 000	**MR 82 X**	—	—	—	4.1	—	6.4	—	0.2	—	0.56	—
	8	2.8	4	0.15	0.15	550	175	60 000	71 000	**602 X**	**602 XZZ**	—	—	3.7	4.1	6.8	7.0	0.15	0.15	0.63	0.83
3	6	2	2.5	0.1	0.1	208	74	71 000	80 000	**MR 63**	**MR 63 ZZ**	—	—	3.8	3.7	5.2	5.4	0.1	0.1	0.20	0.27
	7	2	3	0.1	0.1	390	130	63 000	75 000	**683 A**	**683 AZZ**	—	—	3.8	4.0	6.2	6.4	0.1	0.1	0.32	0.45
	8	2.5	—	0.15	—	560	179	60 000	67 000	**MR 83**	—	—	—	4.2	—	6.8	—	0.15	—	0.54	—
	8	3	4	0.15	0.15	560	179	60 000	67 000	**693**	**693 ZZ**	—	—	4.2	4.3	6.8	7.3	0.15	0.15	0.61	0.83
	9	2.5	4	0.2	0.15	570	187	56 000	67 000	**MR 93**	**MR 93 ZZ**	—	—	4.6	4.3	7.4	7.9	0.2	0.15	0.73	1.18
	9	3	5	0.15	0.15	570	187	56 000	67 000	**603**	**603 ZZ**	—	—	4.2	4.3	7.8	7.9	0.15	0.15	0.87	1.45
	10	4	4	0.15	0.15	630	218	50 000	60 000	**623**	**623 ZZ**	—	—	4.2	4.3	8.8	8.0	0.15	0.15	1.65	1.66
	13	5	5	0.2	0.2	1 300	485	40 000	48 000	**633**	**633 ZZ**	—	—	4.6	6.0	11.4	11.3	0.2	0.2	3.38	3.33
4	7	2	—	0.1	—	310	115	60 000	67 000	**MR 74**	—	—	—	4.8	—	6.2	—	0.1	—	0.22	—
	7	—	2.5	—	0.1	255	107	60 000	71 000	—	**MR 74 ZZ**	—	—	—	4.8	—	6.3	—	0.1	—	0.29
	8	2	3	0.15	0.1	395	139	56 000	67 000	**MR 84**	**MR 84 ZZ**	—	—	5.2	5.0	6.8	7.4	0.15	0.1	0.36	0.56
	9	2.5	4	(0.15)	(0.15)	640	225	53 000	63 000	**684 A**	**684 AZZ**	—	—	4.8	5.2	8.2	8.1	0.1	0.1	0.63	1.01
	10	3	4	0.2	0.15	710	270	50 000	60 000	**MR 104 B**	**MR 104 BZZ**	—	—	5.6	5.9	8.4	8.8	0.2	0.15	1.04	1.42
	11	4	4	0.15	0.15	960	345	48 000	56 000	**694**	**694 ZZ**	—	—	5.2	5.6	9.8	9.9	0.15	0.15	1.7	1.75
	12	4	4	0.2	0.2	960	345	48 000	56 000	**604**	**604 ZZ**	—	—	5.6	5.6	10.4	9.9	0.2	0.2	2.25	2.29
	13	5	5	0.2	0.2	1 300	485	40 000	48 000	**624**	**624 ZZ**	—	—	5.6	6.0	11.4	11.3	0.2	0.2	3.03	3.04
	16	5	5	0.3	0.3	1 730	670	36 000	43 000	**634**	**634 ZZ1**	—	—	6.0	7.5	14.0	13.8	0.3	0.3	5.24	5.21

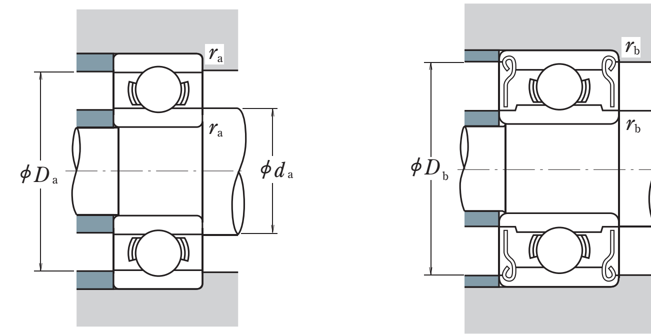
Note (1) The values in parentheses are not based on ISO 15.

Remark When using bearings with a rotating outer ring, please contact NSK if they are shielded.

EXTRA SMALL BALL BEARINGS · MINIATURE BALL BEARINGS

Metric Design
Bore Diameter 5 – 9 mm





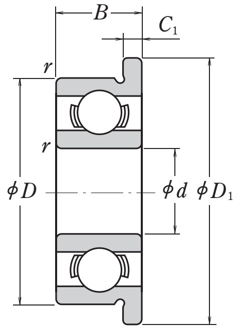
Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min⁻¹) Grease		Oil	Bearing Numbers				Abutment and Fillet Dimensions (mm)						Mass (g)	
d	D	B	B_1	r (1) min.	r_1 (1) min.	C_r	C_{0r}	Open Z · ZZ V · VV	D · DD	Open Z	Open	Shielded	Sealed		d_a min.	d_b max.	D_a max.	D_b min.	r_a max.	r_b max.	approx. Open	Shielded
5	8	2	—	0.1	—	310	120	53 000	—	63 000	**MR 85**	—	—	—	5.8	—	7.2	—	0.1	—	0.26	—
	8	—	2.5	—	0.1	278	131	53 000	—	63 000	—	**MR 85 ZZ**	—	—	—	5.8	—	7.4	—	0.1	—	0.34
	9	2.5	3	0.15	0.15	430	168	50 000	—	60 000	**MR 95**	**MR 95 ZZ1**	—	—	6.2	6.0	7.8	8.2	0.15	0.15	0.50	0.58
	10	3	4	0.15	0.15	430	168	50 000	—	60 000	**MR 105**	**MR 105 ZZ**	—	—	6.2	6.0	8.8	8.4	0.15	0.15	0.95	1.29
	11	—	4	—	0.15	715	276	48 000	—	56 000	—	**MR 115 ZZ**	**VV**	—	—	6.3	—	9.8	—	0.15	—	1.49
	11	3	5	0.15	0.15	715	281	45 000	—	53 000	**685**	**685 ZZ**	—	—	6.2	6.2	9.8	9.9	0.15	0.15	1.2	1.96
	13	4	4	0.2	0.2	1 080	430	43 000	40 000	50 000	**695**	**695 ZZ**	**VV**	**DD**	6.6	6.6	11.4	11.2	0.2	0.2	2.45	2.5
	14	5	5	0.2	0.2	1 330	505	40 000	38 000	50 000	**605**	**605 ZZ**	—	**DD**	6.6	6.9	12.4	12.2	0.2	0.2	3.54	3.48
	16	5	5	0.3	0.3	1 730	670	36 000	32 000	43 000	**625**	**625 ZZ1**	**VV**	**DD**	7.0	7.5	14.0	13.8	0.3	0.3	4.95	4.86
	19	6	6	0.3	0.3	2 340	885	32 000	30 000	40 000	**635**	**635 ZZ1**	**VV**	**DD**	7.0	8.5	17.0	16.5	0.3	0.3	8.56	8.34
6	10	2.5	3	0.15	0.1	495	218	45 000	—	53 000	**MR 106**	**MR 106 ZZ1**	—	—	7.2	7.0	8.8	9.3	0.15	0.1	0.56	0.68
	12	3	4	0.2	0.15	715	292	43 000	40 000	50 000	**MR 126**	**MR 126 ZZ**	—	**DD**	7.6	7.2	10.4	10.9	0.2	0.15	1.27	1.74
	13	3.5	5	0.15	0.15	1 080	440	40 000	38 000	50 000	**686 A**	**686 AZZ**	**VV**	**DD**	7.2	7.4	11.8	11.7	0.15	0.15	1.91	2.69
	15	5	5	0.2	0.2	1 730	670	40 000	36 000	45 000	**696**	**696 ZZ1**	**VV**	**DD**	7.6	7.9	13.4	13.3	0.2	0.2	3.88	3.72
	17	6	6	0.3	0.3	2 260	835	38 000	34 000	45 000	**606**	**606 ZZ**	**VV**	**DD**	8.0	8.2	15.0	14.8	0.3	0.3	5.97	6.08
	19	6	6	0.3	0.3	2 340	885	32 000	30 000	40 000	**626**	**626 ZZ1**	**VV**	**DD**	8.0	8.5	17.0	16.5	0.3	0.3	8.15	7.94
	22	7	7	0.3	0.3	3 300	1 370	30 000	28 000	36 000	**636**	**636 ZZ**	**VV**	**DD**	8.0	10.5	20.0	19.0	0.3	0.3	14	14
7	11	2.5	3	0.15	0.1	455	201	43 000	—	50 000	**MR 117**	**MR 117 ZZ**	—	—	8.2	8.0	9.8	10.5	0.15	0.1	0.62	0.72
	13	3	4	0.2	0.15	540	276	40 000	—	48 000	**MR 137**	**MR 137 ZZ**	—	—	8.6	9.0	11.4	11.6	0.2	0.15	1.58	2.02
	14	3.5	5	0.15	0.15	1 170	510	40 000	34 000	45 000	**687**	**687 ZZ1**	**VV**	**DD**	8.2	8.5	12.8	12.7	0.15	0.15	2.13	2.97
	17	5	5	0.3	0.3	1 610	710	36 000	28 000	43 000	**697**	**697 ZZ1**	**VV**	**DD**	9.0	10.2	15.0	14.8	0.3	0.3	5.26	5.12
	19	6	6	0.3	0.3	2 340	885	36 000	32 000	43 000	**607**	**607 ZZ1**	**VV**	**DD**	9.0	9.1	17.0	16.5	0.3	0.3	7.67	7.51
	22	7	7	0.3	0.3	3 300	1 370	30 000	28 000	36 000	**627**	**627 ZZ**	**VV**	**DD**	9.0	10.5	20.0	19.0	0.3	0.3	12.7	12.9
	26	9	9	0.3	0.3	4 550	1 970	28 000	22 000	34 000	**637**	**637 ZZ1**	**VV**	**DD**	9.0	12.8	24.0	22.8	0.3	0.3	24	25
8	12	2.5	3.5	0.15	0.1	545	274	40 000	—	48 000	**MR 128**	**MR 128 ZZ1**	—	—	9.2	9.0	10.8	11.3	0.15	0.1	0.71	0.97
	14	3.5	4	0.2	0.15	820	385	38 000	32 000	45 000	**MR 148**	**MR 148 ZZ**	**VV**	**DD**	9.6	9.2	12.4	12.8	0.2	0.15	1.86	2.16
	16	4	5	0.2	0.2	1 610	710	36 000	28 000	43 000	**688 A**	**688 AZZ1**	**VV**	**DD**	9.6	10.2	14.4	14.2	0.2	0.2	3.12	4.02
	19	6	6	0.3	0.3	2 240	910	36 000	28 000	43 000	**698**	**698 ZZ**	**VV**	**DD**	10.0	10.0	17.0	16.5	0.3	0.3	7.23	7.18
	22	7	7	0.3	0.3	3 300	1 370	34 000	28 000	40 000	**608**	**608 ZZ**	**VV**	**DD**	10.0	10.5	20.0	19.0	0.3	0.3	12.1	12.2
	24	8	8	0.3	0.3	3 350	1 430	28 000	24 000	34 000	**628**	**628 ZZ**	**VV**	**DD**	10.0	12.0	22.0	20.5	0.3	0.3	17.2	17.4
	28	9	9	0.3	0.3	4 550	1 970	28 000	22 000	34 000	**638**	**638 ZZ1**	**VV**	**DD**	10.0	12.8	26.0	22.8	0.3	0.3	28.3	28.6
9	17	4	5	0.2	0.2	1 330	665	36 000	24 000	43 000	**689**	**689 ZZ1**	**VV**	**DD**	10.6	11.5	15.4	15.2	0.2	0.2	3.53	4.43
	20	6	6	0.3	0.3	1 720	840	34 000	24 000	40 000	**699**	**699 ZZ1**	**VV**	**DD**	11.0	12.0	18.0	17.2	0.3	0.3	8.45	8.33
	24	7	7	0.3	0.3	3 350	1 430	32 000	24 000	38 000	**609**	**609 ZZ**	**VV**	**DD**	11.0	12.0	22.8	20.5	0.3	0.3	14.5	14.7
	26	8	8	(0.6)	(0.6)	4 550	1 970	28 000	22 000	34 000	**629**	**629 ZZ**	**VV**	**DD**	11.0	12.8	24.0	22.8	0.3	0.3	19.5	19.3
	30	10	10	0.6	0.6	5 100	2 390	24 000	—	30 000	**639**	**639 ZZ**	**VV**	—	13.0	16.1	26.0	25.6	0.6	0.6	36.5	36

Note (1) The values in parentheses are not based on ISO 15.

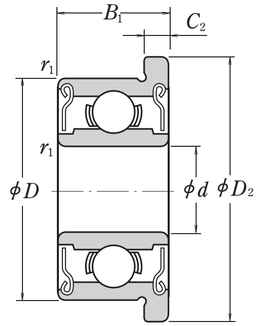
Remarks 1. When using bearings with a rotating outer ring, please contact NSK if they are sealed or shielded.
2. Bearings with snap rings are also available, please contact NSK.

EXTRA SMALL BALL BEARINGS · MINIATURE BALL BEARINGS

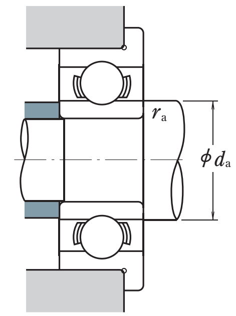
Metric Design With Flange
Bore Diameter 1 – 4 mm

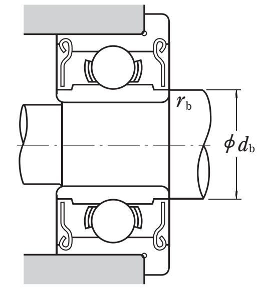


Open Type



Shielded Type
ZZ · ZZ1





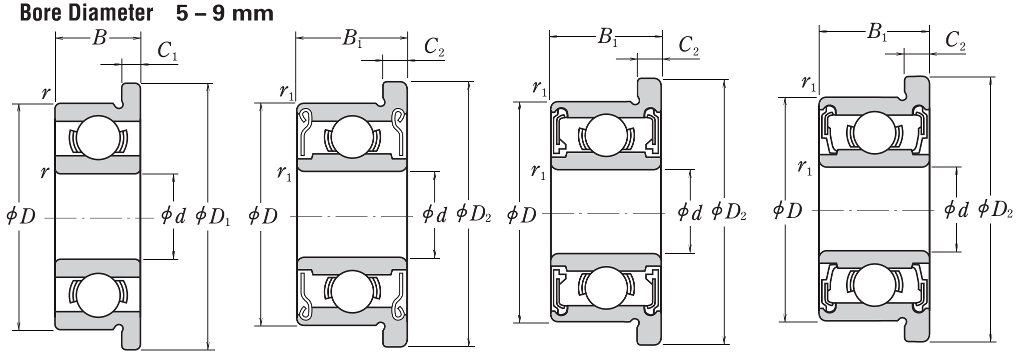
Boundary Dimensions (mm)										Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers			Abutment and Fillet Dimensions (mm)				Mass (g) approx.	
d	D	D_1	D_2	B	B_1	C_1	C_2	r(1) min.	r_1(1) min.	C_r	C_{0r}	Grease Open Z · ZZ	Oil Open Z	Open	Shielded	Sealed	d_a min.	d_b max.	r_a max.	r_b max.	Open	Shielded
1	3	3.8	—	1	—	0.3	—	0.05	—	80	23	130 000	150 000	F 681	—	— —	1.4	—	0.05	—	0.04	—
	4	5	—	1.6	—	0.5	—	0.1	—	140	36	100 000	120 000	F 691	—	— —	1.8	—	0.1	—	0.14	—
1.2	4	4.8	—	1.8	—	0.4	—	0.1	—	138	35	110 000	130 000	MF 41 X	—	— —	2.0	—	0.1	—	0.12	—
1.5	4	5	5	1.2	2	0.4	0.6	0.05	0.05	112	33	100 000	120 000	F 681 X	F 681 XZZ	— —	1.9	2.1	0.05	0.05	0.09	0.14
	5	6.5	6.5	2	2.6	0.6	0.8	0.15	0.15	237	69	85 000	100 000	F 691 X	F 691 XZZ	— —	2.7	2.5	0.15	0.15	0.23	0.28
	6	7.5	7.5	2.5	3	0.6	0.8	0.15	0.15	330	98	75 000	90 000	F 601 X	F 601 XZZ	— —	2.7	3.0	0.15	0.15	0.42	0.52
2	5	6.1	6.1	1.5	2.3	0.5	0.6	0.08	0.08	169	50	85 000	100 000	F 682	F 682 ZZ	— —	2.6	2.7	0.08	0.08	0.16	0.22
	5	6.2	6.2	2	2.5	0.6	0.6	0.1	0.1	187	58	85 000	100 000	MF 52 B	MF 52 BZZ	— —	2.8	2.7	0.1	0.1	0.21	0.27
	6	7.5	7.5	2.3	3	0.6	0.8	0.15	0.15	330	98	75 000	90 000	F 692	F 692 ZZ	— —	3.2	3.0	0.15	0.15	0.35	0.48
	6	7.2	—	2.5	—	0.6	—	0.15	—	330	98	75 000	90 000	MF 62	—	— —	3.2	—	0.15	—	0.36	—
	7	8.2	8.2	2.5	3	0.6	0.6	0.15	0.15	385	127	63 000	75 000	MF 72	MF 72 ZZ	— —	3.2	3.8	0.15	0.15	0.52	0.56
	7	8.5	8.5	2.8	3.5	0.7	0.9	0.15	0.15	385	127	63 000	75 000	F 602	F 602 ZZ	— —	3.2	3.1	0.15	0.15	0.60	0.71
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	F 682 X	F 682 XZZ	— —	3.1	3.7	0.08	0.08	0.25	0.36
	7	8.5	8.5	2.5	3.5	0.7	0.9	0.15	0.15	385	127	63 000	75 000	F 692 X	F 692 XZZ	— —	3.7	3.8	0.15	0.15	0.51	0.68
	8	9.2	—	2.5	—	0.6	—	0.2	—	560	179	60 000	67 000	MF 82 X	—	— —	4.1	—	0.2	—	0.62	—
	8	9.5	9.5	2.8	4	0.7	0.9	0.15	0.15	550	175	60 000	71 000	F 602 X	F 602 XZZ	— —	3.7	3.5	0.15	0.15	0.74	0.98
3	6	7.2	7.2	2	2.5	0.6	0.6	0.1	0.1	208	74	71 000	80 000	MF 63	MF 63 ZZ	— —	3.8	3.7	0.1	0.1	0.27	0.33
	7	8.1	8.1	2	3	0.5	0.8	0.1	0.1	390	130	63 000	75 000	F 683 A	F 683 AZZ	— —	3.8	4.0	0.1	0.1	0.37	0.53
	8	9.2	—	2.5	—	0.6	—	0.15	—	560	179	60 000	67 000	MF 83	—	— —	4.2	—	0.15	—	0.56	—
	8	9.5	9.5	3	4	0.7	0.9	0.15	0.15	560	179	60 000	67 000	F 693	F 693 ZZ	— —	4.2	4.3	0.15	0.15	0.70	0.97
	9	10.2	10.6	2.5	4	0.6	0.8	0.2	0.15	570	187	56 000	67 000	MF 93	MF 93 ZZ	— —	4.6	4.3	0.2	0.15	0.81	1.34
	9	10.5	10.5	3	5	0.7	1	0.15	0.15	570	187	56 000	67 000	F 603	F 603 ZZ	— —	4.2	4.3	0.15	0.15	1.0	1.63
	10	11.5	11.5	4	4	1	1	0.15	0.15	630	218	50 000	60 000	F 623	F 623 ZZ	— —	4.2	4.3	0.15	0.15	1.85	1.86
	13	15	15	5	5	1	1	0.2	0.2	1 300	485	36 000	43 000	F 633	F 633 ZZ	— —	4.6	6.0	0.2	0.2	3.73	3.59
4	7	8.2	—	2	—	0.6	—	0.1	—	310	115	60 000	67 000	MF 74	—	— —	4.8	—	0.1	—	0.29	—
	7	—	8.2	—	2.5	—	0.6	—	0.1	255	107	60 000	71 000	—	MF 74 ZZ	— —	—	4.8	—	0.1	—	0.35
	8	9.2	9.2	2	3	0.6	0.6	0.15	0.1	395	139	56 000	67 000	MF 84	MF 84 ZZ	— —	5.2	5.0	0.15	0.1	0.44	0.63
	9	10.3	10.3	2.5	4	0.6	1	(0.15)	(0.15)	640	225	53 000	63 000	F 684	F 684 ZZ	— —	4.8	5.2	0.1	0.1	0.70	1.14
	10	11.2	11.6	3	4	0.6	0.8	0.2	0.15	710	270	50 000	60 000	MF 104 B	MF 104 BZZ	— —	5.6	5.9	0.2	0.15	1.13	1.59
	11	12.5	12.5	4	4	1	1	0.15	0.15	960	345	48 000	56 000	F 694	F 694 ZZ	— —	5.2	5.6	0.15	0.15	1.91	1.96
	12	13.5	13.5	4	4	1	1	0.2	0.2	960	345	48 000	56 000	F 604	F 604 ZZ	— —	5.6	5.6	0.2	0.2	2.53	2.53
	13	15	15	5	5	1	1	0.2	0.2	1 300	485	40 000	48 000	F 624	F 624 ZZ	— —	5.6	6.0	0.2	0.2	3.38	3.53
	16	18	18	5	5	1	1	0.3	0.3	1 730	670	36 000	43 000	F 634	F 634 ZZ1	— —	6.0	7.5	0.3	0.3	5.73	5.62

Note (1) The values in parentheses are not based on ISO 15.

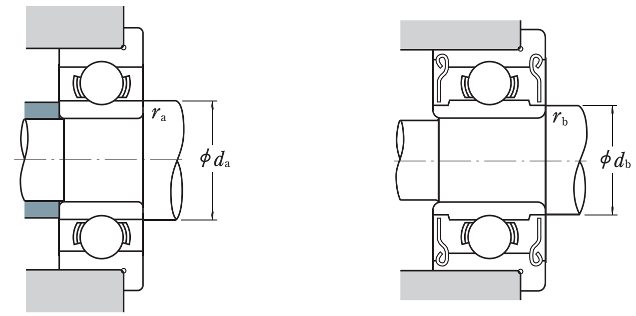
Remark When using bearings with a rotating outer ring, please contact NSK if they are shielded.

EXTRA SMALL BALL BEARINGS · MINIATURE BALL BEARINGS

Metric Design With Flange
Bore Diameter 5 – 9 mm



Open Type / Shielded Type ZZ · ZZ1 / Non-Contact Sealed Type VV / Contact Sealed Type DD

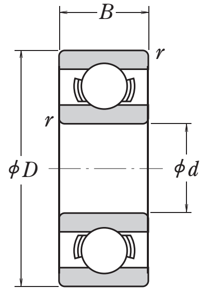


Boundary Dimensions (mm)										Basic Load Ratings (N)		Limiting Speeds (min⁻¹) Grease		Oil	Bearing Numbers				Abutment and Fillet Dimensions (mm)				Mass (g) approx.	
d	D	D_1	D_2	B	B_1	C_1	C_2	r min.	r_1 min.	C_r	C_{0r}	Open Z · ZZ V · VV	D · DD	Open Z	Open	Shielded	Sealed		d_a min.	d_b max.	r_a max.	r_b max.	Open	Shielded
5	8	9.2	—	2	—	0.6	—	0.1	—	310	120	53 000	—	63 000	MF 85	—	—	—	5.8	—	0.1	—	0.33	—
	8	—	9.2	—	2.5	—	0.6	—	0.1	278	131	53 000	—	63 000	—	MF 85 ZZ	—	—	—	5.8	—	0.1	—	0.41
	9	10.2	10.2	2.5	3	0.6	0.6	0.15	0.15	430	168	50 000	—	60 000	MF 95	MF 95 ZZ1	—	—	6.2	6.0	0.15	0.15	0.59	0.66
	10	11.2	11.6	3	4	0.6	0.8	0.15	0.15	430	168	50 000	—	60 000	MF 105	MF 105 ZZ	—	—	6.2	6.0	0.15	0.15	1.05	1.46
	11	12.5	12.5	3	5	0.8	1	0.15	0.15	715	281	45 000	—	53 000	F 685	F 685 ZZ	—	—	6.2	6.2	0.15	0.15	1.37	2.18
	13	15	15	4	4	1	1	0.2	0.2	1 080	430	43 000	40 000	50 000	F 695	F 695 ZZ	VV	DD	6.6	6.6	0.2	0.2	2.79	2.84
	14	16	16	5	5	1	1	0.2	0.2	1 330	505	40 000	38 000	50 000	F 605	F 605 ZZ	—	DD	6.6	6.9	0.2	0.2	3.9	3.85
	16	18	18	5	5	1	1	0.3	0.3	1 730	670	36 000	32 000	43 000	F 625	F 625 ZZ1	VV	DD	7.0	7.5	0.3	0.3	5.37	5.27
	19	22	22	6	6	1.5	1.5	0.3	0.3	2 340	885	32 000	30 000	40 000	F 635	F 635 ZZ1	VV	DD	7.0	8.5	0.3	0.3	9.49	9.49
6	10	11.2	11.2	2.5	3	0.6	0.6	0.15	0.1	495	218	45 000	—	53 000	MF 106	MF 106 ZZ1	—	—	7.2	7.0	0.15	0.1	0.65	0.77
	12	13.2	13.6	3	4	0.6	0.8	0.2	0.15	715	292	43 000	40 000	50 000	MF 126	MF 126 ZZ	—	DD	7.6	7.2	0.2	0.15	1.38	1.94
	13	15	15	3.5	5	1	1.1	0.15	0.15	1 080	440	40 000	38 000	50 000	F 686 A	F 686 AZZ	VV	DD	7.2	7.4	0.15	0.15	2.25	3.04
	15	17	17	5	5	1.2	1.2	0.2	0.2	1 730	670	40 000	36 000	45 000	F 696	F 696 ZZ1	VV	DD	7.6	7.9	0.2	0.2	4.34	4.26
	17	19	19	6	6	1.2	1.2	0.3	0.3	2 260	835	38 000	34 000	45 000	F 606	F 606 ZZ	VV	DD	8.0	8.2	0.3	0.3	6.58	6.61
	19	22	22	6	6	1.5	1.5	0.3	0.3	2 340	885	32 000	30 000	40 000	F 626	F 626 ZZ1	VV	DD	8.0	8.5	0.3	0.3	9.09	9.09
	22	25	25	7	7	1.5	1.5	0.3	0.3	3 300	1 370	30 000	28 000	36 000	F 636	F 636 ZZ	VV	DD	8.0	10.5	0.3	0.3	14.6	14.7
7	11	12.2	12.2	2.5	3	0.6	0.6	0.15	0.1	455	201	43 000	—	50 000	MF 117	MF 117 ZZ	—	—	8.2	8.0	0.15	0.1	0.72	0.82
	13	14.2	14.6	3	4	0.6	0.8	0.2	0.15	540	276	40 000	—	48 000	MF 137	MF 137 ZZ	—	—	8.6	9.0	0.2	0.15	1.7	2.23
	14	16	16	3.5	5	1	1.1	0.15	0.15	1 170	510	40 000	34 000	45 000	F 687	F 687 ZZ1	VV	DD	8.2	8.5	0.15	0.15	2.48	3.37
	17	19	19	5	5	1.2	1.2	0.3	0.3	1 610	715	36 000	28 000	43 000	F 697	F 697 ZZ1	VV	DD	9.0	10.2	0.3	0.3	5.65	5.65
	19	22	22	6	6	1.5	1.5	0.3	0.3	2 340	885	36 000	32 000	43 000	F 607	F 607 ZZ1	VV	DD	9.0	9.1	0.3	0.3	8.66	8.66
	22	25	25	7	7	1.5	1.5	0.3	0.3	3 300	1 370	30 000	28 000	36 000	F 627	F 627 ZZ	VV	DD	9.0	10.5	0.3	0.3	14.2	14.2
8	12	13.2	13.6	2.5	3.5	0.6	0.8	0.15	0.1	545	274	40 000	—	48 000	MF 128	MF 128 ZZ1	—	—	9.2	9.0	0.15	0.1	0.82	1.15
	14	15.6	15.6	3.5	4	0.8	0.8	0.2	0.15	820	385	38 000	32 000	45 000	MF 148	MF 148 ZZ	VV	DD	9.6	9.2	0.2	0.15	2.09	2.39
	16	18	18	4	5	1	1.1	0.2	0.2	1 610	710	36 000	30 000	43 000	F 688 A	F 688 AZZ	VV	DD	9.6	10.2	0.2	0.2	3.54	4.47
	19	22	22	6	6	1.5	1.5	0.3	0.3	2 240	910	36 000	28 000	43 000	F 698	F 698 ZZ	VV	DD	10.0	10.0	0.3	0.3	8.35	8.3
	22	25	25	7	7	1.5	1.5	0.3	0.3	3 300	1 370	34 000	28 000	40 000	F 608	F 608 ZZ	VV	DD	10.0	10.5	0.3	0.3	13.4	13.5
9	17	19	19	4	5	1	1.1	0.2	0.2	1 330	665	36 000	24 000	43 000	F 689	F 689 ZZ1	VV	DD	10.6	11.5	0.2	0.2	3.97	4.91
	20	23	23	6	6	1.5	1.5	0.3	0.3	1 720	840	34 000	24 000	40 000	F 699	F 699 ZZ1	VV	DD	11.0	12.0	0.3	0.3	9.51	9.51

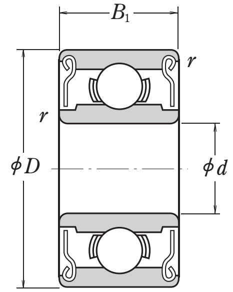
Remark When using bearings with a rotating outer ring, please contact NSK if they are shielded.

EXTRA SMALL BALL BEARINGS · MINIATURE BALL BEARINGS

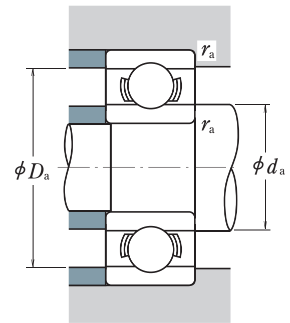
Inch Design
Bore Diameter 1.016 – 9.525 mm

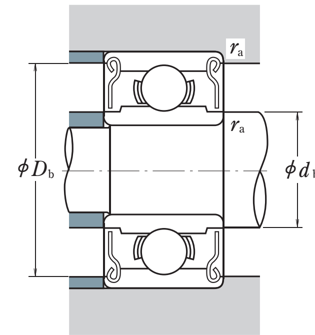


Open Type



Shielded Type
ZZ · ZZS



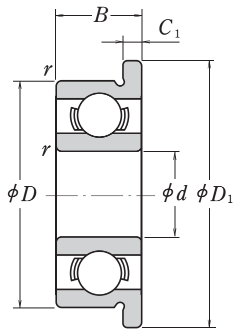


Boundary Dimensions (mm)					Basic Load Ratings (N)		Limiting Speeds (min^{-1})		Bearing Numbers		Abutment and Fillet Dimensions (mm)					Mass (g) approx.	
d	D	B	B_1	r min.	C_r	C_{0r}	Grease Open Z · ZZ	Oil Open Z	Open	Shielded	d_a min.	d_b max.	D_a max.	D_b min.	r_a max.	Open	Shielded
1.016	3.175	1.191	—	0.1	80	23	130 000	150 000	**R 09**	—	1.9	—	2.3	—	0.1	0.04	—
1.191	3.967	1.588	2.380	0.1	138	35	110 000	130 000	**R 0**	**R 0 ZZ**	2.0	1.9	3.1	3.5	0.1	0.09	0.11
1.397	4.762	1.984	2.779	0.1	231	66	90 000	110 000	**R 1**	**R 1 ZZ**	2.2	2.3	3.9	4.1	0.1	0.15	0.19
1.984	6.350	2.380	3.571	0.1	310	108	67 000	80 000	**R 1-4**	**R 1-4 ZZ**	2.8	3.9	5.5	5.9	0.1	0.35	0.50
2.380	4.762	1.588	—	0.1	188	60	80 000	95 000	**R 133**	—	3.2	—	3.9	—	0.1	0.10	—
	4.762	—	2.380	0.1	143	52	80 000	95 000	—	**R 133 ZZS**	—	3.0	—	4.2	0.1	—	0.13
	7.938	2.779	3.571	0.15	550	175	60 000	71 000	**R 1-5**	**R 1-5 ZZ**	3.6	4.1	6.7	7.0	0.15	0.60	0.72
3.175	6.350	2.380	2.779	0.1	283	95	67 000	80 000	**R 144**	**R 144 ZZ**	4.0	3.9	5.5	5.9	0.1	0.25	0.27
	7.938	2.779	3.571	0.1	560	179	60 000	67 000	**R 2-5**	**R 2-5 ZZ**	4.0	4.3	7.1	7.3	0.1	0.55	0.72
	9.525	2.779	3.571	0.15	640	225	53 000	63 000	**R 2-6**	**R 2-6 ZZS**	4.4	4.6	8.3	8.2	0.15	0.96	1.13
	9.525	3.967	3.967	0.3	630	218	56 000	67 000	**R 2**	**R 2 ZZ**	5.2	4.8	7.5	8.0	0.3	1.36	1.39
	12.700	4.366	4.366	0.3	640	225	53 000	63 000	**R 2A**	**R 2A ZZ**	5.2	4.6	10.7	8.2	0.3	3.3	3.23
3.967	7.938	2.779	3.175	0.1	360	149	53 000	63 000	**R 155**	**R 155 ZZS**	4.8	5.5	7.1	7.3	0.1	0.51	0.56
4.762	7.938	2.779	3.175	0.1	360	149	53 000	63 000	**R 156**	**R 156 ZZS**	5.6	5.5	7.1	7.3	0.1	0.39	0.42
	9.525	3.175	3.175	0.1	710	270	50 000	60 000	**R 166**	**R 166 ZZ**	5.6	5.9	8.7	8.8	0.1	0.81	0.85
	12.700	3.967	4.978	0.3	1 300	485	43 000	53 000	**R 3**	**R 3 ZZ**	6.8	6.5	10.7	11.2	0.3	2.21	2.79
6.350	9.525	3.175	3.175	0.1	420	204	48 000	56 000	**R 168B**	**R 168 BZZ**	7.2	7.0	8.7	8.9	0.1	0.58	0.62
	12.700	3.175	4.762	0.15	1 080	440	40 000	50 000	**R 188**	**R 188 ZZ**	7.6	7.4	11.5	11.6	0.15	1.53	2.21
	15.875	4.978	4.978	0.3	1 610	660	38 000	45 000	**R 4B**	**R 4B ZZ**	8.4	8.4	13.8	13.8	0.3	4.5	4.43
	19.050	5.558	7.142	0.4	2 620	1 060	36 000	43 000	**R 4AA**	**R 4AA ZZ**	9.4	9.0	16.0	16.6	0.4	7.48	9.17
7.938	12.700	3.967	3.967	0.15	540	276	40 000	48 000	**R 1810**	**R 1810 ZZ**	9.2	9.0	11.5	11.6	0.15	1.56	1.48
9.525	22.225	5.558	7.142	0.4	3 350	1 410	32 000	38 000	**R 6**	**R 6 ZZ**	12.6	11.9	19.2	20.0	0.4	9.02	11

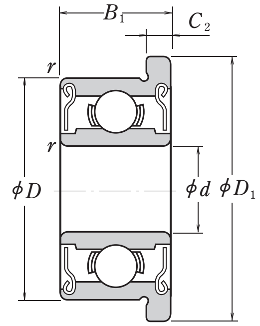
Remarks 1. When using bearings with a rotating outer ring, please contact NSK if they are shielded.
2. Bearings with double shields (ZZ, ZZS) are also available with single shields (Z, ZS).

EXTRA SMALL BALL BEARINGS · MINIATURE BALL BEARINGS

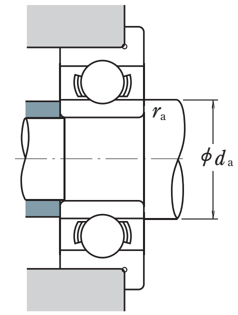
Inch Design With Flange
Bore Diameter 1.191 – 9.525 mm

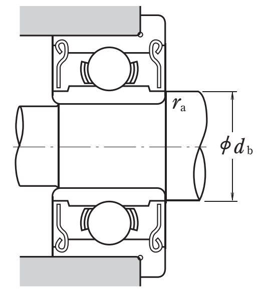


Open Type



Shielded Type
ZZ · ZZS





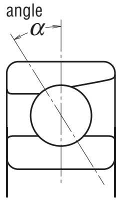
Boundary Dimensions (mm)								Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers		Abutment and Fillet Dimensions (mm)			Mass (g)	
d	D	D_1	B	B_1	C_1	C_2	r min.	C_r	C_{0r}	Grease Open Z · ZZ	Oil Open Z	Open	Shielded	d_a min.	d_b max.	r_a max.	approx. Open	approx. Shielded
1.191	3.967	5.156	1.588	2.380	0.330	0.790	0.1	138	35	110 000	130 000	**FR 0**	**FR 0 ZZ**	2.0	1.9	0.1	0.11	0.16
1.397	4.762	5.944	1.984	2.779	0.580	0.790	0.1	231	66	90 000	110 000	**FR 1**	**FR 1 ZZ**	2.2	2.3	0.1	0.20	0.25
1.984	6.350	7.518	2.380	3.571	0.580	0.790	0.1	310	108	67 000	80 000	**FR 1-4**	**FR 1-4 ZZ**	2.8	3.9	0.1	0.41	0.58
2.380	4.762	5.944	1.588	—	0.460	—	0.1	188	60	80 000	95 000	**FR 133**	—	3.2	—	0.1	0.13	—
	4.762	5.944	—	2.380	—	0.790	0.1	143	52	80 000	95 000	—	**FR 133 ZZS**	—	3.0	0.1	—	0.19
	7.938	9.119	2.779	3.571	0.580	0.790	0.15	550	175	60 000	71 000	**FR 1-5**	**FR 1-5 ZZ**	3.6	4.1	0.15	0.68	0.82
3.175	6.350	7.518	2.380	2.779	0.580	0.790	0.1	283	95	67 000	80 000	**FR 144**	**FR 144 ZZ**	4.0	3.9	0.1	0.31	0.35
	7.938	9.119	2.779	3.571	0.580	0.790	0.1	560	179	60 000	67 000	**FR 2-5**	**FR 2-5 ZZ**	4.0	4.3	0.1	0.62	0.81
	9.525	10.719	2.779	3.571	0.580	0.790	0.15	640	225	53 000	63 000	**FR 2-6**	**FR 2-6 ZZS**	4.4	4.6	0.15	1.04	1.25
	9.525	11.176	3.967	3.967	0.760	0.760	0.3	630	218	56 000	67 000	**FR 2**	**FR 2 ZZ**	5.2	4.8	0.3	1.51	1.55
3.967	7.938	9.119	2.779	3.175	0.580	0.910	0.1	360	149	53 000	63 000	**FR 155**	**FR 155 ZZS**	4.8	5.5	0.1	0.59	0.67
4.762	7.938	9.119	2.779	3.175	0.580	0.910	0.1	360	149	53 000	63 000	**FR 156**	**FR 156 ZZS**	5.6	5.5	0.1	0.47	0.53
	9.525	10.719	3.175	3.175	0.580	0.790	0.1	710	270	50 000	60 000	**FR 166**	**FR 166 ZZ**	5.6	5.9	0.1	0.90	0.98
	12.700	14.351	4.978	4.978	1.070	1.070	0.3	1 300	485	43 000	53 000	**FR 3**	**FR 3 ZZ**	6.8	6.5	0.3	2.97	3.09
6.350	9.525	10.719	3.175	3.175	0.580	0.910	0.1	420	204	48 000	56 000	**FR 168B**	**FR 168 BZZ**	7.2	7.0	0.1	0.66	0.75
	12.700	13.894	3.175	4.762	0.580	1.140	0.15	1 080	440	40 000	50 000	**FR 188**	**FR 188 ZZ**	7.6	7.4	0.15	1.64	2.49
	15.875	17.526	4.978	4.978	1.070	1.070	0.3	1 610	660	38 000	45 000	**FR 4B**	**FR 4B ZZ**	8.4	8.4	0.3	4.78	4.78
7.938	12.700	13.894	3.967	3.967	0.790	0.790	0.15	540	276	40 000	48 000	**FR 1810**	**FR 1810 ZZ**	9.2	9.0	0.15	1.71	1.63
9.525	22.225	24.613	7.142	7.142	1.570	1.570	0.4	3 350	1 410	32 000	38 000	**FR 6**	**FR 6 ZZ**	12.6	11.9	0.4	10.1	12.1

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

3. ANGULAR CONTACT BALL BEARINGS

DESIGN, TYPES, AND FEATURES

Contact angle



SINGLE-ROW ANGULAR CONTACT BALL BEARINGS

Since these bearings have a contact angle, they can 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 opposed bearings or a combination of more than two 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, for which high running accuracy is required. (Refer to Chapter 9, Preload, Page A192).

Usually, the cages for angular contact ball bearings with a contact angle of 30° (Symbol **A**) or 40°(Symbol **B**) are in accordance with Table 1,but depending on the application, machined synthetic resin cages or molded polyamide resin cages are also used. The basic load ratings given in the bearing tables are based on the standard cages.

Though the figures in the bearing tables (Pages C086 to C101; bearing bore diameters of 10 to 120) show bearings with single-shoulder-type inner rings, both-shoulder-type 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	
	Symbols	W	TYN	T85	T7	Omitted	MR
Features	High Load Capacity	◎	○	◎	◎	○	◎
	High-Speed	△	◎	○	○	△	○
	High-Temperature	◎	△	△	◎	◎	◎
	Vibration	△	△	△	△	◎	◎

In addition, for bearings with the same serial number, if the type of cages are different, the number of balls may also be different. In such a case, the load rating will differ from the one listed in the bearing tables.

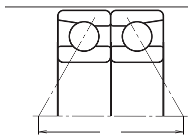
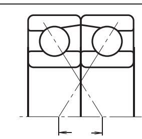
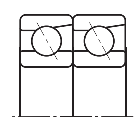
Angular Contact Ball Bearings with contact angles of 15° (Symbol **C**) and 25° (Symbol **A5**) are primarily for high precision or high speed applications, and molded polyamide cages (Symbol TYN) or machined brass cages or synthetic resin cages (Symbol T) are used.

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 $_0$ is big, 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 to the DB Type.
	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

In comparison with standard angular contact ball bearings, these bearings have high capacity, high limiting speed, and highly accurate universal matching as the features. The molded polyamide cages are standard specification for the HPS type.

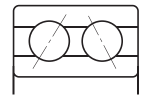
Formulation of Bearing Numbers

Single-Row Angular Contact Ball Bearings Matched Angular Contact Ball Bearings

Bearing number example : 7 2 08 B EA MR SU CNB

①Bearing type symbol (7)
②Dimension symbol (2)
③Bore number (08)
④Contact angle symbol (B)
⑤Internal design symbol (EA)
⑥Cage symbol (MR)
⑦Arrangement symbol (SU)
⑧Preload symbol Axial internal clearance symbol (CNB)

①Bearing type symbol	7 : Single-Row Angular Contact Ball Bearings, Matched Angular Contact Ball Bearings
②Dimension symbol	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 symbol	C : 15°, A5 : 25°, A : 30°, B : 40°
⑤Internal design symbol	EA : High Load Capacity
⑥Cage symbol	W : Pressed Steel Cage, MR : Machined Brass Cage (Ball guided), No symbol : Machined Brass Cage (Outer Ring guided), TYN : Polyamide Resin Cage, T85 : Polyamide 46 Resin Cage, T7 : L-PPS Resin Cage
⑦Arrangement symbol	SU: Universal arrangement (Single row), DU : Universal arrangement (Double row), DB : Back-to-back arrangement, DF : Face-to-face arrangement, DT : Tandem arrangement
⑧Preload symbol Axial internal clearance symbol	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

This is basically a back-to-back mounting of two single-row angular contact ball bearings, but their inner and outer rings are each integrated into one. Axial loads in both directions can be sustained, and the capacity to sustain moments is good. This type is used as fixed-end bearings.

Their cages are pressed steel.

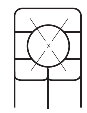
Formulation of Bearing Numbers

Double-Row Angular Contact Ball Bearings

Bearing number example : 5 2 01

①Bearing type symbol (5)
②Dimension symbol (2)
③Bore number (01)

①Bearing type symbol	5 : Double-Row Angular Contact Ball Bearings
②Dimension symbol	2 : 02 Series
③Bore number	Less than 03, Bearing bore 00 : 10mm, 01 : 12mm, 02 : 15mm, 03 : 17mm Over 04, Bearing bore Bore number ×5 (mm)



FOUR-POINT CONTACT BALL BEARINGS

The inner ring is split radially into two pieces. Their design allows one bearing to sustain significant axial loads in either direction.

The contact angle is 35°, so the axial load capacity is high. This type is suitable for carrying pure axial loads or combined loads where the axial loads are high.

The cages are made of machined brass.

Formulation of Bearing Numbers

Four-Point Contact Ball Bearings

Bearing number example : QJ 2 16 M C3

①Bearing type symbol (QJ)
②Dimension symbol (2)
③Bore number (16)
④Cage symbol (M)
⑤Internal clearance symbol (C3)

①Bearing type symbol	QJ : Four-Point Contact Ball Bearings
②Dimension symbol	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 symbol	M : Machined Brass Cage
⑤Internal clearance symbol	C2 : Clearance less than CN, 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 the speed and temperature are close to their limits, lubrication is marginal, vibration and moment loads are heavy, they may not be suitable, particularly for certain types of cages. In such a case, please consult with NSK beforehand.

And 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*' (*e* is listed in the bearings tables) during operation, slippage occurs between the balls and raceways, which may result in smearing. Especially with large bearings since the weight of the balls and cage is high. If such load conditions are expected, please consult with NSK for selection of the bearings.

TOLERANCES AND RUNNING ACCURACY

SINGLE-ROW ANGULAR CONTACT BALL BEARINGS .... Table 7.2 (Pages A128 to A131)

NSKHPS ANGULAR CONTACT BALL BEARINGS
Tolerance for Dimensions: 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 HPS 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 better than P5 are primarily used in the main spindles of machine tools, so they are used with a preload for rigidity. For convenience of selection, internal clearances are adjusted to produce Very Light, Light, Medium, and Heavy Preloads. Their fitting is also special. Concerning these matters, please refer to Tables 9.1 and 9.5 (Pages A194 and A197).

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)

In cases of single-row and matched angular contact ball bearings, The limiting speeds (grease) and limiting speeds (oil) listed in the bearing table are for bearings with standard cage. For those with option cages, limiting speeds (grease/oil) may differ depending on cages. Please consult with NSK. For example, limiting speeds (grease/oil) of machined cage (No symbol) is 1.25 times higher than pressed cage.

The limiting speeds of bearings with contact angles of 15° (Symbol **C**) and 25° (Symbol **A5**) are for bearings with precision of P5 and 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 the bearing load conditions. Also, 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.

This kind of bearing is used mostly with grease lubrication. But such grease lubrication may affect the bearing in terms of temperature rise or durability. To allow a bearing to demonstrate its full performance, it is essential to fill the bearing with the proper amount of a suitable grease. A prerequisite for this job is a knowledge of the bearing's free space.

The angular ball bearing is available in various kinds which are independent of the combinations of bearing series, contact angle, and cage type. The free space of the bearing used most frequently is described below. Table 1 shows the free space of a bearing with a pressed cage for general use and Table 2 shows that of a bearing with a high-tension brass machined cage. The contact angle symbols A, B, and C in each table refer to the nominal contact angle of 30°, 40°, and 15° of each bearing.

Table 1 Free Space of Angular Contact Ball Bearing (1) (With Pressed Steel Cage)

Units: cm^3

Bearing bore No.	Bearing free space			
	Bearing series — Contact angle symbol			
	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 Bearing (2) (With High-Tension Brass Machined Cage)

Units: cm^3

Bearing bore No.	Bearing free space				
	Bearing series — Contact angle symbol				
	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 to be used to carry a large axial load. There are three patterns of combination, which are expressed by combination symbols of 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.

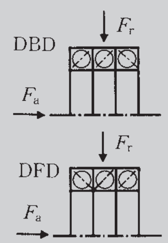
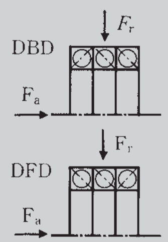
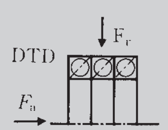
Assuming the dynamic equivalent radial load as P_r, the radial load as F_r, and axial load as F_a, the relationship between the dynamic equivalent radial load and bearing load may be approximated as follows:

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

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

The axial load factor varies with the contact angle. In an angular contact ball bearing, whose contact angle is small, the contact angle varies substantially when the 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. Accordingly, for the angular contact ball bearing with a contact angle of 15°, the axial load factor at a contact angle corresponding to this ratio is shown. If the 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)	

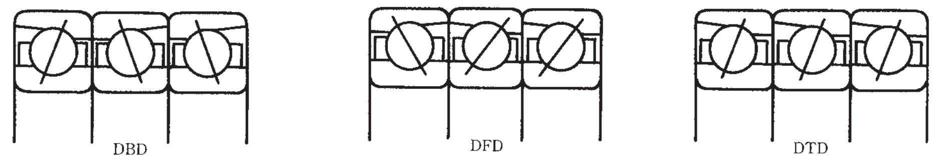


Table 1 Factors X and Y of Triplex Angular Contact Ball Bearing

Contact angle α	j	$\frac{C_{0r}}{jF_a}$	$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		e	Basic load rating of 3 row ball bearings	
			X	Y	X	Y		C_r	C_{0r}
15°	1.5	5	1	0.64	0.58	1.46	0.51	2.16 times of single bearing	3 times of 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 of single bearing	3 times of 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 of single bearing	3 times of 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 in 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 is the greatest possible angular displacement of the axis of the other ring.

Since the angular clearance is the greatest total relative displacement of the two ring axes, it is twice the possible angle of inner and outer ring movement (the maximum angular displacement in one direction from the center without creating a moment).

The relationship between axial and angular clearance for double-row angular contact ball bearings is given by Equation (1) below.

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

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 NSK double-row angular contact ball bearings series 52, 53, 32, and 33.

The relationship between radial clearance Δ_r and axial clearance Δ_a for double-row angular contact ball bearings was explained in pages C086 and C087. Based on those equations, Fig. 2 shows the relationship between angular clearance θ and radial clearance Δ_r.

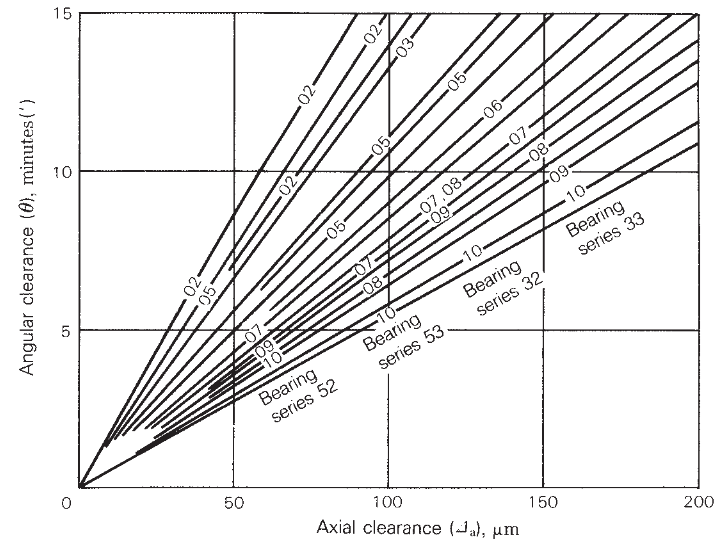


Fig. 1 Relationship between Axial and Angular Clearances

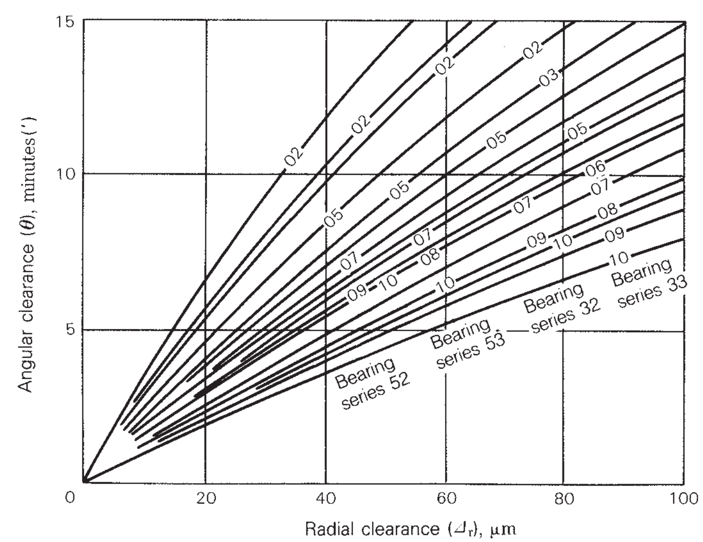


Fig. 2 Relationship between Radial and Angular Clearances

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.

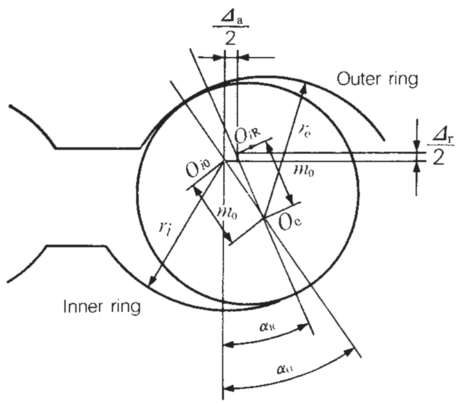


Fig. 1

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:

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

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

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

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

Combined Equations (1), (2), and (3), we obtain:

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

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

α_R is 25° for 52 and 53 series bearings and 32° for 32 and 33 series 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.

$$\therefore \Delta_a \doteqdot 2m_0^{1/2} \Delta_r^{1/2} \quad \cdots\cdots \quad (6)$$

This is identical to the relationship between the radial and axial clearances in single-row deep groove ball bearings.

The value of m_0 is dependent on the inner and outer ring groove radii. The relation between Δ_r and Δ_a, as given by Equation (5), is shown in Figs. 2 and 3 for NSK 52, 53, 32, and 33 series double-row angular contact ball bearings. When the clearance range is small, the axial clearance is given approximately by

$$\Delta_a \doteqdot \Delta_r \cot \alpha_R \quad \cdots\cdots \quad (7)$$

However, when the clearance is relatively large, (when Δ_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).

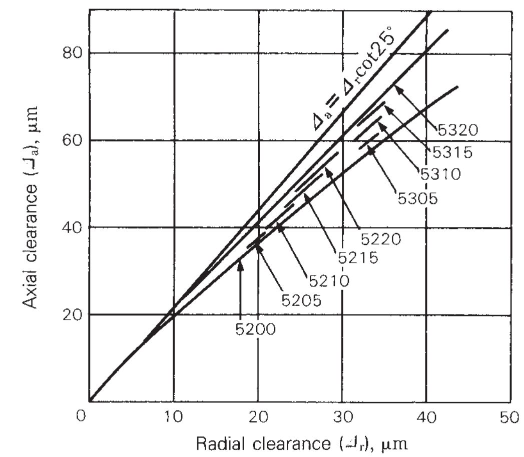


Fig. 2 Radial and Axial Clearances of Bearing Series 52 and 53

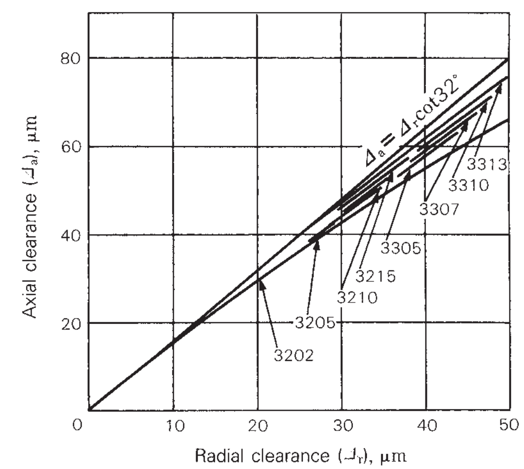
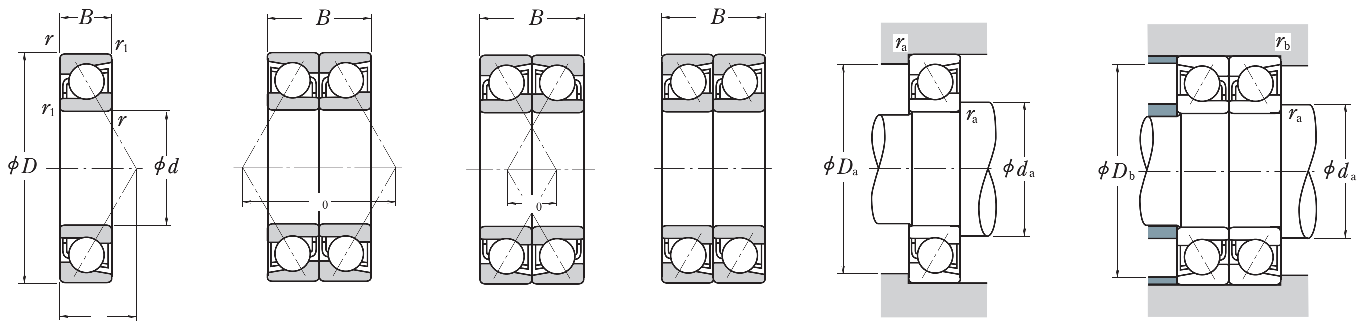


Fig. 3 Radial and Axial Clearances of Bearing Series 32 and 33

ANGULAR CONTACT BALL BEARINGS

SINGLE/MATCHED MOUNTINGS
Bore Diameter 10 – 15 mm



Single | Back-to-Back DB | Face-to-Face DF | Tandem DT

Dynamic Equivalent Load $P=XF_r+YF_a$

Contact Angle	$\frac{if_0F_a}{C_{0r}}$	e	Single, DT F_a/F_r e X	Single, DT F_a/F_r e Y	Single, DT F_a/F_r e X	Single, DT F_a/F_r e Y	DB or DF F_a/F_r e X	DB or DF F_a/F_r e Y	DB or DF F_a/F_r e X	DB or DF F_a/F_r e 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, 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 $P_0=F_r$

Boundary Dimensions (mm) d	D	B	r min.	r_1 min.	Basic Load Ratings (Single) (N) C_r	C_{0r}	Factor f_0	Limiting Speeds (1) (min⁻¹) Grease	Oil	Eff.Load Centers (mm) a	Abutment and Fillet Dimensions (mm) d_a min.	D_a max.	r_a max.	Mass (kg) approx.	Bearing Numbers (2) Single
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	7900 A5
	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	7900 C
	26	8	0.3	0.15	5 350	2 600	—	24 000	34 000	9.2	12.5	23.5	0.3	0.019	7000 A
	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	7000 C
	30	9	0.6	0.3	5 400	2 710	—	22 000	30 000	10.3	15	25	0.6	0.032	7200 A
	30	9	0.6	0.3	5 000	2 500	—	16 000	22 000	12.9	15	25	0.6	0.032	7200 B
	30	9	0.6	0.3	5 400	2 610	13.2	40 000	56 000	7.2	15	25	0.6	0.032	7200 C
	35	11	0.6	0.3	9 300	4 300	—	16 000	22 000	12.0	15	30	0.6	0.053	7300 A
	35	11	0.6	0.3	8 750	4 050	—	14 000	20 000	14.9	15	30	0.6	0.054	7300 B
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	7901 A5
	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	7901 C
	28	8	0.3	0.15	5 800	2 980	—	22 000	30 000	9.8	14.5	25.5	0.3	0.021	7001 A
	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	7001 C
	32	10	0.6	0.3	8 000	4 050	—	20 000	28 000	11.4	17	27	0.6	0.037	7201 A
	32	10	0.6	0.3	7 450	3 750	—	15 000	20 000	14.2	17	27	0.6	0.038	7201 B
	32	10	0.6	0.3	8 150	3 750	—	20 000	30 000	14.2	17	27	0.6	0.036	7201 BEA
	32	10	0.6	0.3	7 900	3 850	12.5	36 000	50 000	7.9	17	27	0.6	0.036	7201 C
	37	12	1	0.6	9 450	4 500	—	15 000	20 000	13.1	18	31	1	0.060	7301 A
	37	12	1	0.6	8 850	4 200	—	13 000	18 000	16.3	18	31	1	0.062	7301 B
	37	12	1	0.6	11 100	4 950	—	18 000	26 000	16.3	18	31	1	0.061	7301 BEA
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	7902 A5
	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	7902 C
	32	9	0.3	0.15	6 100	3 450	—	19 000	26 000	11.3	17.5	29.5	0.3	0.030	7002 A
	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	7002 C
	35	11	0.6	0.3	8 650	4 650	—	18 000	24 000	12.7	20	30	0.6	0.045	7202 A
	35	11	0.6	0.3	7 950	4 300	—	13 000	18 000	16.0	20	30	0.6	0.046	7202 B
	35	11	0.6	0.3	9 800	4 800	—	18 000	26 000	16.0	20	30	0.6	0.044	7202 BEA
	35	11	0.6	0.3	8 650	4 550	13.2	32 000	45 000	8.8	20	30	0.6	0.045	7202 C
	42	13	1	0.6	13 400	7 100	—	13 000	17 000	14.7	21	36	1	0.084	7302 A
	42	13	1	0.6	12 500	6 600	—	11 000	15 000	18.5	21	36	1	0.086	7302 B
	42	13	1	0.6	14 300	6 900	—	16 000	22 000	18.5	21	36	1	0.084	7302 BEA

Bearing Numbers (2) Single	Cage Symbol (4) Standard	Option	Duplex			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

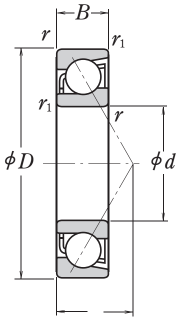
Notes (1) For applications operating near the limiting speed, refer to Page C077.
(2) The suffixes A, A5, B, and C represent contact angles of 30°, 25°, 40°, and 15° respectively.
(3) For bearings marked — in the column for d_b, d_b and r_b for shafts are d_a (min) and r_a (max) respectively.

Note (4) (M) in the column of cage symbols are usually omitted from the bearing number.
Remark The bearings denoted by an asterisk ( ) are NSKHPS™ Angular contact ball bearings and the column of Duplex in Bearing Numbers indicates the universal matching.

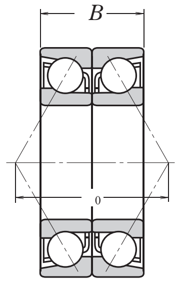
ANGULAR CONTACT BALL BEARINGS

SINGLE/MATCHED MOUNTINGS

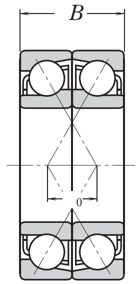
Bore Diameter 17 – 25 mm



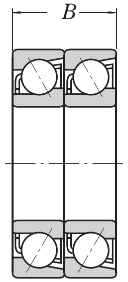
Single



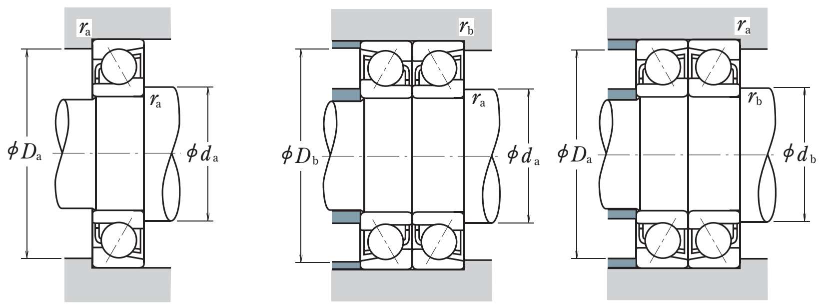
Back-to-Back
DB



Face-to-Face
DF



Tandem
DT



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
15°	0.178	0.38	1	0	0.44	1.47	1	1.65	0.72	2.39
	0.357	0.40	1	0	0.44	1.40	1	1.57	0.72	2.28
	0.714	0.43	1	0	0.44	1.30	1	1.46	0.72	2.11
	1.07	0.46	1	0	0.44	1.23	1	1.38	0.72	2.00
	1.43	0.47	1	0	0.44	1.19	1	1.34	0.72	1.93
	2.14	0.50	1	0	0.44	1.12	1	1.26	0.72	1.82
	3.57	0.55	1	0	0.44	1.02	1	1.14	0.72	1.66
	5.35	0.56	1	0	0.44	1.00	1	1.12	0.72	1.63
25°	—	0.68	1	0	0.41	0.87	1	0.92	0.67	1.41
30°	—	0.80	1	0	0.39	0.76	1	0.78	0.63	1.24
40°	—	1.14	1	0	0.35	0.57	1	0.55	0.57	0.93

For i, use 2 for DB, 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
15°	0.5	0.46	1	0.92
25°	0.5	0.38	1	0.76
30°	0.5	0.33	1	0.66
40°	0.5	0.26	1	0.52

Single or DT mounting When F_r $0.5F_r+Y_0F_a$ use $P_0=F_r$

d	D	B	r min.	r_1 min.	Basic Load Ratings (Single) (N) C_r	C_{0r}	Factor f_0	Limiting Speeds (1) (min⁻¹) Grease	Oil	Eff.Load Centers (mm) a	Abutment and Fillet Dimensions (mm) d_a min.	D_a max.	r_a max.	Mass (kg) approx.	Bearing Numbers (2) Cage Symbol (4) Single	Standard	Option	Duplex	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.
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	**7903 A5**	**TYN**	**(M),T**	**DB DF DT**	7 750	5 600	24 000	32 000	18.0	4.0	—	28.8	0.15
	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	**7903 C**	**TYN**	**(M),T**	**DB DF DT**	8 150	5 850	28 000	38 000	13.3	0.7	—	28.8	0.15
	35	10	0.3	0.15	6 400	3 800	—	17 000	24 000	12.5	19.5	32.5	0.3	0.040	**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
	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	**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
	40	12	0.6	0.3	10 800	6 000	—	16 000	22 000	14.2	22	35	0.6	0.067	**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
	40	12	0.6	0.3	9 950	5 500	—	11 000	15 000	18.0	22	35	0.6	0.068	**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
	40	12	0.6	0.3	11 600	6 100	—	16 000	22 000	18.2	22	35	0.6	0.065	**7203 BEA**	**T85**	**T7**	— — —	—	—	13 000	18 000	36.3	12.3	19.5	37.5	0.3
	40	12	0.6	0.3	10 900	5 850	13.3	28 000	38 000	9.8	22	35	0.6	0.065	**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
	47	14	1	0.6	15 900	8 650	—	11 000	15 000	16.2	23	41	1	0.116	**7303 A**	**W**	**(M), T**	**DB DF DT**	25 900	17 300	9 000	12 000	32.5	4.5	22	42	0.6
	47	14	1	0.6	14 800	8 000	—	10 000	14 000	20.4	23	41	1	0.118	**7303 B**	**W**	**(M), T**	**DB DF DT**	24 000	16 000	8 000	11 000	40.9	12.9	22	42	0.6
	47	14	1	0.6	16 800	8 300	—	14 000	20 000	20.4	23	41	1	0.113	**7303 BEA**	**T85**	—	— — —	—	—	11 000	16 000	40.9	12.9	22	42	0.6
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	**7904 A5**	**TYN**	**(M),T**	**DB DF DT**	10 700	8 100	19 000	26 000	22.3	4.3	—	35.8	0.15
	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	**7904 C**	**TYN**	**(M),T**	**DB DF DT**	11 300	8 500	22 000	32 000	16.6	1.4	—	35.8	0.15
	42	12	0.6	0.3	10 800	6 600	—	14 000	20 000	14.9	25	37	0.6	0.068	**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
	42	12	0.6	0.3	11 100	6 550	14.0	26 000	36 000	10.1	25	37	0.6	0.068	**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
	47	14	1	0.6	14 500	8 300	—	13 000	18 000	16.7	26	41	1	0.106	**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
	47	14	1	0.6	13 300	7 650	—	9 500	13 000	21.1	26	41	1	0.109	**7204 B**	**W**	**(M),T**	**DB DF DT**	21 600	15 300	7 500	11 000	42.1	14.1	25	42	0.6
	47	14	1	0.6	15 600	8 150	—	13 000	19 000	21.1	26	41	1	0.103	**7204 BEA**	**T85**	**T7**	— — —	—	—	11 000	16 000	42.1	14.1	25	42	0.6
	47	14	1	0.6	14 600	8 050	13.3	24 000	34 000	11.5	26	41	1	0.104	**7204 C**	**TYN**	**W,(M),T**	**DB DF DT**	23 600	16 100	19 000	26 000	23.0	5.0	—	42	0.6
	52	15	1.1	0.6	18 700	10 400	—	10 000	13 000	17.9	27	45	1	0.146	**7304 A**	**W**	**(M), T**	**DB DF DT**	30 500	20 800	8 000	11 000	35.8	5.8	25	47	0.6
	52	15	1.1	0.6	17 300	9 650	—	9 000	12 000	22.6	27	45	1	0.150	**7304 B**	**W**	**(M), T**	**DB DF DT**	28 200	19 300	7 100	10 000	45.2	15.2	25	47	0.6
	52	15	1.1	0.6	19 800	10 500	—	13 000	18 000	22.6	27	45	1	0.149	**7304 BEA**	**T85**	**MR, T7**	— — —	—	—	10 000	14 000	45.2	15.2	25	47	0.6
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	**7905 A5**	**TYN**	**(M),T**	**DB DF DT**	12 100	10 300	16 000	22 000	24.6	6.6	—	40.8	0.15
	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	**7905 C**	**TYN**	**(M),T**	**DB DF DT**	12 700	10 800	19 000	26 000	18.0	0.0	—	40.8	0.15
	47	12	0.6	0.3	11 300	7 400	—	12 000	17 000	16.4	30	42	0.6	0.079	**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
	47	12	0.6	0.3	11 700	7 400	14.7	22 000	30 000	10.8	30	42	0.6	0.078	**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
	52	15	1	0.6	16 200	10 300	—	12 000	16 000	18.6	31	46	1	0.130	**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
	52	15	1	0.6	14 800	9 400	—	8 500	11 000	23.7	31	46	1	0.133	**7205 B**	**W**	**(M),T**	**DB DF DT**	24 000	18 800	6 700	9 000	47.3	17.3	30	47	0.6
	52	15	1	0.6	17 600	10 200	—	12 000	17 000	23.7	31	46	1	0.127	**7205 BEA**	**T85**	**T7**	— — —	—	—	9 500	14 000	47.3	17.3	30	47	0.6
	52	15	1	0.6	16 600	10 200	14.0	22 000	28 000	12.7	31	46	1	0.129	**7205 C**	**TYN**	**W,(M),T**	**DB DF DT**	27 000	20 400	17 000	24 000	25.3	4.7	—	47	0.6
	62	17	1.1	0.6	26 400	15 800	—	8 500	11 000	21.1	32	55	1	0.235	**7305 A**	**W**	**(M), T**	**DB DF DT**	43 000	31 500	6 700	9 000	42.1	8.1	30	57	0.6

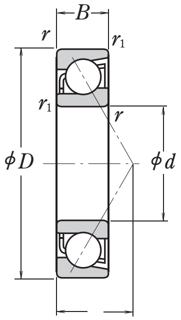
Notes (1) For applications operating near the limiting speed, refer to Page C077.
(2) The suffixes A, A5, B, and C represent contact angles of 30°, 25°, 40°, and 15° respectively.
(3) For bearings marked — in the column for d_b, d_b and r_b for shafts are d_a (min) and r_a (max) respectively.

Note (4) (M) in the column of cage symbols are usually omitted from the bearing number.
Remark The bearings denoted by an asterisk ( ) are NSKHPS™ Angular contact ball bearings and the column of Duplex in Bearing Numbers indicates the universal matching.

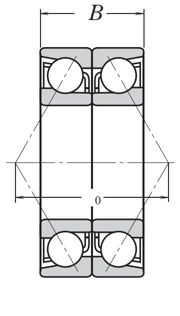
ANGULAR CONTACT BALL BEARINGS

SINGLE/MATCHED MOUNTINGS

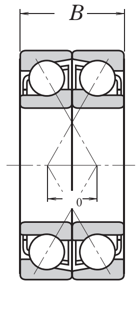
Bore Diameter 25 – 40 mm



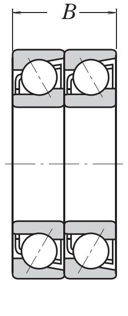
Single



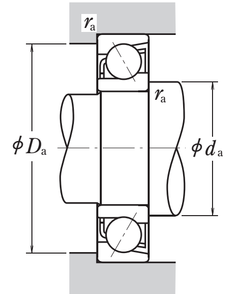
Back-to-Back
DB

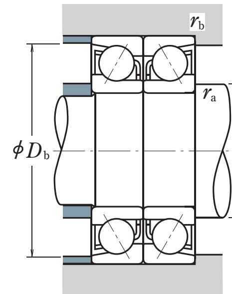


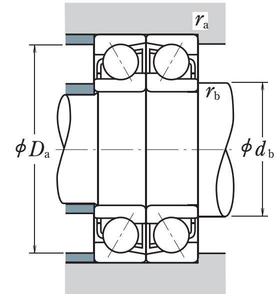
Face-to-Face
DF



Tandem
DT







Dynamic Equivalent Load $P = XF_r + YF_a$

Contact Angle	$\frac{if_0F_a}{C_{0r}}$	e	Single, DT F_a/F_r e X	Single, DT F_a/F_r e Y	Single, DT F_a/F_r e X	Single, DT F_a/F_r e Y	DB or DF F_a/F_r e X	DB or DF F_a/F_r e Y	DB or DF F_a/F_r e X	DB or DF F_a/F_r e 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, 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 $P_0 = F_r$

Boundary Dimensions (mm) d	D	B	r min.	r_1 min.	Basic Load Ratings (Single) (N) C_r	C_{0r}	Factor f_0	Limiting Speeds ([1]) (min⁻¹) Grease	Oil	Eff. Load Centers (mm) a	Abutment and Fillet Dimensions (mm) d_a min.	D_a max.	r_a max.	Mass (kg) approx.	Bearing Numbers ([2]) Single	Cage Symbol ([4]) Standard	Option	Duplex			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.
25	62	17	1.1	0.6	24 400	14 600	—	7 500	10 000	26.7	32	55	1	0.241	**7305 B**	**W**	**(M), T**	**DB**	**DF**	**DT**	39 500	29 300	6 000	8 000	53.5	19.5	30	57	0.6
	62	17	1.1	0.6	27 200	14 900	—	10 000	15 000	26.8	32	55	1	0.229	**7305 BEA**	**T85**	**MR, T7**	—	—	—	—	—	8 500	12 000	53.5	19.5	30	57	0.6
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	**7906 A5**	**TYN**	**(M),T**	**DB**	**DF**	**DT**	12 800	11 900	14 000	19 000	27.0	9.0	—	45.8	0.15
	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	**7906 C**	**TYN**	**(M),T**	**DB**	**DF**	**DT**	13 500	12 500	17 000	24 000	19.3	1.3	—	45.8	0.15
	55	13	1	0.6	14 500	10 100	—	11 000	14 000	18.8	36	49	1	0.116	**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
	55	13	1	0.6	15 100	10 300	14.9	19 000	26 000	12.2	36	49	1	0.115	**7006 C**	**TYN**	**W,(M),T**	**DB**	**DF**	**DT**	24 600	20 500	15 000	22 000	24.4	1.6	—	50	0.6
	62	16	1	0.6	22 500	14 800	—	9 500	13 000	21.3	36	56	1	0.197	**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
	62	16	1	0.6	20 500	13 500	—	7 100	9 500	27.3	36	56	1	0.202	**7206 B**	**W**	**(M),T**	**DB**	**DF**	**DT**	33 500	27 000	5 600	7 500	54.6	22.6	35	57	0.6
	62	16	1	0.6	23 700	14 300	—	10 000	14 000	27.3	36	56	1	0.194	**7206 BEA**	**T85**	**MR, T7**	—	—	—	—	—	8 000	11 000	54.6	22.6	35	57	0.6
	62	16	1	0.6	23 000	14 700	13.9	18 000	24 000	14.2	36	56	1	0.197	**7206 C**	**TYN**	**W,(M),T**	**DB**	**DF**	**DT**	37 500	29 300	14 000	20 000	28.3	3.7	—	57	0.6
	72	19	1.1	0.6	33 500	20 900	—	7 100	9 500	24.2	37	65	1	0.346	**7306 A**	**W**	**(M), T**	**DB**	**DF**	**DT**	54 500	41 500	5 600	7 500	48.4	10.4	35	67	0.6
	72	19	1.1	0.6	31 000	19 300	—	6 300	8 500	30.9	37	65	1	0.354	**7306 B**	**W**	**(M), T**	**DB**	**DF**	**DT**	50 500	38 500	5 000	7 100	61.8	23.8	35	67	0.6
	72	19	1.1	0.6	36 500	20 600	—	9 000	13 000	30.9	37	65	1	0.336	**7306 BEA**	**T85**	**MR, T7**	—	—	—	—	—	7 100	10 000	61.8	23.8	35	67	0.6
35	55	10	0.6	0.3	11 400	8 700	—	15 000	20 000	15.5	40	50	0.6	0.075	**7907 A5**	**TYN**	**(M),T**	**DB**	**DF**	**DT**	18 600	17 400	12 000	17 000	31.0	11.0	—	52.5	0.3
	55	10	0.6	0.3	12 100	9 150	15.7	18 000	24 000	11.0	40	50	0.6	0.075	**7907 C**	**TYN**	**(M),T**	**DB**	**DF**	**DT**	19 600	18 300	14 000	20 000	22.1	2.1	—	52.5	0.3
	62	14	1	0.6	18 300	13 400	—	9 000	13 000	21.0	41	56	1	0.153	**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
	62	14	1	0.6	19 100	13 700	15.0	17 000	22 000	13.5	41	56	1	0.153	**7007 C**	**TYN**	**W,(M),T**	**DB**	**DF**	**DT**	31 000	27 300	13 000	19 000	27.0	1.0	—	57	0.6
	72	17	1.1	0.6	29 700	20 100	—	8 500	12 000	23.9	42	65	1	0.287	**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
	72	17	1.1	0.6	27 100	18 400	—	6 000	8 000	30.9	42	65	1	0.294	**7207 B**	**W**	**(M),T**	**DB**	**DF**	**DT**	44 000	36 500	4 800	6 700	61.9	27.9	40	67	0.6
	72	17	1.1	0.6	32 500	19 600	—	8 500	12 000	30.9	42	65	1	0.271	**7207 BEA**	**T85**	**MR, T7**	—	—	—	—	—	6 700	9 500	61.9	27.9	40	67	0.6
	72	17	1.1	0.6	30 500	19 900	13.9	15 000	20 000	15.7	42	65	1	0.320	**7207 C**	**(M)**	**W,T,TYN**	**DB**	**DF**	**DT**	49 500	40 000	12 000	17 000	31.3	2.7	—	67	0.6
	80	21	1.5	1	40 000	26 300	—	6 300	8 500	27.1	44	71	1.5	0.464	**7307 A**	**W**	**(M), T**	**DB**	**DF**	**DT**	65 000	52 500	5 000	6 700	54.2	12.2	41	74	1
	80	21	1.5	1	36 500	24 200	—	5 600	7 500	34.6	44	71	1.5	0.474	**7307 B**	**W**	**(M), T**	**DB**	**DF**	**DT**	59 500	48 500	4 500	6 000	69.2	27.2	41	74	1
	80	21	1.5	1	40 500	24 400	—	8 000	11 000	34.6	44	71	1.5	0.451	**7307 BEA**	**T85**	**MR, T7**	—	—	—	—	—	6 300	9 000	69.2	27.2	41	74	1
40	62	12	0.6	0.3	14 300	11 200	—	14 000	18 000	17.9	45	57	0.6	0.110	**7908 A5**	**TYN**	**(M),T**	**DB**	**DF**	**DT**	23 300	22 300	11 000	15 000	35.8	11.8	—	59.5	0.3
	62	12	0.6	0.3	15 100	11 700	15.7	16 000	22 000	12.8	45	57	0.6	0.109	**7908 C**	**TYN**	**(M),T**	**DB**	**DF**	**DT**	24 600	23 500	13 000	18 000	25.7	1.7	—	59.5	0.3
	68	15	1	0.6	19 500	15 400	—	8 500	11 000	23.1	46	62	1	0.190	**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
	68	15	1	0.6	20 600	15 900	15.4	15 000	20 000	14.7	46	62	1	0.213	**7008 C**	**(M)**	**W,T, TYN**	**DB**	**DF**	**DT**	33 500	32 000	12 000	17 000	29.5	0.5	—	63	0.6
	80	18	1.1	0.6	35 500	25 100	—	7 500	10 000	26.3	47	73	1	0.375	**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
	80	18	1.1	0.6	32 000	23 000	—	5 300	7 500	34.2	47	73	1	0.383	**7208 B**	**W**	**(M),T**	**DB**	**DF**	**DT**	52 000	46 000	4 300	6 000	68.3	32.3	45	75	0.6

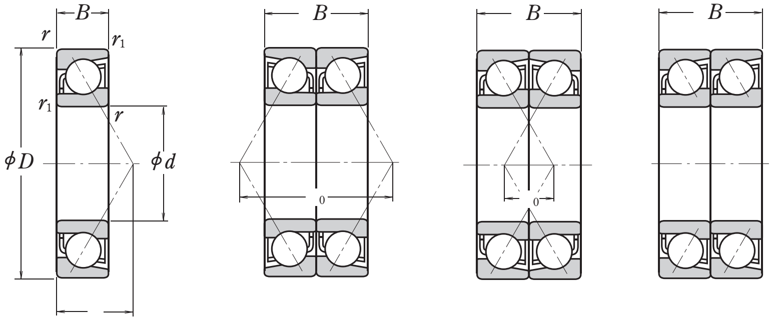
Notes ([1]) For applications operating near the limiting speed, refer to Page C077.
([2]) The suffixes A, A5, B, and C represent contact angles of 30°, 25°, 40°, and 15° respectively.
([3]) For bearings marked — in the column for d_b, d_b and r_b for shafts are d_a (min) and r_a (max) respectively.

Note ([4]) (M) in the column of cage symbols are usually omitted from the bearing number.
Remark The bearings denoted by an asterisk ( ) are NSKHPS™ Angular contact ball bearings and the column of Duplex in Bearing Numbers indicates the universal matching.

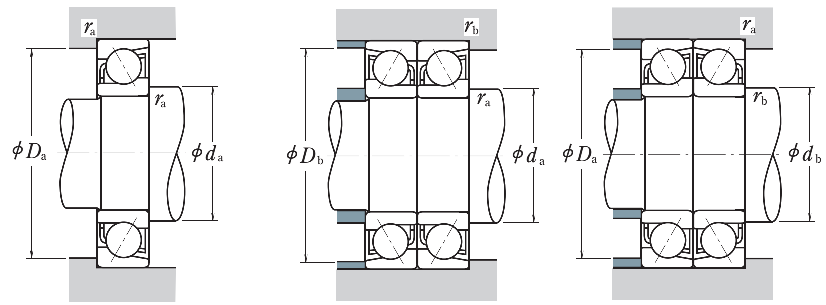
ANGULAR CONTACT BALL BEARINGS

SINGLE/MATCHED MOUNTINGS

Bore Diameter 40 – 55 mm



Single | Back-to-Back DB | Face-to-Face DF | Tandem DT



Dynamic Equivalent Load $P = XF_r + YF_a$

Contact Angle	$\frac{if_0F_a}{C_{0r}}$	e	Single, DT $F_a/F_r \le e$ X	Single, DT $F_a/F_r \le e$ Y	Single, DT $F_a/F_r > e$ X	Single, DT $F_a/F_r > e$ Y	DB or DF $F_a/F_r \le e$ X	DB or DF $F_a/F_r \le e$ Y	DB or DF $F_a/F_r > e$ X	DB or DF $F_a/F_r > e$ 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, 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 $P_0 = F_r$

Boundary Dimensions (mm) d	D	B	r min.	r_1 min.	Basic Load Ratings (Single) (N) C_r	C_{0r}	Factor f_0	Limiting Speeds (1) (min⁻¹) Grease	Oil	Eff.Load Centers (mm) a	Abutment and Fillet Dimensions (mm) d_a min.	D_a max.	r_a max.	Mass (kg) approx.	Bearing Numbers (2) Cage Symbol (4) Single	Standard	Option	Duplex	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.
40	80	18	1.1	0.6	38 500	24 500	—	7 500	11 000	34.2	47	73	1	0.357	**7208 BEA**	**T85**	**MR, T7**	— — —	—	—	6 000	8 500	68.3	32.3	45	75	0.6
	80	18	1.1	0.6	36 500	25 200	14.1	14 000	19 000	17.0	47	73	1	0.418	**7208 C**	**(M)**	**W,T,TYN**	**DB DF DT**	59 000	50 500	11 000	15 000	34.1	1.9	—	75	0.6
	90	23	1.5	1	49 000	33 000	—	5 600	7 500	30.3	49	81	1.5	0.633	**7308 A**	**W**	**(M), T**	**DB DF DT**	79 500	66 000	4 500	6 000	60.5	14.5	46	84	1
	90	23	1.5	1	45 000	30 500	—	5 000	6 700	38.8	49	81	1.5	0.648	**7308 B**	**W**	**(M), T**	**DB DF DT**	73 000	60 500	4 000	5 300	77.5	31.5	46	84	1
	90	23	1.5	1	53 000	33 000	—	7 100	10 000	38.8	49	81	1.5	0.619	**7308 BEA**	**T85**	**MR, T7**	— — —	—	—	5 600	8 000	77.5	31.5	46	84	1
45	68	12	0.6	0.3	15 100	12 700	—	12 000	17 000	19.2	50	63	0.6	0.130	**7909 A5**	**(M)**	**T,TYN**	**DB DF DT**	24 600	25 400	9 500	13 000	38.4	14.4	—	65.5	0.3
	68	12	0.6	0.3	16 000	13 400	16.0	14 000	20 000	13.6	50	63	0.6	0.129	**7909 C**	**(M)**	**T, TYN**	**DB DF DT**	26 000	26 800	12 000	16 000	27.1	3.1	—	65.5	0.3
	75	16	1	0.6	23 100	18 700	—	7 500	10 000	25.3	51	69	1	0.250	**7009 A**	**W**	**(M), TYN**	**DB DF DT**	37 500	37 500	6 000	8 500	50.6	18.6	50	70	0.6
	75	16	1	0.6	24 400	19 300	15.4	14 000	19 000	16.0	51	69	1	0.274	**7009 C**	**(M)**	**W,TYN**	**DB DF DT**	39 500	38 500	11 000	15 000	32.1	0.1	—	70	0.6
	85	19	1.1	0.6	39 500	28 700	—	6 700	9 500	28.3	52	78	1	0.411	**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
	85	19	1.1	0.6	36 000	26 200	—	5 000	6 700	36.8	52	78	1	0.421	**7209 B**	**W**	**(M),T**	**DB DF DT**	58 500	52 500	4 000	5 300	73.5	35.5	50	80	0.6
	85	19	1.1	0.6	40 500	27 100	—	7 100	10 000	36.8	52	78	1	0.400	**7209 BEA**	**T85**	**MR, T7**	— — —	—	—	5 600	8 000	73.5	35.5	50	80	0.6
	85	19	1.1	0.6	41 000	28 800	14.2	12 000	17 000	18.2	52	78	1	0.468	**7209 C**	**(M)**	**W,T, TYN**	**DB DF DT**	66 500	57 500	10 000	14 000	36.4	1.6	—	80	0.6
	100	25	1.5	1	63 500	43 500	—	5 000	6 700	33.4	54	91	1.5	0.848	**7309 A**	**W**	**(M), T**	**DB DF DT**	103 000	87 000	4 000	5 300	66.9	16.9	51	94	1
	100	25	1.5	1	58 500	40 000	—	4 500	6 000	42.9	54	91	1.5	0.869	**7309 B**	**W**	**(M), T**	**DB DF DT**	95 000	80 500	3 600	4 800	85.8	35.8	51	94	1
	100	25	1.5	1	62 500	39 500	—	6 300	9 000	42.9	54	91	1.5	0.823	**7309 BEA**	**T85**	**MR, T7**	— — —	—	—	5 000	7 100	85.8	35.8	51	94	1
50	72	12	0.6	0.3	15 900	14 200	—	11 000	15 000	20.2	55	67	0.6	0.132	**7910 A5**	**(M)**	**T,TYN**	**DB DF DT**	25 900	28 400	9 000	12 000	40.5	16.5	—	69.5	0.3
	72	12	0.6	0.3	16 900	15 000	16.2	13 000	18 000	14.2	55	67	0.6	0.130	**7910 C**	**(M)**	**T, TYN**	**DB DF DT**	27 400	30 000	11 000	15 000	28.3	4.3	—	69.5	0.3
	80	16	1	0.6	24 500	21 100	—	6 700	9 500	26.8	56	74	1	0.263	**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
	80	16	1	0.6	26 000	21 900	15.7	12 000	17 000	16.7	56	74	1	0.293	**7010 C**	**(M)**	**W,T, TYN**	**DB DF DT**	42 000	44 000	10 000	14 000	33.4	1.4	—	75	0.6
	90	20	1.1	0.6	41 500	31 500	—	6 300	9 000	30.2	57	83	1	0.466	**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
	90	20	1.1	0.6	37 500	28 600	—	4 500	6 300	39.4	57	83	1	0.477	**7210 B**	**W**	**(M),T**	**DB DF DT**	60 500	57 000	3 600	5 000	78.7	38.7	55	85	0.6
	90	20	1.1	0.6	42 000	29 700	—	6 300	9 500	39.4	57	83	1	0.453	**7210 BEA**	**T85**	**MR, T7**	— — —	—	—	5 000	7 500	78.7	38.7	55	85	0.6
	90	20	1.1	0.6	43 000	31 500	14.5	12 000	16 000	19.4	57	83	1	0.528	**7210 C**	**(M)**	**W,T,TYN**	**DB DF DT**	69 500	63 500	9 500	13 000	38.7	1.3	—	85	0.6
	110	27	2	1	74 000	52 000	—	4 500	6 000	36.6	60	100	2	1.10	**7310 A**	**W**	**(M), T**	**DB DF DT**	121 000	104 000	3 600	4 800	73.2	19.2	56	104	1
	110	27	2	1	68 000	48 000	—	4 000	5 600	47.1	60	100	2	1.12	**7310 B**	**W**	**(M), T**	**DB DF DT**	111 000	96 000	3 200	4 500	94.1	40.1	56	104	1
	110	27	2	1	78 000	50 500	—	5 600	8 000	47.1	60	100	2	1.07	**7310 BEA**	**T85**	**MR, T7**	— — —	—	—	4 500	6 700	94.1	40.1	56	104	1
55	80	13	1	0.6	18 100	16 800	—	10 000	14 000	22.2	61	74	1	0.184	**7911 A5**	**(M)**	**T,TYN**	**DB DF DT**	29 300	33 500	8 000	11 000	44.5	18.5	—	75	0.6
	80	13	1	0.6	19 100	17 700	16.3	12 000	16 000	15.5	61	74	1	0.182	**7911 C**	**(M)**	**T, TYN**	**DB DF DT**	31 000	35 500	9 500	13 000	31.1	5.1	—	75	0.6
	90	18	1.1	0.6	32 500	27 700	—	6 300	8 500	29.9	62	83	1	0.391	**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

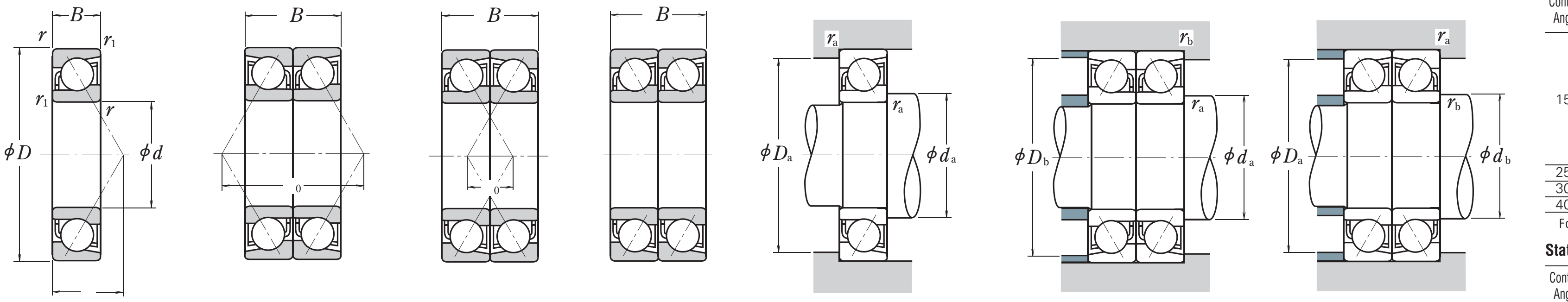
Notes (1) For applications operating near the limiting speed, refer to Page C077.
(2) The suffixes A, A5, B, and C represent contact angles of 30°, 25°, 40°, and 15° respectively.
(3) For bearings marked — in the column for d_b, d_b and r_b for shafts are d_a (min) and r_a (max) respectively.

Note (4) (M) in the column of cage symbols are usually omitted from the bearing number.
Remark The bearings denoted by an asterisk ( ) are NSKHPS™ Angular contact ball bearings and the column of Duplex in Bearing Numbers indicates the universal matching.

ANGULAR CONTACT BALL BEARINGS

SINGLE/MATCHED MOUNTINGS

Bore Diameter 55 – 65 mm



Single | Back-to-Back DB | Face-to-Face DF | Tandem DT

Dynamic Equivalent Load $P = XF_r + YF_a$

Contact Angle	$\frac{if_0F_a}{C_{0r}}$	e	Single, DT F_a/F_r e X	Single, DT F_a/F_r e Y	Single, DT F_a/F_r e X	Single, DT F_a/F_r e Y	DB or DF F_a/F_r e X	DB or DF F_a/F_r e Y	DB or DF F_a/F_r e X	DB or DF F_a/F_r e 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, 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 $P_0 = F_r$

Boundary Dimensions (mm) d	D	B	r min.	r_1 min.	Basic Load Ratings (Single) (N) C_r	C_{0r}	Factor f_0	Limiting Speeds (1) (min⁻¹) Grease	Oil	Eff.Load Centers (mm) a	Abutment and Fillet Dimensions (mm) d_a min.	D_a max.	r_a max.	Mass (kg) approx.	Bearing Numbers (2) Single	Cage Symbol (4) Standard	Option	Duplex			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.
55	90	18	1.1	0.6	34 000	28 600	15.5	11 000	15 000	18.7	62	83	1	0.430	**7011 C**	**(M)**	**W,T, TYN**	**DB**	**DF**	**DT**	55 500	57 500	9 000	12 000	37.4	1.4	—	85	0.6
	100	21	1.5	1	51 000	39 500	—	5 600	8 000	32.9	64	91	1.5	0.613	**7211 A**	**W**	**(M), T,TYN**	**DB**	**DF**	**DT**	83 000	79 000	4 500	6 300	65.7	23.7	61	94	1
	100	21	1.5	1	46 500	36 000	—	4 000	5 600	43.0	64	91	1.5	0.627	**7211 B**	**W**	**(M),T**	**DB**	**DF**	**DT**	75 000	72 000	3 400	4 500	86.0	44.0	61	94	1
	100	21	1.5	1	51 500	37 000	—	6 000	8 500	43.0	64	91	1.5	0.596	**7211 BEA**	**T85**	**MR, T7**	—	—	—	—	—	4 500	6 700	86.0	44.0	61	94	1
	100	21	1.5	1	53 000	40 000	14.5	10 000	14 000	20.9	64	91	1.5	0.688	**7211 C**	**(M)**	**W,T,TYN**	**DB**	**DF**	**DT**	86 000	80 000	8 500	12 000	41.7	0.3	—	94	1
	120	29	2	1	86 000	61 500	—	4 000	5 600	39.8	65	110	2	1.41	**7311 A**	**W**	**(M), T**	**DB**	**DF**	**DT**	139 000	123 000	3 200	4 300	79.5	21.5	61	114	1
	120	29	2	1	79 000	56 500	—	3 600	5 000	51.2	65	110	2	1.45	**7311 B**	**W**	**(M), T**	**DB**	**DF**	**DT**	128 000	113 000	3 000	4 000	102.4	44.4	61	114	1
	120	29	2	1	89 000	58 500	—	5 000	7 500	51.2	65	110	2	1.36	**7311 BEA**	**T85**	**MR, T7**	—	—	—	—	—	4 000	6 000	102.4	44.4	61	114	1
60	85	13	1	0.6	18 300	17 700	—	9 500	13 000	23.4	66	79	1	0.197	**7912 A5**	**(M)**	**T,TYN**	**DB**	**DF**	**DT**	29 800	35 500	7 500	10 000	46.8	20.8	—	80	0.6
	85	13	1	0.6	19 400	18 700	16.5	11 000	15 000	16.2	66	79	1	0.194	**7912 C**	**(M)**	**T, TYN**	**DB**	**DF**	**DT**	31 500	37 500	9 000	12 000	32.4	6.4	—	80	0.6
	95	18	1.1	0.6	33 000	29 500	—	5 600	8 000	31.4	67	88	1	0.417	**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
	95	18	1.1	0.6	35 000	30 500	15.7	10 000	14 000	19.4	67	88	1	0.460	**7012 C**	**(M)**	**W,T, TYN**	**DB**	**DF**	**DT**	57 000	61 500	8 500	12 000	38.8	2.8	—	90	0.6
	110	22	1.5	1	62 000	48 500	—	5 300	7 100	35.5	69	101	1.5	0.798	**7212 A**	**W**	**(M), T,TYN**	**DB**	**DF**	**DT**	100 000	97 500	4 300	6 000	71.1	27.1	66	104	1
	110	22	1.5	1	56 000	44 500	—	3 800	5 300	46.7	69	101	1.5	0.815	**7212 B**	**W**	**(M),T**	**DB**	**DF**	**DT**	91 000	89 000	3 000	4 000	93.3	49.3	66	104	1
	110	22	1.5	1	61 500	45 000	—	5 300	7 500	46.7	69	101	1.5	0.791	**7212 BEA**	**T85**	**MR, T7**	—	—	—	—	—	4 300	6 000	93.3	49.3	66	104	1
	110	22	1.5	1	64 000	49 000	14.4	9 500	13 000	22.4	69	101	1.5	0.889	**7212 C**	**(M)**	**W,T,TYN**	**DB**	**DF**	**DT**	104 000	98 500	7 500	11 000	44.8	0.8	—	104	1
	130	31	2.1	1.1	98 000	71 500	—	3 800	5 000	42.9	72	118	2	1.74	**7312 A**	**W**	**(M), T**	**DB**	**DF**	**DT**	159 000	143 000	3 000	4 000	85.9	23.9	67	123	1
	130	31	2.1	1.1	90 000	65 500	—	3 400	4 500	55.4	72	118	2	1.78	**7312 B**	**W**	**(M), T**	**DB**	**DF**	**DT**	146 000	131 000	2 600	3 800	110.7	48.7	67	123	1
	130	31	2.1	1.1	102 000	68 500	—	4 800	6 700	55.4	72	118	2	1.70	**7312 BEA**	**T85**	**MR, T7**	—	—	—	—	—	3 800	5 600	110.7	48.7	67	123	1
65	90	13	1	0.6	19 100	19 400	—	9 000	12 000	24.6	71	84	1	0.211	**7913 A5**	**(M)**	**T,TYN**	**DB**	**DF**	**DT**	31 000	39 000	7 100	9 500	49.1	23.1	—	85	0.6
	90	13	1	0.6	20 200	20 500	16.7	10 000	14 000	16.9	71	84	1	0.208	**7913 C**	**(M)**	**T, TYN**	**DB**	**DF**	**DT**	33 000	41 000	8 500	12 000	33.8	7.8	—	85	0.6
	100	18	1.1	0.6	35 000	33 000	—	5 300	7 500	32.8	72	93	1	0.455	**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
	100	18	1.1	0.6	37 000	34 500	15.9	10 000	13 000	20.0	72	93	1	0.493	**7013 C**	**(M)**	**W,T, TYN**	**DB**	**DF**	**DT**	60 500	68 500	8 000	11 000	40.1	4.1	—	95	0.6
	120	23	1.5	1	70 500	58 000	—	4 800	6 700	38.2	74	111	1.5	1.03	**7213 A**	**W**	**(M), T,TYN**	**DB**	**DF**	**DT**	114 000	116 000	3 800	5 300	76.4	30.4	71	114	1
	120	23	1.5	1	63 500	52 500	—	3 400	4 800	50.3	74	111	1.5	1.05	**7213 B**	**W**	**(M),T**	**DB**	**DF**	**DT**	103 000	105 000	2 800	3 800	100.6	54.6	71	114	1
	120	23	1.5	1	70 000	53 500	—	4 800	7 100	50.3	74	111	1.5	1.01	**7213 BEA**	**T85**	**MR, T7**	—	—	—	—	—	3 800	5 600	100.6	54.6	71	114	1
	120	23	1.5	1	73 000	58 500	14.6	9 000	12 000	23.9	74	111	1.5	1.14	**7213 C**	**(M)**	**W,T,TYN**	**DB**	**DF**	**DT**	119 000	117 000	7 100	9 500	47.8	1.8	—	114	1
	140	33	2.1	1.1	111 000	82 000	—	3 600	4 800	46.1	77	128	2	2.12	**7313 A**	**W**	**(M), T**	**DB**	**DF**	**DT**	180 000	164 000	2 800	3 800	92.2	26.2	72	133	1
	140	33	2.1	1.1	102 000	75 500	—	3 200	4 300	59.5	77	128	2	2.17	**7313 B**	**W**	**(M), T**	**DB**	**DF**	**DT**	166 000	151 000	2 400	3 400	119.0	53.0	72	133	1
	140	33	2.1	1.1	114 000	77 000	—	4 300	6 300	59.5	77	128	2	2.09	**7313 BEA**	**T85**	**MR, T7**	—	—	—	—	—	3 600	5 000	119.0	53.0	72	133	1

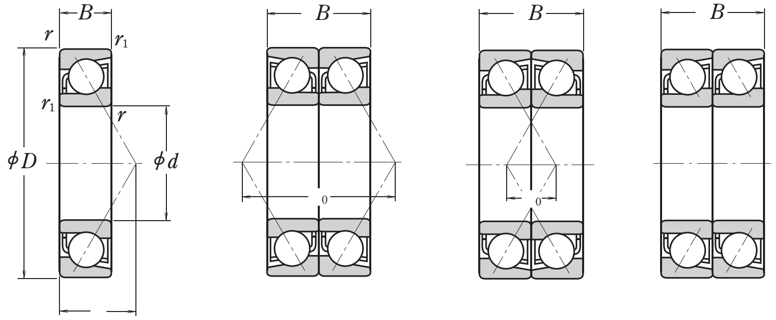
Notes (1) For applications operating near the limiting speed, refer to Page C077.
(2) The suffixes A, A5, B, and C represent contact angles of 30°, 25°, 40°, and 15° respectively.
(3) For bearings marked — in the column for d_b, d_b and r_b for shafts are d_a (min) and r_a (max) respectively.

Note (4) (M) in the column of cage symbols are usually omitted from the bearing number.
Remark The bearings denoted by an asterisk ( ) are NSKHPS™ Angular contact ball bearings and the column of Duplex in Bearing Numbers indicates the universal matching.

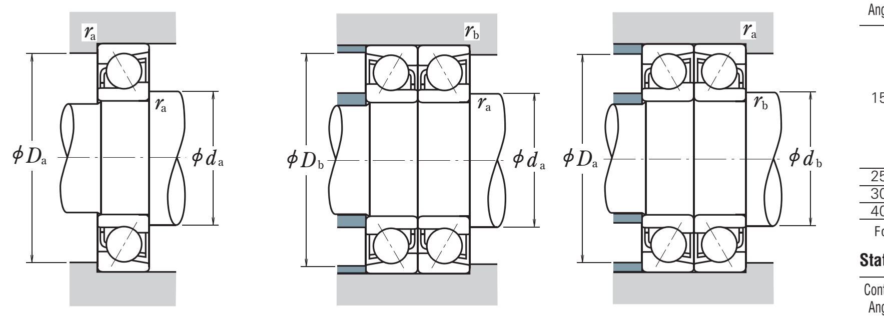
ANGULAR CONTACT BALL BEARINGS

SINGLE/MATCHED MOUNTINGS

Bore Diameter 70 – 80 mm



Single | Back-to-Back DB | Face-to-Face DF | Tandem DT



Dynamic Equivalent Load $P = XF_r + YF_a$

Contact Angle	$\frac{if_0F_a}{C_{0r}}$	e	Single, DT: $F_a/F_r \le e$ X	Y	Single, DT: $F_a/F_r > e$ X	Y	DB or DF: $F_a/F_r \le e$ X	Y	DB or DF: $F_a/F_r > e$ X	Y
15°	0.178	0.38	1	0	0.44	1.47	1	1.65	0.72	2.39
	0.357	0.40	1	0	0.44	1.40	1	1.57	0.72	2.28
	0.714	0.43	1	0	0.44	1.30	1	1.46	0.72	2.11
	1.07	0.46	1	0	0.44	1.23	1	1.38	0.72	2.00
	1.43	0.47	1	0	0.44	1.19	1	1.34	0.72	1.93
	2.14	0.50	1	0	0.44	1.12	1	1.26	0.72	1.82
	3.57	0.55	1	0	0.44	1.02	1	1.14	0.72	1.66
	5.35	0.56	1	0	0.44	1.00	1	1.12	0.72	1.63
25°	—	0.68	1	0	0.41	0.87	1	0.92	0.67	1.41
30°	—	0.80	1	0	0.39	0.76	1	0.78	0.63	1.24
40°	—	1.14	1	0	0.35	0.57	1	0.55	0.57	0.93

For i, use 2 for DB, 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
15°	0.5	0.46	1	0.92
25°	0.5	0.38	1	0.76
30°	0.5	0.33	1	0.66
40°	0.5	0.26	1	0.52

Single or DT mounting When F_r $0.5F_r + Y_0F_a$ use $P_0 = F_r$

Boundary Dimensions (mm) d	D	B	r min.	r_1 min.	Basic Load Ratings (Single) (N) C_r	C_{0r}	Factor f_0	Limiting Speeds (1) (min⁻¹) Grease	Oil	Eff.Load Centers (mm) a	Abutment and Fillet Dimensions (mm) d_a min.	D_a max.	r_a max.	Mass (kg) approx.	Bearing Numbers (2) Cage Symbol (4) Single	Standard	Option	Duplex	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.
70	100	16	1	0.6	26 500	26 300	—	8 000	11 000	27.8	76	94	1	0.341	**7914 A5**	**(M)**	**T,TYN**	**DB DF DT**	43 000	52 500	6 300	9 000	55.6	23.6	—	95	0.6
	100	16	1	0.6	28 100	27 800	16.4	9 500	13 000	19.4	76	94	1	0.338	**7914 C**	**(M)**	**T, TYN,T85**	**DB DF DT**	45 500	55 500	7 500	11 000	38.8	6.8	—	95	0.6
	110	20	1.1	0.6	44 000	41 500	—	5 000	6 700	36.0	77	103	1	0.625	**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
	110	20	1.1	0.6	47 000	43 000	15.7	9 000	12 000	22.1	77	103	1	0.698	**7014 C**	**(M)**	**W,T, TYN**	**DB DF DT**	76 000	86 000	7 100	10 000	44.1	4.1	—	105	0.6
	125	24	1.5	1	76 500	63 500	—	4 500	6 300	40.1	79	116	1.5	1.11	**7214 A**	**W**	**(M), T,TYN**	**DB DF DT**	124 000	127 000	3 600	5 000	80.3	32.3	76	119	1
	125	24	1.5	1	69 000	58 000	—	3 200	4 500	52.9	79	116	1.5	1.14	**7214 B**	**W**	**(M),T**	**DB DF DT**	112 000	116 000	2 600	3 600	105.8	57.8	76	119	1
	125	24	1.5	1	75 500	58 500	—	4 500	6 700	52.9	79	116	1.5	1.08	**7214 BEA**	**T85**	**MR, T7**	**— — —**	—	—	3 600	5 300	105.8	57.8	76	119	1
	125	24	1.5	1	79 500	64 500	14.6	8 500	11 000	25.1	79	116	1.5	1.24	**7214 C**	**(M)**	**W,T,TYN,T7**	**DB DF DT**	129 000	129 000	6 700	9 000	50.1	2.1	—	119	1
	150	35	2.1	1.1	125 000	93 500	—	3 200	4 300	49.3	82	138	2	2.60	**7314 A**	**W**	**(M), T**	**DB DF DT**	203 000	187 000	2 600	3 400	98.5	28.5	77	143	1
	150	35	2.1	1.1	114 000	86 000	—	2 800	4 000	63.6	82	138	2	2.65	**7314 B**	**W**	**(M), T**	**DB DF DT**	186 000	172 000	2 400	3 200	127.3	57.3	77	143	1
	150	35	2.1	1.1	124 000	87 500	—	4 000	6 000	63.7	82	138	2	2.53	**7314 BEA**	**T85**	**MR, T7**	**— — —**	—	—	3 200	4 800	127.3	57.3	77	143	1
75	105	16	1	0.6	26 900	27 700	—	7 500	10 000	29.0	81	99	1	0.355	**7915 A5**	**(M)**	**TYN**	**DB DF DT**	44 000	55 500	6 000	8 500	58.0	26.0	—	100	0.6
	105	16	1	0.6	28 600	29 300	16.6	9 000	12 000	20.1	81	99	1	0.357	**7915 C**	**(M)**	**T, TYN**	**DB DF DT**	46 500	58 500	7 100	10 000	40.1	8.1	—	100	0.6
	115	20	1.1	0.6	45 000	43 500	—	4 800	6 300	37.4	82	108	1	0.661	**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
	115	20	1.1	0.6	48 000	45 500	15.9	8 500	12 000	22.7	82	108	1	0.748	**7015 C**	**(M)**	**W,T, TYN**	**DB DF DT**	78 000	91 500	6 700	9 500	45.4	5.4	—	110	0.6
	130	25	1.5	1	76 000	64 500	—	4 300	6 000	42.1	84	121	1.5	1.19	**7215 A**	**W**	**(M), T,TYN**	**DB DF DT**	123 000	129 000	3 600	4 800	84.2	34.2	81	124	1
	130	25	1.5	1	68 500	58 500	—	3 200	4 300	55.5	84	121	1.5	1.22	**7215 B**	**W**	**(M),T**	**DB DF DT**	112 000	117 000	2 400	3 400	111.0	61.0	81	124	1
	130	25	1.5	1	78 500	63 500	—	4 300	6 300	55.5	84	121	1.5	1.18	**7215 BEA**	**T85**	**MR**	**— — —**	—	—	3 600	5 000	111.0	61.0	81	124	1
	130	25	1.5	1	83 000	70 000	14.8	8 000	11 000	26.2	84	121	1.5	1.36	**7215 C**	**(M)**	**W,T,TYN,T7**	**DB DF DT**	134 000	140 000	6 300	9 000	52.4	2.4	—	124	1
	160	37	2.1	1.1	136 000	106 000	—	3 000	4 000	52.4	87	148	2	3.13	**7315 A**	**W**	**(M), T**	**DB DF DT**	221 000	212 000	2 400	3 200	104.8	30.8	82	153	1
	160	37	2.1	1.1	125 000	97 500	—	2 800	3 800	67.8	87	148	2	3.19	**7315 B**	**W**	**(M),MR,T**	**DB DF DT**	202 000	195 000	2 200	3 000	135.6	61.6	82	153	1
	160	37	2.1	1.1	134 000	98 500	—	3 800	5 600	67.8	87	148	2	3.03	**7315 BEA**	**T85**	**MR**	**— — —**	—	—	3 000	4 500	135.6	61.6	82	153	1
80	110	16	1	0.6	27 300	29 000	—	7 100	10 000	30.2	86	104	1	0.380	**7916 A5**	**(M)**	**T,TYN**	**DB DF DT**	44 500	58 000	5 600	8 000	60.3	28.3	—	105	0.6
	110	16	1	0.6	29 000	30 500	16.7	8 500	12 000	20.7	86	104	1	0.376	**7916 C**	**(M)**	**T, TYN**	**DB DF DT**	47 000	61 500	6 700	9 500	41.5	9.5	—	105	0.6
	125	22	1.1	0.6	55 000	53 000	—	4 300	6 000	40.6	87	118	1	0.880	**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
	125	22	1.1	0.6	58 500	55 500	15.7	8 000	11 000	24.7	87	118	1	0.966	**7016 C**	**(M)**	**W,T, TYN**	**DB DF DT**	95 500	111 000	6 300	9 000	49.4	5.4	—	120	0.6
	140	26	2	1	89 000	76 000	—	4 000	5 600	44.8	90	130	2	1.46	**7216 A**	**W**	**(M), T,TYN**	**DB DF DT**	145 000	152 000	3 200	4 500	89.5	37.5	86	134	1
	140	26	2	1	80 500	69 500	—	2 800	4 000	59.1	90	130	2	1.49	**7216 B**	**W**	**(M),T**	**DB DF DT**	131 000	139 000	2 400	3 200	118.3	66.3	86	134	1
	140	26	2	1	87 500	70 000	—	4 000	6 000	59.2	90	130	2	1.42	**7216 BEA**	**T85**	**MR, T7**	**— — —**	—	—	3 200	4 800	118.3	66.3	86	134	1
	140	26	2	1	93 000	77 500	14.7	7 500	10 000	27.7	90	130	2	1.63	**7216 C**	**(M)**	**W,T,TYN**	**DB DF DT**	151 000	155 000	6 000	8 000	55.5	3.5	—	134	1
	170	39	2.1	1.1	147 000	119 000	—	2 800	3 800	55.6	92	158	2	3.71	**7316 A**	**W**	**(M), T**	**DB DF DT**	239 000	238 000	2 200	3 000	111.2	33.2	87	163	1
	170	39	2.1	1.1	135 000	109 000	—	2 600	3 400	71.9	92	158	2	3.79	**7316 B**	**W**	**(M), T**	**DB DF DT**	219 000	218 000	2 000	2 800	143.9	65.9	87	163	1
	170	39	2.1	1.1	144 000	110 000	—	3 600	5 300	71.9	92	158	2	3.59	**7316 BEA**	**T85**	**MR, T7**	**— — —**	—	—	2 800	4 300	143.9	65.9	87	163	1

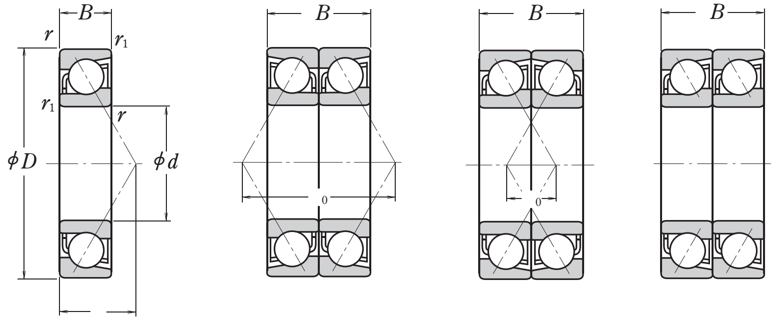
Notes (1) For applications operating near the limiting speed, refer to Page C077.
(2) The suffixes A, A5, B, and C represent contact angles of 30°, 25°, 40°, and 15° respectively.
(3) For bearings marked — in the column for d_b, d_b and r_b for shafts are d_a (min) and r_a (max) respectively.

Note (4) (M) in the column of cage symbols are usually omitted from the bearing number.
Remark The bearings denoted by an asterisk ( ) are NSKHPS™ Angular contact ball bearings and the column of Duplex in Bearing Numbers indicates the universal matching.

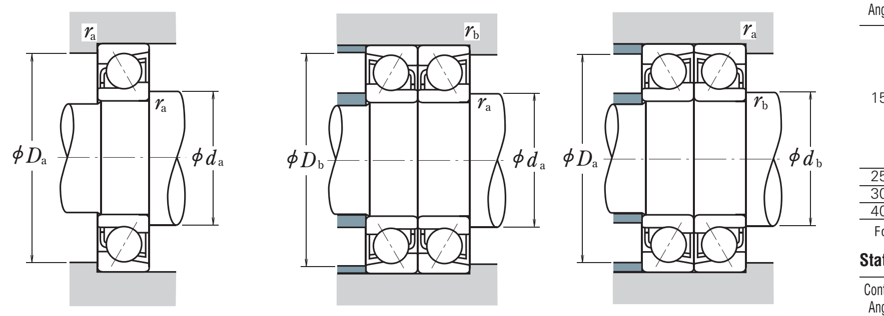
ANGULAR CONTACT BALL BEARINGS

SINGLE/MATCHED MOUNTINGS

Bore Diameter 85 – 100 mm



Single | Back-to-Back DB | Face-to-Face DF | Tandem DT



Dynamic Equivalent Load $P = XF_r + YF_a$

Contact Angle	$\frac{if_0F_a}{C_{or}}$	e	Single, DT $F_a/F_r \le e$ X	Y	Single, DT $F_a/F_r > e$ X	Y	DB or DF $F_a/F_r \le e$ 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, 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 $P_0 = F_r$

Boundary Dimensions (mm) d	D	B	r min.	r_1 min.	Basic Load Ratings (Single) (N) C_r	C_{0r}	Factor f_0	Limiting Speeds (1) (min⁻¹) Grease	Oil	Eff.Load Centers (mm) a	Abutment and Fillet Dimensions (mm) d_a min.	D_a max.	r_a max.	Mass (kg) approx.	Bearing Numbers (2) Cage Symbol (4) Single	Standard	Option	Duplex	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.
85	120	18	1.1	0.6	36 500	38 500	—	6 700	9 000	32.9	92	113	1	0.541	**7917 A5**	**(M)**	**T,TYN**	**DB DF DT**	59 500	77 000	5 300	7 500	65.8	29.8	—	115	0.6
	120	18	1.1	0.6	39 000	40 500	16.5	8 000	11 000	22.7	92	113	1	0.534	**7917 C**	**(M)**	**T, TYN**	**DB DF DT**	63 000	81 500	6 300	9 000	45.5	9.5	—	115	0.6
	130	22	1.1	0.6	56 500	56 000	—	4 300	5 600	42.0	92	123	1	0.913	**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
	130	22	1.1	0.6	60 000	58 500	15.9	7 500	10 000	25.4	92	123	1	1.01	**7017 C**	**(M)**	**W,T, TYN**	**DB DF DT**	98 000	117 000	6 000	8 500	50.8	6.8	—	125	0.6
	150	28	2	1	103 000	89 000	—	3 800	5 300	47.9	95	140	2	1.83	**7217 A**	**W**	**(M), T,TYN**	**DB DF DT**	167 000	178 000	3 000	4 300	95.8	39.8	91	144	1
	150	28	2	1	93 000	81 000	—	2 800	3 800	63.3	95	140	2	1.87	**7217 B**	**W**	**(M), T**	**DB DF DT**	151 000	162 000	2 200	3 000	126.6	70.6	91	144	1
	150	28	2	1	96 000	81 500	—	3 800	5 600	63.3	95	140	2	1.75	**7217 BEA**	**T85**	**—**	**— — —**	—	—	3 200	4 500	126.6	70.6	91	144	1
	150	28	2	1	107 000	90 500	14.7	6 700	9 500	29.7	95	140	2	2.04	**7217 C**	**(M)**	**W,T,TYN**	**DB DF DT**	174 000	181 000	5 600	7 500	59.5	3.5	—	144	1
	180	41	3	1.1	159 000	133 000	—	2 600	3 600	58.8	99	166	2.5	4.33	**7317 A**	**W**	**(M), T**	**DB DF DT**	258 000	265 000	2 200	2 800	117.5	35.5	92	173	1
	180	41	3	1.1	146 000	122 000	—	2 400	3 200	76.1	99	166	2.5	4.42	**7317 B**	**W**	**(M), T**	**DB DF DT**	236 000	244 000	1 900	2 600	152.2	70.2	92	173	1
	180	41	3	1.1	157 000	133 000	—	3 400	5 000	76.1	99	166	2.5	4.34	**7317 BEA**	**T85**	**MR, T7**	**— — —**	—	—	2 800	4 000	152.2	70.2	92	173	1
90	125	18	1.1	0.6	39 500	43 500	—	6 300	8 500	34.1	97	118	1	0.560	**7918 A5**	**(M)**	**T,TYN**	**DB DF DT**	64 000	87 000	5 000	7 100	68.1	32.1	—	120	0.6
	125	18	1.1	0.6	41 500	46 000	16.6	7 500	10 000	23.4	97	118	1	0.563	**7918 C**	**(M)**	**T, TYN**	**DB DF DT**	67 500	92 000	6 000	8 500	46.8	10.8	—	120	0.6
	140	24	1.5	1	67 500	66 500	—	3 800	5 300	45.2	99	131	1.5	1.19	**7018 A**	**W**	**(M), T,TYN**	**DB DF DT**	109 000	133 000	3 200	4 300	90.4	42.4	96	134	1
	140	24	1.5	1	71 500	69 000	15.7	7 100	9 500	27.4	99	131	1.5	1.34	**7018 C**	**(M)**	**W,T, TYN**	**DB DF DT**	116 000	138 000	5 600	8 000	54.8	6.8	—	134	1
	160	30	2	1	118 000	103 000	—	3 600	4 800	51.1	100	150	2	2.25	**7218 A**	**W**	**(M), T,TYN**	**DB DF DT**	191 000	206 000	2 800	4 000	102.2	42.2	96	154	1
	160	30	2	1	107 000	94 000	—	2 600	3 400	67.4	100	150	2	2.29	**7218 B**	**W**	**(M), T**	**DB DF DT**	173 000	188 000	2 000	2 800	134.9	74.9	96	154	1
	160	30	2	1	109 000	93 500	—	3 600	5 300	67.4	100	150	2	2.19	**7218 BEA**	**T85**	**MR**	**— — —**	—	—	3 000	4 300	134.9	74.9	96	154	1
	160	30	2	1	123 000	105 000	14.6	6 300	9 000	31.7	100	150	2	2.51	**7218 C**	**(M)**	**W,T,TYN**	**DB DF DT**	199 000	209 000	5 300	7 100	63.5	3.5	—	154	1
	190	43	3	1.1	171 000	147 000	—	2 600	3 400	61.9	104	176	2.5	5.06	**7318 A**	**W**	**(M), T**	**DB DF DT**	277 000	294 000	2 000	2 800	123.8	37.8	97	183	1
	190	43	3	1.1	156 000	135 000	—	2 200	3 000	80.2	104	176	2.5	5.17	**7318 B**	**W**	**(M), T**	**DB DF DT**	254 000	270 000	1 800	2 400	160.5	74.5	97	183	1
	190	43	3	1.1	169 000	146 000	—	3 200	4 500	80.2	104	176	2.5	4.97	**7318 BEA**	**T85**	**MR**	**— — —**	—	—	2 600	3 600	160.5	74.5	97	183	1
95	130	18	1.1	0.6	40 000	45 500	—	6 000	8 500	35.2	102	123	1	0.597	**7919 A5**	**(M)**	**T,TYN**	**DB DF DT**	64 500	91 000	4 800	6 700	70.5	34.5	—	125	0.6
	130	18	1.1	0.6	42 500	48 000	16.7	7 100	10 000	24.1	102	123	1	0.591	**7919 C**	**(M)**	**T, TYN**	**DB DF DT**	68 500	96 000	5 600	8 000	48.1	12.1	—	125	0.6
	145	24	1.5	1	67 000	67 000	—	4 500	6 300	46.6	104	136	1.5	1.43	**7019 A**	**(M)**	**T,TYN**	**DB DF DT**	109 000	134 000	3 800	5 000	93.3	45.3	—	139	1
	145	24	1.5	1	73 500	73 000	15.9	6 700	9 000	28.1	104	136	1.5	1.42	**7019 C**	**(M)**	**T, TYN**	**DB DF DT**	119 000	146 000	5 300	7 500	56.1	8.1	—	139	1
	170	32	2.1	1.1	128 000	111 000	—	3 400	4 500	54.2	107	158	2	2.68	**7219 A**	**W**	**(M), T,TYN**	**DB DF DT**	208 000	221 000	2 600	3 600	108.5	44.5	102	163	1
	170	32	2.1	1.1	116 000	101 000	—	2 400	3 200	71.6	107	158	2	2.74	**7219 B**	**W**	**(M), T**	**DB DF DT**	188 000	202 000	1 900	2 600	143.2	79.2	102	163	1
	170	32	2.1	1.1	123 000	107 000	—	3 400	5 000	71.6	107	158	2	2.67	**7219 BEA**	**T85**	**MR, T7**	**— — —**	—	—	2 800	4 000	143.2	79.2	102	163	1
	170	32	2.1	1.1	133 000	112 000	14.6	6 000	8 500	33.7	107	158	2	3.05	**7219 C**	**(M)**	**W,T,TYN**	**DB DF DT**	216 000	224 000	4 800	6 700	67.5	3.5	—	163	1
	200	45	3	1.1	183 000	162 000	—	2 400	3 200	65.1	109	186	2.5	5.83	**7319 A**	**W**	**(M), T**	**DB DF DT**	297 000	325 000	1 900	2 600	130.2	40.2	102	193	1
	200	45	3	1.1	167 000	149 000	—	2 200	3 000	84.3	109	186	2.5	5.98	**7319 B**	**W**	**(M), T**	**DB DF DT**	272 000	298 000	1 700	2 400	168.7	78.7	102	193	1
	200	45	3	1.1	180 000	160 000	—	3 000	4 500	84.3	109	186	2.5	5.82	**7319 BEA**	**T85**	**MR**	**— — —**	—	—	2 400	3 600	168.7	78.7	102	193	1
100	140	20	1.1	0.6	47 500	51 500	—	5 600	8 000	38.0	107	133	1	0.804	**7920 A5**	**(M)**	**T,TYN**	**DB DF DT**	77 000	103 000	4 500	6 300	76.0	36.0	—	135	0.6
	140	20	1.1	0.6	50 000	54 000	16.5	6 700	9 000	26.1	107	133	1	0.794	**7920 C**	**(M)**	**T, TYN**	**DB DF DT**	81 500	108 000	5 300	7 500	52.2	12.2	—	135	0.6
	150	24	1.5	1	68 500	70 500	—	4 500	6 000	48.1	109	141	1.5	1.48	**7020 A**	**(M)**	**T,TYN**	**DB DF DT**	111 000	141 000	3 600	5 000	96.2	48.2	—	144	1

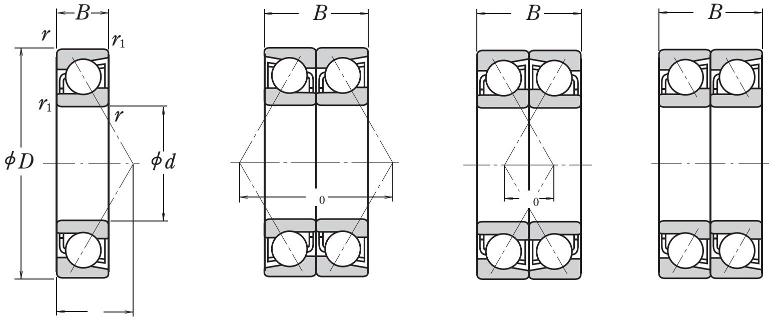
Notes (1) For applications operating near the limiting speed, refer to Page C077.
(2) The suffixes A, A5, B, and C represent contact angles of 30°, 25°, 40°, and 15° respectively.
(3) For bearings marked — in the column for d_b, d_b and r_b for shafts are d_a (min) and r_a (max) respectively.

Note (4) (M) in the column of cage symbols are usually omitted from the bearing number.

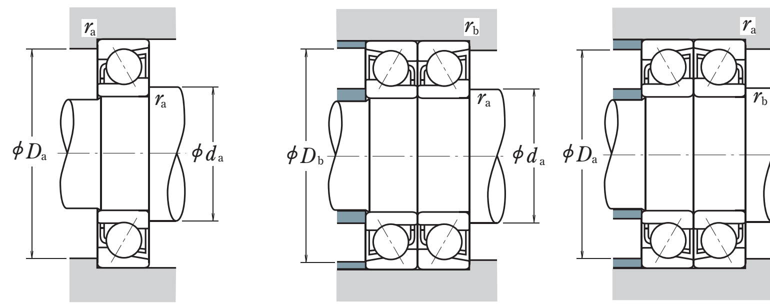
ANGULAR CONTACT BALL BEARINGS

SINGLE/MATCHED MOUNTINGS

Bore Diameter 100 – 120 mm



Single | Back-to-Back DB | Face-to-Face DF | Tandem DT



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 e		F_a/F_r e		F_a/F_r 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, 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 $P_0 = F_r$

Boundary Dimensions (mm)					Basic Load Ratings (Single) (N)		Factor	Limiting Speeds ([1]) (min⁻¹)		Eff.Load Centers (mm)	Abutment and Fillet Dimensions (mm)			Mass (kg)	Bearing Numbers ([2]) Cage Symbol ([4])			Duplex			Basic Load Ratings (Matched) (N)		Limiting Speeds ([1]) (Matched) (min⁻¹)		Load Center Spacings (mm) a_0		Abutment and Fillet Dimensions (mm)		
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.	Single	Standard	Option				C_r	C_{0r}	Grease	Oil	DB	DF	d_b([3]) min.	D_b max.	r_b([3]) max.
100	150	24	1.5	1	75 500	77 000	16.0	6 300	9 000	28.7	109	141	1.5	1.46	**7020 C**	**(M)**	**T, TYN**	**DB**	**DF**	**DT**	122 000	154 000	5 300	7 100	57.5	9.5	—	144	1
	180	34	2.1	1.1	144 000	126 000	—	3 200	4 300	57.4	112	168	2	3.22	**7220 A**	**W**	**(M), T,TYN**	**DB**	**DF**	**DT**	233 000	251 000	2 600	3 400	114.8	46.8	107	173	1
	180	34	2.1	1.1	130 000	114 000	—	2 200	3 000	75.7	112	168	2	3.28	**7220 B**	**W**	**(M), T**	**DB**	**DF**	**DT**	212 000	229 000	1 800	2 400	151.5	83.5	107	173	1
	180	34	2.1	1.1	136 000	122 000	—	3 200	4 500	75.7	112	168	2	3.27	**7220 BEA**	**T85**	**MR**	—	—	—	—	—	2 600	3 600	151.5	83.5	107	173	1
	180	34	2.1	1.1	149 000	127 000	14.5	5 600	8 000	35.7	112	168	2	3.65	**7220 C**	**(M)**	**W,T,TYN**	**DB**	**DF**	**DT**	242 000	254 000	4 500	6 300	71.5	3.5	—	173	1
	215	47	3	1.1	207 000	193 000	—	2 200	3 000	69.0	114	201	2.5	7.29	**7320 A**	**W**	**(M), T**	**DB**	**DF**	**DT**	335 000	385 000	1 800	2 400	137.9	43.9	107	208	1
	215	47	3	1.1	190 000	178 000	—	2 000	2 800	89.6	114	201	2.5	7.43	**7320 B**	**W**	**(M), T**	**DB**	**DF**	**DT**	310 000	355 000	1 600	2 200	179.2	85.2	107	208	1
	215	47	3	1.1	202 000	187 000	—	2 800	4 000	89.6	114	201	2.5	7.14	**7320 BEA**	**T85**	**MR, T7**	—	—	—	—	—	2 200	3 200	179.2	85.2	107	208	1
105	145	20	1.1	0.6	48 000	54 000	—	5 600	7 500	39.2	112	138	1	0.820	**7921 A5**	**(M)**	**T,TYN**	**DB**	**DF**	**DT**	78 500	108 000	4 300	6 000	78.3	38.3	—	140	0.6
	145	20	1.1	0.6	51 000	57 000	16.6	6 300	9 000	26.7	112	138	1	0.826	**7921 C**	**(M)**	**T, TYN**	**DB**	**DF**	**DT**	83 000	114 000	5 300	7 100	53.5	13.5	—	140	0.6
	160	26	2	1	80 000	81 500	—	4 300	5 600	51.2	115	150	2	1.84	**7021 A**	**(M)**	**T,TYN**	**DB**	**DF**	**DT**	130 000	163 000	3 400	4 500	102.5	50.5	—	154	1
	160	26	2	1	88 000	89 500	15.9	6 000	8 500	30.7	115	150	2	1.82	**7021 C**	**(M)**	**T, TYN**	**DB**	**DF**	**DT**	143 000	179 000	4 800	6 700	61.5	9.5	—	154	1
	190	36	2.1	1.1	157 000	142 000	—	3 000	4 000	60.6	117	178	2	3.84	**7221 A**	**W**	**(M), T**	**DB**	**DF**	**DT**	254 000	283 000	2 400	3 400	121.2	49.2	112	183	1
	190	36	2.1	1.1	142 000	129 000	—	2 200	3 000	79.9	117	178	2	3.92	**7221 B**	**W**	**(M), T**	**DB**	**DF**	**DT**	231 000	258 000	1 700	2 400	159.8	87.8	112	183	1
	190	36	2.1	1.1	148 000	133 000	—	3 000	4 500	79.9	117	178	2	3.69	**7221 BEA**	**T85**	**—**	—	—	—	—	—	2 400	3 600	159.8	87.8	112	183	1
	190	36	2.1	1.1	162 000	143 000	14.5	5 300	7 500	37.7	117	178	2	4.33	**7221 C**	**(M)**	**W,T,TYN**	**DB**	**DF**	**DT**	264 000	286 000	4 300	6 000	75.5	3.5	—	183	1
	225	49	3	1.1	208 000	193 000	—	2 600	3 600	72.1	119	211	2.5	9.34	**7321 A**	**(M)**	**T**	**DB**	**DF**	**DT**	335 000	385 000	2 200	2 800	144.3	46.3	—	218	1
	225	49	3	1.1	191 000	177 000	—	2 400	3 200	93.7	119	211	2.5	9.43	**7321 B**	**(M)**	**T**	**DB**	**DF**	**DT**	310 000	355 000	1 900	2 600	187.4	89.4	—	218	1
	225	49	3	1.1	213 000	203 000	—	2 600	4 000	93.7	119	211	2.5	8.12	**7321 BEA**	**T85**	**T7**	—	—	—	—	—	2 200	3 200	187.4	89.4	—	218	1
110	150	20	1.1	0.6	49 000	56 000	—	5 300	7 100	40.3	117	143	1	0.877	**7922 A5**	**(M)**	**T,TYN**	**DB**	**DF**	**DT**	79 500	112 000	4 300	5 600	80.6	40.6	—	145	0.6
	150	20	1.1	0.6	52 000	59 500	16.7	6 300	8 500	27.4	117	143	1	0.867	**7922 C**	**(M)**	**T, TYN**	**DB**	**DF**	**DT**	84 500	119 000	5 000	6 700	54.8	14.8	—	145	0.6
	170	28	2	1	96 500	95 500	—	4 000	5 300	54.4	120	160	2	2.28	**7022 A**	**(M)**	**T,TYN**	**DB**	**DF**	**DT**	157 000	191 000	3 200	4 300	108.8	52.8	—	164	1
	170	28	2	1	106 000	104 000	15.6	5 600	8 000	32.7	120	160	2	2.26	**7022 C**	**(M)**	**T, TYN**	**DB**	**DF**	**DT**	172 000	208 000	4 500	6 300	65.5	9.5	—	164	1
	200	38	2.1	1.1	170 000	158 000	—	2 800	3 800	63.7	122	188	2	4.49	**7222 A**	**W**	**(M), T,TYN**	**DB**	**DF**	**DT**	276 000	315 000	2 200	3 200	127.5	51.5	117	193	1
	200	38	2.1	1.1	154 000	144 000	—	2 000	2 800	84.0	122	188	2	4.58	**7222 B**	**W**	**(M), T**	**DB**	**DF**	**DT**	250 000	289 000	1 600	2 200	168.1	92.1	117	193	1
	200	38	2.1	1.1	154 000	144 000	—	2 800	4 300	84.0	122	188	2	4.48	**7222 BEA**	**T85**	**MR**	—	—	—	—	—	2 400	3 400	168.1	92.1	117	193	1
	200	38	2.1	1.1	176 000	160 000	14.5	5 000	7 100	39.8	122	188	2	5.10	**7222 C**	**(M)**	**W,T,TYN**	**DB**	**DF**	**DT**	286 000	320 000	4 000	5 600	79.5	3.5	—	193	1
	240	50	3	1.1	220 000	215 000	—	2 600	3 400	75.5	124	226	2.5	11.1	**7322 A**	**(M)**	**W,T**	**DB**	**DF**	**DT**	360 000	430 000	2 000	2 600	151.0	51.0	—	233	1
	240	50	3	1.1	201 000	197 000	—	2 200	3 000	98.4	124	226	2.5	11.2	**7322 B**	**(M)**	**W,T**	**DB**	**DF**	**DT**	325 000	395 000	1 800	2 400	196.8	96.8	—	233	1
	240	50	3	1.1	226 000	226 000	—	2 600	3 800	98.4	124	226	2.5	9.91	**7322 BEA**	**T85**	**MR**	—	—	—	—	—	2 000	3 000	196.8	96.8	—	233	1
120	165	22	1.1	0.6	67 500	77 000	—	4 800	6 300	44.2	127	158	1	1.15	**7924 A5**	**(M)**	**T,TYN**	**DB**	**DF**	**DT**	110 000	154 000	3 800	5 300	88.5	44.5	—	160	0.6
	165	22	1.1	0.6	72 000	81 000	16.5	5 600	7 500	30.1	127	158	1	1.15	**7924 C**	**(M)**	**T, TYN**	**DB**	**DF**	**DT**	117 000	162 000	4 500	6 300	60.2	16.2	—	160	0.6
	180	28	2	1	102 000	107 000	—	3 600	5 000	57.3	130	170	2	2.45	**7024 A**	**(M)**	**T,TYN**	**DB**	**DF**	**DT**	166 000	213 000	3 000	4 000	114.6	58.6	—	174	1
	215	40	2.1	1.1	183 000	177 000	—	3 200	4 500	68.3	132	203	2	6.22	**7224 A**	**(M)**	**T**	**DB**	**DF**	**DT**	297 000	355 000	2 600	3 600	136.7	56.7	—	208	1
	215	40	2.1	1.1	165 000	162 000	—	2 400	3 200	90.3	132	203	2	6.26	**7224 B**	**(M)**	**T**	**DB**	**DF**	**DT**	269 000	325 000	1 900	2 600	180.5	100.5	—	208	1
	215	40	2.1	1.1	179 000	177 000	—	2 600	3 800	90.3	132	203	2	5.37	**7224 BEA**	**T85**	**MR, T7**	—	—	—	—	—	2 200	3 000	180.5	100.5	—	208	1
	260	55	3	1.1	246 000	252 000	—	2 200	3 000	82.3	134	246	2.5	14.5	**7324 A**	**(M)**	**T**	**DB**	**DF**	**DT**	400 000	505 000	1 800	2 400	164.7	54.7	—	253	1
	260	55	3	1.1	225 000	231 000	—	2 000	2 800	107.2	134	246	2.5	14.4	**7324 B**	**(M)**	**T**	**DB**	**DF**	**DT**	365 000	460 000	1 600	2 200	214.4	104.4	—	253	1
	260	55	3	1.1	238 000	250 000	—	2 200	3 400	107.2	134	246	2.5	12.8	**7324 BEA**	**T85**	**MR**	—	—	—	—	—	1 900	2 800	214.4	104.4	—	253	1

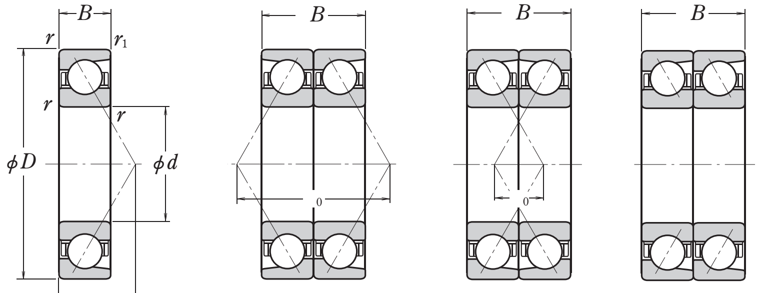
Notes ([1]) For applications operating near the limiting speed, refer to Page C077.
([2]) The suffixes A, A5, B, and C represent contact angles of 30°, 25°, 40°, and 15° respectively.
([3]) For bearings marked — in the column for d_b, d_b and r_b for shafts are d_a (min) and r_a (max) respectively.

Note ([4]) (M) in the column of cage symbols are usually omitted from the bearing number.

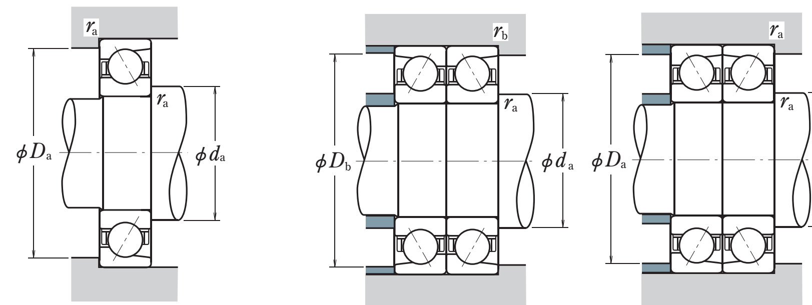
ANGULAR CONTACT BALL BEARINGS

SINGLE/MATCHED MOUNTINGS

Bore Diameter 130 – 170 mm



Single | Back-to-Back DB | Face-to-Face DF | Tandem DT



Dynamic Equivalent Load $P=XF_r+YF_a$

Contact Angle	$\frac{if_0F_a}{C_{0r}}$	e	Single, DT $F_a/F_r \le e$ X	Single, DT $F_a/F_r \le e$ Y	Single, DT $F_a/F_r > e$ X	Single, DT $F_a/F_r > e$ Y	DB or DF $F_a/F_r \le e$ X	DB or DF $F_a/F_r \le e$ Y	DB or DF $F_a/F_r > e$ X	DB or DF $F_a/F_r > e$ 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, 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 $P_0=F_r$

Boundary Dimensions (mm) d	D	B	r min.	r_1 min.	Basic Load Ratings (Single) (N) C_r	C_{0r}	Factor f_0	Limiting Speeds (1) (min⁻¹) Grease	Oil	Eff.Load Centers (mm) a	Abutment and Fillet Dimensions (mm) d_a min.	D_a max.	r_a max.	Mass (kg) approx.	Bearing Numbers (2) Cage Symbol (4) Single	Standard	Option	Duplex	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.
130	180	24	1.5	1	74 000	86 000	—	4 300	6 000	48.1	139	171	1.5	1.54	**7926 A5**	(M)	T,TYN	DB DF DT	120 000	172 000	3 400	4 800	96.3	48.3	—	174	1
	180	24	1.5	1	78 500	91 000	16.5	5 000	7 100	32.8	139	171	1.5	1.50	**7926 C**	(M)	T, TYN	DB DF DT	128 000	182 000	4 000	5 600	65.5	17.5	—	174	1
	200	33	2	1	117 000	125 000	—	3 400	4 500	64.1	140	190	2	3.68	**7026 A**	(M)	T,TYN	DB DF DT	191 000	251 000	2 600	3 600	128.3	62.3	—	194	1
	230	40	3	1.1	189 000	193 000	—	2 400	3 200	72.0	144	216	2.5	7.06	**7226 A**	(M)	T	DB DF DT	310 000	385 000	1 900	2 600	143.9	63.9	—	223	1
	230	40	3	1.1	171 000	175 000	—	2 200	3 000	95.5	144	216	2.5	7.10	**7226 B**	(M)	T	DB DF DT	278 000	350 000	1 700	2 400	191.0	111.0	—	223	1
	280	58	4	1.5	273 000	293 000	—	2 200	2 800	88.2	148	262	3	17.5	**7326 A**	(M)	T	DB DF DT	445 000	585 000	1 700	2 200	176.3	60.3	—	271	1.5
	280	58	4	1.5	250 000	268 000	—	1 900	2 600	115.0	148	262	3	17.6	**7326 B**	(M)	T	DB DF DT	405 000	535 000	1 500	2 000	230.0	114.0	—	271	1.5
140	190	24	1.5	1	75 000	90 000	—	4 000	5 600	50.5	149	181	1.5	1.63	**7928 A5**	(M)	T,TYN	DB DF DT	122 000	180 000	3 200	4 500	100.9	52.9	—	184	1
	190	24	1.5	1	79 500	95 500	16.7	4 800	6 700	34.1	149	181	1.5	1.63	**7928 C**	(M)	T, TYN	DB DF DT	129 000	191 000	3 800	5 300	68.2	20.2	—	184	1
	210	33	2	1	120 000	133 000	—	3 200	4 300	67.0	150	200	2	3.90	**7028 A**	(M)	T	DB DF DT	194 000	265 000	2 600	3 400	134.0	68.0	—	204	1
	250	42	3	1.1	218 000	234 000	—	2 200	3 000	77.3	154	236	2.5	8.92	**7228 A**	(M)	T	DB DF DT	355 000	470 000	1 800	2 400	154.6	70.6	—	243	1
	250	42	3	1.1	197 000	213 000	—	2 000	2 800	102.8	154	236	2.5	8.94	**7228 B**	(M)	T	DB DF DT	320 000	425 000	1 600	2 200	205.6	121.6	—	243	1
	300	62	4	1.5	300 000	335 000	—	2 000	2 600	94.5	158	282	3	21.4	**7328 A**	(M)	T	DB DF DT	490 000	670 000	1 600	2 000	189.0	65.0	—	291	1.5
	300	62	4	1.5	275 000	310 000	—	1 700	2 400	123.3	158	282	3	21.6	**7328 B**	(M)	T	DB DF DT	445 000	615 000	1 400	1 900	246.6	122.6	—	291	1.5
150	210	28	2	1	96 500	115 000	—	3 800	5 000	56.0	160	200	2	2.97	**7930 A5**	(M)	—	DB DF DT	157 000	231 000	3 000	4 000	112.0	56.0	—	204	1
	210	28	2	1	102 000	122 000	16.6	4 300	6 000	38.1	160	200	2	2.96	**7930 C**	(M)	—	DB DF DT	166 000	244 000	3 600	4 800	76.2	20.2	—	204	1
	225	35	2.1	1.1	137 000	154 000	—	2 400	3 000	71.6	162	213	2	4.75	**7030 A**	(M)	T	DB DF DT	222 000	305 000	1 900	2 400	143.3	73.3	—	218	1
	270	45	3	1.1	248 000	280 000	—	2 000	2 800	83.1	164	256	2.5	11.2	**7230 A**	(M)	—	DB DF DT	405 000	560 000	1 600	2 200	166.3	76.3	—	263	1
	270	45	3	1.1	225 000	254 000	—	1 800	2 600	110.6	164	256	2.5	11.2	**7230 B**	(M)	T	DB DF DT	365 000	510 000	1 500	2 000	221.2	131.2	—	263	1
	320	65	4	1.5	315 000	370 000	—	1 800	2 400	100.3	168	302	3	26.0	**7330 A**	(M)	—	DB DF DT	515 000	745 000	1 500	1 900	200.7	70.7	—	311	1.5
	320	65	4	1.5	289 000	340 000	—	1 600	2 200	131.1	168	302	3	25.9	**7330 B**	(M)	T	DB DF DT	470 000	680 000	1 300	1 800	262.2	132.2	—	311	1.5
160	220	28	2	1	106 000	133 000	16.7	3 800	5 000	39.4	170	210	2	3.10	**7932 C**	(M)	TYN	DB DF DT	173 000	265 000	3 000	4 000	78.9	22.9	—	214	1
	240	38	2.1	1.1	155 000	176 000	—	2 200	2 800	76.7	172	228	2	5.77	**7032 A**	(M)	T	DB DF DT	252 000	355 000	1 700	2 400	153.5	77.5	—	233	1
	290	48	3	1.1	263 000	305 000	—	1 900	2 600	89.0	174	276	2.5	14.1	**7232 A**	(M)	T	DB DF DT	425 000	615 000	1 500	2 000	177.9	81.9	—	283	1
	290	48	3	1.1	238 000	279 000	—	1 700	2 400	118.4	174	276	2.5	14.2	**7232 B**	(M)	—	DB DF DT	385 000	555 000	1 400	1 900	236.8	140.8	—	283	1
	340	68	4	1.5	345 000	420 000	—	1 700	2 200	106.2	178	322	3	30.7	**7332 A**	(M)	T	DB DF DT	565 000	845 000	1 400	1 800	212.3	76.3	—	331	1.5
	340	68	4	1.5	315 000	385 000	—	1 500	2 000	138.9	178	322	3	30.8	**7332 B**	(M)	T	DB DF DT	515 000	770 000	1 200	1 700	277.8	141.8	—	331	1.5
170	230	28	2	1	113 000	148 000	16.8	3 600	4 800	40.8	180	220	2	3.36	**7934 C**	(M)	—	DB DF DT	183 000	297 000	2 800	3 800	81.6	25.6	—	224	1
	260	42	2.1	1.1	186 000	214 000	—	2 000	2 600	83.1	182	248	2	7.90	**7034 A**	(M)	—	DB DF DT	300 000	430 000	1 600	2 200	166.1	82.1	—	253	1
	310	52	4	1.5	295 000	360 000	—	1 800	2 400	95.3	188	292	3	17.3	**7234 A**	(M)	—	DB DF DT	480 000	715 000	1 400	1 900	190.6	86.6	—	301	1.5
	310	52	4	1.5	266 000	325 000	—	1 600	2 200	126.7	188	292	3	17.6	**7234 B**	(M)	—	DB DF DT	435 000	650 000	1 300	1 700	253.4	149.4	—	301	1.5
	360	72	4	1.5	390 000	485 000	—	1 600	2 200	112.5	188	342	3	35.8	**7334 A**	(M)	—	DB DF DT	630 000	970 000	1 300	1 700	225.0	81.0	—	351	1.5
	360	72	4	1.5	355 000	445 000	—	1 400	2 000	147.2	188	342	3	35.6	**7334 B**	(M)	T	DB DF DT	575 000	890 000	1 100	1 600	294.3	150.3	—	351	1.5

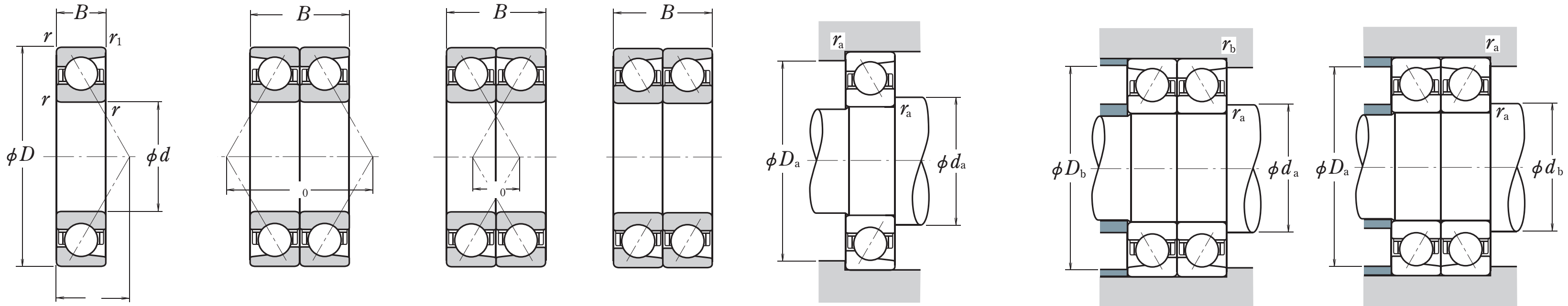
Notes (1) For applications operating near the limiting speed, refer to Page C077.
(2) The suffixes A, A5, B, and C represent contact angles of 30°, 25°, 40°, and 15° respectively.
(3) For bearings marked — in the column for d_b, d_b and r_b for shafts are d_a (min) and r_a (max) respectively.

Note (4) (M) in the column of cage symbols are usually omitted from the bearing number.

ANGULAR CONTACT BALL BEARINGS

SINGLE/MATCHED MOUNTINGS

Bore Diameter 180 – 200 mm



Single | Back-to-Back DB | Face-to-Face DF | Tandem DT

Dynamic Equivalent Load $P = XF_r + YF_a$

Contact Angle	$\frac{if_0F_a}{C_{or}}$	e	Single, DT F_a/F_r e X	Y	Single, DT F_a/F_r e X	Y	DB or DF F_a/F_r 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, 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 $P_0 = F_r$

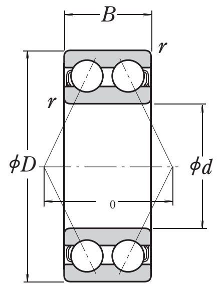
Boundary Dimensions (mm) d	D	B	r min.	r_1 min.	Basic Load Ratings (Single) (N) C_r	C_{0r}	Factor f_0	Limiting Speeds (1) (min⁻¹) Grease	Oil	Eff.Load Centers (mm) a	Abutment and Fillet Dimensions (mm) d_a min.	D_a max.	r_a max.	Mass (kg) approx.	Bearing Numbers (2) Single	Cage Symbol (4) Standard	Option	Duplex	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.
180	250	33	2	1	145 000	184 000	16.6	3 200	4 500	45.3	190	240	2	4.90	**7936 C**	**(M)**	—	**DB DF DT**	236 000	370 000	2 600	3 600	90.6	24.6	—	244	1
	280	46	2.1	1.1	207 000	252 000	—	1 900	2 400	89.4	192	268	2	10.5	**7036 A**	**(M)**	—	**DB DF DT**	335 000	505 000	1 500	2 000	178.8	86.8	—	273	1
	320	52	4	1.5	305 000	385 000	—	1 700	2 200	98.2	198	302	3	18.1	**7236 A**	**(M)**	—	**DB DF DT**	495 000	770 000	1 400	1 800	196.3	92.3	—	311	1.5
	320	52	4	1.5	276 000	350 000	—	1 500	2 000	130.9	198	302	3	18.4	**7236 B**	**(M)**	—	**DB DF DT**	450 000	700 000	1 200	1 700	261.8	157.8	—	311	1.5
	380	75	4	1.5	410 000	535 000	—	1 500	2 000	118.3	198	362	3	42.1	**7336 A**	**(M)**	—	**DB DF DT**	665 000	1 070 000	1 200	1 600	236.6	86.6	—	371	1.5
	380	75	4	1.5	375 000	490 000	—	1 300	1 800	155.0	198	362	3	42.6	**7336 B**	**(M)**	—	**DB DF DT**	605 000	975 000	1 100	1 500	309.9	159.9	—	371	1.5
190	260	33	2	1	147 000	192 000	16.7	3 000	4 300	46.6	200	250	2	4.98	**7938 C**	**(M)**	**TYN**	**DB DF DT**	239 000	385 000	2 400	3 400	93.3	27.3	—	254	1
	290	46	2.1	1.1	224 000	280 000	—	1 800	2 400	92.3	202	278	2	11.3	**7038 A**	**(M)**	—	**DB DF DT**	365 000	560 000	1 400	1 900	184.6	92.6	—	283	1
	340	55	4	1.5	315 000	410 000	—	1 600	2 200	104.0	208	322	3	22.4	**7238 A**	**(M)**	—	**DB DF DT**	510 000	825 000	1 300	1 700	208.0	98.0	—	331	1.5
	340	55	4	1.5	284 000	375 000	—	1 400	2 000	138.7	208	322	3	22.5	**7238 B**	**(M)**	—	**DB DF DT**	460 000	750 000	1 100	1 600	277.3	167.3	—	331	1.5
	400	78	5	2	450 000	600 000	—	1 400	1 900	124.2	212	378	4	47.5	**7338 A**	**(M)**	**T**	**DB DF DT**	730 000	1 200 000	1 100	1 500	248.3	92.3	—	390	2
	400	78	5	2	410 000	550 000	—	1 300	1 700	162.8	212	378	4	47.2	**7338 B**	**(M)**	—	**DB DF DT**	670 000	1 100 000	1 000	1 400	325.5	169.5	—	390	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	**7940 C**	**(M)**	—	**DB DF DT**	305 000	490 000	2 200	3 200	102.3	26.3	—	273	1
	310	51	2.1	1.1	240 000	310 000	—	1 700	2 200	99.1	212	298	2	13.7	**7040 A**	**(M)**	**T**	**DB DF DT**	390 000	620 000	1 300	1 800	198.2	96.2	—	303	1
	360	58	4	1.5	335 000	450 000	—	1 500	2 000	109.8	218	342	3	26.5	**7240 A**	**(M)**	—	**DB DF DT**	550 000	900 000	1 200	1 600	219.6	103.6	—	351	1.5
	360	58	4	1.5	305 000	410 000	—	1 300	1 800	146.5	218	342	3	26.6	**7240 B**	**(M)**	—	**DB DF DT**	495 000	815 000	1 100	1 500	292.9	176.9	—	351	1.5
	420	80	5	2	475 000	660 000	—	1 300	1 800	129.5	222	398	4	54.4	**7340 A**	**(M)**	**T**	**DB DF DT**	770 000	1 320 000	1 100	1 400	259.0	99.0	—	410	2
	420	80	5	2	430 000	600 000	—	1 200	1 600	170.1	222	398	4	55.3	**7340 B**	**(M)**	—	**DB DF DT**	700 000	1 200 000	950	1 300	340.1	180.1	—	410	2

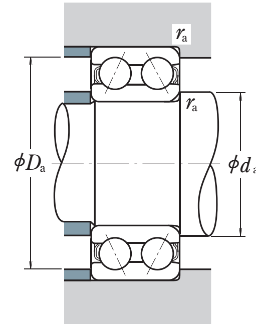
Notes (1) For applications operating near the limiting speed, refer to Page C077.
(2) The suffixes A, A5, B, and C represent contact angles of 30°, 25°, 40°, and 15° respectively.
(3) For bearings marked — in the column for d_b, d_b and r_b for shafts are d_a (min) and r_a (max) respectively.

Note (4) (M) in the column of cage symbols are usually omitted from the bearing number.

DOUBLE-ROW ANGULAR CONTACT BALL BEARINGS

Bore Diameter 10 – 85 mm





Dynamic Equivalent Load

$P = XF_r + YF_a$

F_a/F_r e		F_a/F_r e		e
X	Y	X	Y	
1	0.92	0.67	1.41	0.68

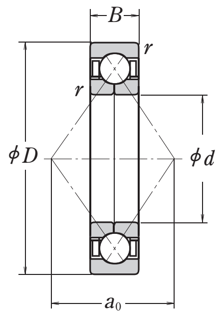
Static Equivalent Load

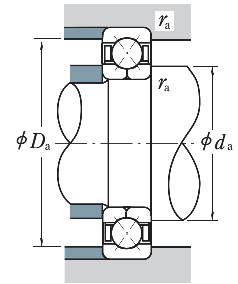
$P_0 = F_r + 0.76\,F_a$

Boundary Dimensions (mm) d	D	B	r min.	Basic Load Ratings (N) C_r	C_{0r}	Limiting Speeds (min⁻¹) Grease	Oil	Bearing Numbers	Load Center Spacings (mm) a_0	Abutment and Fillet Dimensions (mm) d_a min.	D_a max.	r_a max.	Mass (kg) approx.
10	30	14.3	0.6	7 150	3 900	17 000	22 000	**5200**	14.5	15	25	0.6	0.050
12	32	15.9	0.6	10 500	5 800	15 000	20 000	**5201**	16.7	17	27	0.6	0.060
15	35	15.9	0.6	11 700	7 050	13 000	17 000	**5202**	18.3	20	30	0.6	0.070
	42	19	1	17 600	10 200	11 000	15 000	**5302**	22.0	21	36	1	0.13
17	40	17.5	0.6	14 600	9 050	11 000	15 000	**5203**	20.8	22	35	0.6	0.10
	47	22.2	1	21 000	12 600	10 000	13 000	**5303**	25.0	23	41	1	0.18
20	47	20.6	1	19 600	12 400	10 000	13 000	**5204**	24.3	26	41	1	0.16
	52	22.2	1.1	24 600	15 000	9 000	12 000	**5304**	26.7	27	45	1	0.22
25	52	20.6	1	21 300	14 700	8 500	11 000	**5205**	26.8	31	46	1	0.18
	62	25.4	1.1	32 500	20 700	7 500	10 000	**5305**	31.8	32	55	1	0.35
30	62	23.8	1	29 600	21 100	7 100	9 500	**5206**	31.6	36	56	1	0.30
	72	30.2	1.1	40 500	28 100	6 300	8 500	**5306**	36.5	37	65	1	0.57
35	72	27	1.1	39 000	28 700	6 300	8 000	**5207**	36.6	42	65	1	0.46
	80	34.9	1.5	51 000	36 000	5 600	7 500	**5307**	41.6	44	71	1.5	0.76
40	80	30.2	1.1	44 000	33 500	5 600	7 100	**5208**	41.5	47	73	1	0.62
	90	36.5	1.5	56 500	41 000	5 300	6 700	**5308**	45.5	49	81	1.5	1.03
45	85	30.2	1.1	49 500	38 000	5 000	6 700	**5209**	43.4	52	78	1	0.67
	100	39.7	1.5	68 500	51 000	4 500	6 000	**5309**	50.6	54	91	1.5	1.37
50	90	30.2	1.1	53 000	43 500	4 800	6 000	**5210**	45.9	57	83	1	0.72
	110	44.4	2	81 500	61 500	4 300	5 600	**5310**	55.6	60	100	2	1.84
55	100	33.3	1.5	56 000	49 000	4 300	5 600	**5211**	50.1	64	91	1.5	1.01
	120	49.2	2	95 000	73 000	3 800	5 000	**5311**	60.6	65	110	2	2.40
60	110	36.5	1.5	69 000	62 000	3 800	5 000	**5212**	56.5	69	101	1.5	1.33
	130	54	2.1	125 000	98 500	3 400	4 500	**5312**	69.2	72	118	2	2.92
65	120	38.1	1.5	76 500	69 000	3 600	4 500	**5213**	59.7	74	111	1.5	1.71
	140	58.7	2.1	142 000	113 000	3 200	4 300	**5313**	72.8	77	128	2	3.67
70	125	39.7	1.5	94 000	82 000	3 400	4 500	**5214**	63.8	79	116	1.5	1.75
	150	63.5	2.1	159 000	128 000	3 000	3 800	**5314**	78.3	82	138	2	4.55
75	130	41.3	1.5	93 500	83 000	3 200	4 300	**5215**	66.1	84	121	1.5	1.88
80	140	44.4	2	99 000	93 000	3 000	3 800	**5216**	69.6	90	130	2	2.51
85	150	49.2	2	116 000	110 000	2 800	3 600	**5217**	75.3	95	140	2	3.16

FOUR-POINT CONTACT BALL BEARINGS

Bore Diameter 30 – 95 mm





Dynamic Equivalent Load

$P_a = F_a$

Static Equivalent Load

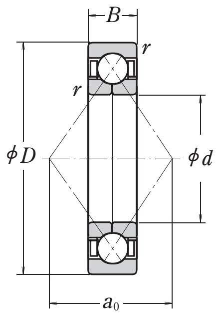
$P_{0a} = F_a$

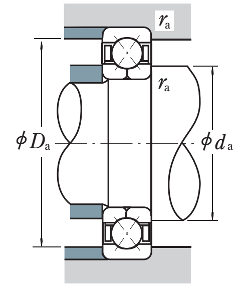
Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers	Load Center Spacings (mm)	Abutment and Fillet Dimensions (mm)			Mass (kg)
d	D	B	r min.	C_a	C_{0a}	Grease	Oil		a_0	d_a min.	D_a max.	r_a max.	approx.
30	62	16	1	31 000	45 000	8 500	12 000	**QJ 206**	32.2	36	56	1	0.24
	72	19	1.1	46 000	63 000	8 000	11 000	**QJ 306**	35.7	37	65	1	0.42
35	72	17	1.1	41 000	61 500	7 500	10 000	**QJ 207**	37.5	42	65	1	0.35
	80	21	1.5	55 000	80 000	7 100	9 500	**QJ 307**	40.3	44	71	1.5	0.57
40	80	18	1.1	49 000	77 500	6 700	9 000	**QJ 208**	42.0	47	73	1	0.45
	90	23	1.5	67 000	100 000	6 300	8 500	**QJ 308**	45.5	49	81	1.5	0.78
45	85	19	1.1	55 000	88 500	6 300	8 500	**QJ 209**	45.5	52	78	1	0.52
	100	25	1.5	87 500	133 000	5 600	7 500	**QJ 309**	50.8	54	91	1.5	1.05
50	90	20	1.1	57 000	97 000	5 600	8 000	**QJ 210**	49.0	57	83	1	0.59
	110	27	2	102 000	159 000	5 000	6 700	**QJ 310**	56.0	60	100	2	1.35
55	100	21	1.5	71 000	122 000	5 300	7 100	**QJ 211**	54.3	64	91	1.5	0.77
	120	29	2	118 000	187 000	4 500	6 300	**QJ 311**	61.3	65	110	2	1.75
60	110	22	1.5	85 500	150 000	4 800	6 300	**QJ 212**	59.5	69	101	1.5	0.98
	130	31	2.1	135 000	217 000	4 300	5 600	**QJ 312**	66.5	72	118	2	2.15
65	120	23	1.5	97 500	179 000	4 300	6 000	**QJ 213**	64.8	74	111	1.5	1.2
	140	33	2.1	153 000	250 000	3 800	5 300	**QJ 313**	71.8	77	128	2	2.7
70	125	24	1.5	106 000	197 000	4 000	5 600	**QJ 214**	68.3	79	116	1.5	1.3
	150	35	2.1	172 000	285 000	3 600	5 000	**QJ 314**	77.0	82	138	2	3.18
75	130	25	1.5	110 000	212 000	3 800	5 300	**QJ 215**	71.8	84	121	1.5	1.5
	160	37	2.1	187 000	320 000	3 400	4 800	**QJ 315**	82.3	87	148	2	3.9
80	125	22	1.1	77 000	167 000	3 800	5 300	**QJ 1016**	71.8	87	118	1	1.05
	140	26	2	124 000	236 000	3 600	5 000	**QJ 216**	77.0	90	130	2	1.85
	170	39	2.1	202 000	360 000	3 200	4 300	**QJ 316**	87.5	92	158	2	4.6
85	130	22	1.1	79 000	176 000	3 800	5 000	**QJ 1017**	75.3	92	123	1	1.1
	150	28	2	143 000	276 000	3 400	4 800	**QJ 217**	82.3	95	140	2	2.2
	180	41	3	218 000	405 000	3 000	4 000	**QJ 317**	92.8	99	166	2.5	5.34
90	140	24	1.5	94 000	208 000	3 400	4 800	**QJ 1018**	80.5	99	131	1.5	1.45
	160	30	2	164 000	320 000	3 200	4 300	**QJ 218**	87.5	100	150	2	2.75
	190	43	3	235 000	450 000	2 800	3 800	**QJ 318**	98.0	104	176	2.5	6.4
95	145	24	1.5	96 500	220 000	3 400	4 500	**QJ 1019**	84.0	104	136	1.5	1.5
	170	32	2.1	177 000	340 000	3 000	4 000	**QJ 219**	92.8	107	158	2	3.35
	200	45	3	251 000	495 000	2 600	3 600	**QJ 319**	103.3	109	186	2.5	7.4

Remark When using four-point contact ball bearings, please contact NSK.

FOUR-POINT CONTACT BALL BEARINGS

Bore Diameter 100 – 200 mm





Dynamic Equivalent Load
$P_a = F_a$

Static Equivalent Load
$P_{0a} = F_a$

Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers	Load Center Spacings (mm)	Abutment and Fillet Dimensions (mm)			Mass (kg)
d	D	B	r min.	C_a	C_{0a}	Grease	Oil		a_0	d_a min.	D_a max.	r_a max.	approx.
100	150	24	1.5	98 500	232 000	3 200	4 300	**QJ 1020**	87.5	109	141	1.5	1.6
	180	34	2.1	199 000	390 000	2 800	3 800	**QJ 220**	98.0	112	168	2	4.0
	215	47	3	300 000	640 000	2 400	3 400	**QJ 320**	110.3	114	201	2.5	9.3
105	160	26	2	115 000	269 000	3 000	4 000	**QJ 1021**	92.8	115	150	2	2.0
	190	36	2.1	217 000	435 000	2 600	3 600	**QJ 221**	103.3	117	178	2	4.7
	225	49	3	305 000	640 000	2 400	3 200	**QJ 321**	115.5	119	211	2.5	10.5
110	170	28	2	139 000	315 000	2 800	3 800	**QJ 1022**	98.0	120	160	2	2.5
	200	38	2.1	235 000	490 000	2 600	3 400	**QJ 222**	108.5	122	188	2	5.6
	240	50	3	320 000	710 000	2 200	3 000	**QJ 322**	122.5	124	226	2.5	12.5
120	180	28	2	147 000	350 000	2 600	3 600	**QJ 1024**	105.0	130	170	2	2.65
	215	40	2.1	265 000	585 000	2 400	3 200	**QJ 224**	117.3	132	203	2	6.9
	260	55	3	360 000	835 000	2 000	2 800	**QJ 324**	133.0	134	246	2.5	15.4
130	200	33	2	169 000	415 000	2 400	3 200	**QJ 1026**	115.5	140	190	2	4.0
	230	40	3	274 000	635 000	2 200	3 000	**QJ 226**	126.0	144	216	2.5	7.7
	280	58	4	400 000	970 000	1 900	2 600	**QJ 326**	143.5	148	262	3	19
140	210	33	2	172 000	435 000	2 200	3 000	**QJ 1028**	122.5	150	200	2	4.3
	250	42	3	315 000	775 000	2 000	2 800	**QJ 228**	136.5	154	236	2.5	9.8
	300	62	4	440 000	1 110 000	1 700	2 400	**QJ 328**	154.0	158	282	3	24
150	225	35	2.1	197 000	505 000	2 000	2 800	**QJ 1030**	131.3	162	213	2	5.2
	270	45	3	360 000	925 000	1 800	2 600	**QJ 230**	147.0	164	256	2.5	12
	320	65	4	460 000	1 230 000	1 600	2 200	**QJ 330**	164.5	168	302	3	29
160	240	38	2.1	224 000	580 000	1 900	2 600	**QJ 1032**	140.0	172	228	2	6.4
	290	48	3	380 000	1 010 000	1 700	2 400	**QJ 232**	157.5	174	276	2.5	15
	340	68	4	505 000	1 400 000	1 500	2 000	**QJ 332**	175.1	178	322	3	31
170	260	42	2.1	268 000	705 000	1 800	2 400	**QJ 1034**	150.5	182	248	2	8.6
	310	52	4	425 000	1 180 000	1 600	2 200	**QJ 234**	168.0	188	292	3	19.5
	360	72	4	565 000	1 610 000	1 400	2 000	**QJ 334**	185.6	188	342	3	41
180	280	46	2.1	299 000	830 000	1 700	2 200	**QJ 1036**	161.0	192	268	2	11
	320	52	4	440 000	1 270 000	1 500	2 000	**QJ 236**	175.1	198	302	3	20.5
	380	75	4	595 000	1 770 000	1 300	1 800	**QJ 336**	196.1	198	362	3	48
190	290	46	2.1	325 000	925 000	1 600	2 200	**QJ 1038**	168.0	202	278	2	11.5
	340	55	4	440 000	1 290 000	1 400	2 000	**QJ 238**	185.6	208	322	3	23
	400	78	5	655 000	1 980 000	1 300	1 700	**QJ 338**	206.6	212	378	4	54.5
200	310	51	2.1	345 000	1 020 000	1 500	2 000	**QJ 1040**	178.6	212	298	2	15
	360	58	4	490 000	1 480 000	1 300	1 800	**QJ 240**	196.1	218	342	3	27
	420	80	5	690 000	2 180 000	1 200	1 600	**QJ 340**	217.1	222	398	4	61.5

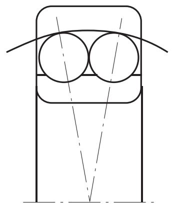
Remark When using four-point contact ball bearings, please contact NSK.

4. SELF-ALIGNING BALL BEARINGS

DESIGN, TYPES, AND FEATURES

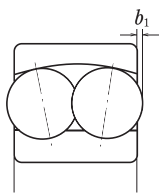
The outer ring has a spherical raceway and its center of curvature coincides with that of the bearing; therefore, the axis of the inner ring, balls and cage can deflect to some extent around the bearing center. This type is recommended when the alignment of the shaft and housing is difficult and when the shaft may bend. Since the contact angle is small, the axial load capacity is low.

Pressed steel cages are usually used.



PROTRUSION AMOUNT OF BALLS

Among self-aligning ball bearings, there are some in which the balls protrude from the side face as shown below. This protrusion amount b_1 is listed in the following table.



Bearing No.	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)

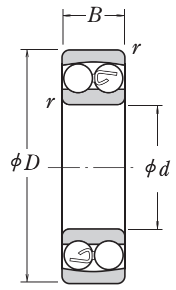
INTERNAL CLEARANCE .... Table 8.13 (Page A170)

PERMISSIBLE MISALIGNMENT

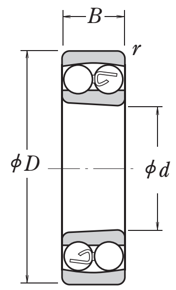
The permissible misalignment of self-aligning ball bearings is approximately 0.07 to 0.12 radian (4° to 7°) under normal loads. However, depending on the surrounding structure, such an angle may not be possible. Use care in the structural design.

SELF-ALIGNING BALL BEARINGS

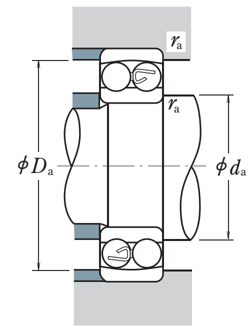
Bore Diameter 5 – 30 mm



Cylindrical Bore



Tapered Bore



Dynamic Equivalent Load

$P = XF_r + YF_a$

F_a/F_r 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.

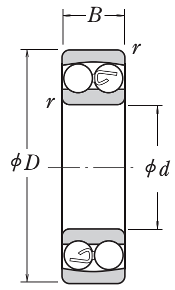
Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers		Abutment and Fillet Dimensions (mm)			Constant	Axial Load Factors			Mass (kg)
d	D	B	r min.	C_r	C_{0r}	Grease	Oil	Cylindrical Bore	Tapered Bore([1])	d_a min.	D_a max.	r_a max.	e	Y_2	Y_3	Y_0	approx.
5	19	6	0.3	2 530	475	30 000	36 000	**135**	—	7	17	0.3	0.34	2.9	1.9	1.9	0.009
6	19	6	0.3	2 530	475	30 000	36 000	**126**	—	8	17	0.3	0.34	2.9	1.9	1.9	0.008
7	22	7	0.3	2 750	600	26 000	32 000	**127**	—	9	20	0.3	0.31	3.1	2.0	2.1	0.013
8	22	7	0.3	2 750	600	26 000	32 000	**108**	—	10	20	0.3	0.31	3.1	2.0	2.1	0.016
9	26	8	0.6	4 150	895	26 000	30 000	**129**	—	13	22	0.6	0.32	3.1	2.0	2.1	0.021
10	30	9	0.6	5 550	1 190	22 000	28 000	**1200**	—	14	26	0.6	0.32	3.1	2.0	2.1	0.041
	30	14	0.6	7 450	1 590	24 000	28 000	**2200**	—	14	26	0.6	0.64	1.5	0.98	1.0	0.046
	35	11	0.6	7 350	1 620	20 000	24 000	**1300**	—	14	31	0.6	0.35	2.8	1.8	1.9	0.059
	35	17	0.6	9 200	2 010	18 000	22 000	**2300**	—	14	31	0.6	0.71	1.4	0.89	0.93	0.078
12	32	10	0.6	5 700	1 270	22 000	26 000	**1201**	—	16	28	0.6	0.36	2.7	1.8	1.8	0.039
	32	14	0.6	7 750	1 730	22 000	26 000	**2201**	—	16	28	0.6	0.58	1.7	1.1	1.1	0.051
	37	12	1	9 650	2 160	18 000	22 000	**1301**	—	17	32	1	0.33	2.9	1.9	2.0	0.068
	37	17	1	12 100	2 730	17 000	22 000	**2301**	—	17	32	1	0.60	1.6	1.1	1.1	0.087
15	35	11	0.6	7 600	1 750	18 000	22 000	**1202**	—	19	31	0.6	0.32	3.1	2.0	2.1	0.051
	35	14	0.6	7 800	1 850	18 000	22 000	**2202**	—	19	31	0.6	0.50	1.9	1.3	1.3	0.058
	42	13	1	9 700	2 290	16 000	20 000	**1302**	—	20	37	1	0.33	2.9	1.9	2.0	0.101
	42	17	1	12 300	2 910	14 000	18 000	**2302**	—	20	37	1	0.51	1.9	1.2	1.3	0.113
17	40	12	0.6	8 000	2 010	16 000	20 000	**1203**	—	21	36	0.6	0.31	3.1	2.0	2.1	0.072
	40	16	0.6	9 950	2 420	16 000	20 000	**2203**	—	21	36	0.6	0.50	1.9	1.3	1.3	0.089
	47	14	1	12 700	3 200	14 000	17 000	**1303**	—	22	42	1	0.32	3.1	2.0	2.1	0.13
	47	19	1	14 700	3 550	13 000	16 000	**2303**	—	22	42	1	0.51	1.9	1.2	1.3	0.16
20	47	14	1	10 000	2 610	14 000	17 000	**1204**	**1204 K**	25	42	1	0.29	3.4	2.2	2.3	0.12
	47	18	1	12 800	3 300	14 000	17 000	**2204**	**2204 K**	25	42	1	0.47	2.1	1.3	1.4	0.142
	52	15	1.1	12 600	3 350	12 000	15 000	**1304**	**1304 K**	26.5	45.5	1	0.29	3.4	2.2	2.3	0.164
	52	21	1.1	18 500	4 700	11 000	14 000	**2304**	**2304 K**	26.5	45.5	1	0.50	1.9	1.2	1.3	0.207
25	52	15	1	12 200	3 300	12 000	14 000	**1205**	**1205 K**	30	47	1	0.28	3.5	2.3	2.4	0.14
	52	18	1	12 400	3 450	12 000	14 000	**2205**	**2205 K**	30	47	1	0.41	2.4	1.5	1.6	0.16
	62	17	1.1	18 200	5 000	10 000	13 000	**1305**	**1305 K**	31.5	55.5	1	0.28	3.5	2.3	2.4	0.261
	62	24	1.1	24 900	6 600	9 500	12 000	**2305**	**2305 K**	31.5	55.5	1	0.47	2.1	1.4	1.4	0.332
30	62	16	1	15 800	4 650	10 000	12 000	**1206**	**1206 K**	35	57	1	0.25	3.9	2.5	2.6	0.22
	62	20	1	15 300	4 550	10 000	12 000	**2206**	**2206 K**	35	57	1	0.38	2.5	1.6	1.7	0.262
	72	19	1.1	21 400	6 300	8 500	11 000	**1306**	**1306 K**	36.5	65.5	1	0.26	3.7	2.4	2.5	0.391
	72	27	1.1	32 000	8 750	8 000	10 000	**2306**	**2306 K**	36.5	65.5	1	0.44	2.2	1.4	1.5	0.5

Note ([1]) The suffix K represents bearings with tapered bores (1 : 12)

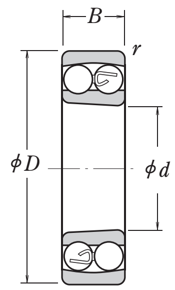
Remark For the dimensions related to adapters, refer to Page C348.

SELF-ALIGNING BALL BEARINGS

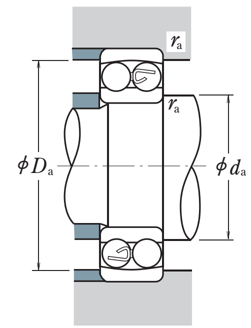
Bore Diameter 35 – 70 mm



Cylindrical Bore



Tapered Bore



Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.65	Y_2

Static Equivalent Load

$P_0 = F_r + Y_0 F_a$

The values of e, Y_2, Y_3, and Y_0 are listed in the table below.

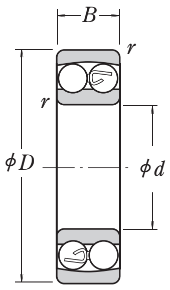
Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers		Abutment and Fillet Dimensions (mm)			Constant	Axial Load Factors			Mass (kg)
d	D	B	r min.	C_r	C_{0r}	Grease	Oil	Cylindrical Bore	Tapered Bore([1])	d_a min.	D_a max.	r_a max.	e	Y_2	Y_3	Y_0	approx.
35	72	17	1.1	15 900	5 100	8 500	10 000	**1207**	**1207 K**	41.5	65.5	1	0.23	4.2	2.7	2.8	0.33
	72	23	1.1	21 700	6 600	8 500	10 000	**2207**	**2207 K**	41.5	65.5	1	0.37	2.6	1.7	1.8	0.403
	80	21	1.5	25 300	7 850	7 500	9 500	**1307**	**1307 K**	43	72	1.5	0.26	3.8	2.5	2.6	0.52
	80	31	1.5	40 000	11 300	7 100	9 000	**2307**	**2307 K**	43	72	1.5	0.46	2.1	1.4	1.4	0.671
40	80	18	1.1	19 300	6 500	7 500	9 000	**1208**	**1208 K**	46.5	73.5	1	0.22	4.3	2.8	2.9	0.42
	80	23	1.1	22 400	7 350	7 500	9 000	**2208**	**2208 K**	46.5	73.5	1	0.33	3.0	1.9	2.0	0.506
	90	23	1.5	29 800	9 700	6 700	8 500	**1308**	**1308 K**	48	82	1.5	0.24	4.0	2.6	2.7	0.727
	90	33	1.5	45 500	13 500	6 300	8 000	**2308**	**2308 K**	48	82	1.5	0.43	2.3	1.5	1.5	0.918
45	85	19	1.1	22 000	7 350	7 100	8 500	**1209**	**1209 K**	51.5	78.5	1	0.21	4.7	3.0	3.1	0.47
	85	23	1.1	23 300	8 150	7 100	8 500	**2209**	**2209 K**	51.5	78.5	1	0.30	3.2	2.1	2.2	0.556
	100	25	1.5	38 500	12 700	6 000	7 500	**1309**	**1309 K**	53	92	1.5	0.25	4.0	2.6	2.7	0.971
	100	36	1.5	55 000	16 700	5 600	7 100	**2309**	**2309 K**	53	92	1.5	0.41	2.4	1.5	1.6	1.2
50	90	20	1.1	22 800	8 100	6 300	8 000	**1210**	**1210 K**	56.5	83.5	1	0.21	4.7	3.1	3.2	0.535
	90	23	1.1	23 300	8 450	6 300	8 000	**2210**	**2210 K**	56.5	83.5	1	0.28	3.4	2.2	2.3	0.598
	110	27	2	43 500	14 100	5 600	6 700	**1310**	**1310 K**	59	101	2	0.23	4.2	2.7	2.8	1.23
	110	40	2	65 000	20 200	5 000	6 300	**2310**	**2310 K**	59	101	2	0.42	2.3	1.5	1.6	1.63
55	100	21	1.5	26 900	10 000	6 000	7 100	**1211**	**1211 K**	63	92	1.5	0.20	4.9	3.2	3.3	0.708
	100	25	1.5	26 700	9 900	6 000	7 100	**2211**	**2211 K**	63	92	1.5	0.28	3.5	2.3	2.4	0.807
	120	29	2	51 500	17 900	5 000	6 300	**1311**	**1311 K**	64	111	2	0.23	4.2	2.7	2.8	1.6
	120	43	2	76 500	24 000	4 800	6 000	**2311**	**2311 K**	64	111	2	0.41	2.4	1.5	1.6	2.08
60	110	22	1.5	30 500	11 500	5 300	6 300	**1212**	**1212 K**	68	102	1.5	0.18	5.3	3.4	3.6	0.91
	110	28	1.5	34 000	12 600	5 300	6 300	**2212**	**2212 K**	68	102	1.5	0.28	3.5	2.3	2.4	1.1
	130	31	2.1	57 500	20 800	4 500	5 600	**1312**	**1312 K**	71	119	2	0.23	4.3	2.8	2.9	2.0
	130	46	2.1	88 500	28 300	4 300	5 300	**2312**	**2312 K**	71	119	2	0.40	2.4	1.6	1.6	2.58
65	120	23	1.5	31 000	12 500	4 800	6 000	**1213**	**1213 K**	73	112	1.5	0.17	5.7	3.7	3.8	1.16
	120	31	1.5	43 500	16 400	4 800	6 000	**2213**	**2213 K**	73	112	1.5	0.28	3.5	2.3	2.4	1.5
	140	33	2.1	62 500	22 900	4 300	5 300	**1313**	**1313 K**	76	129	2	0.23	4.2	2.7	2.9	2.47
	140	48	2.1	97 000	32 500	3 800	4 800	**2313**	**2313 K**	76	129	2	0.39	2.5	1.6	1.7	3.2
70	125	24	1.5	35 000	13 800	4 800	5 600	**1214**	—	78	117	1.5	0.18	5.3	3.4	3.6	1.3
	125	31	1.5	44 000	17 100	4 500	5 600	**2214**	—	78	117	1.5	0.26	3.7	2.4	2.5	1.55
	150	35	2.1	75 000	27 700	4 000	5 000	**1314**	—	81	139	2	0.22	4.4	2.8	3.0	3.03
	150	51	2.1	111 000	37 500	3 600	4 500	**2314**	—	81	139	2	0.38	2.6	1.7	1.8	3.9

Note ([1]) The suffix K represents bearings with tapered bores (1 : 12)

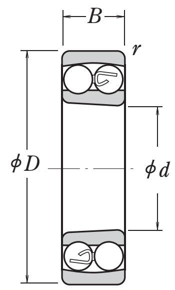
Remark For the dimensions related to adapters, refer to Pages C348 and C349.

SELF-ALIGNING BALL BEARINGS

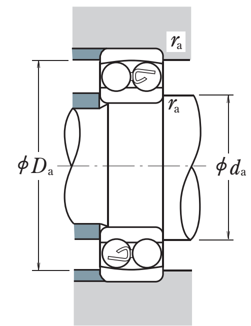
Bore Diameter 75 – 110 mm



Cylindrical Bore



Tapered Bore



Dynamic Equivalent Load

$P = XF_r + YF_a$

F_a/F_r 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.

Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers		Abutment and Fillet Dimensions (mm)			Constant	Axial Load Factors			Mass (kg)
d	D	B	r min.	C_r	C_{0r}	Grease	Oil	Cylindrical Bore	Tapered Bore([1])	d_a min.	D_a max.	r_a max.	e	Y_2	Y_3	Y_0	approx.
75	130	25	1.5	39 000	15 700	4 300	5 300	**1215**	**1215 K**	83	122	1.5	0.17	5.6	3.6	3.8	1.41
	130	31	1.5	44 500	17 800	4 300	5 300	**2215**	**2215 K**	83	122	1.5	0.25	3.9	2.5	2.6	1.6
	160	37	2.1	80 000	30 000	3 800	4 500	**1315**	**1315 K**	86	149	2	0.22	4.4	2.8	2.9	3.63
	160	55	2.1	125 000	43 000	3 400	4 300	**2315**	**2315 K**	86	149	2	0.38	2.5	1.6	1.7	4.78
80	140	26	2	40 000	17 000	4 000	5 000	**1216**	**1216 K**	89	131	2	0.16	6.0	3.9	4.1	1.73
	140	33	2	49 000	19 900	4 000	5 000	**2216**	**2216 K**	89	131	2	0.25	3.9	2.5	2.7	2.02
	170	39	2.1	89 000	33 000	3 600	4 300	**1316**	**1316 K**	91	159	2	0.22	4.5	2.9	3.1	4.24
	170	58	2.1	130 000	45 000	3 200	4 000	**2316**	**2316 K**	91	159	2	0.39	2.5	1.6	1.7	5.63
85	150	28	2	49 500	20 800	3 800	4 500	**1217**	**1217 K**	94	141	2	0.17	5.7	3.7	3.8	2.09
	150	36	2	58 500	23 600	3 800	4 800	**2217**	**2217 K**	94	141	2	0.25	3.9	2.5	2.6	2.56
	180	41	3	98 500	38 000	3 400	4 000	**1317**	**1317 K**	98	167	2.5	0.21	4.6	2.9	3.1	5.03
	180	60	3	142 000	51 500	3 000	3 800	**2317**	**2317 K**	98	167	2.5	0.37	2.6	1.7	1.8	6.56
90	160	30	2	57 500	23 500	3 600	4 300	**1218**	**1218 K**	99	151	2	0.17	5.8	3.8	3.9	2.55
	160	40	2	70 500	28 700	3 600	4 300	**2218**	**2218 K**	99	151	2	0.27	3.7	2.4	2.5	3.22
	190	43	3	117 000	44 500	3 200	3 800	**1318**	**1318 K**	103	177	2.5	0.22	4.3	2.8	2.9	5.83
	190	64	3	154 000	57 500	2 800	3 600	**2318**	**2318 K**	103	177	2.5	0.38	2.6	1.7	1.7	7.75
95	170	32	2.1	64 000	27 100	3 400	4 000	**1219**	**1219 K**	106	159	2	0.17	5.8	3.7	3.9	3.21
	170	43	2.1	84 000	34 500	3 400	4 000	**2219**	**2219 K**	106	159	2	0.27	3.7	2.4	2.5	3.96
	200	45	3	129 000	51 000	3 000	3 600	**1319**	**1319 K**	108	187	2.5	0.23	4.3	2.8	2.9	6.79
	200	67	3	161 000	64 500	2 800	3 400	**2319**	**2319 K**	108	187	2.5	0.38	2.6	1.7	1.8	8.97
100	180	34	2.1	69 500	29 700	3 200	3 800	**1220**	**1220 K**	111	169	2	0.17	5.6	3.6	3.8	3.82
	180	46	2.1	94 500	38 500	3 200	3 800	**2220**	**2220 K**	111	169	2	0.27	3.7	2.4	2.5	4.71
	215	47	3	140 000	57 500	2 800	3 400	**1320**	**1320 K**	113	202	2.5	0.24	4.1	2.7	2.8	8.4
	215	73	3	187 000	79 000	2 400	3 200	**2320**	**2320 K**	113	202	2.5	0.38	2.6	1.7	1.8	11.5
105	190	36	2.1	75 000	32 500	3 000	3 600	**1221**	—	116	179	2	0.18	5.5	3.6	3.7	4.52
	190	50	2.1	109 000	45 000	3 000	3 600	**2221**	—	116	179	2	0.28	3.5	2.3	2.4	5.73
	225	49	3	154 000	64 500	2 600	3 200	**1321**	—	118	212	2.5	0.23	4.2	2.7	2.9	9.58
	225	77	3	200 000	87 000	2 400	3 000	**2321**	—	118	212	2.5	0.38	2.6	1.7	1.7	14.5
110	200	38	2.1	87 000	38 500	2 800	3 400	**1222**	**1222 K**	121	189	2	0.17	5.7	3.7	3.9	5.33
	200	53	2.1	122 000	51 500	2 800	3 400	**2222**	**2222 K**	121	189	2	0.28	3.5	2.2	2.3	6.75
	240	50	3	161 000	72 000	2 400	3 000	**1322**	**1322 K**	123	227	2.5	0.22	4.4	2.8	3.0	11.5
	240	80	3	211 000	94 500	2 200	2 800	**2322**	**2322 K**	123	227	2.5	0.37	2.6	1.7	1.8	17.5

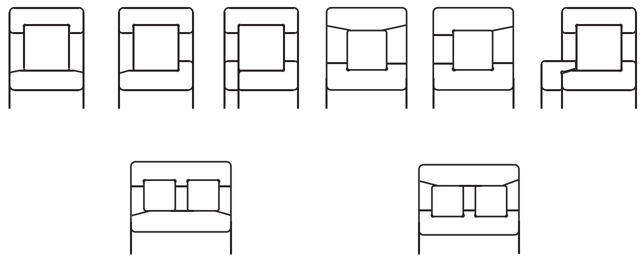
Notes ([1]) The suffix K represents bearings with tapered bores (1 : 12)
( ) The balls of the bearings marked protrude slightly from the bearing face. The protrusion amounts are shown on Page C114.

Remark For the dimensions related to adapters, refer to Pages C350 and C351.

5. CYLINDRICAL ROLLER BEARINGS

DESIGN, TYPES, AND FEATURES

Depending on the existence of ribs on their rings, Cylindrical Roller Bearings are classified into the following types.



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.

NH-type cylindrical roller bearings consist of the NJ-type cylindrical roller bearings and HJ-type L-shaped thrust collars (See Pages C156 and C157).

The inner ring loose rib of a NUP-type cylindrical roller bearing should be mounted so that the marked side is on the outside.

Features of Single-Row Cylindrical Roller Bearings

Cage Spec.	Material	Steel	Steel	Polyamide 66 resin	L-PPS resin	Brass	
	Method	pressed		Molded		machined	
	Symbols	W	EW	ET	ET7	M	EM
Features	High Load Capacity	○	◎	◎	◎	△	◎
	High-Speed	△	○	○	○	○	◎
	High-Temperature	○	○	△	○	○	○
	Vibration	×	×	×	×	△	○

For a given bearing number, if the type of cage is not the standard one, the number of rollers may vary; in such a case, the load rating will differ from the one listed in the bearing tables.

Among the NN Type of double-row bearings, there are many of high precision that have tapered bores, and they are primarily used in the main spindles of machine tools. Their cages are either molded polyphenylenesulfide (PPS) or machined brass.

□ Formulation of Bearing Numbers

Single-Row Cylindrical Rollers

Bearing number example：

NU 3 08 E M C3 P5 &

①Bearing type symbol (NU)
②Dimension symbol (3)
③Bore number (08)
④Internal design symbol (E)
⑤Cage symbol (M)
⑥Internal clearance symbol (C3)
⑦Tolerance Class symbol (P5)
⑧NSK HPS™symbol (&)

①Bearing type symbol	NU : Single-Row Cylindrical Roller Bearings (Outer ring with both ribs + Inner ring without rib) Please refer to page C124 for detailed information.
②Dimension symbol	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 symbol	E : High Load Capacity
⑤Cage symbol	W : Pressed Steel Cage, M : Machined Brass Cage, No symbol : Machined Brass Cage(In case of 10 Series) T : Polyamide 66 Resin Cage, T7 : L-PPS Resin Cage
⑥Radial Internal clearance symbol	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 symbol	Omitted : ISO Normal, P6 : ISO Class 6, P5 : ISO Class 5, P4 : ISO Class 4
⑧NSK HPS™symbol	& : NSK HPS™Symbol

PRECAUTIONS FOR USE OF CYLINDRICAL ROLLER BEARINGS

If the load on cylindrical roller bearings becomes too small during operation, slippage between the rollers and raceways occurs, which may result in smearing. Especially with large bearings since the weight of the roller and cage is high.

In case of strong shock loads or vibration, pressed-steel cages are sometimes inadequate.

If very small bearing load or 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 used in gear oil, nonflammable hydraulic oil, or ester oil at a high temperature over 100°C, please contact NSK beforehand.

TOLERANCES AND RUNNING ACCURACY

CYLINDRICAL ROLLER BEARINGS .... Table 7.2 (Pages A128 to A131)

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 Having Interchangeable Rings

Units : m

Nominal Bore Diameter d (mm)		Tolerances for F_w of types NU, NJ, NUP, NH, and NNU F_w		Tolerances for E_w of types N, NF, and NN E_w	
over	incl.	high	low	high	low
—	20	+10	0	0	−10
20	50	+15	0	0	−15
50	120	+20	0	0	−20
120	200	+25	0	0	−25
200	250	+30	0	0	−30
250	315	+35	0	0	−35
315	400	+40	0	0	−40
400	500	+45	0	—	—

RECOMMENDED FITS

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)

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 are the values for the standard cage type. Please consult with NSK about the limiting speeds(mechanical) of optional cage.

LIMITING SPEEDS (Grease/Oil)

The limiting speeds (grease) and limiting speeds (oil) listed in the bearing tables should be adjusted depending on the bearing load condition. Also, 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 Cylindrical Roller Bearings

Cylindrical roller bearings employ grease lubrication in many cases because it makes maintenance easier and simplifies the peripheral construction of the housing. It is essential to select a grease brand appropriate for the operating conditions while paying due attention to the filling amount and position of the bearing as well as its housing.

The cylindrical roller bearings can be divided into NU, NJ, N, NF, NH, and NUP types of construction 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. The free space also differs 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 which show the free space of NU type bearings. (By the way, the cylindrical roller bearing type is used most frequently).

For types other than the NU type, the free space can be determined from the free space ratio with the NU type. Table 3 shows the approximate free space ratio for each type of cylindrical roller bearing. For example, the free space of NJ310 with a pressed steel cage may be calculated approximately at 47 cm^3. This result was calculated by multiplying the free space 52 cm^3 of NU310 in Table 1 by the space ratio 0.90 for the NJ type (Table 3).

Table 1 Free Space of Cylindrical Roller Bearing (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 Bearing (NU Type) (2) (with High-Tension Brass Machined Cage)

Units: cm^3

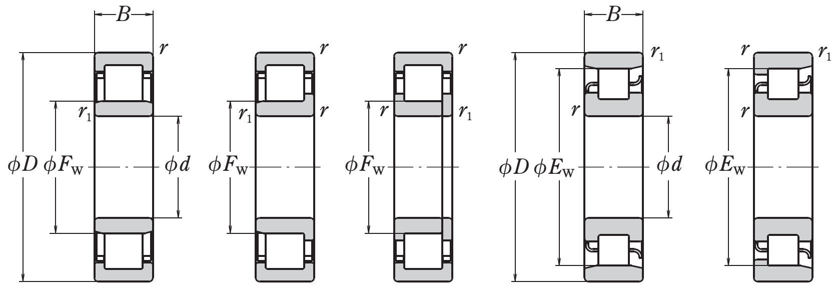
Bearing bore No.	Bearing free space			
	Bearing series			
	NU2	NU3	NU22	NU23
05	5.0	7.6	5.7	10
06	7.4	12	7.9	16
07	9.6	16	12	27
08	12	21	15	32
09	15	29	16	45
10	18	38	17	58
11	22	52	24	77
12	26	62	31	88
13	31	74	43	104
14	37	92	44	129
15	42	102	50	149
16	51	122	60	181
17	64	164	74	200
18	79	193	96	279
19	94	218	116	280
20	115	221	137	355

Table 3 Free Space Ratio of Each Type of Cylindrical Roller Bearing

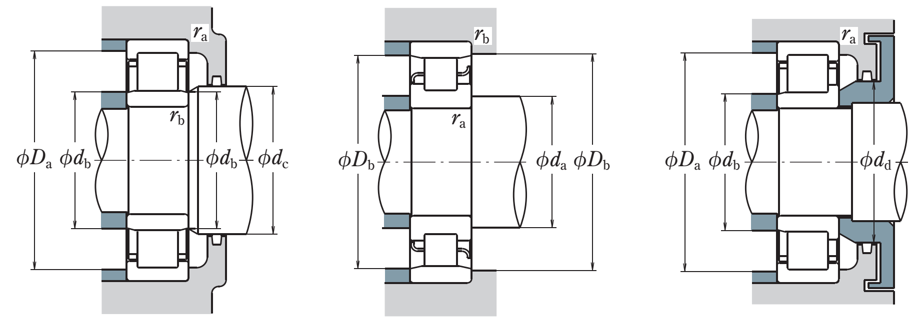
NU Type	NJ Type	N Type	NF Type
1	0.90	1.05	0.95

SINGLE-ROW CYLINDRICAL ROLLER BEARINGS

Bore Diameter 20 – 30 mm



NU NJ NUP N NF



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	Limiting Speeds 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	—	33 000	30 000	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	9 000
	52	15	1	0.6	31.5	—	29 300	27 700	14 000	17 000	9 000
	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	7 100
	62	17	1.1	1.1	34	—	41 500	37 500	11 000	15 000	7 100
	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	7 500
	62	16	1	0.6	37.5	—	39 000	37 500	12 000	14 000	7 500
	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	6 300
	72	19	1.1	1.1	40.5	—	53 000	50 000	9 500	13 000	6 300
	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) (M) in the column of cage symbols are usually omitted from the bearing number.
(2) When L-Shaped thrust collars (See section for L-Shaped Thrust Collars starting on page C156) are used, the bearings become the NH type.

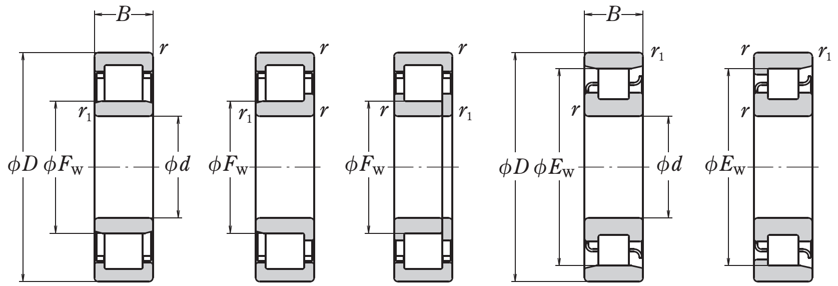
Bearing Numbers	Cage symbol(1) Standard	Cage symbol(1) Option	(2) NU	NJ	NUP	N	NF	d_a(3) min.	d_b min.	d_b(4) max.	d_c min.	d_d min.	D_a(3) max.	D_b max.	D_b min.	r_a max.	r_b max.	Mass (kg) approx.
N 204	W	—	—	—	—	N	NF	25	—	—	—	—	—	43	42	1	0.6	0.107
NU204E	T	T7	NU	NJ	NUP	—	—	25	24	25	29	32	42	—	—	1	0.6	0.107
NU2204	W	M	NU	NJ	—	—	—	25	24	25	29	32	42	—	—	1	0.6	0.144
N 304	W	—	—	—	—	N	NF	26.5	—	—	—	—	—	48	46	1	0.6	0.148
NU304E	T	T7	NU	NJ	NUP	—	—	26.5	24	26	30	33	45.5	—	—	1	0.6	0.145
NU2304	M	—	NU	NJ	NUP	—	—	26.5	24	27	30	33	45.5	—	—	1	0.6	0.217
NU2304E	T7	—	NU	NJ	NUP	—	—	26.5	24	26	30	33	45.5	—	—	1	0.6	0.209
NU1005	(M)	—	NU	—	—	—	—	—	27	30	32	—	43	—	—	0.6	0.3	0.094
N 205	W	M	—	—	—	N	NF	30	—	—	—	—	—	48	46	1	0.6	0.135
∗**NU205E**	W	M, T, T7	NU	NJ	NUP	—	—	30	29	30	34	37	47	—	—	1	0.6	0.136
NU205E	W	M, T, T7	NU	NJ	NUP	—	—	30	29	30	34	37	47	—	—	1	0.6	0.136
∗**NU2205E**	M	T, T7	NU	NJ	NUP	—	—	30	29	30	34	37	47	—	—	1	0.6	0.16
NU2205E	M	T, T7	NU	NJ	NUP	—	—	30	29	30	34	37	47	—	—	1	0.6	0.16
N 305	W	M	—	—	—	N	NF	31.5	—	—	—	—	—	55.5	50	1	1	0.233
∗**NU305E**	W	M, T, T7	NU	NJ	NUP	—	—	31.5	31.5	32	37	40	55.5	—	—	1	1	0.269
NU305E	W	M, T, T7	NU	NJ	NUP	—	—	31.5	31.5	32	37	40	55.5	—	—	1	1	0.269
∗**NU2305E**	M	T, T7	NU	NJ	NUP	—	—	31.5	31.5	32	37	40	55.5	—	—	1	1	0.338
NU2305E	M	T, T7	NU	NJ	NUP	—	—	31.5	31.5	32	37	40	55.5	—	—	1	1	0.338
NU405	W	—	NU	NJ	—	N	NF	33	33	37	41	46	72	72	64	1.5	1.5	0.57
NU1006	(M)	—	NU	—	—	N	—	35	34	36	38	—	50	51	49	1	0.5	0.136
N 206	W	M	—	—	—	N	NF	35	—	—	—	—	—	58	56	1	0.6	0.208
∗**NU206E**	W	M, T, T7	NU	NJ	NUP	—	—	35	34	36	40	44	57	—	—	1	0.6	0.205
NU206E	W	M, T, T7	NU	NJ	NUP	—	—	35	34	36	40	44	57	—	—	1	0.6	0.205
∗**NU2206E**	M	T, T7	NU	NJ	NUP	—	—	35	34	36	40	44	57	—	—	1	0.6	0.255
NU2206E	M	T, T7	NU	NJ	NUP	—	—	35	34	36	40	44	57	—	—	1	0.6	0.255
N 306	W	M	—	—	—	N	NF	36.5	—	—	—	—	—	65.5	64	1	1	0.353
∗**NU306E**	W	M, T, T7	NU	NJ	NUP	—	—	36.5	36.5	39	44	48	65.5	—	—	1	1	0.409
NU306E	W	M, T, T7	NU	NJ	NUP	—	—	36.5	36.5	39	44	48	65.5	—	—	1	1	0.409
∗**NU2306E**	M	T, T7	NU	NJ	NUP	—	—	36.5	36.5	39	44	48	65.5	—	—	1	1	0.518
NU2306E	M	T, T7	NU	NJ	NUP	—	—	36.5	36.5	39	44	48	65.5	—	—	1	1	0.518
NU406	W	M	NU	NJ	—	N	NF	38	38	43	47	52	82	82	75	1.5	1.5	0.758

Notes (3) If axial loads are applied, increase d_a and reduce D_a from the values listed above.
(4) d_b (max.) are values for adjusting rings for NU, NJ Types.
(5) The limiting speeds(mechanical) in the bearing tables are the value for the standard cage type.

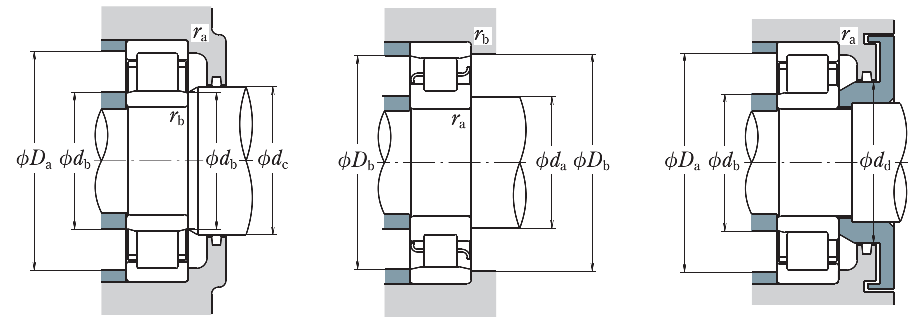
Remark The bearings denoted by an asterisk ( ) are NSKHPS™ Cylindrical roller bearings.

SINGLE-ROW CYLINDRICAL ROLLER BEARINGS

Bore Diameter 35 – 40 mm



NU NJ NUP N NF



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	Limiting Speeds 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	6 700
	72	17	1.1	0.6	44	—	50 500	50 000	10 000	12 000	6 700
	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	5 600
	80	21	1.5	1.1	46.2	—	66 500	65 500	8 500	11 000	5 600
	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	6 000
	80	18	1.1	1.1	49.5	—	55 500	55 500	9 000	11 000	6 000
	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	4 800
	90	23	1.5	1.5	52	—	83 000	81 500	7 500	10 000	4 800
	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) (M) in the column of cage symbols are usually omitted from the bearing number.
(2) When L-Shaped thrust collars (See section for L-Shaped Thrust Collars starting on page C156) are used, the bearings become the NH type.

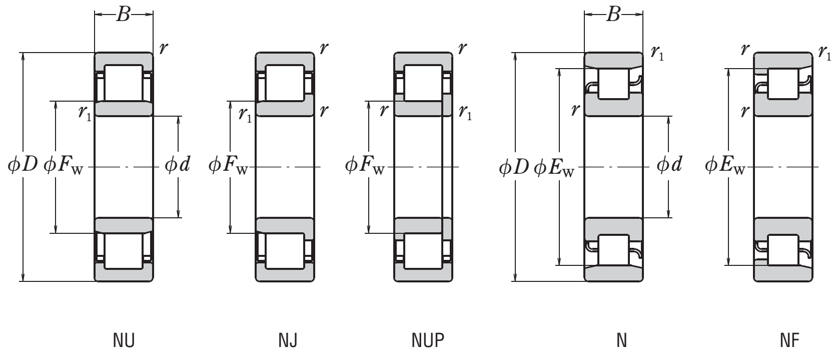
Bearing Numbers	Cage symbol(1) Standard	Cage symbol(1) Option	NU (2)	NJ	NUP	N	NF	d_a(3) min.	d_b min.	d_b(4) max.	d_c min.	d_d min.	D_a(3) max.	D_b max.	D_b min.	r_a max.	r_b max.	Mass (kg) approx.
NU1007	(M)	—	NU	NJ	—	N	—	40	39	41	44	—	57	58	56	1	0.5	0.18
N 207	W	M	—	—	—	N	NF	41.5	—	—	—	—	—	68	64	1	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

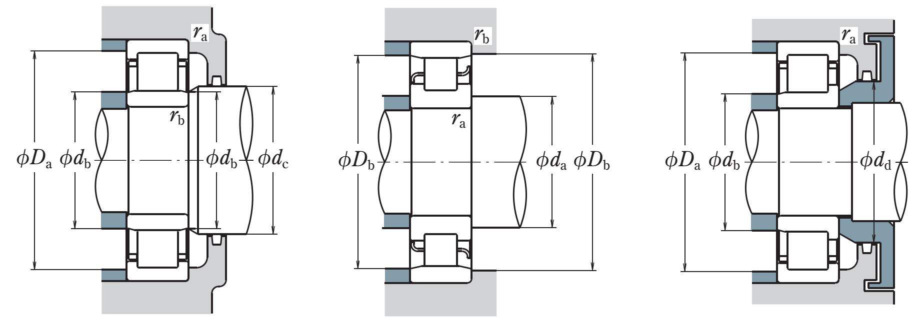
Notes (3) If axial loads are applied, increase d_a and reduce D_a from the values listed above.
(4) d_b (max.) are values for adjusting rings for NU, NJ Types.
(5) The limiting speeds(mechanical) in the bearing tables are the value for the standard cage type.

Remark The bearings denoted by an asterisk ( ) are NSKHPS™ Cylindrical roller bearings.

SINGLE-ROW CYLINDRICAL ROLLER BEARINGS

Bore Diameter 45 – 50 mm





Boundary Dimensions (mm)							Basic Load Ratings (N)		Speeds (min⁻¹)			Bearing Numbers								Abutment and Fillet Dimensions (mm)										Mass (kg)
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		Cage symbol(1) Standard	Cage symbol(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.	approx.
45	75	16	1	0.6	52.5	67.5	32 500	35 500	9 500	—	9 000	NU1009	(M)	—	NU	—	—	N	NF	50	49	51	54	—	70	71	68	1	0.6	0.279
	85	19	1.1	1.1	—	75	46 000	47 000	9 000	—	6 300	N 209	W	M	—	—	—	N	NF	51.5	—	—	—	—	—	78.5	77	1	1	0.429
	85	19	1.1	1.1	54.5	—	72 500	66 500	8 500	10 000	5 600	*NU209E	W	M, T, T7	NU	NJ	NUP	—	—	51.5	51.5	52	57	61	78.5	—	—	1	1	0.438
	85	19	1.1	1.1	54.5	—	63 000	66 500	8 500	10 000	5 600	NU209E	W	M, T, T7	NU	NJ	NUP	—	—	51.5	51.5	52	57	61	78.5	—	—	1	1	0.438
	85	23	1.1	1.1	54.5	—	87 500	84 500	8 500	12 000	6 700	*NU2209E	M	T, T7	NU	NJ	NUP	—	—	51.5	51.5	52	57	61	78.5	—	—	1	1	0.521
	85	23	1.1	1.1	54.5	—	76 000	84 500	8 500	12 000	6 700	NU2209E	M	T, T7	NU	NJ	NUP	—	—	51.5	51.5	52	57	61	78.5	—	—	1	1	0.521
	100	25	1.5	1.5	—	86.5	79 000	77 500	7 500	—	5 000	N 309	W	M	—	—	—	N	NF	53	—	—	—	—	—	92	77	1.5	1.5	0.869
	100	25	1.5	1.5	58.5	—	112 000	98 500	7 100	9 000	4 300	*NU309E	W	M, T, T7	NU	NJ	NUP	—	—	53	53	56	60	66	92	—	—	1.5	1.5	1.01
	100	25	1.5	1.5	58.5	—	97 500	98 500	7 100	9 000	4 300	NU309E	W	M, T, T7	NU	NJ	NUP	—	—	53	53	56	60	66	92	—	—	1.5	1.5	1.01
	100	36	1.5	1.5	58.5	—	158 000	153 000	7 100	11 000	5 300	*NU2309E	M	T, T7	NU	NJ	NUP	—	—	53	53	56	60	66	92	—	—	1.5	1.5	1.28
	100	36	1.5	1.5	58.5	—	137 000	153 000	7 100	11 000	5 300	NU2309E	M	T, T7	NU	NJ	NUP	—	—	53	53	56	60	66	92	—	—	1.5	1.5	1.28
	120	29	2	2	64.5	100.5	107 000	102 000	6 300	—	4 300	NU409	W	—	NU	NJ	NUP	N	NF	54	54	62	66	74	111	111	103	2	2	1.62
50	80	16	1	0.6	57.5	72.5	32 000	36 000	8 500	—	8 000	NU1010	(M)	—	NU	NJ	NUP	N	—	55	54	56	59	—	75	76	73	1	0.6	0.301
	90	20	1.1	1.1	—	80.4	48 000	51 000	8 500	—	5 600	N 210	W	M	—	—	—	N	NF	56.5	—	—	—	—	—	83.5	82	1	1	0.483
	90	20	1.1	1.1	59.5	—	79 500	76 500	8 000	9 000	5 000	*NU210E	W	M, T, T7	NU	NJ	NUP	—	—	56.5	56.5	57	62	67	83.5	—	—	1	1	0.50
	90	20	1.1	1.1	59.5	—	69 000	76 500	8 000	9 000	5 000	NU210E	W	M, T, T7	NU	NJ	NUP	—	—	56.5	56.5	57	62	67	83.5	—	—	1	1	0.50
	90	23	1.1	1.1	59.5	—	96 000	97 000	7 500	11 000	6 300	*NU2210E	M	T, T7	NU	NJ	NUP	—	—	56.5	56.5	57	62	67	83.5	—	—	1	1	0.562
	90	23	1.1	1.1	59.5	—	83 500	97 000	7 500	11 000	6 300	NU2210E	M	T, T7	NU	NJ	NUP	—	—	56.5	56.5	57	62	67	83.5	—	—	1	1	0.562
	110	27	2	2	—	95	87 000	86 000	7 100	—	4 500	N 310	W	M	—	—	—	N	NF	59	—	—	—	—	—	101	97	2	2	1.11
	110	27	2	2	65	—	127 000	113 000	6 700	8 000	4 000	*NU310E	W	M, T, T7	NU	NJ	NUP	—	—	59	59	63	67	73	101	—	—	2	2	1.3
	110	27	2	2	65	—	110 000	113 000	6 700	8 000	4 000	NU310E	W	M, T, T7	NU	NJ	NUP	—	—	59	59	63	67	73	101	—	—	2	2	1.3
	110	40	2	2	65	—	187 000	187 000	6 700	10 000	5 000	*NU2310E	M	T, T7	NU	NJ	NUP	—	—	59	59	63	67	73	101	—	—	2	2	1.7
	110	40	2	2	65	—	163 000	187 000	6 700	10 000	5 000	NU2310E	M	T, T7	NU	NJ	NUP	—	—	59	59	63	67	73	101	—	—	2	2	1.7
	130	31	2.1	2.1	—	110.8	139 000	136 000	5 600	—	4 000	N 410	W	M	—	—	—	N	NF	65	—	—	—	—	—	117	113	2	2	2
	130	31	2.1	2.1	70.8	—	129 000	124 000	5 600	—	4 000	NU410	W	M	NU	NJ	NUP	—	—	61	61	68	73	81	119	119	113.3	2	2	1.99

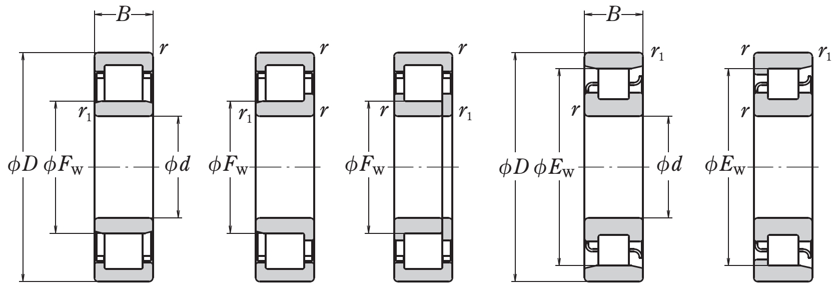
Notes (1) (M) in the column of cage symbols are usually omitted from the bearing number.
(2) When L-Shaped thrust collars (See section for L-Shaped Thrust Collars starting on page C156) are used, the bearings become the NH type.

Notes (3) If axial loads are applied, increase d_a and reduce D_a from the values listed above.
(4) d_b (max.) are values for adjusting rings for NU, NJ Types.
(5) The limiting speeds(mechanical) in the bearing tables are the value for the standard cage type.

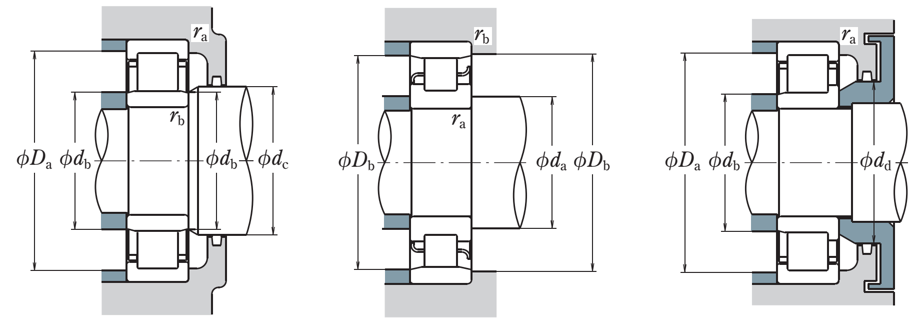
Remark The bearings denoted by an asterisk ( ) are NSKHPS™ Cylindrical roller bearings.

■SINGLE-ROW CYLINDRICAL ROLLER BEARINGS

Bore Diameter 55 – 60 mm



NU NJ NUP N NF



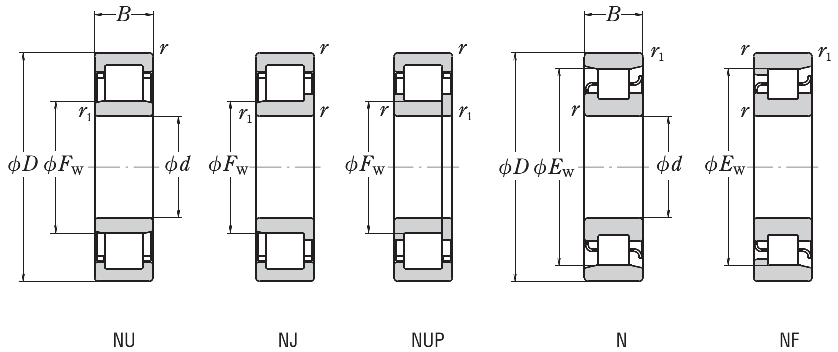
Boundary Dimensions (mm)							Basic Load Ratings (N)		Speeds (min⁻¹)			Bearing Numbers	Cage symbol(1)		(2)					Abutment and Fillet Dimensions (mm)										Mass (kg)
d	D	B	r min.	r_1 min.	F_W	E_W	C_r	C_{0r}	Thermal Reference Speed	Limiting Speeds (5) Mechanical	Limiting Speeds Grease		Standard	Option	NU	NJ	NUP	N	NF	d_a(3) min.	d_b min.	d_b(4) max.	d_c min.	d_d min.	D_a(3) max.	D_b max.	D_b min.	r_a max.	r_b max.	approx.
55	90	18	1.1	1	64.5	80.5	37 500	44 000	8 000	—	7 500	**NU1011**	(M)	—	NU	NJ	—	N	—	61.5	60	63	66	—	83.5	85	82	1	1	0.445
	100	21	1.5	1.1	—	88.5	58 000	62 500	7 500	—	5 300	**N 211**	W	M	—	—	—	N	NF	63	—	—	—	—	—	93.5	91	1.5	1	0.634
	100	21	1.5	1.1	66	—	99 000	98 500	6 700	8 500	4 500	**∗NU211E**	W	M, T, T7	NU	NJ	NUP	—	—	63	61.5	64	68	73	92	—	—	1.5	1	0.669
	100	21	1.5	1.1	66	—	86 500	98 500	6 700	8 500	4 500	**NU211E**	W	M, T, T7	NU	NJ	NUP	—	—	63	61.5	64	68	73	92	—	—	1.5	1	0.669
	100	25	1.5	1.1	66	—	117 000	122 000	6 700	10 000	5 600	**∗NU2211E**	M	T, T7	NU	NJ	NUP	—	—	63	61.5	64	68	73	92	—	—	1.5	1	0.783
	100	25	1.5	1.1	66	—	101 000	122 000	6 700	10 000	5 600	**NU2211E**	M	T, T7	NU	NJ	NUP	—	—	63	61.5	64	68	73	92	—	—	1.5	1	0.783
	120	29	2	2	—	104.5	111 000	111 000	6 300	—	4 000	**N 311**	W	M	—	—	—	N	NF	64	—	—	—	—	—	111	107	2	2	1.42
	120	29	2	2	70.5	—	158 000	143 000	6 000	7 500	3 600	**∗NU311E**	W	M, T, T7	NU	NJ	NUP	—	—	64	64	68	72	80	111	—	—	2	2	1.64
	120	29	2	2	70.5	—	137 000	143 000	6 000	7 500	3 600	**NU311E**	W	M, T, T7	NU	NJ	NUP	—	—	64	64	68	72	80	111	—	—	2	2	1.64
	120	43	2	2	70.5	—	231 000	233 000	6 000	9 000	4 500	**∗NU2311E**	M	T, T7	NU	NJ	NUP	—	—	64	64	68	72	80	111	—	—	2	2	2.18
	120	43	2	2	70.5	—	201 000	233 000	6 000	9 000	4 500	**NU2311E**	M	T, T7	NU	NJ	NUP	—	—	64	64	68	72	80	111	—	—	2	2	2.18
	140	33	2.1	2.1	77.2	117.2	139 000	138 000	5 300	—	3 800	**NU411**	W	—	NU	NJ	NUP	N	NF	66	66	75	79	87	129	129	119	2	2	2.5
60	95	18	1.1	1	69.5	85.5	40 000	48 500	7 500	—	6 700	**NU1012**	(M)	—	NU	NJ	—	N	NF	66.5	65	68	71	—	88.5	90	87	1	1	0.474
	110	22	1.5	1.5	—	97.5	68 500	75 000	7 100	—	4 800	**N 212**	W	M	—	—	—	N	NF	68	—	—	—	—	—	102	100	1.5	1.5	0.823
	110	22	1.5	1.5	72	—	112 000	107 000	6 300	7 500	4 300	**∗NU212E**	W	M, T, T7	NU	NJ	NUP	—	—	68	68	70	75	80	102	—	—	1.5	1.5	0.824
	110	22	1.5	1.5	72	—	97 500	107 000	6 300	7 500	4 300	**NU212E**	W	M, T, T7	NU	NJ	NUP	—	—	68	68	70	75	80	102	—	—	1.5	1.5	0.824
	110	28	1.5	1.5	72	—	151 000	157 000	6 300	9 500	5 300	**∗NU2212E**	M	T, T7	NU	NJ	NUP	—	—	68	68	70	75	80	102	—	—	1.5	1.5	1.06
	110	28	1.5	1.5	72	—	131 000	157 000	6 300	9 500	5 300	**NU2212E**	M	T, T7	NU	NJ	NUP	—	—	68	68	70	75	80	102	—	—	1.5	1.5	1.06
	130	31	2.1	2.1	—	113	124 000	126 000	6 000	—	3 800	**N 312**	W	M	—	—	—	N	NF	71	—	—	—	—	—	119	115	2	2	1.78
	130	31	2.1	2.1	77	—	124 000	126 000	6 000	—	3 800	**NU312**	W	M	NU	NJ	NUP	—	—	71	71	75	79	86	119	—	—	2	2	1.82
	130	31	2.1	2.1	77	—	169 000	157 000	5 600	9 500	4 800	**∗NU312E**	M	T, T7	NU	NJ	NUP	—	—	71	71	75	79	86	119	—	—	2	2	2.06
	130	31	2.1	2.1	77	—	150 000	157 000	5 600	9 500	4 800	**NU312E**	M	T, T7	NU	NJ	NUP	—	—	71	71	75	79	86	119	—	—	2	2	2.06
	130	46	2.1	2.1	77	—	251 000	262 000	5 600	8 500	4 300	**∗NU2312E**	M	T, T7	NU	NJ	NUP	—	—	71	71	75	79	86	119	—	—	2	2	2.7
	130	46	2.1	2.1	77	—	222 000	262 000	5 600	8 500	4 300	**NU2312E**	M	T, T7	NU	NJ	NUP	—	—	71	71	75	79	86	119	—	—	2	2	2.7
	150	35	2.1	2.1	83	127	167 000	168 000	5 000	—	3 400	**NU412**	W	M	NU	NJ	NUP	N	NF	71	71	80	85	94	139	139	130	2	2	3.04

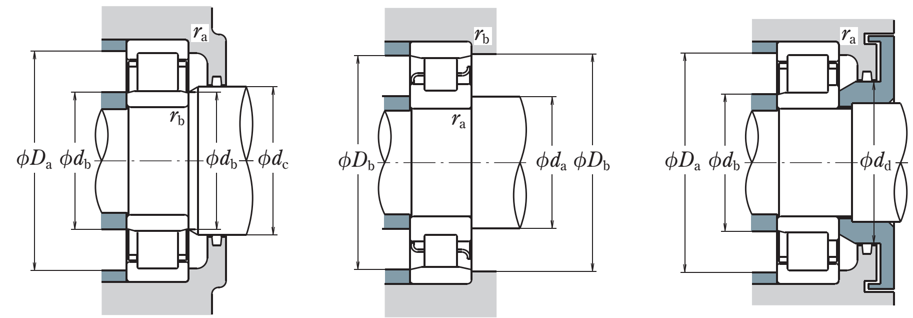
Notes (1) (M) in the column of cage symbols are usually omitted from the bearing number.
(2) When L-Shaped thrust collars (See section for L-Shaped Thrust Collars starting on page C156) are used, the bearings become the NH type.

Notes (3) If axial loads are applied, increase d_a and reduce D_a from the values listed above.
(4) d_b (max.) are values for adjusting rings for NU, NJ Types.
(5) The limiting speeds(mechanical) in the bearing tables are the value for the standard cage type.
Remark The bearings denoted by an asterisk ( ) are NSKHPS™ Cylindrical roller bearings.

SINGLE-ROW CYLINDRICAL ROLLER BEARINGS

Bore Diameter 65 – 70 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	Limiting Speeds Grease
65	100	18	1.1	1	74.5	90.5	41 000	51 000	6 700	—	6 300
	120	23	1.5	1.5	—	105.6	84 000	94 500	6 300	—	4 300
	120	23	1.5	1.5	78.5	—	124 000	119 000	6 000	7 100	3 800
	120	23	1.5	1.5	78.5	—	108 000	119 000	6 000	7 100	3 800
	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) (M) in the column of cage symbols are usually omitted from the bearing number.
(2) When L-Shaped thrust collars (See section for L-Shaped Thrust Collars starting on page C156) are used, the bearings become the NH type.

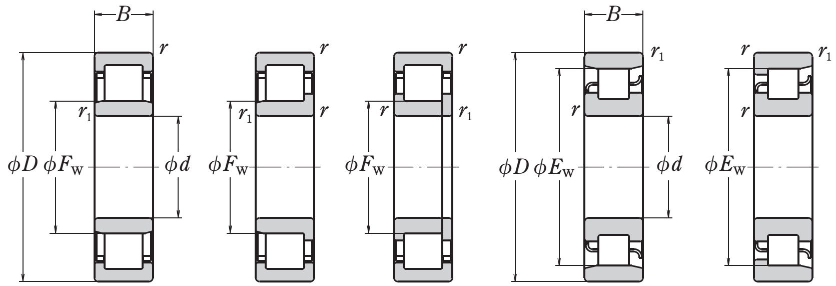
Bearing Numbers	Cage symbol (1) Standard	Option	NU (2)	NJ (2)	NUP (2)	N (2)	NF (2)	d_a (3) min.	d_b min.	d_b (4) max.	d_c min.	d_d min.	D_a (3) max.	D_b max.	D_b min.	r_a max.	r_b max.	Mass (kg) approx.
NU1013	(M)	—	NU	NJ	—	N	NF	71.5	70	73	76	—	93.5	95	92	1	1	0.504
N 213	W	M	—	—	—	N	NF	73	—	—	—	—	—	112	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.) are values for adjusting rings for NU, NJ Types.
(5) The limiting speeds(mechanical) in the bearing tables are the value for the standard cage type.

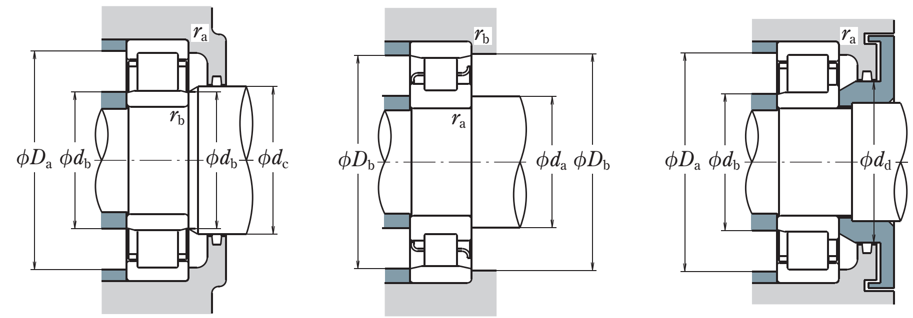
Remark The bearings denoted by an asterisk ( ) are NSKHPS™ Cylindrical roller bearings.

SINGLE-ROW CYLINDRICAL ROLLER BEARINGS

Bore Diameter 75 mm



NU NJ NUP N NF



Boundary Dimensions (mm)							Basic Load Ratings (N)		Speeds (min⁻¹)			Bearing Numbers								Abutment and Fillet Dimensions (mm)										Mass (kg)
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		Cage symbol(1) Standard	Cage symbol(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.	approx.
75	115	20	1.1	1	85	105	60 000	74 500	6 000	—	5 600	**NU1015**	**(M)**	—	**NU**	—	—	**N**	**NF**	81.5	80	83	87	—	108.5	110	106	1	1	0.731
	130	25	1.5	1.5	—	116.5	96 500	111 000	6 000	—	3 800	**N 215**	**W**	**M**	—	—	—	**N**	**NF**	83	—	—	—	—	—	122	119	1.5	1.5	1.23
	130	25	1.5	1.5	88.5	—	150 000	156 000	5 300	8 500	4 800	**∗NU215E**	**M**	**T, T7**	**NU**	**NJ**	**NUP**	—	—	83	83	86	90	96	122	—	—	1.5	1.5	1.44
	130	25	1.5	1.5	88.5	—	130 000	156 000	5 300	8 500	4 800	**NU215E**	**M**	**T, T7**	**NU**	**NJ**	**NUP**	—	—	83	83	86	90	96	122	—	—	1.5	1.5	1.44
	130	31	1.5	1.5	88.5	—	186 000	207 000	5 300	7 500	4 300	**∗NU2215E**	**M**	**T, T7**	**NU**	**NJ**	**NUP**	—	—	83	83	86	90	96	122	—	—	1.5	1.5	1.57
	130	31	1.5	1.5	88.5	—	162 000	207 000	5 300	7 500	4 300	**NU2215E**	**M**	**T, T7**	**NU**	**NJ**	**NUP**	—	—	83	83	86	90	96	122	—	—	1.5	1.5	1.57
	160	37	2.1	2.1	—	139.5	179 000	189 000	5 000	—	3 000	**N 315**	**W**	**M**	—	—	—	**N**	**NF**	86	—	—	—	—	—	149	143	2	2	3.2
	160	37	2.1	2.1	95.5	—	179 000	189 000	5 000	—	3 000	**NU315**	**W**	**M**	**NU**	**NJ**	**NUP**	—	—	86	86	93	97	106	149	—	—	2	2	3.26
	160	37	2.1	2.1	95	—	271 000	263 000	4 500	7 500	3 800	**∗NU315E**	**M**	**T, T7**	**NU**	**NJ**	**NUP**	—	—	86	86	92	97	106	149	—	—	2	2	3.73
	160	37	2.1	2.1	95	—	240 000	263 000	4 500	7 500	3 800	**NU315E**	**M**	**T, T7**	**NU**	**NJ**	**NUP**	—	—	86	86	92	97	106	149	—	—	2	2	3.73
	160	55	2.1	2.1	95	—	370 000	395 000	4 800	6 700	3 400	**∗NU2315E**	**M**	**T, T7**	**NU**	**NJ**	**NUP**	—	—	86	86	92	97	106	149	—	—	2	2	4.86
	160	55	2.1	2.1	95	—	330 000	395 000	4 800	6 700	3 400	**NU2315E**	**M**	**T, T7**	**NU**	**NJ**	**NUP**	—	—	86	86	92	97	106	149	—	—	2	2	4.86
	190	45	3	3	104.5	160.5	262 000	274 000	4 300	—	2 600	**NU415**	**W**	**M**	**NU**	**NJ**	—	**N**	**NF**	88	88	102	107	118	177	177	164	2.5	2.5	6.27

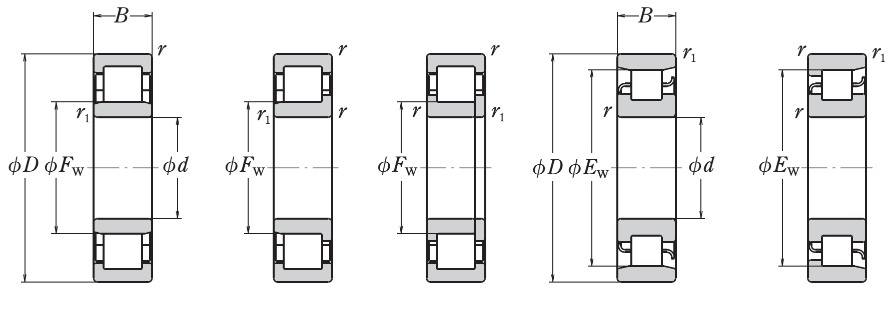
Notes (1) (M) in the column of cage symbols are usually omitted from the bearing number.
(2) When L-Shaped thrust collars (See section for L-Shaped Thrust Collars starting on page C156) are used, the bearings become the NH type.

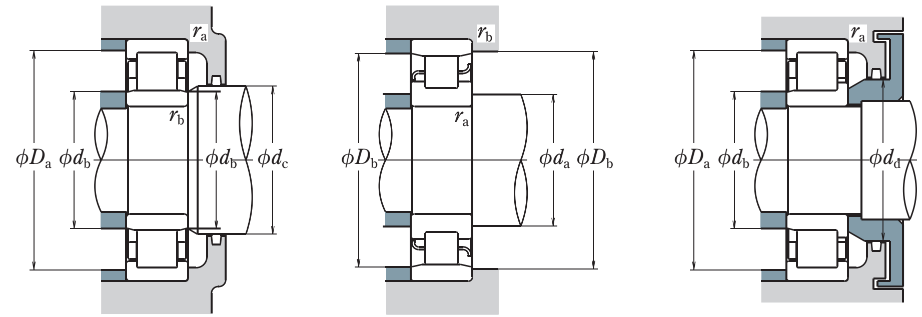
Notes (3) If axial loads are applied, increase d_a and reduce D_a from the values listed above.
(4) d_b (max.) are values for adjusting rings for NU, NJ Types.
(5) The limiting speeds(mechanical) in the bearing tables are the value for the standard cage type.

Remark The bearings denoted by an asterisk ( ) are NSKHPS™ Cylindrical roller bearings.

SINGLE-ROW CYLINDRICAL ROLLER BEARINGS

Bore Diameter 80 – 90 mm





Boundary Dimensions (mm)							Basic Load Ratings (N)		Speeds (min⁻¹)			Bearing Numbers	Cage symbol(1)		(2)					Abutment and Fillet Dimensions (mm)										Mass (kg)
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		Standard	Option	NU	NJ	NUP	N	NF	d_a(3) min.	d_b min.	d_b(4) max.	d_c min.	d_d min.	D_a(3) max.	D_b max.	D_b min.	r_a max.	r_b max.	approx.
80	125	22	1.1	1	91.5	113.5	72 500	90 500	6 000	—	5 300	**NU1016**	(M)	—	NU	—	NUP	N	—	86.5	85	90	94	—	118.5	120	115	1	1	0.969
	140	26	2	2	—	125.3	106 000	122 000	5 600	—	3 600	**N 216**	W	M	—	—	—	N	NF	89	—	—	—	—	—	131	128	2	2	1.47
	140	26	2	2	95.3	—	160 000	167 000	5 000	8 000	4 500	**∗NU216E**	M	T, T7	NU	NJ	NUP	—	—	89	89	92	97	104	131	—	—	2	2	1.7
	140	26	2	2	95.3	—	139 000	167 000	5 000	8 000	4 500	**NU216E**	M	T, T7	NU	NJ	NUP	—	—	89	89	92	97	104	131	—	—	2	2	1.7
	140	33	2	2	95.3	—	214 000	243 000	5 000	7 100	4 000	**∗NU2216E**	M	T, T7	NU	NJ	NUP	—	—	89	89	92	97	104	131	—	—	2	2	1.96
	140	33	2	2	95.3	—	186 000	243 000	5 000	7 100	4 000	**NU2216E**	M	T, T7	NU	NJ	NUP	—	—	89	89	92	97	104	131	—	—	2	2	1.96
	170	39	2.1	2.1	—	147	190 000	207 000	4 800	—	2 800	**N 316**	W	M	—	—	—	N	NF	91	—	—	—	—	—	159	150	2	2	3.85
	170	39	2.1	2.1	101	—	289 000	282 000	4 300	7 100	3 600	**∗NU316E**	M	T, T7	NU	NJ	NUP	—	—	91	91	98	105	114	159	—	—	2	2	4.45
	170	39	2.1	2.1	101	—	256 000	282 000	4 300	7 100	3 600	**NU316E**	M	T, T7	NU	NJ	NUP	—	—	91	91	98	105	114	159	—	—	2	2	4.45
	170	58	2.1	2.1	101	—	400 000	430 000	4 500	6 300	3 200	**∗NU2316E**	M	T, T7	NU	NJ	NUP	—	—	91	91	98	105	114	159	—	—	2	2	5.73
	170	58	2.1	2.1	101	—	355 000	430 000	4 500	6 300	3 200	**NU2316E**	M	T, T7	NU	NJ	NUP	—	—	91	91	98	105	114	159	—	—	2	2	5.73
	200	48	3	3	110	170	299 000	315 000	4 000	—	2 600	**NU416**	W	M	NU	NJ	—	N	NF	93	93	107	112	124	187	187	173	2.5	2.5	7.36
85	130	22	1.1	1	96.5	118.5	74 500	95 500	5 600	—	5 000	**NU1017**	(M)	—	NU	—	—	N	—	91.5	90	95	99	—	123.5	125	120	1	1	1.01
	150	28	2	2	—	133.8	120 000	140 000	5 300	—	3 400	**N 217**	W	M	—	—	—	N	NF	94	—	—	—	—	—	141	137	2	2	1.87
	150	28	2	2	100.5	—	192 000	199 000	4 800	7 500	4 300	**∗NU217E**	M	T, T7	NU	NJ	NUP	—	—	94	94	98	104	110	141	—	—	2	2	2.11
	150	28	2	2	100.5	—	167 000	199 000	4 800	7 500	4 300	**NU217E**	M	T, T7	NU	NJ	NUP	—	—	94	94	98	104	110	141	—	—	2	2	2.11
	150	36	2	2	100.5	—	250 000	279 000	4 800	6 700	3 800	**∗NU2217E**	M	T, T7	NU	NJ	NUP	—	—	94	94	98	104	110	141	—	—	2	2	2.44
	150	36	2	2	100.5	—	217 000	279 000	4 800	6 700	3 800	**NU2217E**	M	T, T7	NU	NJ	NUP	—	—	94	94	98	104	110	141	—	—	2	2	2.44
	180	41	3	3	—	156	225 000	247 000	4 500	—	2 600	**N 317**	W	M	—	—	—	N	NF	98	—	—	—	—	—	167	159	2.5	2.5	4.53
	180	41	3	3	108	—	212 000	228 000	4 800	—	2 600	**NU317**	W	N	NU	NJ	NUP	—	—	98	98	105	110	119	167	—	—	2.5	2.5	4.6
	180	41	3	3	108	—	291 000	330 000	4 000	6 700	3 400	**NU317E**	M	T, T7	NU	NJ	NUP	—	—	98	98	105	110	119	167	—	—	2.5	2.5	5.26
	180	60	3	3	108	—	395 000	485 000	4 300	6 000	3 000	**NU2317E**	M	T, T7	NU	NJ	NUP	—	—	98	98	105	110	119	167	—	—	2.5	2.5	6.77
	210	52	4	4	113	177	335 000	350 000	4 000	—	3 000	**NU417**	M	—	NU	NJ	—	N	NF	101	101	110	115	128	194	194	180	3	3	9.56
90	140	24	1.5	1.1	103	127	88 000	114 000	5 300	—	4 500	**NU1018**	(M)	—	NU	—	NUP	N	—	98	96.5	101	106	—	132	133.5	129	1.5	1	1.35
	160	30	2	2	—	143	152 000	178 000	5 000	—	3 200	**N 218**	W	M	—	—	—	N	NF	99	—	—	—	—	—	151	146	2	2	2.31
	160	30	2	2	107	—	205 000	217 000	4 800	7 100	4 000	**∗NU218E**	M	T, T7	NU	NJ	NUP	—	—	99	99	104	109	116	151	—	—	2	2	2.6
	160	30	2	2	107	—	182 000	217 000	4 800	7 100	4 000	**NU218E**	M	T, T7	NU	NJ	NUP	—	—	99	99	104	109	116	151	—	—	2	2	2.6
	160	40	2	2	107	—	274 000	315 000	4 800	6 300	3 600	**∗NU2218E**	M	T, T7	NU	NJ	NUP	—	—	99	99	104	109	116	151	—	—	2	2	3.11
	160	40	2	2	107	—	242 000	315 000	4 800	6 300	3 600	**NU2218E**	M	T, T7	NU	NJ	NUP	—	—	99	99	104	109	116	151	—	—	2	2	3.11
	190	43	3	3	—	165	240 000	265 000	4 500	—	2 600	**N 318**	W	M	—	—	—	N	NF	103	—	—	—	—	—	177	168	2.5	2.5	5.31
	190	43	3	3	115	—	240 000	265 000	4 500	—	2 600	**NU318**	W	M	NU	NJ	NUP	—	—	103	103	112	117	127	177	—	—	2.5	2.5	5.38
	190	43	3	3	113.5	—	315 000	355 000	4 000	6 300	3 200	**NU318E**	M	T, T7	NU	NJ	NUP	—	—	103	103	111	117	127	177	—	—	2.5	2.5	6.1
	190	64	3	3	113.5	—	435 000	535 000	4 000	5 600	2 800	**NU2318E**	M	T, T7	NU	NJ	NUP	—	—	103	103	111	117	127	177	—	—	2.5	2.5	7.9
	225	54	4	4	123.5	191.5	375 000	400 000	3 600	—	2 800	**NU418**	M	—	NU	NJ	—	N	NF	106	106	120	125	139	209	209	196	3	3	11.5

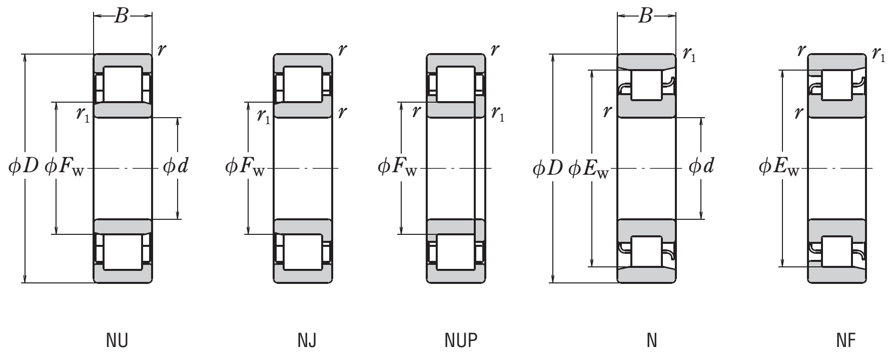
Notes (1) (M) in the column of cage symbols are usually omitted from the bearing number.
(2) When L-Shaped thrust collars (See section for L-Shaped Thrust Collars starting on pages C156 and C157) are used, the bearings become the NH type.

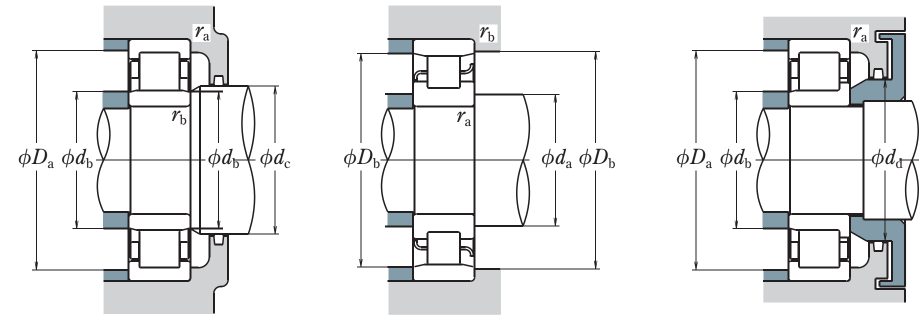
Notes (3) If axial loads are applied, increase d_a and reduce D_a from the values listed above.
(4) d_b (max.) are values for adjusting rings for NU, NJ Types.
(5) The limiting speeds(mechanical) in the bearing tables are the value for the standard cage type.

Remark The bearings denoted by an asterisk ( ) are NSKHPS™ Cylindrical roller bearings.

■SINGLE-ROW CYLINDRICAL ROLLER BEARINGS

Bore Diameter 95 – 110 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)		
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	195 000	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	—	335 000	385 000	3 800	6 000	3 000
	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	—	249 000	305 000	4 300	6 300	3 600
	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	—	380 000	425 000	3 600	5 600	2 800
	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	—	2 600
	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	—	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
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	—	293 000	365 000	4 000	5 600	3 200
	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	—	450 000	525 000	3 200	5 000	2 600
	280	65	4	4	155	—	550 000	620 000	2 600	—	2 200

Notes (1) (M) in the column of cage symbols are usually omitted from the bearing number.
(2) When L-Shaped thrust collars (See section for L-Shaped Thrust Collars starting on page C157) are used, the bearings become the NH type.

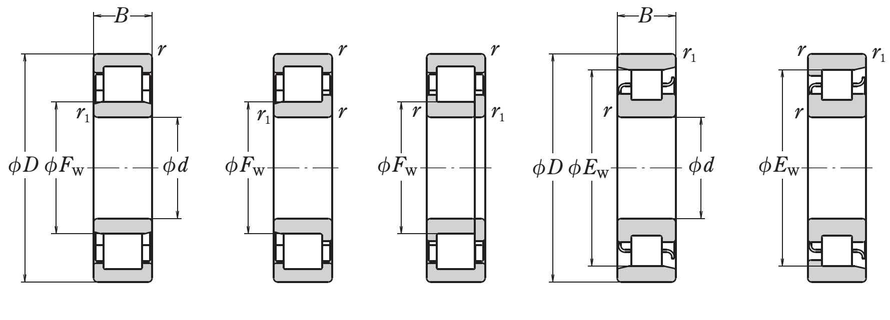
Bearing Numbers	Cage symbol(1) Standard	Cage symbol Option	NU (2)	NJ (2)	NUP (2)	N (2)	NF (2)	d_a(3) min.	d_b min.	d_b(4) max.	d_c min.	d_d min.	D_a(3) max.	D_b max.	D_b min.	r_a max.	r_b max.	Mass (kg) approx.
								Abutment and Fillet Dimensions (mm)										
NU1019	(M)	—	NU	NJ	—	N	—	103	101.5	106	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	T, T7	NU	NJ	NUP	—	—	108	108	118	124	134	187	—	—	2.5	2.5	7.13
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	T, T7	NU	NJ	NUP	—	—	111	111	116	122	130	169	—	—	2	2	3.81
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	T, T7	NU	NJ	NUP	—	—	113	113	124	132	143	202	—	—	2.5	2.5	8.63
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
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
NU421	M	—	NU	NJ	—	N	NF	121	121	141	147	162	244	244	225	3	3	17.3
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	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
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
NU422	M	—	NU	NJ	—	—	—	126	126	151	157	173	264	—	—	3	3	22.1

Notes (3) If axial loads are applied, increase d_a and reduce D_a from the values listed above.
(4) d_b (max.) are values for adjusting rings for NU, NJ Types.
(5) The limiting speeds(mechanical) in the bearing tables are the value for the standard cage type.

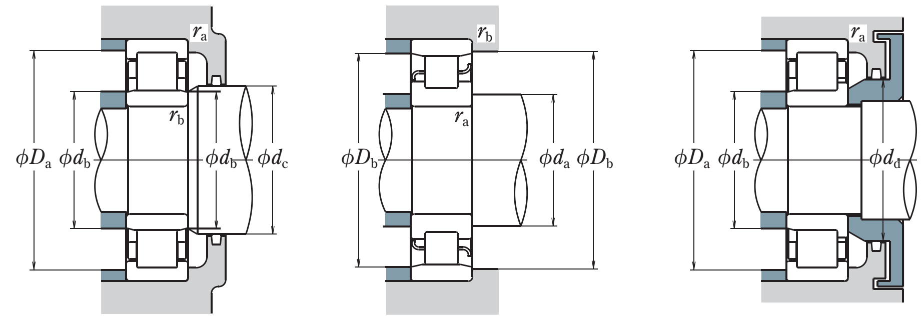
Remark The bearings denoted by an asterisk ( ) are NSKHPS™ Cylindrical roller bearings.

SINGLE-ROW CYLINDRICAL ROLLER BEARINGS

Bore Diameter 120 – 150 mm



NU NJ NUP N NF



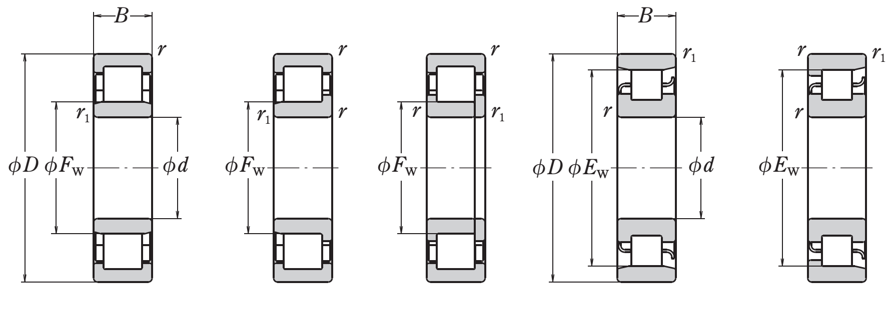
Boundary Dimensions (mm)							Basic Load Ratings (N)		Speeds (min⁻¹)			Bearing Numbers	Cage symbol(1)		(2)					Abutment and Fillet Dimensions (mm)										Mass (kg)
d	D	B	r min.	r_1 min.	F_W	E_W	C_r	C_{0r}	Thermal Reference Speed	Limiting Speeds (5) Mechanical	Limiting Speeds Grease		Standard	Option	NU	NJ	NUP	N	NF	d_a(3) min.	d_b min.	d_b(4) max.	d_c min.	d_d min.	D_a(3) max.	D_b max.	D_b min.	r_a max.	r_b max.	approx.
120	180	28	2	1.1	135	165	139 000	191 000	4 000	—	3 400	**NU1024**	(M)	—	NU	NJ	NUP	N	—	129	126.5	133	138	—	171	173.5	167	2	1	2.43
	215	40	2.1	2.1	—	191.5	260 000	320 000	4 000	—	2 400	**N 224**	W	M	—	—	—	N	NF	131	—	—	—	—	—	204	196	2	2	5.63
	215	40	2.1	2.1	143.5	—	335 000	420 000	3 600	5 300	3 000	**NU224E**	M	—	NU	NJ	NUP	—	—	131	131	140	146	156	204	—	—	2	2	6.43
	215	58	2.1	2.1	143.5	—	450 000	620 000	3 600	4 800	2 600	**NU2224E**	M	—	NU	NJ	NUP	—	—	131	131	140	146	156	204	—	—	2	2	9.51
	260	55	3	3	—	226	450 000	510 000	3 000	—	1 800	**N 324**	W	M	—	—	—	N	NF	133	—	—	—	—	—	247	230	2.5	2.5	12.9
	260	55	3	3	154	—	530 000	610 000	2 800	4 800	2 200	**NU324E**	M	—	NU	NJ	NUP	—	—	133	133	150	156	171	247	—	—	2.5	2.5	15
	260	86	3	3	154	—	795 000	1 030 000	2 600	4 300	2 000	**NU2324E**	M	—	NU	NJ	NUP	—	—	133	133	150	156	171	247	—	—	2.5	2.5	25
	310	72	5	5	170	260	675 000	770 000	2 400	—	2 000	**NU424**	M	—	NU	NJ	NUP	N	—	140	140	166	172	190	290	290	266	4	4	30.2
130	200	33	2	1.1	148	182	172 000	238 000	4 000	—	3 200	**NU1026**	(M)	—	NU	NJ	—	N	NF	139	136.5	146	151	—	191	193.5	184	2	1	3.66
	230	40	3	3	—	204	270 000	340 000	3 800	—	2 200	**N 226**	W	M	—	—	—	N	NF	143	—	—	—	—	—	217	208	2.5	2.5	6.48
	230	40	3	3	153.5	—	365 000	455 000	3 400	5 000	2 600	**NU226E**	M	T, T7	NU	NJ	NUP	—	—	143	143	150	158	168	217	—	—	2.5	2.5	8.03
	230	64	3	3	153.5	—	530 000	735 000	3 400	4 500	2 400	**NU2226E**	M	—	NU	NJ	NUP	—	—	143	143	150	158	168	217	—	—	2.5	2.5	9.44
	280	58	4	4	—	243	500 000	570 000	2 800	—	2 200	**N 326**	M	—	—	—	—	N	NF	146	—	—	—	—	—	264	247.5	3	3	17.7
	280	58	4	4	167	—	615 000	735 000	2 600	4 300	2 200	**NU326E**	M	—	NU	NJ	NUP	—	—	146	146	163	169	184	264	—	—	3	3	18.7
	280	93	4	4	167	—	920 000	1 230 000	2 400	3 800	1 900	**NU2326E**	M	—	NU	NJ	NUP	—	—	146	146	163	169	184	264	—	—	3	3	30
	340	78	5	5	185	285	825 000	955 000	2 000	—	1 800	**NU426**	M	—	NU	NJ	—	—	NF	150	150	180	187	208	320	320	291	4	4	39.6
140	210	33	2	1.1	158	192	176 000	250 000	3 800	—	3 000	**NU1028**	(M)	—	NU	NJ	NUP	N	—	149	146.5	156	161	—	201	203.5	194	2	1	3.87
	250	42	3	3	—	221	297 000	375 000	3 400	—	2 000	**N 228**	W	M	—	—	—	N	NF	153	—	—	—	—	—	237	225	2.5	2.5	8.08
	250	42	3	3	169	—	395 000	515 000	3 200	4 500	2 400	**NU228E**	M	—	NU	NJ	NUP	—	—	153	153	165	171	182	237	—	—	2.5	2.5	9.38
	250	68	3	3	169	—	550 000	790 000	3 200	4 000	2 200	**NU2228E**	M	—	NU	NJ	NUP	—	—	153	153	165	171	182	237	—	—	2.5	2.5	15.2
	300	62	4	4	—	260	550 000	640 000	2 600	—	2 000	**N 328**	M	—	—	—	—	N	NF	156	—	—	—	—	—	284	266	3	3	21.7
	300	62	4	4	180	—	665 000	795 000	2 400	4 000	2 000	**NU328E**	M	—	NU	NJ	NUP	—	—	156	156	176	182	198	284	—	—	3	3	22.8
	300	102	4	4	180	—	1 020 000	1 380 000	2 200	2 600	1 700	**NU2328E**	M	—	NU	NJ	NUP	—	—	156	156	176	182	198	284	—	—	3	3	37.7
	360	82	5	5	198	302	875 000	1 020 000	1 900	—	1 700	**NU428**	M	—	NU	NJ	—	N	—	160	160	193	200	222	340	340	308	4	4	46.4
150	225	35	2.1	1.5	169.5	205.5	202 000	294 000	3 600	—	2 800	**NU1030**	(M)	—	NU	NJ	—	N	NF	161	158	167	173	—	214	217	208	2	1.5	4.77
	270	45	3	3	—	238	360 000	465 000	3 000	—	1 800	**N 230**	W	M	—	—	—	N	NF	163	—	—	—	—	—	257	242	2.5	2.5	10.4
	270	45	3	3	182	—	450 000	595 000	2 800	4 300	2 200	**NU230E**	M	—	NU	NJ	NUP	—	—	163	163	177	184	196	257	—	—	2.5	2.5	11.9
	270	73	3	3	182	—	635 000	930 000	2 800	3 800	2 000	**NU2230E**	M	—	NU	NJ	NUP	—	—	163	163	177	184	196	257	—	—	2.5	2.5	19.3
	320	65	4	4	—	277	665 000	805 000	2 200	—	1 800	**N 330**	M	—	—	—	—	N	NF	166	—	—	—	—	—	304	283	3	3	25.8
	320	65	4	4	193	—	760 000	920 000	2 200	3 800	1 800	**NU330E**	M	—	NU	NJ	NUP	—	—	166	166	188	195	213	304	—	—	3	3	27.1
	320	108	4	4	193	—	1 160 000	1 600 000	2 000	2 400	1 600	**NU2330E**	M	—	NU	NJ	NUP	—	—	166	166	188	195	213	304	—	—	3	3	45.1
	380	85	5	5	213	—	930 000	1 120 000	1 700	—	1 600	**NU430**	M	—	NU	NJ	—	—	—	170	170	208	216	237	360	—	—	4	4	55.8

Notes (1) (M) in the column of cage symbols are usually omitted from the bearing number.
(2) When L-Shaped thrust collars (See section for L-Shaped Thrust Collars starting on page C157) are used, the bearings become the NH type.

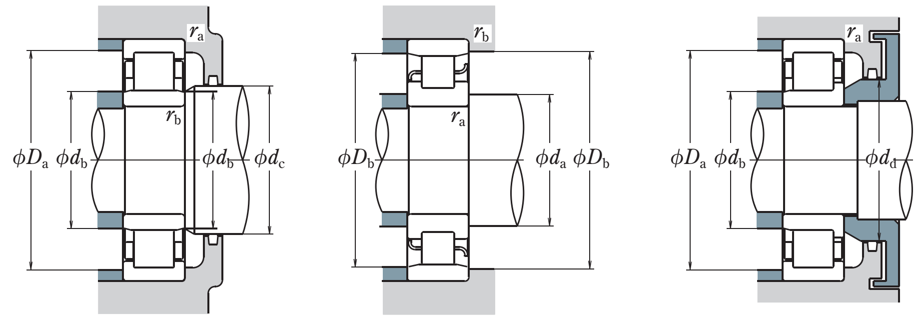
Notes (3) If axial loads are applied, increase d_a and reduce D_a from the values listed above.
(4) d_b (max.) are values for adjusting rings for NU, NJ Types.
(5) The limiting speeds(mechanical) in the bearing tables are the value for the standard cage type.

SINGLE-ROW CYLINDRICAL ROLLER BEARINGS

Bore Diameter 160 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)		
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	—	500 000	665 000	2 600	4 000	2 200
	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	—	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

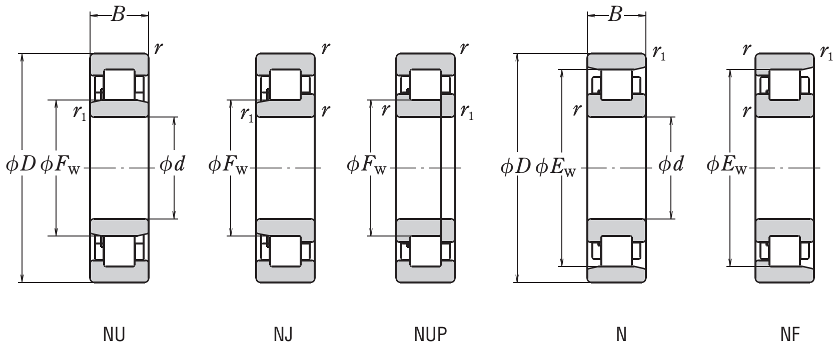
Notes (1) (M) in the column of cage symbols are usually omitted from the bearing number.
(2) When L-Shaped thrust collars (See section for L-Shaped Thrust Collars starting on page C157) are used, the bearings become the NH type.

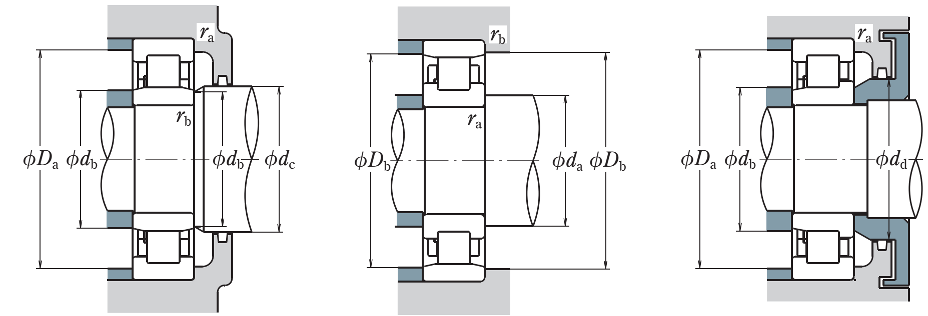
Bearing Numbers	Cage symbol (1) Standard	Cage symbol Option	NU (2)	NJ (2)	NUP (2)	N (2)	NF (2)	d_a (3) min.	d_b min.	d_b (4) max.	d_c min.	d_d min.	D_a (3) max.	D_b max.	D_b min.	r_a max.	r_b max.	Mass (kg) approx.
								Abutment and Fillet Dimensions (mm)										
NU1032	**(M)**	—	**NU**	**NJ**	—	**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
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
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.) are values for adjusting rings for NU, NJ Types.
(5) The limiting speeds(mechanical) in the bearing tables are the value for the standard cage type.

SINGLE-ROW CYLINDRICAL ROLLER BEARINGS

Bore Diameter 170 – 220 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 (4) Mechanical	Limiting Speeds 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	—	605 000	800 000	2 400	3 800	2 000
	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	—	625 000	850 000	2 200	3 600	1 900
	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	—	695 000	955 000	2 000	3 400	1 800
	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	—	765 000	1 060 000	1 900	3 200	1 700
	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
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	270	—	760 000	1 080 000	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

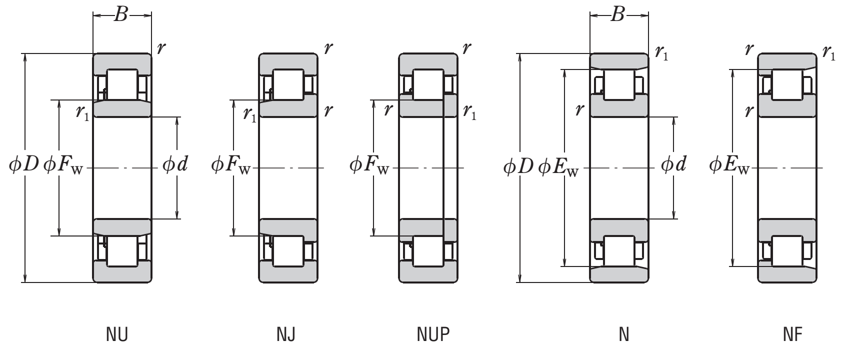
Notes (1) When L-Shaped thrust collars (See section for L-Shaped Thrust Collars starting on page C157) are used, the bearings become the NH type.
(2) If axial loads are applied, increase d_a and reduce D_a from the values listed above.

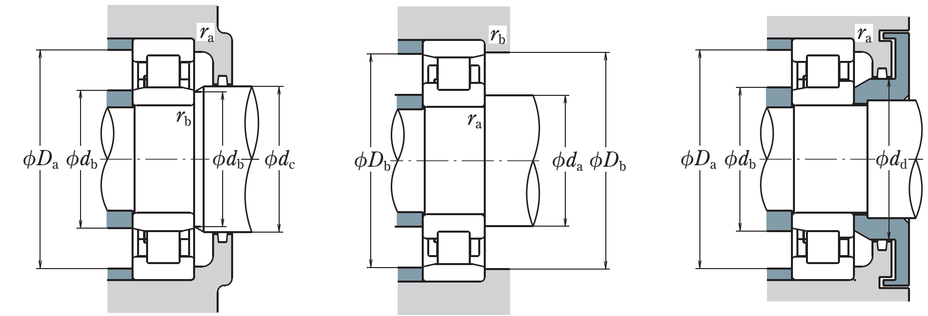
Bearing Numbers								Abutment and Fillet Dimensions (mm)										Mass (kg)
	Cage symbol Standard	Cage symbol Option	NU (1)	NJ (1)	NUP (1)	N (1)	NF (1)	d_a(2) min.	d_b min.	d_b(3) max.	d_c min.	d_d min.	D_a(2) max.	D_b max.	D_b min.	r_a max.	r_b max.	approx.
NU1034	**(M)**	—	**NU**	**NJ**	—	**N**	—	181	181	190	197	—	249	249	239	2	2	7.91
N 234	**M**	—	—	—	—	**N**	**NF**	186	—	—	—	—	—	294	278	3	3	17.4
NU234E	**M**	—	**NU**	**NJ**	**NUP**	—	—	186	186	202	211	223	294	—	—	3	3	18.3
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
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
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
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
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
NU244	**M**	—	**NU**	**NJ**	**NUP**	—	—	236	236	264	273	289	384	—	—	3	3	37.3
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

Notes (3) d_b (max.) are values for adjusting rings for NU, NJ Types.
(4) The limiting speeds(mechanical) in the bearing tables are the value for the standard cage type.

SINGLE-ROW CYLINDRICAL ROLLER BEARINGS

Bore Diameter 240 – 500 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}		Mechanical	Grease
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

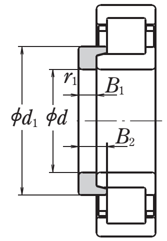
Bearing Numbers								Abutment and Fillet Dimensions (mm)										Mass (kg)
	Cage symbol		(1)															
	Standard	Option	NU	NJ	NUP	N	NF	d_a(2) min.	d_b min.	d_b(3) max.	d_c min.	d_d min.	D_a(2) max.	D_b max.	D_b min.	r_a max.	r_b max.	approx.
NU1048	**(M)**	—	**NU**	**NJ**	—	**N**	—	253	253	266	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 (1) When L-Shaped thrust collars (See section for L-Shaped Thrust Collars starting on page C157) are used, the bearings become the NH type.
(2) If axial loads are applied, increase d_a and reduce D_a from the values listed above.
(3) d_b (max.) are values for adjusting rings for NU, NJ Types.

CYLINDRICAL ROLLER BEARINGS

L-Shaped Thrust Collars

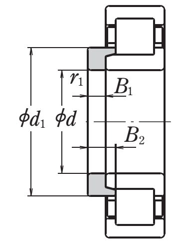
Bore Diameter 20 – 85 mm



L-Shaped Thrust Collar

Boundary Dimensions (mm)					Bearing Numbers	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

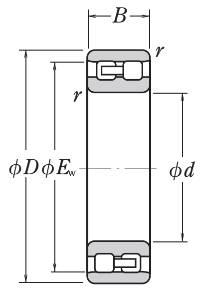


L-Shaped Thrust Collar

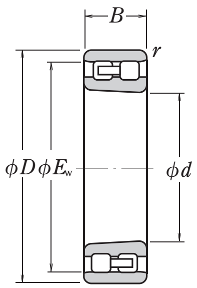
Boundary Dimensions (mm)					Bearing Numbers	Mass (kg)
d	d_1	B_1	B_2	r_1 min.		approx.
90	114.3	9	14	2	HJ 218 E	0.32
	114.3	9	15	2	HJ 2218 E	0.325
	124.2	12	18.5	3	HJ 318 E	0.63
	124.2	12	22	3	HJ 2318 E	0.66
	137	14	24	4	**HJ 418**	1.05
95	120.6	9	14	2.1	HJ 219 E	0.355
	120.6	9	15.5	2.1	HJ 2219 E	0.365
	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
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

DOUBLE-ROW CYLINDRICAL ROLLER BEARINGS

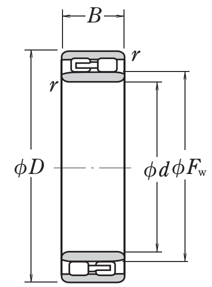
Bore Diameter 25 – 140 mm



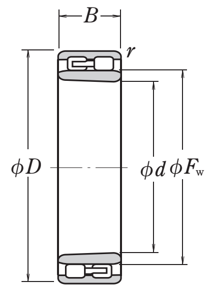
NN
Cylindrical Bore



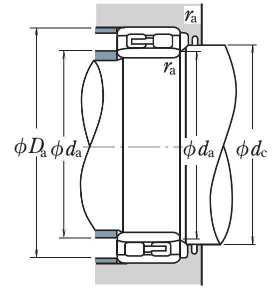
NN
Tapered Bore

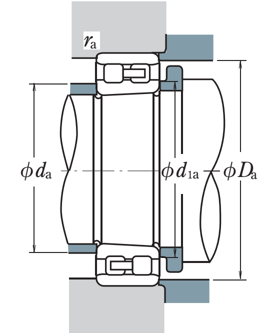


NNU
Cylindrical Bore



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

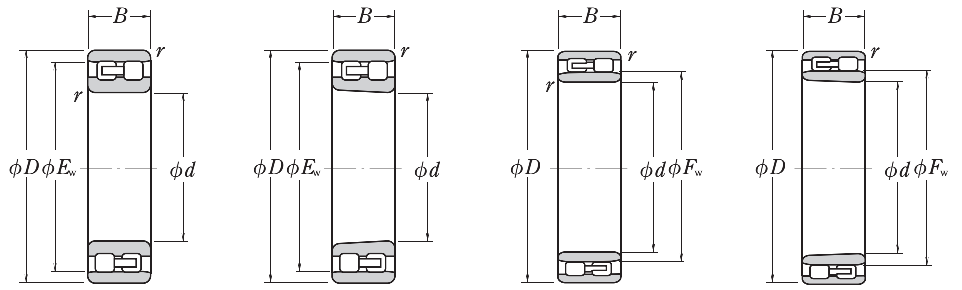
Note (1) The suffix K represents bearings with tapered bores (taper 1 : 12).
Remark Production of double-row cylindrical roller bearings is generally in the high precision classes (Class 5 or better).

Bearing Numbers		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

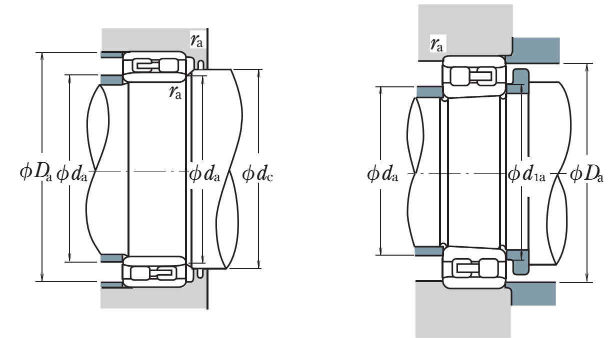
Note (2) d_a (max.) are values for adjusting rings for the NNU Type.

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) The suffix K represents bearings with tapered bores (taper 1 : 12).
Remark Production of double-row cylindrical roller bearings is generally in the high precision classes (Class 5 or better).

Bearing Numbers		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.) are values for adjusting rings for the NNU Type.

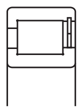
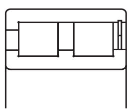
FULL-COMPLEMENT CYLINDRICAL ROLLER BEARINGS SINGLE-ROW(NCF), DOUBLE-ROW(NNCF)

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.

The open-type single- and double-row bearings are mostly used in general industrial applications at low speed and under heavy load, and the shielded-type double-row bearings are often used in crane sheaves.

Table 1 Features of Various Types

Figure	Type	Design and Features
	NCF	The outer and inner rings and rollers are non-separable since a retaining snap ring is installed at the side opposite the outer ring rib. They can sustain axial loads in only one direction.
	NNCF	NNCF is a double-row version of NCF. They 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			
	Normal to heavy loads			
	Light or fluctuating loads			

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 on 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 type double-row cylindrical roller bearings, but they are widely used also for 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	—

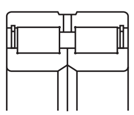
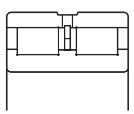
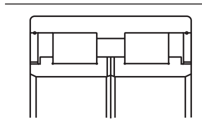
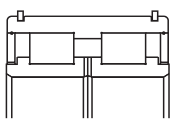
Since all are non-separable type bearings, the inner and outer rings cannot be separated, but the RSF type can be used as a free-end bearing. In this case, the permissible axial displacement is listed in the bearing tables.

Since cylindrical roller bearings for sheaves are a double-row, full-complement type, they can withstand heavy shock loads and moments and have sufficient axial load capacity for use in sheaves.

Since the shielded type is a kind of bearing unit, the number of parts surrounding the bearing can be reduced, so it allows for a simple compact design.

The surface of these bearings is treated for rust prevention.

Table 2 Features of Various Types

Figure	Type	Design and Features
	RS-48E4 RS-49E4	Double-row outer ring with center rib, two single-row inner rings with ribs. The outer and inner rings and rollers are non-separable since there are two retaining snap rings at the sides of the outer ring. They can suntain an axial load in either direction so they can be used as fixed-end bearings. An oil groove and holes are provided at the center of the outer ring.
	RSF-48E4 RSF-49E4	Double-row outer ring without ribs, double-row inner ring with three ribs. The outer and inner rings and rollers are non-separable since there is a retaining snap ring at the middle of the outer ring. They can be used as free-end bearings. The permissible axial movement is listed in the dimensional tables. An oil groove and holes are provided at the center of the outer ring.
 	RS-50 RS-50NR	Both sides shielded, double-row outer ring with center rib, 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 holes in parts mating with the inner rings. If there are snap rings at the outside of the outer ring, this type becomes RS-50NR. They are surface-treated for rust prevention.

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 they are used with inner ring rotation in general applications, and the internal clearance should conform to Table 4.

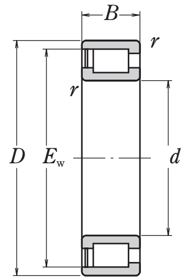
Table 4

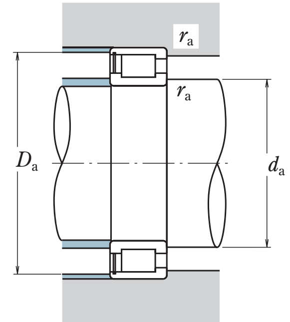
Units : m

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

FULL-COMPLEMENT CYLINDRICAL ROLLER BEARINGS

NCF Type, Single-Row
Bore Diameter 100 – 260 mm



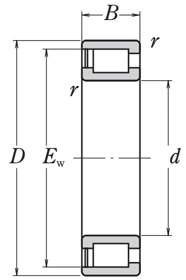


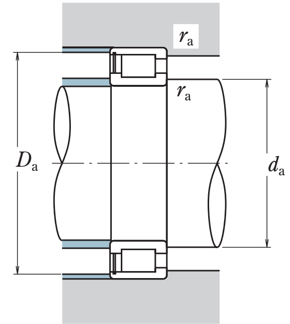
Boundary Dimensions (mm)					Basic Load Ratings (kN)		Bearing Numbers	Abutment and Fillet Dimensions (mm)			Mass (kg)
d	D	B	r min.	E_W	C_r	C_{0r}		d_a	D_a	r_a max.	approx.
100	140	24	1.1	130.5	132	209	**NCF2920V**	109	131	1	1.0
	150	37	1.5	139.7	209	310	**NCF3020V**	111	140	1.5	2.1
110	150	24	1.1	141	138	229	**NCF2922V**	119	142	1	1.1
	170	45	2	156.3	278	405	**NCF3022V**	122	157	2	3.3
120	165	27	1.1	154	177	305	**NCF2924V**	130	155	1	1.7
	180	46	2	167.58	293	440	**NCF3024V**	132	168	2	3.6
130	180	30	1.5	166.5	210	370	**NCF2926V**	141	168	1.5	2.2
	200	52	2	183.81	415	615	NCF3026V	142	187	2	5.6
140	190	30	1.5	179.4	227	395	**NCF2928V**	151	180	1.5	2.3
	210	53	2	197.82	435	680	**NCF3028V**	152	198	2	5.9
150	210	36	2	195	289	505	**NCF2930V**	163	196	2	3.7
	225	56	2.1	206.82	460	710	**NCF3030V**	165	209	2	7.1
160	220	36	2	207	310	535	**NCF2932V**	173	208	2	3.8
	240	60	2.1	224.8	520	810	**NCF3032V**	175	225	2	8.6
170	215	22	1.5	203.5	149	272	**NCF1834V**	182	204	1.5	1.8
	230	36	2	218	320	570	**NCF2934V**	183	219	2	4.1
	260	67	2.1	242.87	675	1 070	**NCF3034V**	185	244	2	11.9
180	225	22	1.5	215	154	290	**NCF1836V**	192	216	1.5	1.8
	250	42	2	231.5	390	695	**NCF2936V**	193	236	2	6.0
	280	74	2.1	260.3	785	1 260	**NCF3036V**	195	263	2	15.8
190	240	24	1.5	228.7	178	335	NCF1838V	202	229	1.5	2.4
	260	42	2	243.6	435	785	**NCF2938V**	203	245	2	6.5
	290	75	2.1	269.9	805	1 320	**NCF3038V**	206	273	2	16.7
200	250	24	1.5	237	182	350	**NCF1840V**	213	238	1.5	2.5
	280	48	2.1	261	530	955	**NCF2940V**	216	263	2	8.9
	310	82	2.1	287.8	910	1 510	**NCF3040V**	216	293	2	21.4
220	270	24	2	257.7	191	385	**NCF1844V**	234	258	2	2.7
	300	48	2.1	282	555	1 050	**NCF2944V**	236	283	2	9.6
	340	90	3	312.3	1 100	1 820	**NCF3044V**	238	320	2.5	28.2
240	300	28	2	283	236	470	**NCF1848V**	254	285	2	4.2
	320	48	2.1	303	580	1 140	**NCF2948V**	257	304	2	10.4
	360	92	3	335.25	1 160	1 990	**NCF3048V**	259	340	2.5	31.2
260	320	28	2	307	247	510	**NCF1852V**	275	308	2	4.5
	360	60	2.1	333.2	750	1 460	**NCF2952V**	277	342	2	18.1
	400	104	4	376.1	1 570	2 600	**NCF3052V**	282	377	3	45.3

Remark Full-complement cylindrical roller bearings are designed for specific applications, when using them, please contact .

FULL-COMPLEMENT CYLINDRICAL ROLLER BEARINGS

NCF Type, Single-Row
Bore Diameter 300 – 800 mm





Boundary Dimensions (mm)					Basic Load Ratings (kN)		Bearing Numbers	Abutment and Fillet Dimensions (mm)			Mass (kg)
d	D	B	r min.	E_W	C_r	C_{0r}		d_a	D_a	r_a max.	approx.
300	380	38	2.5	359	445	870	NCF1860V	319	360	2	9.7
	420	72	3	389.6	1 120	2 200	NCF2960V	320	398	2.5	30.7
	460	118	4	431.7	1 980	3 500	NCF3060V	323	435	3	67.6
320	400	38	2.1	380	460	925	NCF1864V	338	381	2	10.3
	440	72	3	410	1 150	2 340	NCF2964V	340	418	2.5	33
	480	121	4	449.6	2 170	3 900	NCF3064V	343	454	3	73
340	420	38	2.1	401	475	985	NCF1868V	359	402	2	10.7
	460	72	3	430.3	1 190	2 470	NCF2968V	361	438	2.5	34.1
	520	133	5	485.8	2 480	4 350	NCF3068V	368	490	4	97
360	440	38	2.5	422	490	1 040	NCF1872V	380	423	2	11.5
	480	72	3	450.7	1 220	2 610	NCF2972V	381	457	2.5	36
	540	134	5	503.6	2 550	4 600	NCF3072V	388	509	4	102
380	480	46	2.5	452.8	575	1 230	NCF1876V	400	458	2	18.6
	520	82	4	486.7	1 600	3 350	NCF2976V	404	493	3	52
	560	135	5	521.4	2 610	4 800	NCF3076V	408	529	4	108
400	500	46	2.5	475.7	590	1 300	NCF1880V	421	478	2	19.5
	540	82	4	511	1 650	3 550	NCF2980V	425	513	3	53.4
	600	148	5	558.7	3 050	5 750	NCF3080AV	429	568	4	139
420	520	46	2.1	491	600	1 340	NCF1884V	440	498	2	20.5
	560	82	4	523.2	1 680	3 650	NCF2984V	445	533	3	55.7
	620	150	5	577.7	3 000	5 650	NCF3084V	449	588	4	147
440	540	46	2.1	514	615	1 410	NCF1888V	461	518	2	21.3
	600	95	4	562	2 070	4 300	NCF2988V	466	572	3	78.2
460	580	56	3	552.7	920	1 950	NCF1892V	483	555	2.5	32.5
	620	95	4	576.5	2 100	4 450	NCF2992V	486	591	3	81.2
480	600	56	3	573	940	2 040	NCF1896V	503	575	2.5	33.8
	650	100	5	615	2 380	5 100	NCF2996V	510	617	4	95.1
500	620	56	3	593.5	960	2 120	NCF18/500V	524	594	2.5	35
	670	100	5	630.2	2 420	5 250	NCF29/500V	531	637	4	98.4
530	650	56	3	624	990	2 240	NCF18/530V	554	625	2.5	36.9
560	680	56	3	654.7	1 020	2 360	NCF18/560V	585	655	2.5	39.3
	820	195	6	770	5 600	11 300	NCF30/560V	598	778	5	332.5
600	730	60	3	695.5	1 140	2 680	NCF18/600V	626	702	2.5	48.9
	800	118	5	752	3 050	7 300	NCF29/600V	633	764	4	164.9
630	780	69	4	742	1 470	3 400	NCF18/630V	659	748	3	68.8
670	820	69	4	780	1 520	3 550	NCF18/670V	700	787	3	72.7
710	870	74	4	832.5	1 650	3 900	NCF18/710V	741	836	3	87.6
750	920	78	5	882.3	1 930	4 600	NCF18/750V	786	883	4	103.3
800	980	82	5	936	2 110	5 100	NCF18/800V	832	950	4	123.1

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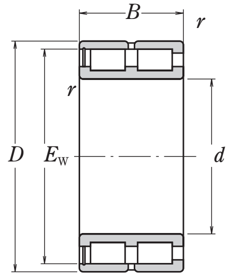
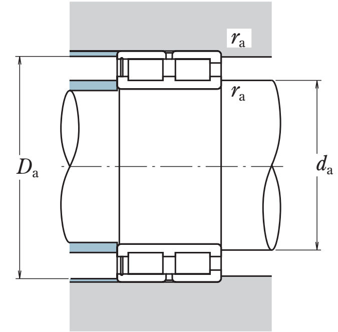
FULL-COMPLEMENT CYLINDRICAL ROLLER BEARINGS

NNCF Type, Double-Row
Bore Diameter 100 – 260 mm



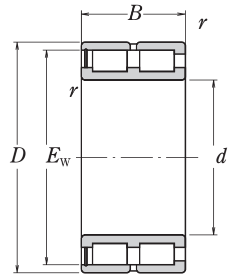


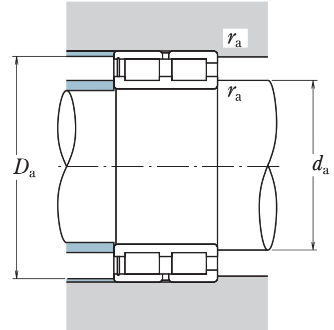
Boundary Dimensions (mm) d	D	B	r min.	E_W	Basic Load Ratings (kN) C_r	C_{0r}	Bearing Numbers	Abutment and Fillet Dimensions (mm) d_a	D_a	r_a max.	Mass (kg) approx.
100	140	40	1.1	129.8	194	400	NNCF4920V	109	130	1	2.0
	150	67	1.5	139.7	360	615	**NNCF5020V**	111	140	1.5	3.8
110	150	40	1.1	138.4	202	430	NNCF4922V	119	140	1	2.1
	170	80	2	156.3	490	840	**NNCF5022V**	122	157	2	6.1
120	165	45	1.1	153.8	226	480	NNCF4924V	130	155	1	2.9
	180	80	2	167.58	500	885	**NNCF5024V**	132	168	2	6.5
130	180	50	1.5	165.7	262	555	NNCF4926V	141	168	1.5	3.9
	200	95	2	183.81	710	1 230	NNCF5026V	142	187	2	10.3
140	190	50	1.5	176.2	272	595	NNCF4928V	151	178	1.5	4.2
	210	95	2	197.82	750	1 360	**NNCF5028V**	152	198	2	10.8
150	210	60	2	191.6	390	865	NNCF4930V	163	196	2	6.6
	225	100	2.1	206.82	785	1 420	**NNCF5030V**	165	209	2	13
160	220	60	2	204.1	410	930	NNCF4932V	173	206	2	7.0
	240	109	2.1	224.8	895	1 620	**NNCF5032V**	175	225	2	15.8
170	230	60	2	212.4	415	975	**NNCF4934V**	183	216	2	7.3
	260	122	2.1	242.87	1 160	2 140	**NNCF5034V**	185	244	2	22.1
180	250	69	2	230.5	550	1 230	**NNCF4936V**	193	236	2	10.7
	280	136	2.1	260.3	1 340	2 510	**NNCF5036V**	195	263	2	29.4
190	260	69	2	240.7	565	1 290	**NNCF4938V**	203	245	2	11.1
	290	136	2.1	269.9	1 380	2 630	NNCF5038V	206	273	2	30.8
200	250	50	1.5	235.9	320	825	NNCF4840V	213	237	1.5	5.9
	280	80	2.1	259.5	665	1 500	NNCF4940V	216	263	2	15.7
	310	150	2.1	287.75	1 560	3 000	NNCF5040V	216	293	2	39.7
220	270	50	1.5	256.9	340	905	NNCF4844V	233	257	1.5	6.4
	300	80	2.1	277	695	1 620	NNCF4944V	236	283	2	17
	340	160	3	312.3	1 890	3 650	**NNCF5044V**	238	320	2.5	50.7
240	300	60	2	282.6	495	1 340	NNCF4848V	254	285	2	10.3
	320	80	2.1	300	725	1 770	NNCF4948V	257	302	2	18.4
	360	160	3	335.25	1 990	4 000	**NNCF5048V**	259	340	2.5	54.3
260	320	60	2	303.6	515	1 450	NNCF4852V	275	304	2	11
	360	100	2.1	331.5	1 050	2 530	NNCF4952V	277	342	2	32
	400	190	4	376.1	2 690	5 200	NNCF5052V	282	377	3	82.7

Remark Full-complement cylindrical roller bearings are designed for specific applications, when using them, please contact .

FULL-COMPLEMENT CYLINDRICAL ROLLER BEARINGS

NNCF Type, Double-Row
Bore Diameter 280 – 500 mm



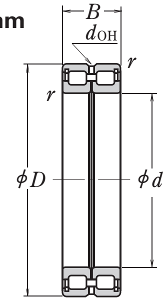


Boundary Dimensions (mm)					Basic Load Ratings (kN)		Bearing Numbers	Abutment and Fillet Dimensions (mm)			Mass (kg)
d	D	B	r min.	E_W	C_r	C_{0r}		d_a	D_a	r_a max.	approx.
280	350	69	2	332.5	685	1 860	NNCF4856V	295	334	2	16
	380	100	2.1	352.5	1 090	2 720	NNCF4956V	297	361	2	34
	420	190	4	390.5	2 770	5 450	NNCF5056V	302	395	3	87.7
300	380	80	2.1	357.2	805	2 160	NNCF4860V	318	361	2	23
	420	118	3	386.5	1 580	3 800	NNCF4960V	320	398	2.5	52
	460	218	4	431.7	3 400	7 000	NNCF5060V	323	435	3	125
320	400	80	2.1	380.2	835	2 310	NNCF4864V	338	381	2	24.3
	440	118	3	404.5	1 620	4 000	NNCF4964V	340	418	2.5	55
	480	218	4	446.9	3 500	7 350	NNCF5064V	343	454	3	131
340	420	80	2.1	397.4	855	2 430	NNCF4868V	359	400	2	25.6
	460	118	3	431	1 690	4 300	NNCF4968V	361	438	2.5	58
	520	243	5	485.8	4 250	8 750	NNCF5068V	368	490	4	177
360	440	80	2.1	420.4	885	2 580	NNCF4872V	379	421	2	27
	480	118	3	449	1 730	4 500	NNCF4972V	381	457	2.5	61
	540	243	5	503.6	4 350	9 150	NNCF5072V	388	509	4	186
380	480	100	2.1	450.6	1 260	3 600	NNCF4876V	399	459	2	45.5
	520	140	4	482.5	2 180	5 650	NNCF4976V	404	493	3	90.5
	560	243	5	521.4	4 500	9 600	NNCF5076V	408	529	4	194
400	500	100	2.1	471.7	1 290	3 750	NNCF4880V	420	479	2	47.5
	540	140	4	503	2 240	5 900	NNCF4980V	425	513	3	94.5
	600	272	5	558.7	5 050	10 900	NNCF5080V	429	568	4	256
420	520	100	2.1	492	1 320	3 950	NNCF4884V	440	498	2	49.5
	560	140	4	523	2 290	6 200	NNCF4984V	445	533	3	98.5
	620	272	5	577.7	5 150	11 300	**NNCF5084V**	449	588	4	267
440	540	100	2.1	513	1 350	4 150	NNCF4888V	461	518	2	51.5
	600	160	4	560.5	3 000	7 850	NNCF4988V	466	572	3	136
460	580	118	3	549.2	1 730	5 150	NNCF4892V	483	555	2.5	77.5
	620	160	4	573	3 050	8 050	NNCF4992V	486	591	3	142
480	600	118	3	565.8	1 760	5 300	NNCF4896V	503	575	2.5	80.5
	650	170	5	603	3 350	8 900	NNCF4996V	510	617	4	167
500	620	118	3	590.7	1 810	5 600	NNCF48/500V	524	594	2.5	83.5
	670	170	5	629	3 400	9 350	NNCF49/500V	531	637	4	173

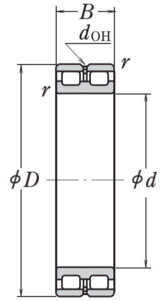
Remark Full-complement cylindrical roller bearings are designed for specific applications, when using them, please contact .

FULL-COMPLEMENT CYLINDRICAL ROLLER BEARINGS FOR SHEAVES

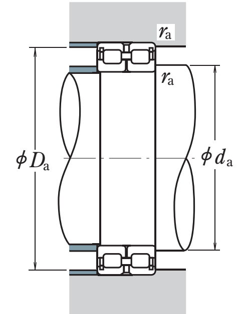
RS-48 · RS-49 Types
RSF-48 · RSF-49 Types
Bore Diameter 50 – 220 mm



Fixed-End Bearing
RS



Free-End Bearing
RSF



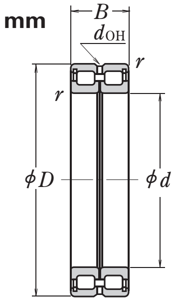
Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers[1]		Dimensions (mm)		Abutment and Fillet Dimensions (mm)			Mass (kg)
d	D	B	r min.	C_r	C_{0r}	Grease	Oil	Fixed-End Bearing	Free-End Bearing	d_{OH}[2]	Axial Disp.[3]	d_a min.	D_a max.	r_a max.	approx.
50	72	22	0.6	48 000	75 500	2 000	4 000	**RS-4910E4**	**RSF-4910E4**	2.5	1.5	54	68	0.6	0.30
60	85	25	1	68 500	118 000	1 600	3 200	**RS-4912E4**	**RSF-4912E4**	2.5	1.5	65	80	1	0.46
65	90	25	1	70 500	125 000	1 600	3 200	**RS-4913E4**	**RSF-4913E4**	2.5	2	70	85	1	0.50
70	100	30	1	102 000	168 000	1 400	2 800	**RS-4914E4**	**RSF-4914E4**	3	2	75	95	1	0.79
80	110	30	1	109 000	191 000	1 300	2 600	**RS-4916E4**	**RSF-4916E4**	3	2	85	105	1	0.89
90	125	35	1.1	147 000	268 000	1 100	2 200	**RS-4918E4**	**RSF-4918E4**	3	2	96.5	118.5	1	1.35
100	125	25	1	87 500	189 000	1 100	2 200	**RS-4820E4**	**RSF-4820E4**	2.5	1.5	105	120	1	0.74
	140	40	1.1	194 000	400 000	1 000	2 000	**RS-4920E4**	**RSF-4920E4**	3	2	106.5	133.5	1	1.97
105	130	25	1	89 000	196 000	1 000	2 000	**RS-4821E4**	**RSF-4821E4**	2.5	1.5	110	125	1	0.77
	145	40	1.1	199 000	420 000	950	1 900	**RS-4921E4**	**RSF-4921E4**	3	2	111.5	138.5	1	2.05
110	140	30	1	114 000	260 000	950	1 900	**RS-4822E4**	**RSF-4822E4**	3	2	115	135	1	1.09
	150	40	1.1	202 000	430 000	900	1 800	**RS-4922E4**	**RSF-4922E4**	3	2	116.5	143.5	1	2.15
120	150	30	1	119 000	283 000	900	1 800	**RS-4824E4**	**RSF-4824E4**	3	2	125	145	1	1.28
	165	45	1.1	226 000	480 000	800	1 600	**RS-4924E4**	**RSF-4924E4**	4	3	126.5	158.5	1	2.95
130	165	35	1.1	162 000	390 000	800	1 600	**RS-4826E4**	**RSF-4826E4**	3	2	136.5	158.5	1	1.9
	180	50	1.5	262 000	555 000	750	1 500	**RS-4926E4**	**RSF-4926E4**	5	3.5	138	172	1.5	3.95
140	175	35	1.1	167 000	415 000	750	1 500	**RS-4828E4**	**RSF-4828E4**	3	2	146.5	168.5	1	2.03
	190	50	1.5	272 000	595 000	710	1 400	**RS-4928E4**	**RSF-4928E4**	5	3.5	148	182	1.5	4.25
150	190	40	1.1	235 000	575 000	670	1 400	**RS-4830E4**	**RSF-4830E4**	3	2	156.5	183.5	1	2.85
	210	60	2	390 000	865 000	670	1 300	**RS-4930E4**	**RSF-4930E4**	5	3.5	159	201	2	6.65
160	200	40	1.1	243 000	615 000	630	1 300	**RS-4832E4**	**RSF-4832E4**	3	2	166.5	193.5	1	3.05
	220	60	2	410 000	930 000	600	1 200	**RS-4932E4**	**RSF-4932E4**	5	3.5	169	211	2	7.0
170	215	45	1.1	265 000	650 000	600	1 200	**RS-4834E4**	**RSF-4834E4**	4	3	176.5	208.5	1	4.1
	230	60	2	415 000	975 000	600	1 200	**RS-4934E4**	**RSF-4934E4**	4	3.5	179	221	2	7.35
180	225	45	1.1	272 000	685 000	560	1 100	**RS-4836E4**	**RSF-4836E4**	4	3	186.5	218.5	1	4.3
	250	69	2	495 000	1 130 000	530	1 100	**RS-4936E4**	**RSF-4936E4**	6	4.5	189	241	2	10.7
190	240	50	1.5	315 000	785 000	530	1 100	**RS-4838E4**	**RSF-4838E4**	5	3.5	198	232	1.5	5.65
	260	69	2	510 000	1 180 000	500	1 000	**RS-4938E4**	**RSF-4938E4**	6	4.5	199	251	2	11.1
200	250	50	1.5	320 000	825 000	500	1 000	**RS-4840E4**	**RSF-4840E4**	5	3.5	208	242	1.5	5.95
	280	80	2.1	665 000	1 500 000	480	950	**RS-4940E4**	**RSF-4940E4**	7	5	211	269	2	15.7
220	270	50	1.5	340 000	905 000	450	900	**RS-4844E4**	**RSF-4844E4**	5	3.5	228	262	1.5	6.45
	300	80	2.1	695 000	1 620 000	430	850	**RS-4944E4**	**RSF-4944E4**	7	5	231	289	2	17

Remark Cylindrical roller bearings for sheaves are designed for specific applications, when using them, please contact NSK.

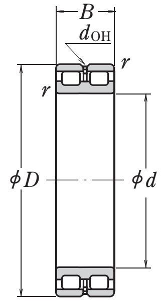
Notes (1) The suffix E4 indicates that the outer ring is provided with oil holes and oil groove.
(2) d_{OH} represents the oil hole diameter in the outer ring.
(3) Permissible axial displacement for free-end bearings.

FULL-COMPLEMENT CYLINDRICAL ROLLER BEARINGS FOR SHEAVES

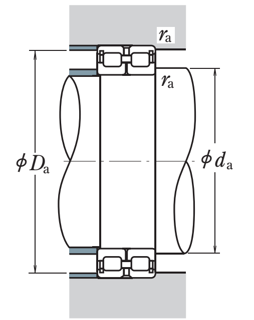
RS-48 · RS-49 Types
RSF-48 · RSF-49 Types
Bore Diameter 240 – 560 mm



Fixed-End Bearing
RS



Free-End Bearing
RSF



Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers[1]		Dimensions (mm)		Abutment and Fillet Dimensions (mm)			Mass (kg)
d	D	B	r min.	C_r	C_{0r}	Grease	Oil	Fixed-End Bearing	Free-End Bearing	d_{OH}[2]	Axial Disp.[3]	d_a min.	D_a max.	r_a max.	approx.
240	300	60	2	495 000	1 340 000	430	850	**RS-4848E4**	**RSF-4848E4**	5	3.5	249	291	2	10.3
	320	80	2.1	725 000	1 770 000	400	800	**RS-4948E4**	**RSF-4948E4**	7	5	251	309	2	18.4
260	320	60	2	515 000	1 450 000	380	750	**RS-4852E4**	**RSF-4852E4**	5	3.5	269	311	2	11
	360	100	2.1	1 050 000	2 530 000	360	710	**RS-4952E4**	**RSF-4952E4**	8	6	271	349	2	32
280	350	69	2	610 000	1 690 000	340	710	**RS-4856E4**	**RSF-4856E4**	6	4.5	289	341	2	16
	380	100	2.1	1 090 000	2 720 000	340	670	**RS-4956E4**	**RSF-4956E4**	8	6	291	369	2	34
300	380	80	2.1	805 000	2 160 000	320	630	**RS-4860E4**	**RSF-4860E4**	6	5	311	369	2	23
	420	118	3	1 460 000	3 400 000	300	600	**RS-4960E4**	**RSF-4960E4**	9	7	313	407	2.5	52
320	400	80	2.1	835 000	2 310 000	300	600	**RS-4864E4**	**RSF-4864E4**	6	5	331	389	2	24.3
	440	118	3	1 500 000	3 600 000	280	560	**RS-4964E4**	**RSF-4964E4**	9	7	333	427	2.5	55
340	420	80	2.1	855 000	2 430 000	280	560	**RS-4868E4**	**RSF-4868E4**	6	5	351	409	2	25.6
	460	118	3	1 560 000	3 900 000	260	530	**RS-4968E4**	**RSF-4968E4**	9	7	353	447	2.5	58
360	440	80	2.1	885 000	2 580 000	260	530	**RS-4872E4**	**RSF-4872E4**	6	5	371	429	2	27
	480	118	3	1 600 000	4 050 000	260	500	**RS-4972E4**	**RSF-4972E4**	9	7	373	467	2.5	61
380	480	100	2.1	1 260 000	3 600 000	240	500	**RS-4876E4**	**RSF-4876E4**	8	6	391	469	2	45.5
	520	140	4	2 040 000	5 200 000	240	450	**RS-4976E4**	**RSF-4976E4**	11	8	396	504	3	90.5
400	500	100	2.1	1 290 000	3 750 000	240	480	**RS-4880E4**	**RSF-4880E4**	8	6	411	489	2	47.5
	540	140	4	2 100 000	5 450 000	220	450	**RS-4980E4**	**RSF-4980E4**	11	8	416	524	3	94.5
420	520	100	2.1	1 320 000	3 950 000	220	450	**RS-4884E4**	**RSF-4884E4**	8	6	431	509	2	49.5
	560	140	4	2 150 000	5 700 000	200	430	**RS-4984E4**	**RSF-4984E4**	11	8	436	544	3	98.5
440	540	100	2.1	1 350 000	4 150 000	200	430	**RS-4888E4**	**RSF-4888E4**	8	6	451	529	2	51.5
	600	160	4	2 840 000	7 350 000	190	380	**RS-4988E4**	**RSF-4988E4**	11	8	456	584	3	136
460	580	118	3	1 730 000	5 150 000	190	380	**RS-4892E4**	**RSF-4892E4**	9	7	473	567	2.5	77.5
	620	160	4	2 870 000	7 500 000	190	380	**RS-4992E4**	**RSF-4992E4**	11	8	476	604	3	142
480	600	118	3	1 760 000	5 300 000	190	380	**RS-4896E4**	**RSF-4896E4**	9	7	493	587	2.5	80.5
	650	170	5	3 200 000	8 500 000	180	360	**RS-4996E4**	**RSF-4996E4**	12	9	500	630	4	167
500	620	118	3	1 810 000	5 600 000	180	360	**RS-48/500E4**	**RSF-48/500E4**	9	7	513	607	2.5	83.5
	670	170	5	3 300 000	8 900 000	170	340	**RS-49/500E4**	**RSF-49/500E4**	12	9	520	650	4	173
530	710	180	5	3 400 000	9 200 000	160	320	**RS-49/530E4**	**RSF-49/530E4**	12	11	550	690	4	206
560	750	190	5	3 800 000	10 100 000	150	300	**RS-49/560E4**	**RSF-49/560E4**	12	11	580	730	4	231

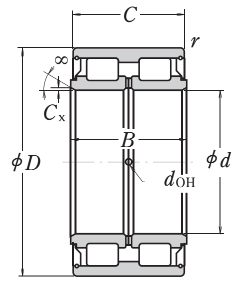
Remark Cylindrical roller bearings for sheaves are designed for specific applications, when using them, please contact NSK.

Notes (1) The suffix E4 indicates that the outer ring is provided with oil holes and oil groove.
(2) d_{OH} represents the oil hole diameter in the outer ring.
(3) Permissible axial displacement for free-end bearings.

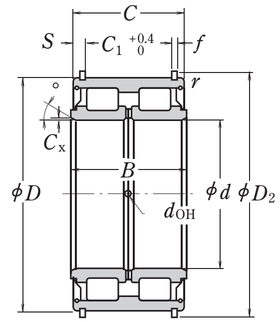
FULL-COMPLEMENT CYLINDRICAL ROLLER BEARINGS FOR SHEAVES

RS-50 Type (Prelubricated)

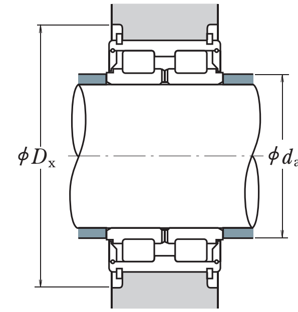
Bore Diameter 40 – 400 mm



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) Chamfer dimension of inner ring in radial direction.

Remarks 1. Good quality grease is prepacked in bearings.
2. Grease can be supplied through oil holes in the inner rings.

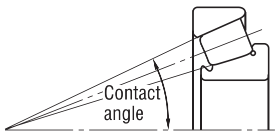
Bearing Numbers		Locating Ring Dimensions (mm)				Oil Holes (mm)	Abutment and Fillet Dimensions (mm)		Mass (kg)
Without Locating Ring	With Locating Ring	C_1	S	D_2	f	d_{OH}	d_a min.	D_x min.	approx.
RS-5008	**RS-5008NR**	28	4.5	71.8	2	2.5	43.5	77.5	0.56
RS-5009	**RS-5009NR**	30	4.5	78.8	2	2.5	48.5	84.5	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 shield with outside diameter larger than 180mm, the above figure is different actual shape. For detail drawing, please contact NSK.

6. TAPERED ROLLER BEARINGS

The index for inch design tapered roller bearings is in Appendix 14 (Page E020).

DESIGN, TYPES, AND FEATURES

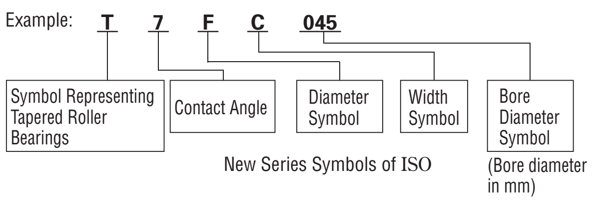


Tapered roller bearings are designed so the apices of the cones formed by the raceways of the cone and cup and the conical rollers all coincide at one point on the axis of the bearing. When a radial load is imposed, an axial force component occurs; therefore, it is necessary to use two bearings in opposition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

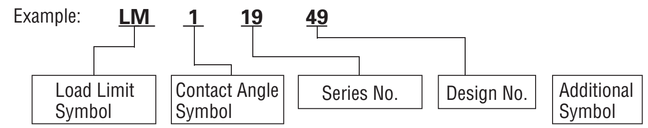
For metric-design medium-angle and steep-angle tapered roller bearings, the respective contact angle symbol C or D is added after the bore number. For normal-angle tapered roller bearings, no contact angle symbol is used. Medium-angle tapered roller bearings are primarily used for the pinion shafts of differential gears of automobiles.

Among those with high load capacity(HR series), some bearings have the basic number suffixed by J to conform to the specifications of ISO for the cup back face raceway diameter, cup width, and contact angle. Therefore, the cone assembly and cup of bearings with the same basic number suffixed by J are internationally interchangeable.

Among metric-design tapered roller bearings specified by ISO 355, there are those having new dimensions that are different than the dimension series 3XX used in the past. Part of them are listed in the bearing tables. They conform to the specifications of ISO for the smaller end diameter of the cup and contact angle. The cone and cup assemblies are internationally interchangeable. The bearing number formulation, which is different than that for past metric design, is as follows:



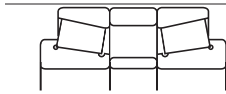
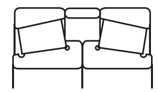
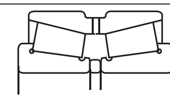
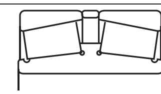
Besides metric design tapered roller bearings, there are also inch design bearings. For the cone assemblies and cups of inch design bearings, except four-row tapered roller bearings, the bearing numbers are approximately formulated as follows:



For tapered roller bearings, besides single-row bearings, there are also various combinations of bearings.

The cages of tapered roller bearings are usually pressed steel.

Table 1 Design and Featured of Combinations of Tapered Roller Bearings

Figure	Arrangement	Examples of Bearing No.	Features
	Back-to-back	HR30210JDB+KLR10	Two standard bearings are combined. The bearing clearances are adjusted by cone spacers or cup spacers. The cones and cups and spacers are marked with serial numbers and mating marks. Components with the same serial number can be assembled referring to the matching symbols.
	Face-to-face	HR30210JDF+KR	
	KBE Type	100KBE31+L	The KBE type is a back-to-back arrangement of bearings with the cup and spacer integrated, and the KH type is a face-to-face arrangement in which the cones are integrated. Since the bearing clearance is adjusted using spacers, it is necessary for components to have the same serial number for assembly with reference to matching symbols.
	KH Type	110KH31+K	

TOLERANCES AND RUNNING ACCURACY

METRIC DESIGN TAPERED ROLLER BEARINGS .... Table 7.3 (Pages A132 to A135)

INCH DESIGN TAPERED ROLLER BEARINGS .... Table 7.4 (Pages A136 and A137)

Among inch design tapered roller bearings, there are those to which the following precision classes apply. For more details, please consult with NSK.

(1) J line bearings(in the bearing tables, bearings preceeded by)

Table 2 Tolerances for Cones(CLASS K)

Units : m

Nominal Bore Diameter d (mm)		$\Delta_{d\text{mp}}$		$V_{d\text{p}}$	$V_{d\text{mp}}$	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 Cups(CALSS K)

Units : m

Nominal Outside Diameter D (mm)		$\Delta_{D\text{mp}}$		$V_{D\text{p}}$	$V_{D\text{mp}}$	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 Tolerances for Effective Widths of Cone Assemblies and Cups, and Overall Width (CLASS K)

Units : m

Nominal Bore Diameter d (mm)		Effective Width Deviation of Cone Assembly Δ_{T1s}		Effective Width Deviation of Cup Δ_{T2s}		Overall Width Deviation 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, those preceded by t)

Table 5 Tolerances for Bore Diameter and Overall Width

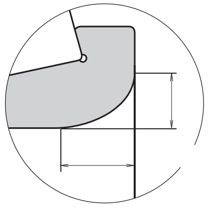
Units : m

Nominal Bore Diameter d				Bore Diameter Deviation Δ_{ds}		Overall Width Deviation Δ_{Ts}	
over (mm)	over 1/25.4	incl. (mm)	incl. 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 cones and cups conform to Table 7.4.2 (Pages A136 and A137).

(3) Special Chamfer Dimensions

For bearings marked "spec." in the column of r in the bearing tables, the chamfer dimension of the cone back-face side is as shown on the following figure.



RECOMMENDED FITS

METRIC DESIGN TAPERED ROLLER BEARINGS ······ Table 8.3 (Page A164)
Table 8.5 (Page A165)

INCH DESIGN TAPERED ROLLER BEARINGS ······ Table 8.7 (Page A166)
Table 8.8 (Page A167)

INTERNAL CLEARANCE

METRIC DESIGN TAPERED ROLLER BEARINGS (Matched and Double-Row) ······ Table 8.17 (Page A173)

INCH DESIGN 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 cone 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 the bearing load condition. Also, 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 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 exceeds 'e'(e is listed in the bearing tables)during operation, slippage between the rollers and raceways occurs, which may result in smearing. Especially 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 dimension of "Abutment and Fillet Dimensions" of D_a, D_b, S_a, S_b at the time of the HR series adoption.

TECHNICAL DATA

Free Space of Tapered Roller Bearings

The tapered roller bearing can carry radial load and uni-direction axial loads. It offers high capacity. This type of bearing is used widely in machine systems with relatively severe loading conditions in various combinations by opposing or combining single-row bearings.

With a view towards easier maintenance and inspection, this kind of bearing is lubricated with grease in most cases. It is important to select a grease appropriate to the operating conditions and to use the proper amount of grease for the housing internal space. As a reference, the free space of a tapered roller bearing is shown in Table 6.

The free space of a tapered roller bearing is the space (shadowed portion) of the bearing outer volume less the inner and outer rings and cage, as shown in Fig. 1. The bearing is filled so that grease reaches the inner ring rib surface and pocket surface in sufficient amount. Due attention must also be paid to the grease filling amount and state, especially if grease leakage occurs or maintenance of low running torque is important.

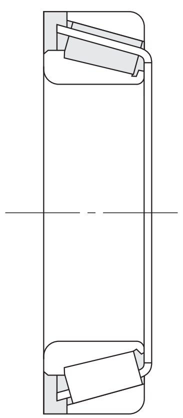


Fig. 1 Free Space of Tapered Roller Bearing

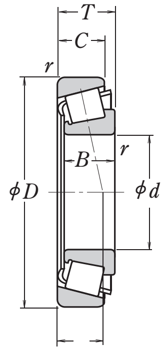
Table 6 Free Space of Tapered Roller Bearing

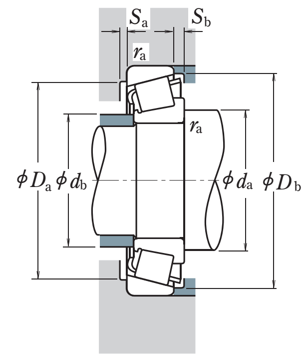
Units: cm^3

Bearing bore No.	Bearing free space									
	Bearing series									
	HR329-J	HR320-XJ	HR330-J	HR331-J	HR302-J	HR322-J	HR332-J	HR303-J	HR303-DJ	HR323-J
02	—	—	—	—	—	—	—	4.5	—	—
03	—	—	—	—	3.3	4.3	—	5.7	—	—
04	—	3.5	—	—	5.3	6.6	—	7.2	—	9.2
/22	—	3.6	—	—	—	7.3	—	9.1	—	—
05	—	3.7	4.3	—	6.3	7.4	7.5	11	13	15
/28	—	5.3	—	—	8.8	9.8	10	16	—	—
06	—	6.2	6.7	—	9.2	11	12	18	21	23
/32	—	6.6	—	—	11	13	14	20	—	—
07	4.0	7.5	8.9	—	13	17	18	23	26	35
08	5.8	9.1	11	—	18	23	25	31	35	45
09	—	11	—	18	22	24	26	41	48	58
10	—	12	15	20	23	26	29	55	59	77
11	8.8	19	21	29	30	36	40	72	78	99
12	9.0	20	23	—	39	47	53	88	95	130
13	—	21	25	—	45	62	65	110	120	150
14	17	29	33	—	53	67	69	130	150	190
15	—	30	34	—	58	73	74	160	180	230
16	—	40	—	—	75	91	100	200	200	270
17	—	43	49	76	92	120	130	230	250	320
18	28	58	—	110	110	150	—	260	310	370
19	29	60	—	—	140	170	—	310	350	430
20	37	64	—	150	160	210	240	380	460	580

SINGLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 15 – 28 mm





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 $F_r \quad 0.5F_r + Y_0F_a$, use $P_0 = F_r$

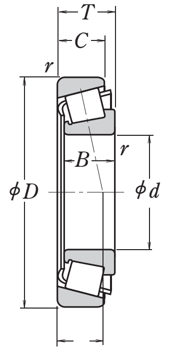
The values of e, Y_1, and Y_0 are given in the table below.

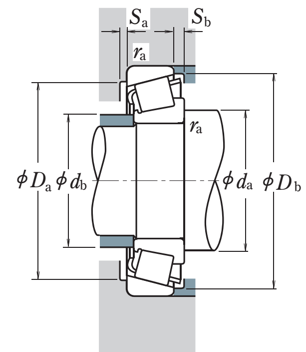
Boundary Dimensions (mm) d	D	T	B	C	Cone r min.	Cup r min.	Basic Load Ratings (N) C_r	C_{0r}	Limiting Speeds (min^{-1}) Grease	Oil	Bearing Numbers	ISO355 Dimension Series approx.	Abutment and Fillet Dimensions (mm) d_a min.	d_b max.	D_a max.	D_a min.	D_b min.	S_a min.	S_b min.	Cone r_a max.	Cup r_a max.	Eff. Load Centers (mm) a	Constant e	Axial Load Factors Y_1	Y_0	Mass (kg) approx.
15	35	11.75	11	10	0.6	0.6	14 800	13 200	11 000	15 000	**30202**	—	23	19	30	30	33	2	1.5	0.6	0.6	8.2	0.32	1.9	1.0	0.053
	42	14.25	13	11	1	1	23 600	21 100	9 500	13 000	**HR 30302 J**	2FB	24	22	36	36	38.5	2	3	1	1	9.5	0.29	2.1	1.2	0.098
17	40	13.25	12	11	1	1	20 100	19 900	9 500	13 000	**HR 30203 J**	2DB	26	23	34	34	37.5	2	2	1	1	9.7	0.35	1.7	0.96	0.079
	40	17.25	16	14	1	1	27 100	28 000	9 500	13 000	**HR 32203 J**	2DD	26	22	34	34	37	2	3	1	1	11.2	0.31	1.9	1.1	0.103
	47	15.25	14	12	1	1	29 200	26 700	8 500	12 000	**HR 30303 J**	2FB	26	24	41	40	43	2	3	1	1	10.4	0.29	2.1	1.2	0.134
	47	15.25	14	10.5	1	1	22 000	20 300	8 000	11 000	**30303 D**	—	29	23	41	34	44	2	4.5	1	1	15.4	0.81	0.74	0.41	0.129
	47	20.25	19	16	1	1	37 500	36 500	8 500	11 000	**HR 32303 J**	2FD	28	23	41	39	43	2	4	1	1	12.5	0.29	2.1	1.2	0.178
20	42	15	15	12	0.6	0.6	24 600	27 400	9 000	12 000	**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
	47	15.25	14	12	1	1	27 900	28 500	8 000	11 000	**HR 30204 J**	2DB	29	27	41	40	44	2	3	1	1	11.0	0.35	1.7	0.96	0.127
	47	15.25	14	12	0.3	1	23 900	24 000	8 000	11 000	**HR 30204 C-A-**	—	29	26	41	37	44	2	3	0.3	1	13.0	0.55	1.1	0.60	0.126
	47	19.25	18	15	1	1	35 500	37 500	8 500	11 000	**HR 32204 J**	2DD	29	25	41	38	44.5	3	4	1	1	12.6	0.33	1.8	1.0	0.161
	47	19.25	18	15	1	1	31 500	33 500	8 000	11 000	**HR 32204 CJ**	5DD	29	25	41	36	44	2	4	1	1	14.5	0.52	1.2	0.64	0.166
	52	16.25	15	13	1.5	1.5	35 000	33 500	7 500	10 000	**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
	52	16.25	15	12	1.5	1.5	25 300	24 500	7 100	10 000	**30304 D**	—	34	26	43	37	49	2	4	1.5	1.5	16.7	0.81	0.74	0.41	0.168
	52	22.25	21	18	1.5	1.5	45 500	47 500	8 000	11 000	**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
22	44	15	15	11.5	0.6	0.6	25 600	29 400	8 500	11 000	**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
	50	15.25	14	12	1	1	29 200	30 500	7 500	10 000	**HR 302/22**	—	31	29	44	42	47	3	3	1	1	11.6	0.37	1.6	0.90	0.139
	50	15.25	14	12	1	1	27 200	29 500	7 500	10 000	**HR 302/22 C**	—	31	29	44	40	47	2	3	1	1	13.0	0.49	1.2	0.67	0.144
	50	19.25	18	15	1	1	36 500	40 500	7 500	11 000	**HR 322/22**	—	31	28	44	41	47	2	4	1	1	13.5	0.37	1.6	0.89	0.18
	50	19.25	18	15	1	1	33 500	39 500	7 500	10 000	**HR 322/22 C**	—	31	29	44	39	48	2	4	1	1	15.2	0.51	1.2	0.65	0.185
	56	17.25	16	14	1.5	1.5	37 000	36 500	7 100	9 500	**HR 303/22**	—	33	30	47	46	50	2	3	1.5	1.5	12.4	0.32	1.9	1.0	0.208
	56	17.25	16	13	1.5	1.5	34 500	34 000	6 700	9 500	**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
25	47	15	15	11.5	0.6	0.6	27 400	33 000	8 000	11 000	**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
	47	17	17	14	0.6	0.6	31 000	38 000	8 000	11 000	**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
	52	16.25	15	13	1	1	32 000	35 000	7 100	10 000	**HR 30205 J**	3CC	34	31	46	44	48.5	2	3	1	1	12.7	0.37	1.6	0.88	0.157
	52	16.25	15	12	1	1	28 100	31 500	9 700	9 500	**HR 30205 C**	—	34	32	46	43	49.5	2	4	1	1	14.4	0.53	1.1	0.62	0.155
	52	19.25	18	16	1	1	40 000	45 000	7 100	10 000	**HR 32205 J**	2CD	34	30	46	44	50	2	3	1	1	13.5	0.36	1.7	0.92	0.189
	52	19.25	18	15	1	1	35 000	42 000	7 100	9 500	**HR 32205 C**	—	34	30	46	40	50	2	4	1	1	15.8	0.53	1.1	0.62	0.19
	52	22	22	18	1	1	47 500	56 500	7 500	10 000	**HR 33205 J**	2DE	34	29	46	43	49.5	4	4	1	1	14.1	0.35	1.7	0.94	0.221
	62	18.25	17	15	1.5	1.5	47 500	46 000	6 300	8 500	**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
	62	18.25	17	14	1.5	1.5	42 000	45 000	6 000	8 500	**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
	62	18.25	17	13	1.5	1.5	38 000	40 500	5 600	8 000	**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
	62	18.25	17	13	1.5	1.5	38 000	40 500	5 600	8 000	**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
	62	25.25	24	20	1.5	1.5	62 500	66 000	6 300	8 500	**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
28	52	16	16	12	1	1	32 000	39 000	7 100	9 500	**HR 320/28 XJ**	4CC	37	33	46	44	50	3	4	1	1	12.8	0.43	1.4	0.77	0.146
	58	17.25	16	14	1	1	39 500	41 500	6 300	9 000	**HR 302/28**	—	37	34	52	50	55	2	3	1	1	13.2	0.35	1.7	0.93	0.203
	58	17.25	16	12	1	1	34 000	38 500	6 300	8 500	**HR 302/28 C**	—	37	34	52	48	54	2	5	1	1	16.9	0.64	0.94	0.52	0.198
	58	20.25	19	16	1	1	47 500	54 000	6 300	9 000	**HR 322/28**	—	37	34	52	49	55	2	4	1	1	14.6	0.37	1.6	0.89	0.243
	58	20.25	19	16	1	1	42 000	49 500	6 300	9 000	**HR 322/28 CJ**	5DD	37	33	52	45	55	2	4	1	1	16.8	0.56	1.1	0.59	0.251
	68	19.75	18	15	1.5	1.5	55 000	55 500	6 000	8 000	**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
	68	19.75	18	14	1.5	1.5	49 500	50 500	5 600	7 500	**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

Remark The suffix C represents medium-angle tapered roller bearings. Since they are designed for specific applications, please consult NSK when using bearings with suffix C.

SINGLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 30 – 35 mm





Dynamic Equivalent Load

$P = XF_r + YF_a$

F_a/F_r 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 $P_0 = F_r$

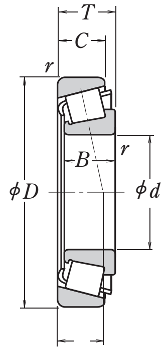
The values of e, Y_1, and Y_0 are given in the table below.

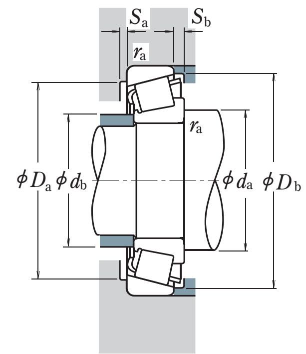
Boundary Dimensions (mm) d	D	T	B	C	Cone r min.	Cup r min.	Basic Load Ratings (N) C_r	C_{0r}	Limiting Speeds (min⁻¹) Grease	Oil	Bearing Numbers	ISO355 Dimension Series approx.	Abutment and Fillet Dimensions (mm) d_a min.	d_b max.	D_a max.	D_a min.	D_b min.	S_a min.	S_b min.	Cone r_a max.	Cup r_a max.	Eff. Load Centers (mm) a	Constant e	Axial Load Factors Y_1	Y_0	Mass (kg) approx.
30	47	12	12	9	0.3	0.3	17 600	24 400	7 500	10 000	**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
	55	17	17	13	1	1	36 000	44 500	6 700	9 000	**HR 32006 XJ**	4CC	39	35	49	47	53	3	4	1	1	13.5	0.43	1.4	0.77	0.172
	55	20	20	16	1	1	42 000	54 000	6 700	9 000	**HR 33006 J**	2CE	39	35	49	48	52	3	4	1	1	13.1	0.29	2.1	1.1	0.208
	62	17.25	16	14	1	1	43 000	47 500	6 000	8 000	**HR 30206 J**	3DB	39	37	56	52	58	2	3	1	1	13.9	0.37	1.6	0.88	0.238
	62	17.25	16	12	1	1	35 500	37 000	5 600	7 500	**HR 30206 C**	—	39	36	56	49	59	2	5	1	1	17.8	0.68	0.88	0.49	0.221
	62	21.25	20	17	1	1	52 000	60 000	6 000	8 500	**HR 32206 J**	3DC	39	36	56	51	58.5	2	4	1	1	15.4	0.37	1.6	0.88	0.297
	62	21.25	20	16	1	1	48 000	56 000	6 000	8 000	**HR 32206 C**	—	39	35	56	48	59	2	5	1	1	17.8	0.55	1.1	0.60	0.293
	62	25	25	19.5	1	1	66 500	79 500	6 000	8 000	**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
	72	20.75	19	16	1.5	1.5	59 500	60 000	5 300	7 500	**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
	72	20.75	19	14	1.5	1.5	56 500	55 500	5 300	7 100	**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
	72	20.75	19	14	1.5	1.5	49 000	52 500	4 800	6 700	**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
	72	20.75	19	14	1.5	1.5	49 000	52 500	4 800	6 800	**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
	72	28.75	27	23	1.5	1.5	80 000	88 500	5 600	7 500	**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
	72	28.75	27	23	1.5	1.5	76 000	86 500	5 600	7 500	**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
32	58	17	17	13	1	1	37 500	47 000	6 300	8 500	**HR 320/32 XJ**	4CC	41	37	52	49	55	3	4	1	1	14.2	0.45	1.3	0.73	0.191
	58	21	20	16	1	1	41 000	50 000	6 300	8 500	**330/32**	—	41	37	52	50	55	2	4	1	1	13.8	0.31	1.9	1.1	0.225
	65	18.25	17	15	1	1	48 500	54 000	5 600	8 000	**HR 302/32**	—	41	39	59	56	61	3	3	1	1	14.7	0.37	1.6	0.88	0.277
	65	18.25	17	14	1	1	45 500	52 500	5 600	7 500	**HR 302/32 C**	—	41	39	59	54	62	3	4	1	1	16.9	0.55	1.1	0.60	0.273
	65	22.25	21	18	1	1	56 000	65 000	6 000	8 000	**HR 322/32**	—	41	38	59	54	61	3	4	1	1	15.9	0.37	1.6	0.88	0.336
	65	22.25	21	17	1	1	49 500	60 000	5 600	7 500	**HR 322/32 C**	—	41	39	59	51	62	3	5	1	1	20.2	0.59	1.0	0.56	0.335
	65	26	26	20.5	1	1	70 000	86 500	5 600	8 000	**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
	75	21.75	20	17	1.5	1.5	56 000	56 000	5 300	7 100	**303/32**	—	44	42	66	64	68	3	4.5	1.5	1.5	15.9	0.33	1.8	1.0	0.435
35	55	14	14	11.5	0.6	0.6	27 400	39 000	6 300	8 500	**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
	62	18	18	14	1	1	43 500	55 500	5 600	8 000	**HR 32007 XJ**	4CC	44	40	56	54	60	4	4	1	1	15.0	0.45	1.3	0.73	0.229
	62	21	21	17	1	1	49 000	65 000	5 600	8 000	**HR 33007 J**	2CE	44	40	56	55	59	4	4	1	1	14.1	0.31	2.0	1.1	0.267
	72	18.25	17	15	1.5	1.5	54 000	59 500	5 300	7 100	**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
	72	18.25	17	13	1.5	1.5	47 000	54 500	5 000	6 700	**HR 30207 C**	—	46	44	63	59	68	3	5	1.5	1.5	19.6	0.66	0.91	0.50	0.331
	72	24.25	23	19	1.5	1.5	70 500	83 500	5 300	7 100	**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
	72	24.25	23	18	1.5	1.5	60 500	71 500	5 000	7 100	**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
	72	28	28	22	1.5	1.5	86 500	108 000	5 300	7 100	**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
	80	22.75	21	18	2	1.5	76 000	79 000	4 800	6 700	**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
	80	22.75	21	16	2	1.5	68 000	70 500	4 800	6 300	**HR 30307 C**	—	47	44	71	65	74	3	6.5	2	1.5	20.3	0.55	1.1	0.60	0.518
	80	22.75	21	15	2	1.5	62 000	68 000	4 300	6 000	**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
	80	22.75	21	15	2	1.5	62 000	68 000	4 300	6 000	**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
	80	32.75	31	25	2	1.5	99 000	111 000	5 000	6 700	**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

Remark The suffix C represents medium-angle tapered roller bearings. Since they are designed for specific applications, please consult NSK when using bearings with suffix C.

SINGLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 40 – 50 mm





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 $P_0 = F_r$

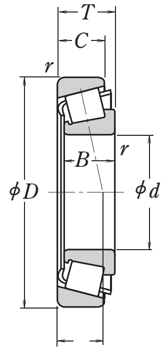
The values of e, Y_1, and Y_0 are given in the table below.

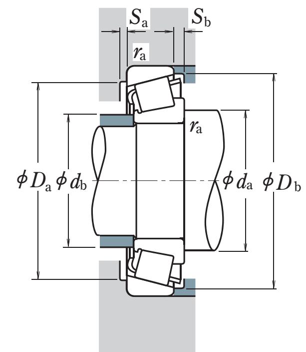
Boundary Dimensions (mm) d	D	T	B	C	Cone r min.	Cup r min.	Basic Load Ratings (N) C_r	C_{0r}	Limiting Speeds (min⁻¹) Grease	Oil	Bearing Numbers	ISO355 Dimension Series approx.	Abutment and Fillet Dimensions (mm) d_a min.	d_b max.	D_a max.	D_a min.	D_b min.	S_a min.	S_b min.	Cone r_a max.	Cup r_a max.	Eff. Load Centers (mm) a	Constant e	Axial Load Factors Y_1	Y_0	Mass (kg) approx.
40	62	15	15	12	0.6	0.6	34 000	47 000	5 600	7 500	**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
	68	19	19	14.5	1	1	53 000	71 000	5 300	7 100	**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
	68	22	22	18	1	1	59 000	81 500	5 300	7 100	**HR 33008 J**	2BE	49	45	62	61	65	4	4	1	1	14.6	0.28	2.1	1.2	0.322
	75	26	26	20.5	1.5	1.5	78 500	101 000	4 800	6 700	**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
	80	19.75	18	16	1.5	1.5	63 500	70 000	4 800	6 300	**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
	80	24.75	23	19	1.5	1.5	77 000	90 500	4 800	6 300	**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
	80	24.75	23	19	1.5	1.5	74 000	90 500	4 500	6 300	**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
	80	32	32	25	1.5	1.5	107 000	137 000	4 800	6 300	**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
	90	25.25	23	20	2	1.5	90 500	101 000	4 300	5 600	**HR 30308 J**	2FB	52	52	81	76	82	3	5	2	1.5	19.5	0.35	1.7	0.96	0.758
	90	25.25	23	18	2	1.5	84 500	93 500	4 300	5 600	**HR 30308 C**	—	52	50	81	72	84	3	7	2	1.5	22.8	0.53	1.1	0.62	0.735
	90	25.25	23	17	2	1.5	80 000	89 500	3 800	5 300	**HR 30308 DJ**	7FB	56	50	81	70	87	3	8	2	1.5	28.7	0.83	0.73	0.40	0.728
	90	25.25	23	17	2	1.5	80 000	89 500	3 800	5 300	**HR 31308 J**	7FB	56	50	81	70	87	3	8	2	1.5	28.7	0.83	0.73	0.40	0.728
	90	35.25	33	27	2	1.5	120 000	145 000	4 300	6 000	**HR 32308 J**	2FD	54	50	81	73	82	3	8	2	1.5	23.4	0.35	1.7	0.96	1.05
45	68	15	15	12	0.6	0.6	34 500	50 500	5 000	6 700	**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
	75	20	20	15.5	1	1	60 000	83 000	4 500	6 300	**HR 32009 XJ**	3CC	54	51	69	67	72	4	4.5	1	1	16.6	0.39	1.5	0.84	0.354
	75	24	24	19	1	1	69 000	99 000	4 800	6 300	**HR 33009 J**	2CE	54	51	69	67	71	4	5	1	1	16.3	0.29	2.0	1.1	0.414
	80	26	26	20.5	1.5	1.5	84 000	113 000	4 500	6 000	**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
	85	20.75	19	16	1.5	1.5	68 500	79 500	4 300	6 000	**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
	85	24.75	23	19	1.5	1.5	83 000	102 000	4 300	6 000	**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
	85	24.75	23	19	1.5	1.5	75 500	95 500	4 300	5 600	**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
	85	32	32	25	1.5	1.5	111 000	147 000	4 300	6 000	**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
	95	29	26.5	20	2.5	2.5	88 500	109 000	3 600	5 000	**T 7 FC045**	7FC	60	53	83	71	91	3	9	2	2	32.1	0.87	0.69	0.38	0.918
	95	36	35	30	2.5	2.5	139 000	174 000	4 000	5 300	**T 2 ED045**	2ED	60	54	83	79	89	5	6	2	2	23.5	0.32	1.9	1.02	1.22
	100	27.25	25	22	2	1.5	112 000	127 000	3 800	5 300	**HR 30309 J**	2FB	57	58	91	86	93	3	5	2	1.5	21.1	0.35	1.7	0.96	1.01
	100	27.25	25	18	2	1.5	95 500	109 000	3 400	4 800	**HR 30309 DJ**	7FB	61	57	91	79	96	3	9	2	1.5	31.5	0.83	0.73	0.40	0.957
	100	27.25	25	18	2	1.5	95 500	109 000	3 400	4 800	**HR 31309 J**	7FB	61	57	91	79	96	3	9	2	1.5	31.5	0.83	0.73	0.40	0.947
	100	38.25	36	30	2	1.5	144 000	177 000	3 800	5 300	**HR 32309 J**	2FD	59	56	91	82	93	3	8	2	1.5	25.0	0.35	1.7	0.96	1.42
50	100	36	35	30	2.5	2.5	144 000	185 000	3 800	5 000	**T 2 ED050**	2ED	65	59	88	83	94	6	6	2	2	24.2	0.34	1.8	0.96	1.3
	72	15	15	12	0.6	0.6	36 000	54 000	4 500	6 300	**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
	80	20	20	15.5	1	1	61 000	87 000	4 300	6 000	**HR 32010 XJ**	3CC	59	56	74	71	77	4	4.5	1	1	17.9	0.42	1.4	0.78	0.38
	80	24	24	19	1	1	70 500	104 000	4 300	6 000	**HR 33010 J**	2CE	59	55	74	71	76	4	5	1	1	17.4	0.32	1.9	1.0	0.452
	85	26	26	20	1.5	1.5	89 000	126 000	4 300	5 600	**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
	90	21.75	20	17	1.5	1.5	76 000	91 500	4 000	5 300	**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
	90	24.75	23	19	1.5	1.5	87 500	109 000	4 000	5 300	**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
	90	24.75	23	18	1.5	1.5	77 500	102 000	3 800	5 300	**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
	90	32	32	24.5	1.5	1.5	118 000	165 000	4 000	5 300	**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
	105	32	29	22	3	3	109 000	133 000	3 200	4 500	**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
	110	29.25	27	23	2.5	2	130 000	148 000	3 400	4 800	**HR 30310 J**	2FB	65	65	100	95	102	3	6	2	2	23.1	0.35	1.7	0.96	1.28
	110	29.25	27	19	2.5	2	114 000	132 000	3 200	4 300	**HR 30310 DJ**	7FB	70	62	100	87	105	3	10	2	2	34.3	0.83	0.73	0.40	1.26
	110	29.25	27	19	2.5	2	114 000	132 000	3 200	4 300	**HR 31310 J**	7FB	70	62	100	87	105	3	10	2	2	34.3	0.83	0.73	0.40	1.26
	110	42.25	40	33	2.5	2	176 000	220 000	3 600	4 800	**HR 32310 J**	2FD	68	62	100	91	102	3	9	2	2	28.0	0.35	1.7	0.96	1.88
	110	42.25	40	33	2.5	2	164 000	218 000	3 400	4 800	**HR 32310 CJ**	5FD	68	59	100	82	103	3	9	2	2	32.8	0.55	1.1	0.60	1.93

Remark The suffix C represents medium-angle tapered roller bearings. Since they are designed for specific applications, please consult NSK when using bearings with suffix C.

SINGLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 55 – 65 mm





Dynamic Equivalent Load

$P = XF_r + YF_a$

F_a/F_r 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 $P_0 = F_r$

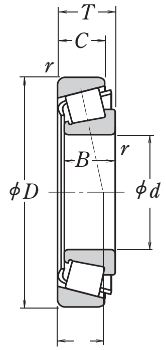
The values of e, Y_1, and Y_0 are given in the table below.

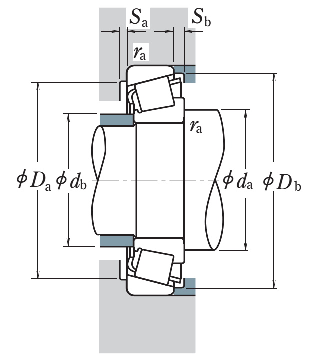
Boundary Dimensions (mm) d	D	T	B	C	Cone r min.	Cup r min.	Basic Load Ratings (N) C_r	C_{0r}	Limiting Speeds (min⁻¹) Grease	Oil	Bearing Numbers	ISO355 Dimension Series approx.	Abutment and Fillet Dimensions (mm) d_a min.	d_b max.	D_a max.	D_a min.	D_b min.	S_a min.	S_b min.	Cone r_a max.	Cup r_a max.	Eff. Load Centers (mm) a	Constant e	Axial Load Factors Y_1	Y_0	Mass (kg) approx.
55	80	17	17	14	1	1	45 500	74 500	4 300	5 600	**HR 32911 J**	2BC	64	60	74	73	76	4	3	1	1	14.6	0.31	1.9	1.1	0.282
	90	23	23	17.5	1.5	1.5	81 500	117 000	3 800	5 300	**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
	90	27	27	21	1.5	1.5	91 500	138 000	3 800	5 300	**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
	95	30	30	23	1.5	1.5	112 000	158 000	3 800	5 000	**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
	100	22.75	21	18	2	1.5	94 500	113 000	3 600	5 000	**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
	100	26.75	25	21	2	1.5	110 000	137 000	3 600	5 000	**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
	100	35	35	27	2	1.5	141 000	193 000	3 600	5 000	**HR 33211 J**	3DE	67	62	91	86	96	6	8	2	1.5	25.2	0.40	1.5	0.83	1.18
	115	34	31	23.5	3	3	126 000	164 000	3 000	4 300	**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
	120	31.5	29	25	2.5	2	150 000	171 000	3 200	4 300	**HR 30311 J**	2FB	70	71	110	104	111	4	6.5	2	2	24.6	0.35	1.7	0.96	1.63
	120	31.5	29	21	2.5	2	131 000	153 000	2 800	4 000	**HR 30311 DJ**	7FB	75	67	110	94	114	4	10.5	2	2	37.0	0.83	0.73	0.40	1.58
	120	31.5	29	21	2.5	2	131 000	153 000	2 800	4 000	**HR 31311 J**	7FB	75	67	110	94	114	4	10.5	2	2	37.0	0.83	0.73	0.40	1.58
	120	45.5	43	35	2.5	2	204 000	258 000	3 200	4 300	**HR 32311 J**	2FD	73	67	110	99	111	4	10.5	2	2	29.9	0.35	1.7	0.96	2.39
	120	45.5	43	35	2.5	2	195 000	262 000	3 200	4 300	**HR 32311 CJ**	5FD	73	65	110	91	112	4	10.5	2	2	35.8	0.55	1.1	0.60	2.47
60	85	17	17	14	1	1	49 000	84 500	3 800	5 300	**HR 32912 J**	2BC	69	65	79	78	81	4	3	1	1	15.5	0.33	1.8	1.0	0.306
	95	23	23	17.5	1.5	1.5	85 500	127 000	3 600	5 000	**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
	95	27	27	21	1.5	1.5	96 000	150 000	3 600	5 000	**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
	100	30	30	23	1.5	1.5	115 000	166 000	3 400	4 800	**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
	110	23.75	22	19	2	1.5	104 000	123 000	3 400	4 500	**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
	110	29.75	28	24	2	1.5	131 000	167 000	3 400	4 500	**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
	110	38	38	29	2	1.5	166 000	231 000	3 400	4 500	**HR 33212 J**	3EE	72	68	101	94	105	6	9	2	1.5	27.6	0.40	1.5	0.82	1.56
	125	37	33.5	26	3	3	151 000	197 000	2 800	3 800	**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
	130	33.5	31	26	3	2.5	174 000	201 000	3 000	4 000	**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
	130	33.5	31	22	3	2.5	151 000	177 000	2 600	3 800	**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
	130	33.5	31	22	3	2.5	151 000	177 000	2 600	3 800	**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
	130	48.5	46	37	3	2.5	233 000	295 000	3 000	4 000	**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
	130	48.5	46	35	3	2.5	196 000	249 000	2 800	3 800	**32312 C**	—	81	74	116	102	125	4	13.5	2.5	2	39.9	0.58	1.0	0.57	2.86
65	90	17	17	14	1	1	49 000	86 500	3 600	5 000	**HR 32913 J**	2BC	74	70	84	82	86	4	3	1	1	16.8	0.35	1.7	0.93	0.323
	100	23	23	17.5	1.5	1.5	86 500	132 000	3 400	4 500	**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
	100	27	27	21	1.5	1.5	97 500	156 000	3 400	4 500	**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
	110	34	34	26.5	1.5	1.5	148 000	218 000	3 200	4 300	**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
	120	24.75	23	20	2	1.5	122 000	151 000	3 000	4 000	**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
	120	32.75	31	27	2	1.5	157 000	202 000	3 000	4 000	**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
	120	41	41	32	2	1.5	202 000	282 000	3 000	4 000	**HR 33213 J**	3EE	77	74	111	102	115	6	9	2	1.5	29.2	0.39	1.5	0.85	2.04
	140	36	33	28	3	2.5	200 000	233 000	2 600	3 600	**HR 30313 J**	2GB	83	83	128	121	130	4	8	2.5	2	27.9	0.35	1.7	0.96	2.51
	140	36	33	23	3	2.5	173 000	205 000	2 400	3 400	**HR 30313 DJ**	7GB	89	80	128	111	133	4	13	2.5	2	43.2	0.83	0.73	0.40	2.43
	140	36	33	23	3	2.5	173 000	205 000	2 400	3 400	**HR 31313 J**	7GB	89	80	128	111	133	4	13	2.5	2	43.2	0.83	0.73	0.40	2.43
	140	51	48	39	3	2.5	267 000	340 000	2 800	3 800	**HR 32313 J**	2GD	86	80	128	116	130	4	12	2.5	2	34.0	0.35	1.7	0.96	3.6

Remark The suffix C represents medium-angle tapered roller bearings. Since they are designed for specific applications, please consult NSK when using bearings with suffix C.

SINGLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 70 – 80 mm





Dynamic Equivalent Load

$P = XF_r + YF_a$

F_a/F_r 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 $P_0 = F_r$

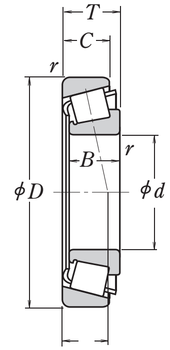
The values of e, Y_1, and Y_0 are given in the table below.

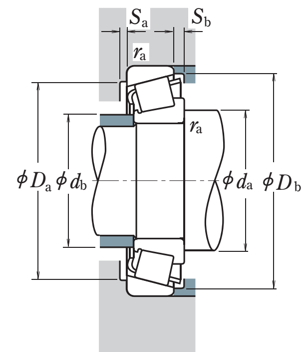
Boundary Dimensions (mm) d	D	T	B	C	Cone r min.	Cup r min.	Basic Load Ratings (N) C_r	C_{0r}	Limiting Speeds (min⁻¹) Grease	Oil	Bearing Numbers	ISO355 Dimension Series approx.	Abutment and Fillet Dimensions (mm) d_a min.	d_b max.	D_a max.	D_a min.	D_b min.	S_a min.	S_b min.	Cone r_a max.	Cup r_a max.	Eff. Load Centers (mm) a	Constant e	Axial Load Factors Y_1	Y_0	Mass (kg) approx.
70	100	20	20	16	1	1	70 000	113 000	3 200	4 500	HR 32914 J	2BC	79	76	94	93	96	4	4	1	1	17.6	0.32	1.9	1.1	0.494
	110	25	25	19	1.5	1.5	104 000	158 000	3 200	4 300	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
	110	31	31	25.5	1.5	1.5	127 000	204 000	3 000	4 300	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
	120	37	37	29	2	1.5	177 000	262 000	3 000	4 000	HR 33114 J	3DE	82	79	111	104	115	6	8	2	1.5	27.9	0.38	1.6	0.87	1.71
	125	26.25	24	21	2	1.5	132 000	163 000	2 800	4 000	HR 30214 J	3EB	82	81	116	110	118	4	5	2	1.5	25.6	0.42	1.4	0.79	1.3
	125	33.25	31	27	2	1.5	157 000	205 000	2 800	4 000	HR 32214 J	3EC	82	80	116	108	119	4	6	2	1.5	28.6	0.42	1.4	0.79	1.66
	125	41	41	32	2	1.5	209 000	299 000	2 800	4 000	HR 33214 J	3EE	82	78	116	107	120	7	9	2	1.5	30.4	0.41	1.5	0.81	2.15
	140	39	35.5	27	3	3	177 000	229 000	2 400	3 400	T 7 FC070	7FC	88	79	126	106	133	5	12	2.5	2.5	46.4	0.87	0.69	0.38	2.55
	150	38	35	30	3	2.5	227 000	268 000	2 400	3 400	HR 30314 J	2GB	88	89	138	132	140	4	8	2.5	2	29.7	0.35	1.7	0.96	3.03
	150	38	35	25	3	2.5	192 000	229 000	2 200	3 200	HR 30314 DJ	7GB	94	85	138	118	142	4	13	2.5	2	45.8	0.83	0.73	0.40	2.94
	150	38	35	25	3	2.5	192 000	229 000	2 200	3 200	HR 31314 J	7GB	94	85	138	118	142	4	13	2.5	2	45.8	0.83	0.73	0.40	2.94
	150	54	51	42	3	2.5	300 000	390 000	2 600	3 400	HR 32314 J	2GD	91	86	138	124	140	4	12	2.5	2	36.1	0.35	1.7	0.96	4.35
	150	54	51	42	3	2.5	280 000	390 000	2 400	3 400	HR 32314 CJ	5GD	91	84	138	115	141	4	12	2.5	2	43.3	0.55	1.1	0.60	4.47
75	105	20	20	16	1	1	72 500	120 000	3 200	4 300	HR 32915 J	2BC	84	81	99	98	101	4	4	1	1	18.7	0.33	1.8	0.99	0.53
	115	25	25	19	1.5	1.5	109 000	171 000	3 000	4 000	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
	115	31	31	25.5	1.5	1.5	133 000	220 000	3 000	4 000	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
	125	37	37	29	2	2	182 000	275 000	2 800	3 800	HR 33115 J	3DE	87	83	115	109	120	6	8	2	2	29.2	0.40	1.5	0.83	1.8
	130	27.25	25	22	2	1.5	143 000	182 000	2 800	3 800	HR 30215 J	4DB	87	85	121	115	124	4	5	2	1.5	27.0	0.44	1.4	0.76	1.43
	130	33.25	31	27	2	1.5	165 000	219 000	2 800	3 800	HR 32215 J	4DC	87	84	121	113	125	4	6	2	1.5	29.8	0.44	1.4	0.76	1.72
	130	41	41	31	2	1.5	215 000	315 000	2 800	3 800	HR 33215 J	3EE	87	83	121	111	125	7	10	2	1.5	31.6	0.43	1.4	0.77	2.25
	160	40	37	31	3	2.5	253 000	300 000	2 400	3 200	HR 30315 J	2GB	93	95	148	141	149	4	9	2.5	2	31.8	0.35	1.7	0.96	3.63
	160	40	37	26	3	2.5	211 000	251 000	2 200	3 000	HR 30315 DJ	7GB	99	91	148	129	152	6	14	2.5	2	48.8	0.83	0.73	0.40	3.47
	160	40	37	26	3	2.5	211 000	251 000	2 200	3 000	HR 31315 J	7GB	99	91	148	129	152	6	14	2.5	2	48.8	0.83	0.73	0.40	3.47
	160	58	55	45	3	2.5	340 000	445 000	2 400	3 200	HR 32315 J	2GD	96	91	148	134	149	4	13	2.5	2	38.9	0.35	1.7	0.96	5.31
	160	58	55	43	3	2.5	310 000	420 000	2 200	3 200	32315 CA	—	96	90	148	124	153	4	15	2.5	2	47.7	0.58	1.0	0.57	5.3
80	110	20	20	16	1	1	75 000	128 000	3 000	4 000	HR 32916 J	2BC	89	85	104	102	106	4	4	1	1	19.8	0.35	1.7	0.94	0.56
	125	29	29	22	1.5	1.5	140 000	222 000	2 800	3 600	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
	125	36	36	29.5	1.5	1.5	172 000	282 000	2 800	3 600	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
	130	37	37	29	2	1.5	186 000	289 000	2 600	3 600	HR 33116 J	3DE	82	88	121	113	126	6	8	2	1.5	30.4	0.42	1.4	0.79	1.88
	140	28.25	26	22	2.5	2	157 000	195 000	2 600	3 400	HR 30216 J	3EB	95	91	130	124	132	4	6	2	2	28.1	0.42	1.4	0.79	1.68
	140	28.25	26	20	2.5	2	147 000	190 000	2 400	3 400	30216 CA	—	95	92	130	122	133	4	8	2	2	33.8	0.58	1.0	0.57	1.66
	140	35.25	33	28	2.5	2	192 000	254 000	2 600	3 400	HR 32216 J	3EC	95	90	130	122	134	4	7	2	2	30.6	0.42	1.4	0.79	2.13
	140	46	46	35	2.5	2	256 000	385 000	2 600	3 400	HR 33216 J	3EE	95	89	130	119	135	7	11	2	2	34.8	0.43	1.4	0.78	2.93
	170	42.5	39	33	3	2.5	276 000	330 000	2 200	3 000	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
	170	42.5	39	27	3	2.5	235 000	283 000	2 000	2 800	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
	170	42.5	39	27	3	2.5	235 000	283 000	2 000	2 800	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
	170	61.5	58	48	3	2.5	385 000	505 000	2 200	3 000	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
	170	61.5	58	48	3	2.5	365 000	530 000	2 200	3 000	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

Remark The suffix CA represents medium-angle tapered roller bearings. Since they are designed for specific applications, please consult NSK when using bearings with suffix CA.

SINGLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 85 – 100 mm





Dynamic Equivalent Load

$P = XF_r + YF_a$

F_a/F_r 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 $P_0 = F_r$

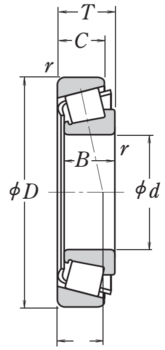
The values of e, Y_1, and Y_0 are given in the table below.

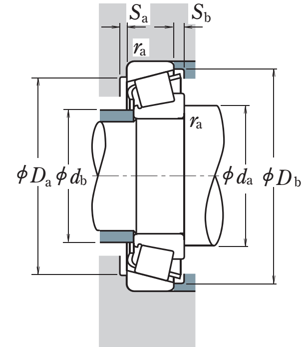
Boundary Dimensions (mm) d	D	T	B	C	Cone r min.	Cup r min.	Basic Load Ratings (N) C_r	C_{0r}	Limiting Speeds (min⁻¹) Grease	Oil	Bearing Numbers	ISO355 Dimension Series approx.	Abutment and Fillet Dimensions (mm) d_a min.	d_b max.	D_a max.	D_a min.	D_b min.	S_a min.	S_b min.	Cone r_a max.	Cup r_a max.	Eff. Load Centers (mm) a	Constant e	Axial Load Factors Y_1	Y_0	Mass (kg) approx.
85	120	23	23	18	1.5	1.5	93 500	157 000	2 800	3 800	**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
	130	29	29	22	1.5	1.5	143 000	231 000	2 600	3 600	**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
	130	36	36	29.5	1.5	1.5	180 000	305 000	2 600	3 600	**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
	140	41	41	32	2.5	2	230 000	365 000	2 400	3 400	**HR 33117 J**	3DE	100	94	130	122	135	7	9	2	2	32.7	0.41	1.5	0.81	2.51
	150	30.5	28	24	2.5	2	184 000	233 000	2 400	3 200	**HR 30217 J**	3EB	100	97	140	133	141	5	6.5	2	2	30.3	0.42	1.4	0.79	2.12
	150	30.5	28	22	2.5	2	171 000	226 000	2 200	3 200	**30217 CA**	—	100	98	140	131	142	5	8.5	2	2	36.2	0.58	1.0	0.57	2.07
	150	38.5	36	30	2.5	2	210 000	277 000	2 200	3 200	**HR 32217 J**	3EC	100	96	140	131	142	5	8.5	2	2	33.9	0.42	1.4	0.79	2.64
	150	49	49	37	2.5	2	281 000	415 000	2 400	3 200	**HR 33217 J**	3EE	100	95	140	129	144	7	12	2	2	37.3	0.42	1.4	0.79	3.57
	180	44.5	41	34	4	3	310 000	375 000	2 000	2 800	**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
	180	44.5	41	28	4	3	261 000	315 000	1 900	2 600	**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
	180	44.5	41	28	4	3	261 000	315 000	1 900	2 600	**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
	180	63.5	60	49	4	3	410 000	535 000	2 000	2 800	**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
90	125	23	23	18	1.5	1.5	97 000	167 000	2 600	3 600	**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
	140	32	32	24	2	1.5	170 000	273 000	2 400	3 200	**HR 32018 XJ**	3CC	102	99	131	124	134	6	8	2	1.5	29.7	0.42	1.4	0.78	1.78
	140	39	39	32.5	2	1.5	220 000	360 000	2 400	3 200	**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
	150	45	45	35	2.5	2	259 000	405 000	2 400	3 200	**HR 33118 J**	3DE	105	100	140	132	144	7	10	2	2	35.2	0.40	1.5	0.83	3.14
	160	32.5	30	26	2.5	2	201 000	256 000	2 200	3 000	**HR 30218 J**	3FB	105	103	150	141	150	5	6.5	2	2	31.7	0.42	1.4	0.79	2.6
	160	42.5	40	34	2.5	2	256 000	350 000	2 200	3 000	**HR 32218 J**	3FC	105	102	150	139	152	5	8.5	2	2	36.2	0.42	1.4	0.79	3.41
	190	46.5	43	36	4	3	345 000	425 000	1 900	2 600	**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
	190	46.5	43	30	4	3	264 000	315 000	1 800	2 400	**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
	190	46.5	43	30	4	3	264 000	315 000	1 800	2 400	**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
	190	67.5	64	53	4	3	450 000	590 000	2 000	2 600	**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
95	130	23	23	18	1.5	1.5	98 000	172 000	2 400	3 400	**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
	145	32	32	24	2	1.5	173 000	283 000	2 400	3 200	**HR 32019 XJ**	4CC	107	104	136	131	140	6	8	2	1.5	31.2	0.44	1.4	0.75	1.88
	145	39	39	32.5	2	1.5	231 000	390 000	2 400	3 200	**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
	160	46	46	38	3	3	283 000	445 000	2 200	3 000	**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
	170	34.5	32	27	3	2.5	223 000	286 000	2 200	2 800	**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
	170	45.5	43	37	3	2.5	289 000	400 000	2 200	2 800	**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
	200	49.5	45	38	4	3	370 000	455 000	1 900	2 600	**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
	200	49.5	45	36	4	3	350 000	435 000	1 800	2 400	**30319 CA**	—	116	119	186	168	188	5	13.5	3	2.5	48.6	0.54	1.1	0.61	6.71
	200	49.5	45	32	4	3	310 000	375 000	1 700	2 400	**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
	200	49.5	45	32	4	3	310 000	375 000	1 700	2 400	**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
	200	71.5	67	55	4	3	525 000	710 000	1 900	2 600	**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
100	140	25	25	20	1.5	1.5	117 000	205 000	2 200	3 200	**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
	145	24	22.5	17.5	3	3	113 000	163 000	2 200	3 000	**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
	150	32	32	24	2	1.5	176 000	294 000	2 200	3 000	**HR 32020 XJ**	4CC	112	109	141	136	144	6	8	2	1.5	32.5	0.46	1.3	0.72	1.95
	150	39	39	32.5	2	1.5	235 000	405 000	2 200	3 000	**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
	165	52	52	40	2.5	2	315 000	515 000	2 000	2 800	**HR 33120 J**	3EE	115	110	155	144	159	8	12	2	2	40.5	0.41	1.5	0.81	4.32
	180	37	34	29	3	2.5	255 000	330 000	2 000	2 600	**HR 30220 J**	3FB	118	116	168	158	168	5	8	2.5	2	36.1	0.42	1.4	0.79	3.78
	180	49	46	39	3	2.5	325 000	450 000	2 000	2 600	**HR 32220 J**	3FC	118	115	168	155	171	5	10	2.5	2	41.5	0.42	1.4	0.79	5.05
	180	63	63	48	3	2.5	410 000	635 000	2 000	2 600	**HR 33220 J**	3FE	118	113	168	152	172	10	15	2.5	2	46.0	0.40	1.5	0.82	6.76
	215	51.5	47	39	4	3	425 000	525 000	1 700	2 400	**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
	215	56.5	51	35	4	3	385 000	505 000	1 500	2 200	**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
	215	77.5	73	60	4	3	565 000	755 000	1 700	2 400	**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

Remark The suffix CA represents medium-angle tapered roller bearings. Since they are designed for specific applications, please consult NSK when using bearings with suffix CA.

SINGLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 105 – 130 mm





Dynamic Equivalent Load

$P = XF_r + YF_a$

F_a/F_r e		F_a/F_r e	
X	Y	X	Y
1	0	0.4	Y_1

Static Equivalent Load

$P_0 = 0.5F_r + Y_0F_a$

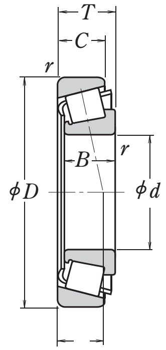
When F_r $0.5F_r + Y_0F_a$, use $P_0 = F_r$

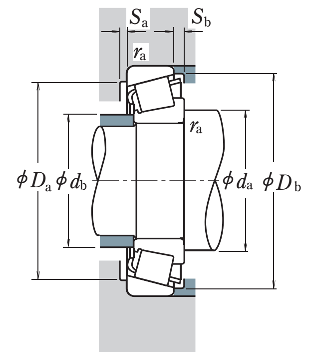
The values of e, Y_1, and Y_0 are given in the table below.

Boundary Dimensions (mm) d	D	T	B	C	Cone r min.	Cup r min.	Basic Load Ratings (N) C_r	C_{0r}	Limiting Speeds (min⁻¹) Grease	Oil	Bearing Numbers	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.	Cone r_a max.	Cup r_a max.	Eff. Load Centers (mm) a	Constant e	Axial Load Factors Y_1	Y_0	Mass (kg) approx.
105	145	25	25	20	1.5	1.5	119 000	212 000	2 200	3 000	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
	160	35	35	26	2.5	2	204 000	340 000	2 000	2 800	HR 32021 XJ	4DC	120	115	150	144	154	6	9	2	2	34.3	0.44	1.4	0.74	2.48
	160	43	43	34	2.5	2	256 000	435 000	2 000	2 800	HR 33021 J	2DE	120	115	150	146	153	7	9	2	2	30.9	0.28	2.1	1.2	3.03
	190	39	36	30	3	2.5	280 000	365 000	1 900	2 600	HR 30221 J	3FB	123	123	178	166	177	6	9	2.5	2	38.1	0.42	1.4	0.79	4.51
	190	53	50	43	3	2.5	360 000	510 000	1 900	2 600	HR 32221 J	3FC	123	120	178	162	180	5	10	2.5	2	44.8	0.42	1.4	0.79	6.25
	225	53.5	49	41	4	3	455 000	565 000	1 600	2 200	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
	225	58	53	36	4	3	415 000	540 000	1 500	2 000	HR 31321 J	7GB	141	130	211	177	211	7	22	3	2.5	70.2	0.83	0.73	0.40	10
	225	81.5	77	63	4	3	670 000	925 000	1 700	2 200	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
110	150	25	25	20	1.5	1.5	123 000	224 000	2 200	2 800	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
	170	38	38	29	2.5	2	236 000	390 000	2 000	2 600	HR 32022 XJ	4DC	125	121	160	153	163	7	9	2	2	35.9	0.43	1.4	0.77	3.09
	170	47	47	37	2.5	2	294 000	515 000	2 000	2 600	HR 33022 J	2DE	125	121	160	153	161	7	10	2	2	33.7	0.29	2.1	1.2	3.84
	180	56	56	43	2.5	2	365 000	610 000	1 900	2 600	HR 33122 J	3EE	125	121	170	156	174	9	13	2	2	44.1	0.42	1.4	0.79	5.54
	200	41	38	32	3	2.5	315 000	420 000	1 800	2 400	HR 30222 J	3FB	128	129	188	175	187	6	9	2.5	2	40.2	0.42	1.4	0.79	5.28
	200	56	53	46	3	2.5	400 000	565 000	1 800	2 400	HR 32222 J	3FC	128	127	188	171	190	5	10	2.5	2	47.2	0.42	1.4	0.79	7.35
	240	54.5	50	42	4	3	485 000	595 000	1 500	2 000	HR 30322 J	2GB	131	143	226	208	220	6	12.5	3	2.5	45.1	0.35	1.7	0.96	11
	240	63	57	38	4	3	470 000	605 000	1 400	1 900	HR 31322 J	7GB	146	136	226	191	224	7	25	3	2.5	74.8	0.83	0.73	0.40	12.3
	240	84.5	80	65	4	3	675 000	910 000	1 500	2 000	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
120	165	29	29	23	1.5	1.5	161 000	291 000	1 900	2 600	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
	170	27	25	19.5	3	3	153 000	243 000	1 800	2 600	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
	180	38	38	29	2.5	2	242 000	405 000	1 800	2 400	HR 32024 XJ	4DC	135	131	170	162	173	7	9	2	2	39.7	0.46	1.3	0.72	3.27
	180	48	48	38	2.5	2	300 000	540 000	1 800	2 600	HR 33024 J	2DE	135	130	168	161	171	6	10	2	2	36.0	0.31	2.0	1.1	4.2
	200	62	62	48	2.5	2	460 000	755 000	1 700	2 400	HR 33124 J	3FE	135	133	190	173	192	9	14	2	2	47.9	0.40	1.5	0.83	7.67
	215	43.5	40	34	3	2.5	335 000	450 000	1 600	2 200	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
	215	61.5	58	50	3	2.5	440 000	635 000	1 600	2 200	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
	260	59.5	55	46	4	3	535 000	655 000	1 400	1 900	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
	260	68	62	42	4	3	560 000	730 000	1 300	1 800	HR 31324 J	7GB	156	148	246	206	244	9	26	3	2.5	81.7	0.83	0.73	0.40	15.6
	260	90.5	86	69	4	3	770 000	1 060 000	1 400	1 900	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
130	180	32	30	26	2	1.5	167 000	281 000	1 800	2 400	32926	—	142	141	171	168	175	6	6	2	1.5	34.7	0.36	1.7	0.92	2.25
	180	32	32	25	2	1.5	200 000	365 000	1 800	2 400	HR 32926 J	2CC	142	140	170	168	173	6	7	2	1.5	31.4	0.34	1.8	0.97	2.46
	185	29	27	21	3	3	183 000	296 000	1 700	2 400	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
	200	45	45	34	2.5	2	320 000	535 000	1 600	2 200	HR 32026 XJ	4EC	145	144	190	179	192	8	11	2	2	43.9	0.43	1.4	0.76	5.06
	200	55	55	43	2.5	2	395 000	715 000	1 700	2 200	HR 33026 J	2EE	145	144	188	179	192	8	12	2	2	42.4	0.34	1.8	0.97	6.25
	230	43.75	40	34	4	3	375 000	505 000	1 500	2 000	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
	230	67.75	64	54	4	3	530 000	790 000	1 500	2 000	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
	280	63.75	58	49	5	4	545 000	675 000	1 300	1 800	30326	—	157	168	262	239	255	8	14.5	4	3	53.9	0.36	1.7	0.92	16.6
	280	63.75	58	49	5	4	650 000	820 000	1 300	1 800	HR 30326 J	2GB	157	166	262	241	255	8	14.5	4	3	52.8	0.35	1.7	0.96	17.2
	280	72	66	44	5	4	625 000	820 000	1 200	1 700	HR 31326 J	7GB	174	159	262	220	261	9	28	4	3	87.1	0.83	0.73	0.40	18.8
	280	98.75	93	78	5	4	830 000	1 150 000	1 300	1 800	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





Dynamic Equivalent Load

$P=XF_r+YF_a$

F_a/F_r e		F_a/F_r e	
X	Y	X	Y
1	0	0.4	Y_1

Static Equivalent Load

$P_0=0.5F_r+Y_0F_a$

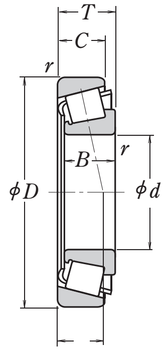
When F_r $0.5F_r+Y_0F_a$, use $P_0=F_r$

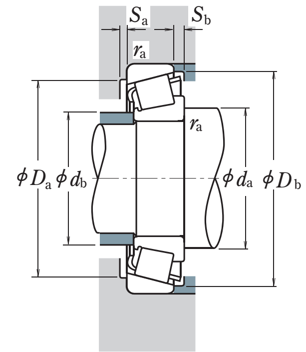
The values of e, Y_1, and Y_0 are given in the table below.

d (mm)	D (mm)	T (mm)	B (mm)	C (mm)	Cone r min. (mm)	Cup r min. (mm)	C_r (N)	C_{0r} (N)	Limiting Speeds Grease (min⁻¹)	Limiting Speeds Oil (min⁻¹)	Bearing Numbers	ISO355 Dimension Series approx.	d_a min.	d_b max.	D_a max.	D_a min.	D_b min.	S_a min.	S_b min.	Cone r_a max.	Cup r_a max.	Eff. Load Centers (mm) a	Constant e	Axial Load Factors Y_1	Axial Load Factors Y_0	Mass (kg) approx.
140	190	32	32	25	2	1.5	206 000	390 000	1 700	2 200	**HR 32928 J**	2CC	152	150	180	178	184	6	7	2	1.5	33.6	0.36	1.7	0.92	2.64
	210	45	45	34	2.5	2	325 000	555 000	1 600	2 200	**HR 32028 XJ**	4DC	155	152	200	189	202	8	11	2	2	46.6	0.46	1.3	0.72	5.32
	210	56	56	44	2.5	2	410 000	770 000	1 600	2 200	**HR 33028 J**	2DE	155	153	198	189	202	7	12	2	2	45.5	0.36	1.7	0.92	6.74
	250	45.75	42	36	4	3	390 000	515 000	1 400	1 900	**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
	250	71.75	68	58	4	3	610 000	915 000	1 400	1 900	**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
	300	67.75	62	53	5	4	740 000	945 000	1 200	1 700	**HR 30328 J**	2GB	167	177	282	256	273	9	14.5	4	3	55.7	0.35	1.7	0.96	21.1
	300	77	70	47	5	4	695 000	955 000	1 100	1 500	**HR 31328 J**	7GB	184	174	282	236	280	9	30	4	3	92.9	0.83	0.73	0.40	28.5
	300	107.75	102	85	5	4	985 000	1 440 000	1 200	1 600	**32328**	—	172	177	282	246	281	9	22.5	4	3	76.4	0.37	1.6	0.88	33.9
150	210	38	36	31	2.5	2	247 000	440 000	1 500	2 000	**32930**	—	165	162	200	195	201	7	7	2	2	36.7	0.33	1.8	1.0	3.8
	210	38	38	30	2.5	2	281 000	520 000	1 500	2 000	**HR 32930 J**	2DC	165	163	198	196	202	7	8	2	2	36.5	0.33	1.8	1.0	4.05
	225	48	48	36	3	2.5	375 000	650 000	1 400	2 000	**HR 32030 XJ**	4EC	168	164	213	202	216	8	12	2.5	2	49.8	0.46	1.3	0.72	6.6
	225	59	59	46	3	2.5	435 000	805 000	1 400	2 000	**HR 33030 J**	2EE	168	165	213	203	217	8	13	2.5	2	48.7	0.36	1.7	0.90	8.07
	270	49	45	38	4	3	485 000	665 000	1 300	1 800	**HR 30230 J**	2GB	171	175	256	236	250	7	11	3	2.5	51.3	0.44	1.4	0.76	11.2
	270	77	73	60	4	3	705 000	1 080 000	1 300	1 800	**HR 32230 J**	4GD	171	171	256	228	254	8	17	3	2.5	64.7	0.44	1.4	0.76	17.8
	320	72	65	55	5	4	690 000	860 000	1 100	1 500	**30330**	—	177	193	302	275	292	8	17	4	3	61.4	0.36	1.7	0.92	24.2
	320	72	65	55	5	4	825 000	1 060 000	1 100	1 600	**HR 30330 J**	2GB	177	190	302	276	292	8	17	4	3	60.0	0.35	1.7	0.96	25
	320	82	75	50	5	4	790 000	1 100 000	1 000	1 400	**HR 31330 J**	7GB	194	187	302	253	300	9	32	4	3	99.3	0.83	0.73	0.40	28.5
	320	114	108	90	5	4	1 120 000	1 700 000	1 100	1 500	**32330**	—	182	191	302	262	297	8	24	4	3	81.5	0.37	1.6	0.88	41.4
160	220	38	38	30	2.5	2	296 000	570 000	1 400	1 900	**HR 32932 J**	2DC	175	173	208	206	212	7	8	2	2	38.7	0.35	1.7	0.95	4.32
	240	51	51	38	3	2.5	425 000	750 000	1 300	1 800	**HR 32032 XJ**	4EC	178	175	228	216	231	8	13	2.5	2	53.0	0.46	1.3	0.72	7.93
	290	52	48	40	4	3	530 000	730 000	1 200	1 600	**HR 30232 J**	4GB	181	189	276	253	269	8	12	3	2.5	55.0	0.44	1.4	0.76	13.7
	290	84	80	67	4	3	795 000	1 220 000	1 200	1 600	**HR 32232 J**	4GD	181	184	276	243	274	10	17	3	2.5	70.5	0.44	1.4	0.76	22.5
	340	75	68	58	5	4	765 000	960 000	1 000	1 400	**30332**	—	187	205	322	293	311	10	17	4	3	64.6	0.36	1.7	0.92	28.4
	340	75	68	58	5	4	915 000	1 180 000	1 100	1 400	**HR 30332 J**	2GB	187	201	322	293	310	10	17	4	3	62.9	0.35	1.7	0.96	29.7
	340	75	68	48	5	4	675 000	875 000	950	1 300	**30332 D**	—	196	198	322	270	313	9	27	4	3	99.4	0.81	0.74	0.41	27.5
	340	121	114	95	5	4	1 210 000	1 770 000	1 000	1 400	**32332**	—	192	202	322	281	319	10	26	4	3	87.1	0.37	1.6	0.88	48.3
170	230	38	36	31	2.5	2.5	258 000	485 000	1 300	1 800	**32934**	—	185	183	220	216	223	7	7	2	2	41.6	0.36	1.7	0.90	4.3
	230	38	38	30	2.5	2	294 000	560 000	1 400	1 800	**HR 32934 J**	3DC	185	180	218	215	222	7	8	2	2	41.7	0.38	1.6	0.86	4.44
	260	57	57	43	3	2.5	505 000	890 000	1 200	1 700	**HR 32034 XJ**	4EC	188	187	248	232	249	10	14	2.5	2	56.6	0.44	1.4	0.74	10.6
	310	57	52	43	5	4	630 000	885 000	1 100	1 500	**HR 30234 J**	4GB	197	202	292	273	288	8	14	4	3	59.4	0.44	1.4	0.76	17.1
	310	91	86	71	5	4	930 000	1 450 000	1 100	1 500	**HR 32234 J**	4GD	197	197	292	262	294	10	20	4	3	76.4	0.44	1.4	0.76	28
	360	80	72	62	5	4	845 000	1 080 000	950	1 300	**30334**	—	197	221	342	312	332	10	18	4	3	70.1	0.37	1.6	0.90	33.5
	360	80	72	62	5	4	960 000	1 230 000	1 000	1 300	**HR 30334 J**	2GB	197	214	342	310	329	10	18	4	3	67.3	0.35	1.7	0.96	34.5
	360	80	72	50	5	4	760 000	1 040 000	900	1 200	**30334 D**	—	206	215	342	288	332	10	30	4	3	107.3	0.81	0.74	0.41	33.4
	360	127	120	100	5	4	1 370 000	2 050 000	1 000	1 300	**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





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

$P_0 = 0.5F_r + Y_0F_a$

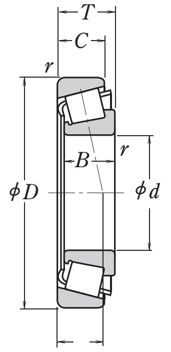
When $F_r > 0.5F_r + Y_0F_a$, use $P_0 = F_r$

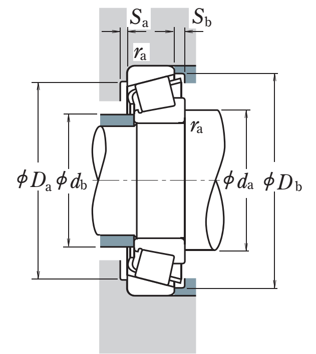
The values of e, Y_1, and Y_0 are given in the table below.

Boundary Dimensions (mm) d	D	T	B	C	Cone r min.	Cup r min.	Basic Load Ratings (N) C_r	C_{0r}	Limiting Speeds (min⁻¹) Grease	Oil	Bearing Numbers	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.	Cone r_a max.	Cup r_a max.	Eff. Load Centers (mm) a	Constant e	Axial Load Factors Y_1	Y_0	Mass (kg) approx.
180	250	45	45	34	2.5	2	350 000	685 000	1 300	1 700	HR 32936 J	4DC	195	192	240	227	241	8	11	2	2	53.9	0.48	1.3	0.69	6.56
	280	64	64	48	3	2.5	640 000	1 130 000	1 200	1 600	HR 32036 XJ	3FD	198	199	268	248	267	10	16	2.5	2	60.4	0.42	1.4	0.78	14.3
	320	57	52	43	5	4	650 000	930 000	1 100	1 400	HR 30236 J	4GB	207	210	302	281	297	9	14	4	3	61.8	0.45	1.3	0.73	17.8
	320	91	86	71	5	4	960 000	1 540 000	1 100	1 400	HR 32236 J	4GD	207	205	302	270	303	10	20	4	3	78.9	0.45	1.3	0.73	29.8
	380	83	75	64	5	4	935 000	1 230 000	900	1 300	30336	—	207	233	362	324	345	10	19	4	3	72.5	0.36	1.7	0.92	39.3
	380	83	75	53	5	4	820 000	1 120 000	850	1 200	30336 D	—	216	229	362	304	352	10	30	4	3	113.1	0.81	0.74	0.41	38.5
	380	134	126	106	5	4	1 520 000	2 290 000	950	1 300	32336	—	212	225	362	310	353	10	28	4	3	96.6	0.37	1.6	0.88	66.8
190	260	45	45	34	2.5	2	365 000	715 000	1 200	1 600	HR 32938 J	4DC	205	201	250	237	251	8	11	2	2	55.3	0.48	1.3	0.69	6.83
	290	64	64	48	3	2.5	650 000	1 170 000	1 100	1 500	HR 32038 XJ	4FD	208	209	278	258	279	10	16	2.5	2	63.4	0.44	1.4	0.75	14.9
	340	60	55	46	5	4	715 000	1 020 000	1 000	1 300	HR 30238 J	4GB	217	223	322	302	318	9	14	4	3	65.6	0.44	1.4	0.76	21.4
	340	97	92	75	5	4	1 110 000	1 770 000	1 000	1 400	HR 32238 J	4GD	217	216	322	290	323	10	22	4	3	80.5	0.44	1.4	0.76	35.2
	400	86	78	65	6	5	1 010 000	1 340 000	850	1 200	30338	—	223	248	378	346	366	11	21	5	4	76.1	0.36	1.7	0.92	46
	400	140	132	109	6	5	1 660 000	2 580 000	850	1 200	32338	—	229	243	378	332	375	11	31	5	4	102.7	0.37	1.6	0.88	78.9
200	280	51	48	41	3	2.5	410 000	780 000	1 100	1 500	32940	—	218	217	268	256	269	9	10	2.5	2	53.4	0.37	1.6	0.88	9.26
	280	51	51	39	3	2.5	480 000	935 000	1 100	1 500	HR 32940 J	3EC	218	216	268	258	271	9	12	2.5	2	54.2	0.39	1.5	0.84	9.65
	310	70	70	53	3	2.5	760 000	1 370 000	1 000	1 400	HR 32040 XJ	4FD	218	221	298	277	297	11	17	2.5	2	67.4	0.43	1.4	0.77	18.9
	360	64	58	48	5	4	795 000	1 120 000	950	1 300	HR 30240 J	4GB	227	236	342	318	336	10	16	4	3	69.1	0.44	1.4	0.76	25.5
	360	104	98	82	5	4	1 210 000	1 920 000	950	1 300	HR 32240 J	3GD	227	230	342	305	340	11	22	4	3	85.1	0.41	1.5	0.81	42.6
	420	89	80	67	6	5	1 030 000	1 390 000	850	1 200	30340	—	233	253	398	346	368	11	22	5	4	81.4	0.37	1.6	0.88	52.3
	420	89	80	56	6	5	965 000	1 330 000	750	1 000	30340 D	—	244	253	398	336	385	11	33	5	4	122.9	0.81	0.74	0.41	49.6
	420	146	138	115	6	5	1 820 000	2 870 000	800	1 100	32340	—	239	253	398	346	392	11	31	5	4	106.7	0.37	1.6	0.88	90.9
220	300	51	51	39	3	2.5	490 000	990 000	1 000	1 400	HR 32944 J	3EC	238	235	288	278	293	9	12	2.5	2	59.2	0.43	1.4	0.78	10.3
	340	76	76	57	4	3	885 000	1 610 000	950	1 300	HR 32044 XJ	4FD	241	244	326	303	326	12	19	3	2.5	73.6	0.43	1.4	0.77	24.4
	400	72	65	54	5	4	810 000	1 150 000	850	1 100	30244	—	247	267	382	350	367	11	18	4	3	74.7	0.40	1.5	0.82	33.6
	400	114	108	90	5	4	1 340 000	2 210 000	850	1 100	32244	—	247	260	382	340	377	12	24	4	3	93.0	0.40	1.5	0.82	57.4
	460	97	88	73	6	5	1 430 000	1 990 000	750	1 000	30344	—	253	283	438	390	414	12	24	5	4	85.4	0.36	1.7	0.92	72.4
	460	154	145	122	6	5	2 020 000	3 200 000	750	1 000	32344	—	259	274	438	372	421	12	32	5	4	114.9	0.37	1.6	0.88	114
240	320	51	51	39	3	2.5	500 000	1 040 000	950	1 300	HR 32948 J	4EC	258	255	308	297	314	9	12	2.5	2	65.1	0.46	1.3	0.72	11.1
	360	76	76	57	4	3	920 000	1 730 000	850	1 200	HR 32048 XJ	4FD	261	262	346	321	346	12	19	3	2.5	79.1	0.46	1.3	0.72	26.2
	440	79	72	60	5	4	990 000	1 400 000	750	1 000	30248	—	267	288	422	384	408	11	19	4	3	85.1	0.44	1.4	0.74	45.2
	440	127	120	100	5	4	1 630 000	2 730 000	750	1 000	32248	—	267	285	422	374	416	12	27	4	3	102.5	0.40	1.5	0.82	78
	500	105	95	80	6	5	1 660 000	2 340 000	670	950	30348	—	273	308	478	422	447	12	25	5	4	92.8	0.36	1.7	0.92	92.6
	500	165	155	132	6	5	2 520 000	4 100 000	670	900	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





Dynamic Equivalent Load

$P = XF_r + YF_a$

F_a/F_r e		F_a/F_r e	
X	Y	X	Y
1	0	0.4	Y_1

Static Equivalent Load

$P_0 = 0.5F_r + Y_0F_a$

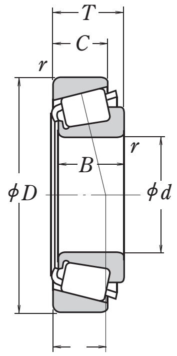
When F_r $0.5F_r + Y_0F_a$, use $P_0 = F_r$

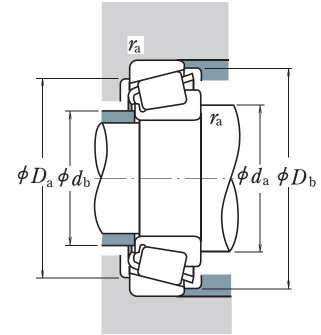
The values of e, Y_1, and Y_0 are given in the table below.

d	D	T	B	C	Cone r min.	Cup r min.	C_r (N)	C_{0r} (N)	Limiting Speeds Grease (min⁻¹)	Limiting Speeds Oil (min⁻¹)	Bearing Numbers	ISO355 Dimension Series approx.	d_a min.	d_b max.	D_a max.	D_a min.	D_b min.	S_a min.	S_b min.	Cone r_a max.	Cup r_a max.	Eff. Load Centers (mm) a	Constant e	Axial Load Factors Y_1	Axial Load Factors Y_0	Mass (kg) approx.
260	360	63.5	63.5	48	3	2.5	730 000	1 450 000	850	1 100	**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
	400	87	87	65	5	4	1 160 000	2 160 000	800	1 100	**HR 32052 XJ**	4FC	287	287	382	357	383	14	22	4	3	86.3	0.43	1.4	0.76	38.5
	480	89	80	67	6	5	1 190 000	1 700 000	670	900	**30252**	—	293	316	458	421	447	12	22	5	4	94.6	0.44	1.4	0.74	60.7
	480	137	130	106	6	5	1 900 000	3 300 000	670	950	**32252**	—	293	305	458	394	446	14	31	5	4	116.0	0.45	1.3	0.73	103
	540	113	102	85	6	6	1 870 000	2 640 000	630	850	**30352**	—	293	336	512	460	487	16	28	5	5	101.6	0.36	1.7	0.92	114
	540	176	165	136	6	6	2 910 000	4 800 000	630	850	**32352**	—	293	328	512	441	495	13	40	5	5	130.5	0.37	1.6	0.88	188
280	380	63.5	63.5	48	3	2.5	765 000	1 580 000	800	1 100	**HR 32956 J**	4EC	298	297	368	352	368	12	15.5	2.5	2	75.3	0.43	1.4	0.76	20
	420	87	87	65	5	4	1 180 000	2 240 000	710	1 000	**HR 32056 XJ**	4FC	307	305	402	374	402	14	22	4	3	91.6	0.46	1.3	0.72	40.6
	500	89	80	67	6	5	1 240 000	1 900 000	630	850	**30256**	—	313	339	478	436	462	12	22	5	4	98.5	0.44	1.4	0.74	66.3
	500	137	130	106	6	5	1 950 000	3 450 000	630	850	**32256**	—	313	325	478	412	467	14	31	5	4	123.1	0.47	1.3	0.70	109
	580	187	175	145	6	6	3 300 000	5 400 000	560	800	**32356**	—	319	353	552	475	532	14	42	5	5	139.6	0.37	1.6	0.89	224
300	420	76	72	62	4	3	895 000	1 820 000	710	950	**32960**	—	321	326	406	386	405	13	14	3	2.5	79.3	0.37	1.6	0.88	30.5
	420	76	76	57	4	3	1 010 000	2 100 000	710	950	**HR 32960 J**	3FD	321	324	406	387	405	13	19	3	2.5	79.9	0.39	1.5	0.84	31.4
	460	100	100	74	5	4	1 440 000	2 700 000	670	900	**HR 32060 XJ**	4GD	327	330	442	408	439	15	26	4	3	98.4	0.43	1.4	0.76	56.6
	540	96	85	71	6	5	1 440 000	2 100 000	600	800	**30260**	—	333	355	518	470	499	14	25	5	4	105.1	0.44	1.4	0.74	80.6
	540	149	140	115	6	5	2 220 000	3 700 000	600	800	**32260**	—	333	352	518	458	514	15	34	5	4	131.7	0.46	1.3	0.72	132
320	440	76	72	63	4	3	900 000	1 880 000	970	900	**32964**	—	341	345	426	404	425	13	13	3	2.5	84.3	0.39	1.5	0.84	32
	440	76	76	57	4	3	1 040 000	2 220 000	670	900	**HR 32964 J**	3FD	341	344	426	406	426	13	19	3	2.5	85.0	0.42	1.4	0.79	33.3
	480	100	100	74	5	4	1 510 000	2 910 000	630	850	**HR 32064 XJ**	4GD	347	350	462	430	461	15	26	4	3	104.5	0.46	1.3	0.72	60
	580	104	92	75	6	5	1 640 000	2 420 000	530	750	**30264**	—	353	381	558	503	533	14	29	5	4	113.7	0.44	1.4	0.74	99.3
	580	159	150	125	6	5	2 860 000	5 050 000	530	750	**32264**	—	353	383	558	487	550	15	34	5	4	141.7	0.46	1.3	0.72	175
	670	210	200	170	7.5	7.5	4 200 000	7 100 000	480	670	**32364**	—	383	412	634	547	616	14	42	6	6	157.5	0.37	1.6	0.88	343
340	460	76	72	63	4	3	910 000	1 940 000	630	850	**32968**	—	361	364	446	426	446	13	13	3	2.5	89.2	0.41	1.5	0.80	33.6
	460	76	76	57	4	3	1 050 000	2 220 000	630	850	**HR 32968 J**	4FD	361	362	446	427	446	13	19	3	2.5	91.0	0.44	1.4	0.75	34.3
	520	112	106	92	6	5	1 650 000	3 400 000	560	750	**32068**	—	373	386	498	464	496	3.5	22	5	4	104.5	0.37	1.6	0.89	83.7
360	480	76	72	62	4	3	945 000	2 100 000	600	800	**32972**	—	381	386	466	445	465	14	14	3	2.5	91.4	0.40	1.5	0.82	35.8
	480	76	76	57	4	3	1 080 000	2 340 000	560	800	**HR 32972 J**	4FD	381	381	466	445	466	13	19	3	2.5	96.8	0.46	1.3	0.72	36.1
	540	112	106	92	6	5	1 680 000	3 500 000	530	750	**32072**	—	393	402	518	480	514	5.5	22	5	4	108.6	0.38	1.6	0.86	86.5
380	520	87	82	71	5	4	1 210 000	2 550 000	560	750	**32976**	—	407	406	502	478	501	16	16	4	3	95.2	0.39	1.6	0.86	49.5
400	540	87	82	71	5	4	1 250 000	2 700 000	530	710	**32980**	—	427	428	522	499	524	16	16	4	3	100.8	0.40	1.5	0.82	52.7
	600	125	118	100	6	5	1 960 000	4 050 000	480	670	**32080**	—	433	443	578	533	565	5	25	5	4	115.3	0.36	1.7	0.92	116
420	560	87	82	72	5	4	1 300 000	2 810 000	500	670	**32984**	—	447	448	542	521	544	3.5	15	4	3	106.1	0.41	1.5	0.81	54.8
	620	125	118	100	6	5	2 000 000	4 200 000	450	630	**32084**	—	453	463	598	552	586	6.5	25	5	4	120.0	0.37	1.6	0.88	121
440	650	130	122	104	6	6	2 230 000	4 600 000	430	600	**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 DESIGN)

Bore Diameter 12.000 – 22.225 mm





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 $P_0 = F_r$

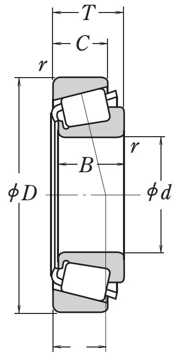
The values of e, Y_1, and Y_0 are given in the table below.

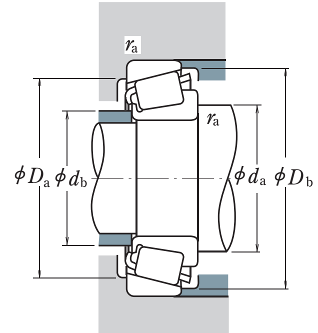
Boundary Dimensions (mm)							Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers		Abutment and Fillet Dimensions (mm)						Eff. Load Centers (mm)	Constant	Axial Load Factors		Mass (kg) approx.	
d	D	T	B	C	Cone r min.	Cup r min.	C_r	C_{0r}	Grease	Oil	CONE	CUP	d_a	d_b	D_a	D_b	Cone r_a max.	Cup r_a max.	a	e	Y_1	Y_0	CONE	CUP
12.000	31.991	10.008	10.785	7.938	0.8	1.3	10 300	8 900	13 000	18 000	**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
12.700	34.988	10.998	10.988	8.730	1.3	1.3	11 700	10 900	12 000	16 000	**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
15.000	34.988	10.998	10.988	8.730	0.8	1.3	11 700	10 900	12 000	16 000	**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
15.875	34.988	10.998	10.998	8.712	1.3	1.3	13 800	13 400	11 000	15 000	**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
	39.992	12.014	11.153	9.525	1.3	1.3	14 900	15 700	9 500	13 000	**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
	41.275	14.288	14.681	11.112	1.3	2.0	21 300	19 900	10 000	13 000	**03062**	**03162**	21.5	20	34	37.5	1.3	2	9.1	0.31	1.9	1.1	0.061	0.035
	42.862	14.288	14.288	9.525	1.5	1.5	17 300	17 200	8 500	12 000	**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
	42.862	16.670	16.670	13.495	1.5	1.5	26 900	26 300	9 500	13 000	**17580**	**17520**	23	21	36.5	39	1.5	1.5	10.6	0.33	1.8	1.0	0.075	0.048
	44.450	15.494	14.381	11.430	1.5	1.5	23 800	23 900	8 500	11 000	**05062**	**05175**	23.5	21	38	42	1.5	1.5	11.2	0.36	1.7	0.93	0.081	0.039
	49.225	19.845	21.539	14.288	0.8	1.3	37 500	37 000	8 500	11 000	**09062**	**09195**	22	21.5	42	44.5	0.8	1.3	10.7	0.27	2.3	1.2	0.139	0.065
16.000	47.000	21.000	21.000	16.000	1.0	2.0	35 000	36 500	9 000	12 000	**HM 81649**	**HM 81610**	27.5	23	37.5	43	1	2	14.9	0.55	1.1	0.60	0.115	0.082
16.993	39.992	12.014	11.153	9.525	0.8	1.3	14 900	15 700	9 500	13 000	**A 6067**	**A 6157**	22	21	34	37	0.8	1.3	10.3	0.53	1.1	0.63	0.042	0.031
17.455	36.525	11.112	11.112	7.938	1.5	1.5	11 600	11 000	10 000	14 000	**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
17.462	39.878	13.843	14.605	10.668	1.3	1.3	22 500	22 500	10 000	13 000	**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
	47.000	14.381	14.381	11.112	0.8	1.3	23 800	23 900	8 500	11 000	**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
19.050	39.992	12.014	11.153	9.525	1.0	1.3	14 900	15 700	9 500	13 000	**A 6075**	**A 6157**	24	23	34	37	1	1.3	10.3	0.53	1.1	0.63	0.037	0.031
	45.237	15.494	16.637	12.065	1.3	1.3	28 500	28 900	9 000	12 000	**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
	47.000	14.381	14.381	11.112	1.3	1.3	23 800	23 900	8 500	11 000	**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
	49.225	18.034	19.050	14.288	1.3	1.3	37 500	37 000	8 500	11 000	**09067**	**09195**	25.5	24	42	44.5	1.3	1.3	10.7	0.27	2.3	1.2	0.115	0.065
	49.225	19.845	21.539	14.288	1.2	1.3	37 500	37 000	8 500	11 000	**09078**	**09195**	25.5	24	42	44.5	1.2	1.3	10.7	0.27	2.3	1.2	0.124	0.065
	49.225	21.209	19.050	17.462	1.3	1.5	37 500	37 000	8 500	11 000	**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
	49.225	23.020	21.539	17.462	C1.5	3.5	37 500	37 000	8 500	11 000	**09074**	**09194**	26	24	39	44.5	1.5	3.5	13.8	0.27	2.3	1.2	0.124	0.082
	53.975	22.225	21.839	15.875	1.5	2.3	40 500	39 500	7 500	10 000	**21075**	**21212**	31.5	26	43	50	1.5	2.3	16.3	0.59	1.0	0.56	0.156	0.097
19.990	47.000	14.381	14.381	11.112	1.5	1.3	23 800	23 900	8 500	11 000	**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
20.000	51.994	15.011	14.260	12.700	1.5	1.3	26 000	27 900	7 500	10 000	**07079**	**07204**	27.5	27	45	48	1.5	1.3	12.1	0.40	1.5	0.82	0.105	0.061
20.625	49.225	23.020	21.539	17.462	1.5	1.5	37 500	37 000	8 500	11 000	**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
20.638	49.225	19.845	19.845	15.875	1.5	1.5	36 000	37 000	8 000	11 000	**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
21.430	50.005	17.526	18.288	13.970	1.3	1.3	38 500	40 000	8 000	11 000	**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
22.000	45.237	15.494	16.637	12.065	1.3	1.3	29 200	33 500	8 500	11 000	**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
	45.975	15.494	16.637	12.065	1.3	1.3	29 200	33 500	8 500	11 000	**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
22.225	50.005	13.495	14.260	9.525	1.3	1.0	26 000	27 900	7 500	10 000	**07087**	**07196**	28.5	27	44.5	47	1.3	1	10.6	0.40	1.5	0.82	0.097	0.035
	50.005	17.526	18.288	13.970	1.3	1.3	38 500	40 000	8 000	11 000	**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
	52.388	19.368	20.168	14.288	1.5	1.5	40 500	43 000	7 500	10 000	**1380**	**1328**	29.5	27	45	48.5	1.5	1.5	11.3	0.29	2.1	1.1	0.137	0.067
	53.975	19.368	20.168	14.288	1.5	1.5	40 500	43 000	7 500	10 000	**1380**	**1329**	29.5	27	46	49	1.5	1.5	11.3	0.29	2.1	1.1	0.137	0.082
	56.896	19.368	19.837	15.875	1.3	1.3	38 000	40 500	7 100	9 500	**1755**	**1729**	29	27.5	49	51	1.3	1.3	12.2	0.31	2.0	1.1	0.152	0.102
	57.150	22.225	22.225	17.462	0.8	1.5	48 000	50 000	7 100	9 500	**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 for overall bearing width is +356 to 0 μm.

SINGLE-ROW TAPERED ROLLER BEARINGS (INCH DESIGN)

Bore Diameter 22.606 – 28.575 mm





Dynamic Equivalent Load

$P = XF_r + YF_a$

F_a/F_r ≤ 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 0.5$F_r + Y_0F_a$, use $P_0 = F_r$

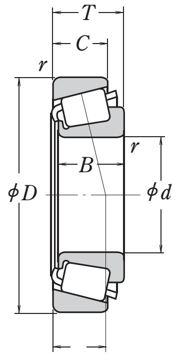
The values of e, Y_1, and Y_0 are given in the table below.

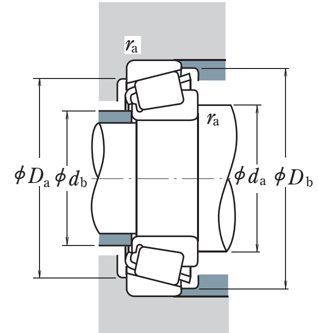
Boundary Dimensions (mm)							Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers		Abutment and Fillet Dimensions (mm)						Eff. Load Centers (mm)	Constant	Axial Load Factors		Mass (kg) approx.	
d	D	T	B	C	Cone r min.	Cup r min.	C_r	C_{0r}	Grease	Oil	CONE	CUP	d_a	d_b	D_a	D_b	Cone r_a max.	Cup r_a max.	a	e	Y_1	Y_0	CONE	CUP
22.606	47.000	15.500	15.500	12.000	1.5	1.0	26 300	30 000	8 000	11 000	**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
23.812	50.292	14.224	14.732	10.668	1.5	1.3	27 600	32 000	7 100	10 000	**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
	56.896	19.368	19.837	15.875	0.8	1.3	38 000	40 500	7 100	9 500	**1779**	**1729**	29.5	28.5	49	51	0.8	1.3	12.2	0.31	2.0	1.1	0.143	0.102
24.000	55.000	25.000	25.000	21.000	2.0	2.0	49 500	55 000	7 100	9 500	**JHM 33449**	**JHM 33410**	35	30	47	52	2	2	15.8	0.35	1.7	0.93	0.181	0.107
24.981	51.994	15.011	14.260	12.700	1.5	1.3	26 000	27 900	7 500	10 000	**07098**	**07204**	31	29	45	48	1.5	1.3	12.1	0.40	1.5	0.82	0.085	0.061
	52.001	15.011	14.260	12.700	1.5	2.0	26 000	27 900	7 500	10 000	**07098**	**07205**	31	29	44.5	48	1.5	2	12.1	0.40	1.5	0.82	0.085	0.061
	62.000	16.002	16.566	14.288	1.5	1.5	37 000	39 500	6 300	8 500	**17098**	**17244**	33	30.5	54	57	1.5	1.5	12.8	0.38	1.6	0.86	0.165	0.091
25.000	50.005	13.495	14.260	9.525	1.5	1.0	26 000	27 900	7 500	10 000	**07097**	**07196**	31	29	44.5	47	1.5	1	10.6	0.40	1.5	0.82	0.085	0.035
	51.994	15.011	14.260	12.700	1.5	1.3	26 000	27 900	7 500	10 000	**07097**	**07204**	31	29	45	48	1.5	1.3	12.1	0.40	1.5	0.82	0.085	0.061
25.400	50.005	13.495	14.260	9.525	3.3	1.0	26 000	27 900	7 500	10 000	**07100 SA**	**07196**	35	29.5	44.5	47	3.3	1	10.6	0.40	1.5	0.82	0.082	0.035
	50.005	13.495	14.260	9.525	1.0	1.0	26 000	27 900	7 500	10 000	**07100**	**07196**	30.5	29.5	44.5	47	1	1	10.6	0.40	1.5	0.82	0.084	0.035
	50.292	14.224	14.732	10.668	1.3	1.3	27 600	32 000	7 100	10 000	**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
	57.150	17.462	17.462	13.495	1.3	1.5	39 500	45 500	6 700	9 000	**15578**	**15520**	32.5	30.5	51	53	1.3	1.5	12.4	0.35	1.7	0.95	0.151	0.070
	57.150	19.431	19.431	14.732	1.5	1.5	42 500	49 000	6 700	9 000	**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
	59.530	23.368	23.114	18.288	0.8	1.5	50 000	58 000	6 300	9 000	**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
	62.000	19.050	20.638	14.288	0.8	1.3	46 000	53 000	6 000	8 000	**15101**	**15245**	32.5	31.5	55	58	0.8	1.3	13.3	0.35	1.7	0.94	0.222	0.081
	63.500	20.638	20.638	15.875	3.5	1.5	46 000	53 000	6 000	8 000	**15100**	**15250 X**	38	31.5	55	59	3.5	1.5	14.9	0.35	1.7	0.94	0.22	0.113
	64.292	21.433	21.433	16.670	1.5	1.5	51 000	64 500	5 600	8 000	**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
	65.088	22.225	21.463	15.875	1.5	1.5	45 000	47 500	5 600	8 000	**23100**	**23256**	39	34.5	53	61	1.5	1.5	20.0	0.73	0.82	0.45	0.214	0.142
	68.262	22.225	22.225	17.462	0.8	1.5	55 000	64 000	5 600	7 500	**02473**	**02420**	34.5	33.5	59	63	0.8	1.5	16.9	0.42	1.4	0.79	0.28	0.152
	72.233	25.400	25.400	19.842	0.8	2.3	63 500	83 500	5 000	7 100	**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
	72.626	24.608	24.257	17.462	2.3	1.5	60 000	58 000	5 600	7 500	**41100**	**41286**	41	36.5	61	68	2.3	1.5	20.7	0.60	1.0	0.55	0.32	0.177
26.988	50.292	14.224	14.732	10.668	3.5	1.3	27 600	32 000	7 100	10 000	**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
	57.150	19.845	19.355	15.875	3.3	1.5	40 000	44 500	6 700	9 000	**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
	60.325	19.842	17.462	15.875	3.5	1.5	39 500	45 500	6 700	9 000	**15580**	**15523**	38.5	32	51	54	3.5	1.5	14.7	0.35	1.7	0.95	0.141	0.123
	62.000	19.050	20.638	14.288	0.8	1.3	46 000	53 000	6 000	8 000	**15106**	**15245**	33.5	33	55	58	0.8	1.3	13.3	0.35	1.7	0.94	0.211	0.081
28.575	57.150	19.845	19.355	15.875	3.5	1.5	40 000	44 500	6 700	9 000	**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
	59.131	15.875	16.764	11.811	spec.	1.3	34 500	41 500	6 300	8 500	**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
	62.000	19.050	20.638	14.288	3.5	1.3	46 000	53 000	6 000	8 000	**15112**	**15245**	40	34	55	58	3.5	1.3	13.3	0.35	1.7	0.94	0.199	0.081
	62.000	19.050	20.638	14.288	0.8	1.3	46 000	53 000	6 000	8 000	**15113**	**15245**	34.5	34	55	58	0.8	1.3	13.3	0.35	1.7	0.94	0.20	0.081
	64.292	21.433	21.433	16.670	1.5	1.5	51 000	64 500	5 600	8 000	**M 86647**	**M 86610**	40	38	54	61	1.5	1.5	17.7	0.55	1.1	0.60	0.223	0.128
	68.262	22.225	22.225	17.462	0.8	1.5	55 000	64 000	5 600	7 500	**02474**	**02420**	36.5	36	59	63	0.8	1.5	16.9	0.42	1.4	0.79	0.257	0.152
	72.626	24.608	24.257	17.462	4.8	1.5	60 000	58 000	5 600	7 500	**41125**	**41286**	48	36.5	61	68	4.8	1.5	20.7	0.60	1.0	0.55	0.292	0.177
	72.626	24.608	24.257	17.462	1.5	1.5	60 000	58 000	5 600	7 500	**41126**	**41286**	41.5	36.5	61	68	1.5	1.5	20.7	0.60	1.0	0.55	0.295	0.177
	73.025	22.225	22.225	17.462	0.8	3.3	54 500	64 500	5 300	7 100	**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). The tolerances are listed in Tables 2, 3 and 4 on Pages C184 and C185.

SINGLE-ROW TAPERED ROLLER BEARINGS (INCH DESIGN)

Bore Diameter 29.000 – 32.000 mm





Dynamic Equivalent Load

$P = XF_r + YF_a$

F_a/F_r 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 $P_0 = F_r$

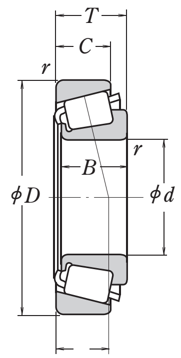
The values of e, Y_1, and Y_0 are given in the table below.

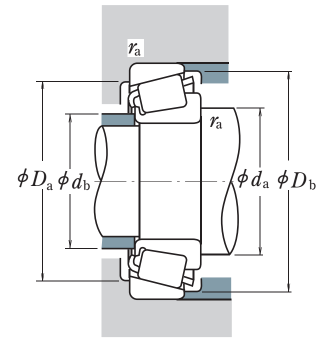
Boundary Dimensions (mm)							Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers		Abutment and Fillet Dimensions (mm)						Eff. Load Centers (mm)	Constant	Axial Load Factors		Mass (kg) approx.	
d	D	T	B	C	Cone r min.	Cup r min.	C_r	C_{0r}	Grease	Oil	CONE	CUP	d_a	d_b	D_a	D_b	Cone r_a max.	Cup r_a max.	a	e	Y_1	Y_0	CONE	CUP
29.000	50.292	14.224	14.732	10.668	3.5	1.3	26 800	34 000	7 100	9 500	**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
29.367	66.421	23.812	25.433	19.050	3.5	1.3	65 000	73 000	6 000	8 000	**2690**	**2631**	41	35	58	60	3.5	1.3	14.3	0.25	2.4	1.3	0.242	0.165
30.000	62.000	16.002	16.566	14.288	1.5	1.5	37 000	39 500	6 300	8 500	**17118**	**17244**	37	34.5	54	57	1.5	1.5	12.8	0.38	1.6	0.86	0.136	0.091
	62.000	19.050	20.638	14.288	1.3	1.3	46 000	53 000	6 000	8 000	**15117**	**15245**	36.5	35	55	58	1.3	1.3	13.3	0.35	1.7	0.94	0.189	0.081
	63.500	20.638	20.638	15.875	1.3	1.3	46 000	53 000	6 000	8 000	**15117**	**15250**	36.5	35	56	59	1.3	1.3	14.9	0.35	1.7	0.94	0.189	0.113
	72.000	19.000	18.923	15.875	1.5	1.5	52 000	56 000	5 600	7 500	**26118**	**26283**	38	36	62	65	1.5	1.5	14.8	0.36	1.7	0.92	0.225	0.163
30.112	62.000	19.050	20.638	14.288	0.8	1.3	46 000	53 000	6 000	8 000	**15116**	**15245**	36	35.5	55	58	0.8	1.3	13.3	0.35	1.7	0.94	0.189	0.081
30.162	58.738	14.684	15.080	10.716	3.5	1.0	28 800	33 500	6 000	8 000	**08118**	**08231**	41.5	35	52	55	3.5	1	13.3	0.47	1.3	0.70	0.12	0.057
	64.292	21.433	21.433	16.670	1.5	1.5	51 000	64 500	5 600	8 000	**M 86649**	**M 86610**	41	38	54	61	1.5	1.5	17.7	0.55	1.1	0.60	0.211	0.128
	68.262	22.225	22.225	17.462	2.3	1.5	55 500	70 500	5 300	7 500	**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
	69.850	23.812	25.357	19.050	2.3	1.3	71 000	84 000	5 600	7 500	**2558**	**2523**	40	36.5	61	64	2.3	1.3	14.5	0.27	2.2	1.2	0.297	0.169
	69.850	23.812	25.357	19.050	0.8	1.3	71 000	84 000	5 600	7 500	**2559**	**2523**	37	36.5	61	64	0.8	1.3	14.5	0.27	2.2	1.2	0.298	0.169
	76.200	24.608	24.074	16.670	1.5	C3.3	67 500	69 500	5 000	6 700	**43118**	**43300**	45	42	64	73	1.5	3.3	22.9	0.67	0.90	0.49	0.383	0.146
30.213	62.000	19.050	20.638	14.288	3.5	1.3	46 000	53 000	6 000	8 000	**15118**	**15245**	41.5	35.5	55	58	3.5	1.3	13.3	0.35	1.7	0.94	0.186	0.081
	62.000	19.050	20.638	14.288	0.8	1.3	46 000	53 000	6 000	8 000	**15120**	**15245**	36	35.5	55	58	0.8	1.3	13.3	0.35	1.7	0.94	0.188	0.081
	62.000	19.050	20.638	14.288	1.5	1.3	46 000	53 000	6 000	8 000	**15119**	**15245**	37.5	35.5	55	58	1.5	1.3	13.3	0.35	1.7	0.94	0.188	0.081
30.955	64.292	21.433	21.433	16.670	1.5	1.5	51 000	64 500	5 600	8 000	**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
31.750	58.738	14.684	15.080	10.716	1.0	1.0	28 800	33 500	6 000	8 000	**08125**	**08231**	37.5	36	52	55	1	1	13.3	0.47	1.3	0.70	0.113	0.057
	59.131	15.875	16.764	11.811	spec.	1.3	34 500	41 500	6 300	8 500	**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
	62.000	18.161	19.050	14.288	spec.	1.3	46 000	53 000	6 000	8 000	**15123**	**15245**	42.5	36.5	55	58	3.5	1.3	13.3	0.35	1.7	0.94	0.165	0.081
	62.000	19.050	20.638	14.288	0.8	1.3	46 000	53 000	6 000	8 000	**15126**	**15245**	37	36.5	55	58	0.8	1.3	13.3	0.35	1.7	0.94	0.176	0.081
	62.000	19.050	20.638	14.288	3.5	1.3	46 000	53 000	6 000	8 000	**15125**	**15245**	42.5	36.5	55	58	3.5	1.3	13.3	0.35	1.7	0.94	0.174	0.081
	63.500	20.638	20.638	15.875	0.8	1.3	46 000	53 000	6 000	8 000	**15126**	**15250**	37	36.5	56	59	0.8	1.3	14.9	0.35	1.7	0.94	0.176	0.113
	68.262	22.225	22.225	17.462	3.5	1.5	55 000	64 000	5 600	7 500	**02475**	**02420**	44.5	38.5	59	63	3.5	1.5	16.9	0.42	1.4	0.79	0.229	0.152
	68.262	22.225	22.225	17.462	1.5	1.5	55 500	70 500	5 300	7 500	**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
	69.012	19.845	19.583	15.875	3.5	1.3	47 000	56 000	5 600	7 500	**14125 A**	**14276**	44	37.5	60	63	3.5	1.3	15.3	0.38	1.6	0.86	0.219	0.135
	69.012	26.982	26.721	15.875	4.3	3.3	47 000	56 000	5 600	7 500	**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
	69.850	23.812	25.357	19.050	0.8	1.3	71 000	84 000	5 600	7 500	**2580**	**2523**	38.5	37.5	61	64	0.8	1.3	14.5	0.27	2.2	1.2	0.282	0.169
	69.850	23.812	25.357	19.050	3.5	1.3	71 000	84 000	5 600	7 500	**2582**	**2523**	44	37.5	61	64	3.5	1.3	14.5	0.27	2.2	1.2	0.28	0.169
	72.626	30.162	29.997	23.812	0.8	3.3	79 500	90 000	5 300	7 500	**3188**	**3120**	39.5	39.5	61	67	0.8	3.3	19.6	0.33	1.8	0.99	0.368	0.225
	73.025	29.370	27.783	23.020	1.3	3.3	74 000	100 000	5 000	7 100	**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
	80.000	21.000	22.403	17.826	0.8	1.3	68 500	75 500	4 500	6 300	**346**	**332**	40	39.5	73	75	0.8	1.3	14.6	0.27	2.2	1.2	0.419	0.146
32.000	72.233	25.400	25.400	19.842	3.3	2.3	63 500	83 500	5 000	7 100	**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 DESIGN)

Bore Diameter 33.338 – 35.000 mm





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 $P_0 = F_r$

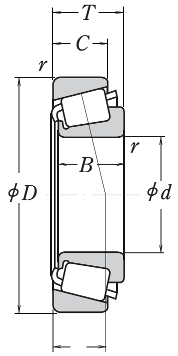
The values of e, Y_1, and Y_0 are given in the table below.

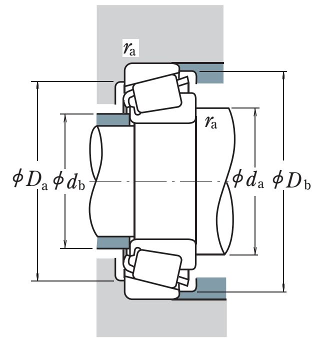
Boundary Dimensions (mm)							Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers		Abutment and Fillet Dimensions (mm)						Eff. Load Centers (mm)	Constant	Axial Load Factors		Mass (kg) approx.	
d	D	T	B	C	Cone r min.	Cup r min.	C_r	C_{0r}	Grease	Oil	CONE	CUP	d_a	d_b	D_a	D_b	Cone r_a max.	Cup r_a max.	a	e	Y_1	Y_0	CONE	CUP
33.338	66.675	20.638	20.638	15.875	3.5	1.5	46 000	53 500	5 600	7 500	**1680**	**1620**	44.5	38.5	58	61	3.5	1.5	15.2	0.37	1.6	0.89	0.196	0.121
	68.262	22.225	22.225	17.462	0.8	1.5	55 500	70 500	5 300	7 500	**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
	69.012	19.845	19.583	15.875	3.5	3.3	47 000	56 000	5 600	7 500	**14130**	**14274**	45	38.5	59	63	3.5	3.3	15.3	0.38	1.6	0.86	0.207	0.132
	69.012	19.845	19.583	15.875	0.8	1.3	47 000	56 000	5 600	7 500	**14131**	**14276**	39.5	38.5	60	63	0.8	1.3	15.3	0.38	1.6	0.86	0.209	0.135
	69.850	23.812	25.357	19.050	3.5	1.3	71 000	84 000	5 600	7 500	**2585**	**2523**	45	39	61	64	3.5	1.3	14.5	0.27	2.2	1.2	0.263	0.169
	72.000	19.000	18.923	15.875	3.5	1.5	52 000	56 000	5 600	7 500	**26131**	**26283**	44.5	38.5	62	65	3.5	1.5	14.7	0.36	1.7	0.92	0.20	0.163
	72.626	30.162	29.997	23.812	0.8	3.3	79 500	90 000	5 300	7 500	**3197**	**3120**	41.5	40.5	61	67	0.8	3.3	19.6	0.33	1.8	0.99	0.348	0.225
	73.025	29.370	27.783	23.020	0.8	3.3	74 000	100 000	5 000	7 100	**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
	76.200	29.370	28.575	23.020	3.8	0.8	78 500	106 000	4 800	6 700	**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
	76.200	29.370	28.575	23.020	0.8	3.3	78 500	106 000	4 800	6 700	**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
	79.375	25.400	24.074	17.462	3.5	1.5	67 500	69 500	5 000	6 700	**43131**	**43312**	51	42	67	74	3.5	1.5	23.7	0.67	0.90	0.49	0.348	0.22
34.925	65.088	18.034	18.288	13.970	spec.	1.3	47 500	57 500	5 600	7 500	**LM 48548**	**LM 48510**	46	40	58	61	3.5	1.3	14.1	0.38	1.6	0.88	0.172	0.087
	65.088	20.320	18.288	16.256	spec.	1.3	47 500	57 500	5 600	7 500	**LM 48548**	**LM 48511**	46	40	58	61	3.5	1.3	16.4	0.38	1.6	0.88	0.172	0.108
	66.675	20.638	20.638	16.670	3.5	2.3	53 000	62 500	5 600	7 500	**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
	69.012	19.845	19.583	15.875	3.5	1.3	47 000	56 000	5 600	7 500	**14138 A**	**14276**	46	40	60	63	3.5	1.3	15.3	0.38	1.6	0.86	0.194	0.135
	69.012	19.845	19.583	15.875	1.5	1.3	47 000	56 000	5 600	7 500	**14137 A**	**14276**	42	40	60	63	1.5	1.3	15.1	0.38	1.6	0.86	0.196	0.135
	72.233	25.400	25.400	19.842	2.3	2.3	63 500	83 500	5 000	7 100	**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
	73.025	22.225	22.225	17.462	0.8	3.3	54 500	64 500	5 300	7 100	**02878**	**02820**	42.5	42	62	68	0.8	3.3	18.3	0.45	1.3	0.73	0.266	0.16
	73.025	22.225	23.812	17.462	3.5	3.3	63 500	77 000	5 300	7 100	**2877**	**2820**	47	41.5	63	68	3.5	3.3	16.1	0.37	1.6	0.90	0.291	0.15
	73.025	23.812	24.608	19.050	1.5	0.8	71 000	86 000	5 300	7 100	**25877**	**25821**	43	40.5	65	68	1.5	0.8	15.7	0.29	2.1	1.1	0.306	0.167
	73.025	23.812	24.608	19.050	3.5	2.3	71 000	86 000	5 300	7 100	**25878**	**25820**	47	40.5	64	68	3.5	2.3	15.7	0.29	2.1	1.1	0.304	0.165
	76.200	29.370	28.575	23.020	0.8	0.8	78 500	106 000	4 800	6 700	**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
	76.200	29.370	28.575	23.020	3.5	0.8	78 500	106 000	4 800	6 700	**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
	76.200	29.370	28.575	23.020	3.5	3.3	78 500	106 000	4 800	6 700	**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
	76.200	29.370	28.575	23.812	1.5	3.3	80 500	96 500	5 000	6 700	**31594**	**31520**	46	43.5	64	72	1.5	3.3	21.6	0.40	1.5	0.82	0.404	0.235
	79.375	29.370	29.771	23.812	3.5	3.3	88 000	106 000	4 800	6 700	**3478**	**3420**	50	43.5	67	74	3.5	3.3	20.0	0.37	1.6	0.90	0.448	0.259
34.976	68.262	15.875	16.520	11.908	1.5	1.5	45 000	53 500	5 300	7 100	**19138**	**19268**	42.5	40.5	61	65	1.5	1.5	14.5	0.44	1.4	0.74	0.196	0.073
	72.085	22.385	19.583	18.415	1.3	2.3	47 000	56 000	5 600	7 500	**14139**	**14283**	41.5	40	60	65	1.3	2.3	17.7	0.38	1.6	0.87	0.198	0.21
	80.000	21.006	20.940	15.875	1.5	1.5	56 500	64 500	5 000	6 700	**28138**	**28315**	43.5	41	69	73	1.5	1.5	16.0	0.40	1.5	0.82	0.308	0.199
35.000	59.131	15.875	16.764	11.938	spec.	1.3	35 000	47 000	6 000	8 000	**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
	59.975	15.875	16.764	11.938	spec.	1.3	35 000	47 000	6 000	8 000	**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
	62.000	16.700	17.000	13.600	spec.	1.0	38 000	50 000	5 600	8 000	**LM 78349**	**LM 78310**	46	40	55	59	3.5	1	14.4	0.44	1.4	0.74	0.137	0.074
	62.000	16.700	17.000	13.600	spec.	1.5	38 000	50 000	5 600	8 000	**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
	65.987	20.638	20.638	16.670	3.5	2.3	53 000	62 500	5 600	7 500	**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
	73.025	26.988	26.975	22.225	3.5	0.8	75 500	88 500	5 300	7 500	**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 for overall bearing width is +356 to 0 μm.

SINGLE-ROW TAPERED ROLLER BEARINGS (INCH DESIGN)

Bore Diameter 35.717 – 41.275 mm





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 $P_0 = F_r$

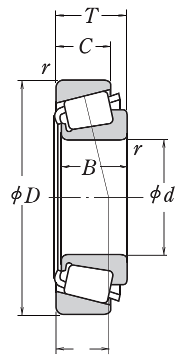
The values of e, Y_1, and Y_0 are given in the table below.

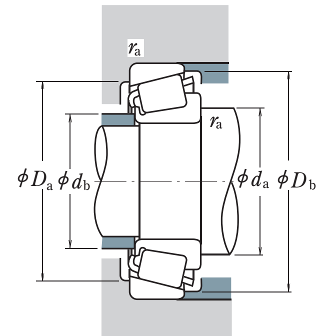
	Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers		Abutment and Fillet Dimensions (mm)						Eff. Load Centers (mm)	Constant	Axial Load Factors		Mass (kg) approx.	
d	D	T	B	C	Cone r min.	Cup r min.	C_r	C_{0r}	Grease	Oil	CONE	CUP	d_a	d_b	D_a	D_b	Cone r_a max.	Cup r_a max.	a	e	Y_1	Y_0	CONE	CUP
35.717	72.233	25.400	25.400	19.842	3.5	2.3	63 500	83 500	5 000	7 100	**HM 88648**	**HM 88610**	52	43	60	69	3.5	2.3	20.7	0.55	1.1	0.60	0.298	0.188
36.487	73.025	23.812	24.608	19.050	1.5	0.8	71 000	86 000	5 300	7 100	**25880**	**25821**	44	42	65	68	1.5	0.8	15.7	0.29	2.1	1.1	0.291	0.167
36.512	76.200	29.370	28.575	23.020	3.5	3.3	78 500	106 000	4 800	6 700	**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
	79.375	29.370	29.771	23.812	0.8	3.3	88 000	106 000	4 800	6 700	**3479**	**3420**	45.5	44.5	67	74	0.8	3.3	20.0	0.37	1.6	0.90	0.429	0.259
	88.501	25.400	23.698	17.462	2.3	1.5	73 000	81 000	4 000	5 600	**44143**	**44348**	54	50	75	84	2.3	1.5	27.9	0.78	0.77	0.42	0.502	0.245
	93.662	31.750	31.750	26.195	1.5	3.3	110 000	142 000	4 000	5 600	**46143**	**46368**	48.5	46.5	79	87	1.5	3.3	24.0	0.40	1.5	0.82	0.765	0.405
38.000	63.000	17.000	17.000	13.500	spec.	1.3	38 500	52 000	5 600	7 500	**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
38.100	63.500	12.700	11.908	9.525	1.5	0.8	24 100	30 500	5 300	7 100	**13889**	**13830**	45	42.5	59	60	1.5	0.8	11.9	0.35	1.7	0.95	0.109	0.046
	65.088	18.034	18.288	13.970	2.3	1.3	42 500	55 000	5 300	7 500	**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
	65.088	18.034	18.288	13.970	spec.	1.3	42 500	55 000	5 300	7 500	**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
	65.088	19.812	18.288	15.748	2.3	1.3	42 500	55 000	5 300	7 500	**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
	68.262	15.875	16.520	11.908	1.5	1.5	45 000	53 500	5 300	7 100	**19150**	**19268**	45	43	61	65	1.5	1.5	14.5	0.44	1.4	0.74	0.173	0.073
	69.012	19.050	19.050	15.083	2.0	2.3	49 000	61 000	5 300	7 100	**13687**	**13621**	46.5	43	61	65	2	2.3	15.8	0.40	1.5	0.82	0.193	0.104
	69.012	19.050	19.050	15.083	3.5	0.8	49 000	61 000	5 300	7 100	**13685**	**13620**	49.5	43	62	65	3.5	0.8	15.8	0.40	1.5	0.82	0.191	0.105
	72.238	20.638	20.638	15.875	3.5	1.3	48 500	59 500	5 300	7 100	**16150**	**16284**	49.5	43	63	67	3.5	1.3	16.0	0.40	1.5	0.82	0.212	0.146
	73.025	23.812	25.654	19.050	3.5	0.8	73 500	91 000	5 000	6 700	**2788**	**2735 X**	50	43.5	66	69	3.5	0.8	15.9	0.30	2.0	1.1	0.312	0.135
	76.200	23.812	25.654	19.050	3.5	3.3	73 500	91 000	5 000	6 700	**2788**	**2720**	50	43.5	66	70	3.5	3.3	15.9	0.30	2.0	1.1	0.312	0.187
	76.200	23.812	25.654	19.050	3.5	0.8	73 500	91 000	5 000	6 700	**2788**	**2729**	50	43.5	68	70	3.5	0.8	15.9	0.30	2.0	1.1	0.312	0.191
	79.375	29.370	29.771	23.812	3.5	3.3	88 000	106 000	4 800	6 700	**3490**	**3420**	52	45.5	67	74	3.5	3.3	20.0	0.37	1.6	0.90	0.404	0.259
	80.035	24.608	23.698	18.512	0.8	1.5	69 000	84 500	4 500	6 300	**27880**	**27820**	48	47	68	75	0.8	1.5	21.5	0.56	1.1	0.59	0.362	0.209
	82.550	29.370	28.575	23.020	0.8	3.3	87 000	117 000	4 500	6 000	**HM 801346**	**HM 801310**	51	49	68	78	0.8	3.3	24.2	0.55	1.1	0.60	0.483	0.282
	88.501	25.400	23.698	17.462	2.3	1.5	73 000	81 000	4 000	5 600	**44150**	**44348**	55	51	75	84	2.3	1.5	27.9	0.78	0.77	0.42	0.484	0.245
	88.501	26.988	29.083	22.225	3.5	1.5	96 500	109 000	4 500	6 000	**418**	**414**	51	44.5	77	80	3.5	1.5	17.1	0.26	2.3	1.3	0.50	0.329
	95.250	30.958	28.301	20.638	1.5	0.8	87 500	97 000	3 600	5 300	**53150**	**53375**	55	53	81	89	1.5	0.8	30.7	0.74	0.81	0.45	0.665	0.365
39.688	73.025	25.654	22.098	21.336	0.8	2.3	62 500	80 000	5 000	6 700	**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
	76.200	23.812	25.654	19.050	3.5	3.3	73 500	91 000	5 000	6 700	**2789**	**2720**	52	45	66	70	3.5	3.3	15.9	0.30	2.0	1.1	0.292	0.187
	80.167	29.370	30.391	23.812	0.8	3.3	92 500	108 000	4 800	6 300	**3386**	**3320**	46.5	45.5	70	75	0.8	3.3	18.4	0.27	2.2	1.2	0.442	0.217
40.000	80.000	21.000	22.403	17.826	3.5	1.3	68 500	75 500	4 500	6 300	**344**	**332**	52	45.5	73	75	3.5	1.3	14.5	0.27	2.2	1.2	0.338	0.146
	80.000	21.000	22.403	17.826	0.8	1.3	68 500	75 500	4 500	6 300	**344 A**	**332**	46	45.5	73	75	0.8	1.3	14.5	0.27	2.2	1.2	0.339	0.146
	88.501	25.400	23.698	17.462	2.3	1.5	73 000	81 000	4 000	5 600	**44157**	**44348**	56	51	75	84	2.3	1.5	27.9	0.78	0.77	0.42	0.463	0.245
41.000	68.000	17.500	18.000	13.500	spec.	1.5	43 500	58 000	5 300	7 100	**LM 300849**	**LM 300811**	52	45	61	65	3.5	1.5	13.9	0.35	1.7	0.95	0.16	0.082
41.275	73.025	16.667	17.462	12.700	3.5	1.5	44 500	54 000	4 800	6 700	**18590**	**18520**	53	46	66	69	3.5	1.5	14.0	0.35	1.7	0.94	0.199	0.086
	73.431	19.558	19.812	14.732	3.5	0.8	54 500	67 000	4 800	6 700	**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
	73.431	21.430	19.812	16.604	3.5	0.8	54 500	67 000	4 800	6 700	**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).
The tolerances are listed in Tables 2, 3 and 4 on Pages C184 and C185.

SINGLE-ROW TAPERED ROLLER BEARINGS (INCH DESIGN)

Bore Diameter 41.275 – 44.450 mm





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 $P_0 = F_r$

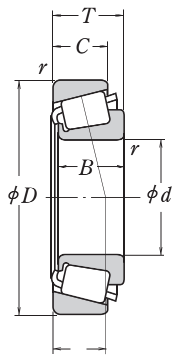
The values of e, Y_1, and Y_0 are given in the table below.

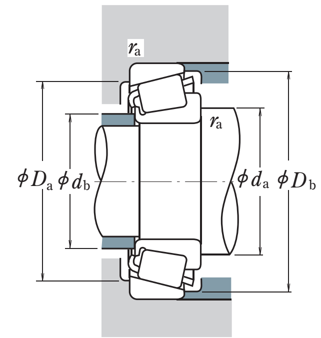
Boundary Dimensions (mm)							Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers		Abutment and Fillet Dimensions (mm)						Eff. Load Centers (mm)	Constant	Axial Load Factors		Mass (kg) approx.	
d	D	T	B	C	Cone r min.	Cup r min.	C_r	C_{0r}	Grease	Oil	CONE	CUP	d_a	d_b	D_a	D_b	Cone r_a max.	Cup r_a max.	a	e	Y_1	Y_0	CONE	CUP
41.275	76.200	18.009	17.384	14.288	1.5	1.5	42 500	51 000	4 500	6 300	**11162**	**11300**	49	46.5	67	71	1.5	1.5	17.4	0.49	1.2	0.68	0.212	0.129
	76.200	22.225	23.020	17.462	3.5	0.8	66 000	82 000	4 800	6 700	**24780**	**24720**	53	47.5	68	72	3.5	0.8	17.0	0.39	1.5	0.84	0.279	0.15
	76.200	25.400	23.020	20.638	3.5	2.3	66 000	82 000	4 800	6 700	**24780**	**24721**	54	47	66	72	3.5	2.3	20.2	0.39	1.5	0.84	0.279	0.189
	79.375	23.812	25.400	19.050	3.5	0.8	77 000	98 500	4 800	6 300	**26882**	**26822**	54	47	71	74	3.5	0.8	16.4	0.32	1.9	1.0	0.349	0.186
	80.000	21.000	22.403	17.826	0.8	1.3	68 500	75 500	4 500	6 300	**336**	**332**	47	46	73	75	0.8	1.3	14.5	0.27	2.2	1.2	0.325	0.146
	80.000	21.000	22.403	17.826	3.5	1.3	68 500	75 500	4 500	6 300	**342**	**332**	53	46	73	75	3.5	1.3	14.5	0.27	2.2	1.2	0.323	0.146
	80.167	25.400	25.400	20.638	3.5	3.3	77 000	98 500	4 800	6 300	**26882**	**26820**	54	47	69	74	3.5	3.3	18.0	0.32	1.9	1.0	0.349	0.219
	82.550	26.543	25.654	20.193	3.5	3.3	78 500	102 000	4 300	6 000	**M 802048**	**M 802011**	57	51	70	79	3.5	3.3	22.9	0.55	1.1	0.60	0.406	0.23
	85.725	30.162	30.162	23.812	3.5	3.3	91 000	115 000	4 300	6 000	**3877**	**3820**	57	50	73	81	3.5	3.3	21.8	0.40	1.5	0.82	0.506	0.285
	87.312	30.162	30.886	23.812	0.8	3.3	96 000	120 000	4 300	6 000	**3576**	**3525**	49	48	75	81	0.8	3.3	19.5	0.31	2.0	1.1	0.532	0.304
	88.501	25.400	23.698	17.462	2.3	1.5	73 000	81 000	4 000	5 600	**44162**	**44348**	57	51	75	84	2.3	1.5	28.0	0.78	0.77	0.42	0.447	0.245
	88.900	30.162	29.370	23.020	3.5	3.3	96 500	129 000	4 000	5 600	**HM 803146**	**HM 803110**	60	53	74	85	3.5	3.3	25.6	0.55	1.1	0.60	0.579	0.322
	88.900	30.162	29.370	23.020	0.8	3.3	96 500	129 000	4 000	5 600	**HM 803145**	**HM 803110**	54	53	74	85	0.8	3.3	25.6	0.55	1.1	0.60	0.582	0.322
	90.488	39.688	40.386	33.338	3.5	3.3	139 000	180 000	4 300	5 600	**4388**	**4335**	57	51	77	85	3.5	3.3	24.6	0.28	2.1	1.2	0.789	0.459
	93.662	31.750	31.750	26.195	0.8	3.3	110 000	142 000	4 000	5 600	**46162**	**46368**	52	51	79	87	0.8	3.3	24.0	0.40	1.5	0.82	0.695	0.405
	95.250	30.162	29.370	23.020	3.5	3.3	106 000	143 000	3 800	5 300	**HM 804840**	**HM 804810**	61	54	81	91	3.5	3.3	26.1	0.55	1.1	0.60	0.726	0.354
	98.425	30.958	28.301	20.638	1.5	0.8	87 500	97 000	3 600	5 300	**53162**	**53387**	57	53	82	91	1.5	0.8	30.7	0.74	0.81	0.45	0.618	0.442
42.862	76.992	17.462	17.145	11.908	1.5	1.5	44 000	54 000	4 500	6 000	**12168**	**12303**	51	48.5	68	73	1.5	1.5	17.7	0.51	1.2	0.65	0.228	0.098
	82.550	19.842	19.837	15.080	2.3	1.5	58 500	69 000	4 500	6 300	**22168**	**22325**	52	48.5	73	76	2.3	1.5	17.6	0.43	1.4	0.77	0.283	0.176
	82.931	23.812	25.400	19.050	2.3	0.8	76 500	99 000	4 500	6 000	**25578**	**25520**	53	49.5	74	77	2.3	0.8	17.6	0.33	1.8	0.99	0.383	0.203
	82.931	26.988	25.400	22.225	2.3	2.3	76 500	99 000	4 500	6 000	**25578**	**25523**	53	49.5	72	77	2.3	2.3	20.8	0.33	1.8	0.99	0.383	0.248
42.875	76.200	25.400	25.400	20.638	3.5	1.5	77 000	98 500	4 800	6 300	**26884**	**26823**	55	48.5	69	73	3.5	1.5	18.0	0.32	1.9	1.0	0.337	0.136
	80.000	21.000	22.403	17.826	3.5	1.3	68 500	75 500	4 500	6 300	**342 S**	**332**	54	47.5	73	75	3.5	1.3	14.5	0.27	2.2	1.2	0.305	0.146
	82.931	26.988	25.400	22.225	3.5	2.3	76 500	99 000	4 500	6 000	**25577**	**25523**	55	49	72	77	3.5	2.3	20.8	0.33	1.8	0.99	0.381	0.248
	83.058	23.812	25.400	19.050	3.5	3.3	76 500	99 000	4 500	6 000	**25577**	**25521**	55	49	72	77	3.5	3.3	17.6	0.33	1.8	0.99	0.381	0.201
43.000	74.988	19.368	19.837	14.288	1.5	1.3	52 500	68 000	4 800	6 300	**16986**	**16929**	51	48.5	67	71	1.5	1.3	17.2	0.44	1.4	0.74	0.24	0.106
44.450	80.962	19.050	17.462	14.288	0.3	1.5	45 000	57 000	4 300	6 000	**13175**	**13318**	50	50	72	76	0.3	1.5	20.1	0.53	1.1	0.63	0.252	0.144
	82.931	23.812	25.400	19.050	3.5	0.8	76 500	99 000	4 500	6 000	**25580**	**25520**	57	50	74	77	3.5	0.8	17.6	0.33	1.8	0.99	0.359	0.203
	83.058	23.812	25.400	19.050	3.5	3.3	76 500	99 000	4 500	6 000	**25580**	**25521**	56	51	72	78	3.5	3.3	17.6	0.33	1.8	0.99	0.359	0.201
	87.312	30.162	30.886	23.812	3.5	3.3	96 000	120 000	4 300	6 000	**3578**	**3525**	57	51	75	81	3.5	3.3	19.5	0.31	2.0	1.1	0.477	0.304
	88.900	30.162	29.370	23.020	3.5	3.3	96 500	129 000	4 000	5 600	**HM 803149**	**HM 803110**	62	53	74	85	3.5	3.3	25.6	0.55	1.1	0.60	0.528	0.322
	93.264	30.162	30.302	23.812	3.5	3.2	103 000	136 000	3 800	5 300	**3782**	**3720**	58	52	82	88	3.5	3.2	22.4	0.34	1.8	0.97	0.678	0.292
	93.662	31.750	31.750	25.400	0.8	3.3	120 000	147 000	4 000	5 600	**49176**	**49368**	54	53	82	87	0.8	3.3	21.6	0.36	1.7	0.92	0.648	0.371
	93.662	31.750	31.750	25.400	3.5	3.3	120 000	147 000	4 000	5 600	**49175**	**49368**	59	53	82	87	3.5	3.3	21.6	0.36	1.7	0.92	0.645	0.371
	93.662	31.750	31.750	26.195	3.5	3.3	110 000	142 000	4 000	5 600	**46176**	**46368**	60	54	79	87	3.5	3.3	24.0	0.40	1.5	0.82	0.635	0.405
	95.250	27.783	29.901	22.225	3.5	2.3	106 000	126 000	4 300	5 600	**438**	**432**	57	51	83	87	3.5	2.3	18.6	0.28	2.1	1.2	0.555	0.384

Note The maximum bore diameter is listed and its tolerance is negative (See Table 7.4.1 on Page A136).

SINGLE-ROW TAPERED ROLLER BEARINGS (INCH DESIGN)

Bore Diameter 44.450 – 47.625 mm





Dynamic Equivalent Load

$P = XF_r + YF_a$

F_a/F_r	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 $P_0 = F_r$

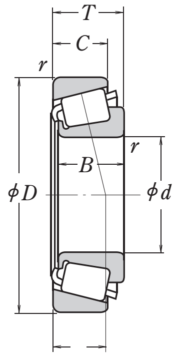
The values of e, Y_1, and Y_0 are given in the table below.

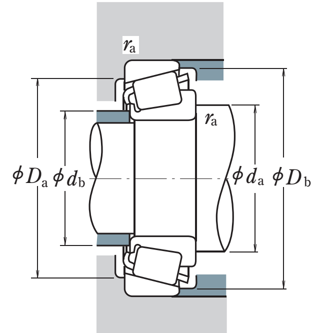
Boundary Dimensions (mm)							Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers		Abutment and Fillet Dimensions (mm)						Eff. Load Centers (mm)	Constant	Axial Load Factors		Mass (kg) approx.	
d	D	T	B	C	Cone r min.	Cup r min.	C_r	C_{0r}	Grease	Oil	CONE	CUP	d_a	d_b	D_a	D_b	Cone r_a max.	Cup r_a max.	a	e	Y_1	Y_0	CONE	CUP
44.450	95.250	30.162	29.370	23.020	3.5	3.3	106 000	143 000	3 800	5 300	**HM 804843**	**HM 804810**	63	57	81	91	3.5	3.3	26.1	0.55	1.1	0.60	0.677	0.354
	95.250	30.958	28.301	20.638	3.5	0.8	87 500	97 000	3 600	5 300	**53177**	**53375**	63	53	81	89	3.5	0.8	30.7	0.74	0.81	0.45	0.572	0.365
	95.250	30.958	28.301	20.638	1.3	0.8	87 500	97 000	3 600	5 300	**53176**	**53375**	59	53	81	89	1.3	0.8	30.7	0.74	0.81	0.45	0.574	0.365
	95.250	30.958	28.301	20.638	2.0	0.8	87 500	97 000	3 600	5 300	**53178**	**53375**	60	53	81	89	2	0.8	30.7	0.74	0.81	0.45	0.574	0.365
	95.250	30.958	28.301	22.225	1.3	0.8	100 000	122 000	3 600	5 000	**HM 903247**	**HM 903210**	61	54	81	91	1.3	0.8	31.5	0.74	0.81	0.45	0.651	0.389
	95.250	30.958	28.575	22.225	3.5	0.8	100 000	122 000	3 600	5 000	**HM 903249**	**HM 903210**	65	54	81	91	3.5	0.8	31.5	0.74	0.81	0.45	0.635	0.389
	98.425	30.958	28.301	20.638	3.5	0.8	87 500	97 000	3 600	5 300	**53177**	**53387**	63	53	82	91	3.5	0.8	30.7	0.74	0.81	0.45	0.568	0.442
	103.188	43.658	44.475	36.512	1.3	3.3	178 000	238 000	3 800	5 000	**5356**	**5335**	58	56	89	97	1.3	3.3	27.0	0.30	2.0	1.1	1.23	0.637
	104.775	36.512	36.512	28.575	3.5	3.3	139 000	192 000	3 400	4 800	**HM 807040**	**HM 807010**	66	59	89	100	3.5	3.3	29.7	0.49	1.2	0.68	1.14	0.502
	107.950	27.783	29.317	22.225	3.5	0.8	116 000	149 000	3 400	4 800	**460**	**453 A**	60	54	97	100	3.5	0.8	20.7	0.34	1.8	0.98	0.93	0.42
	111.125	30.162	26.909	20.638	3.5	3.3	92 500	110 000	3 200	4 300	**55175**	**55437**	67	60	92	105	3.5	3.3	37.3	0.88	0.68	0.37	0.867	0.514
	114.300	44.450	44.450	34.925	3.5	3.3	172 000	205 000	3 600	4 800	**65385**	**65320**	65	59	97	107	3.5	3.3	32.2	0.43	1.4	0.77	1.39	0.894
44.983	82.931	23.812	25.400	19.050	1.5	0.8	76 500	99 000	4 500	6 000	**25584**	**25520**	53	51	74	77	1.5	0.8	17.6	0.33	1.8	0.99	0.354	0.203
45.000	93.264	20.638	22.225	15.082	0.8	1.3	77 000	93 000	3 800	5 300	**376**	**374**	54	54	85	88	0.8	1.3	17.1	0.34	1.8	0.97	0.492	0.174
45.230	79.985	19.842	20.638	15.080	2.0	1.3	62 000	78 500	4 500	6 000	**17887**	**17831**	57	52	68	74	2	1.3	15.9	0.37	1.6	0.90	0.274	0.136
45.242	73.431	19.558	19.812	15.748	3.5	0.8	53 500	75 000	4 800	6 300	**LM 102949**	**LM 102910**	56	50	68	70	3.5	0.8	14.6	0.31	2.0	1.1	0.213	0.102
	77.788	19.842	19.842	15.080	3.5	0.8	56 000	71 000	4 500	6 300	**LM 603049**	**LM 603011**	57	50	71	74	3.5	0.8	17.2	0.43	1.4	0.77	0.249	0.119
	77.788	21.430	19.842	16.667	3.5	0.8	56 000	71 000	4 500	6 300	**LM 603049**	**LM 603012**	57	50	70	74	3.5	0.8	18.8	0.43	1.4	0.77	0.249	0.137
45.618	82.931	23.812	25.400	19.050	3.5	0.8	76 500	99 000	4 500	6 000	**25590**	**25520**	58	51	74	77	3.5	0.8	17.6	0.33	1.8	0.99	0.343	0.203
	82.931	26.988	25.400	22.225	3.5	2.3	76 500	99 000	4 500	6 000	**25590**	**25523**	58	51	72	77	3.5	2.3	20.8	0.33	1.8	0.99	0.343	0.248
46.000	75.000	18.000	18.000	14.000	2.3	1.5	51 000	71 500	4 500	6 300	**LM 503349**	**LM 503310**	55	51	67	71	2.3	1.5	15.9	0.40	1.5	0.82	0.209	0.096
46.038	79.375	17.462	17.462	13.495	2.8	1.5	46 000	57 000	4 500	6 000	**18690**	**18620**	56	51	71	74	2.8	1.5	15.5	0.37	1.6	0.88	0.211	0.126
	80.962	19.050	17.462	14.288	0.8	1.5	45 000	57 000	4 300	6 000	**13181**	**13318**	52	52	72	76	0.8	1.5	20.1	0.53	1.1	0.63	0.236	0.144
	85.000	20.638	21.692	17.462	2.3	1.3	71 500	81 500	4 300	6 000	**359 S**	**354 A**	55	51	77	80	2.3	1.3	15.4	0.31	2.0	1.1	0.343	0.162
	85.000	25.400	25.608	20.638	3.5	1.3	79 500	105 000	4 300	6 000	**2984**	**2924**	58	52	76	80	3.5	1.3	19.0	0.35	1.7	0.95	0.397	0.223
	95.250	27.783	29.901	22.225	3.5	0.8	106 000	126 000	4 300	5 600	**436**	**432 A**	59	52	84	87	3.5	0.8	18.6	0.28	2.1	1.2	0.536	0.381
47.625	88.900	20.638	22.225	16.513	3.5	1.3	73 000	85 000	4 000	5 600	**369 A**	**362 A**	60	53	81	84	3.5	1.3	16.6	0.32	1.9	1.0	0.381	0.166
	88.900	25.400	25.400	19.050	3.5	3.3	86 000	107 000	4 000	5 600	**M 804049**	**M 804010**	63	56	77	85	3.5	3.3	23.8	0.55	1.1	0.60	0.455	0.218
	95.250	30.162	29.370	23.020	3.5	3.3	106 000	143 000	3 800	5 300	**HM 804846**	**HM 804810**	66	57	81	91	3.5	3.3	26.1	0.55	1.1	0.60	0.626	0.354
	101.600	34.925	36.068	26.988	3.5	3.3	137 000	169 000	3 800	5 000	**528**	**522**	62	55	89	95	3.5	3.3	22.1	0.29	2.1	1.2	0.894	0.416
	111.125	30.162	26.909	20.638	3.5	3.3	92 500	110 000	3 200	4 300	**55187**	**55437**	69	62	92	105	3.5	3.3	37.3	0.88	0.68	0.37	0.817	0.514
	112.712	30.162	26.909	20.638	3.5	3.3	92 500	110 000	3 200	4 300	**55187**	**55443**	69	62	92	106	3.5	3.3	37.3	0.88	0.68	0.37	0.816	0.554
	117.475	33.338	31.750	23.812	3.5	3.3	137 000	156 000	3 200	4 300	**66187**	**66462**	66	62	100	111	3.5	3.3	32.1	0.63	0.96	0.53	1.19	0.552
	123.825	36.512	32.791	25.400	3.5	3.3	143 000	160 000	3 000	4 000	**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 DESIGN)

Bore Diameter 48.412 – 52.388 mm





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 $P_0 = F_r$

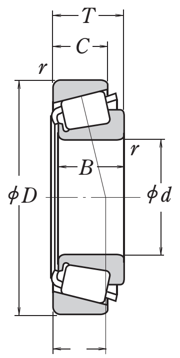
The values of e, Y_1, and Y_0 are given in the table below.

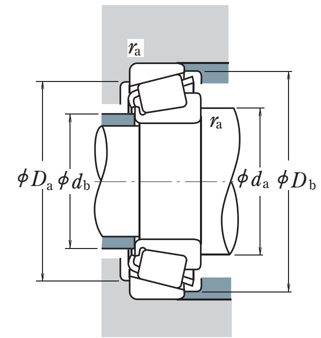
Boundary Dimensions (mm)							Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers		Abutment and Fillet Dimensions (mm)						Eff. Load Centers (mm)	Constant	Axial Load Factors		Mass (kg) approx.	
d	D	T	B	C	Cone r min.	Cup r min.	C_r	C_{0r}	Grease	Oil	CONE	CUP	d_a	d_b	D_a	D_b	Cone r_a max.	Cup r_a max.	a	e	Y_1	Y_0	CONE	CUP
48.412	95.250	30.162	29.370	23.020	3.5	3.3	106 000	143 000	3 800	5 300	**HM 804849**	**HM 804810**	66	57	81	91	3.5	3.3	26.1	0.55	1.1	0.60	0.61	0.354
	95.250	30.162	29.370	23.020	2.3	3.3	106 000	143 000	3 800	5 300	**HM 804848**	**HM 804810**	63	57	81	91	2.3	3.3	26.1	0.55	1.1	0.60	0.614	0.354
49.212	104.775	36.512	36.512	28.575	3.5	0.8	139 000	192 000	3 400	4 800	**HM 807044**	**HM 807011**	69	63	91	100	3.5	0.8	29.7	0.49	1.2	0.68	1.03	0.508
	114.300	44.450	44.450	36.068	3.5	3.3	196 000	243 000	3 400	4 800	**HH 506348**	**HH 506310**	71	61	97	107	3.5	3.3	30.8	0.40	1.5	0.82	1.43	0.837
50.000	82.000	21.500	21.500	17.000	3.0	0.5	71 000	96 000	4 300	5 600	**JLM 104948**	**JLM 104910**	60	55	76	78	3	0.5	16.1	0.31	2.0	1.1	0.306	0.129
	82.550	21.590	22.225	16.510	0.5	1.3	71 000	96 000	4 300	5 600	**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
	88.900	20.638	22.225	16.513	2.3	1.3	73 000	85 000	4 000	5 600	**366**	**362 A**	59	55	81	84	2.3	1.3	16.6	0.32	1.9	1.0	0.351	0.166
	90.000	28.000	28.000	23.000	3.0	2.5	104 000	136 000	4 000	5 600	**JM 205149**	**JM 205110**	62	57	80	85	3	2.5	19.9	0.33	1.8	1.0	0.507	0.246
	105.000	37.000	36.000	29.000	3.0	2.5	139 000	192 000	3 400	4 800	**JHM 807045**	**JHM 807012**	69	63	90	100	3	2.5	29.7	0.49	1.2	0.68	1.01	0.523
50.800	80.962	18.258	18.258	14.288	1.5	1.5	53 000	81 000	4 300	5 600	**L 305649**	**L 305610**	58	56	73	77	1.5	1.5	15.7	0.36	1.7	0.93	0.239	0.119
	82.550	23.622	22.225	18.542	3.5	0.8	71 000	96 000	4 300	5 600	**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
	82.931	21.590	22.225	16.510	3.5	1.3	71 000	96 000	4 300	5 600	**LM 104949**	**LM 104912**	62	55	75	78	3.5	1.3	15.7	0.31	2.0	1.1	0.301	0.14
	85.000	17.462	17.462	13.495	3.5	1.5	48 500	63 000	4 300	5 600	**18790**	**18720**	62	56	77	80	3.5	1.5	16.7	0.41	1.5	0.81	0.239	0.136
	85.725	19.050	18.263	12.700	1.5	1.5	42 500	54 000	4 000	5 300	**18200**	**18337**	59	56	76	81	1.5	1.5	21.0	0.57	1.1	0.58	0.268	0.136
	88.900	20.638	22.225	16.513	3.5	1.3	73 000	85 000	4 000	5 600	**368 A**	**362 A**	62	56	81	84	3.5	1.3	16.6	0.32	1.9	1.0	0.338	0.166
	88.900	20.638	22.225	16.513	1.5	1.3	73 000	85 000	4 000	5 600	**368**	**362 A**	58	56	81	84	1.5	1.3	16.6	0.32	1.9	1.0	0.341	0.166
	92.075	24.608	25.400	19.845	3.5	0.8	84 500	117 000	4 000	5 300	**28580**	**28521**	63	57	83	87	3.5	0.8	20.0	0.38	1.6	0.87	0.46	0.247
	93.264	30.162	30.302	23.812	0.8	0.8	103 000	136 000	3 800	5 300	**3775**	**3730**	58	58	84	88	0.8	0.8	22.4	0.34	1.8	0.97	0.568	0.297
	93.264	30.162	30.302	23.812	3.5	0.8	103 000	136 000	3 800	5 300	**3780**	**3730**	64	58	84	88	3.5	0.8	22.4	0.34	1.8	0.97	0.564	0.297
	95.250	27.783	28.575	22.225	3.5	2.3	110 000	144 000	3 800	5 300	**33889**	**33821**	64	58	85	90	3.5	2.3	19.8	0.33	1.8	1.0	0.601	0.267
	101.600	31.750	31.750	25.400	3.5	3.3	118 000	150 000	3 600	5 000	**49585**	**49520**	66	59	88	96	3.5	3.3	23.4	0.40	1.5	0.82	0.744	0.389
	101.600	34.925	36.068	26.988	0.8	3.3	137 000	169 000	3 800	5 000	**529**	**522**	59	58	89	95	0.8	3.3	22.1	0.29	2.1	1.2	0.822	0.416
	101.600	34.925	36.068	26.988	3.5	3.3	137 000	169 000	3 800	5 000	**529 X**	**522**	65	58	89	95	3.5	3.3	22.1	0.29	2.1	1.2	0.819	0.416
	104.775	36.512	36.512	28.575	3.5	0.8	139 000	192 000	3 400	4 800	**HM 807046**	**HM 807011**	70	63	91	100	3.5	0.8	29.7	0.49	1.2	0.68	0.992	0.508
	104.775	36.512	36.512	28.575	3.5	3.3	139 000	192 000	3 400	4 800	**HM 807046**	**HM 807010**	70	63	89	100	3.5	3.3	29.7	0.49	1.2	0.68	0.993	0.502
	108.966	34.925	36.512	26.988	3.5	3.3	145 000	181 000	3 600	4 800	**59200**	**59429**	68	61	93	101	3.5	3.3	25.4	0.40	1.5	0.82	0.943	0.594
	111.125	30.162	26.909	20.638	3.5	3.3	113 000	152 000	3 000	4 300	**55200 C**	**55437**	71	65	92	105	3.5	3.3	37.6	0.88	0.68	0.37	0.845	0.514
	111.125	30.162	26.909	20.638	3.5	3.3	92 500	110 000	3 200	4 300	**55200**	**55437**	71	64	92	105	3.5	3.3	37.3	0.88	0.68	0.37	0.767	0.514
	123.825	36.512	32.791	25.400	3.5	3.3	162 000	199 000	2 800	4 000	**72200 C**	**72487**	77	67	102	116	3.5	3.3	38.0	0.74	0.81	0.45	1.33	0.79
	123.825	36.512	32.791	25.400	3.5	3.3	143 000	160 000	3 000	4 000	**72200**	**72487**	74	66	102	116	3.5	3.3	37.0	0.74	0.81	0.45	1.22	0.79
	127.000	44.450	44.450	34.925	3.5	3.3	199 000	258 000	3 000	4 000	**65200**	**65500**	75	69	107	119	3.5	3.3	35.0	0.49	1.2	0.68	1.86	1.03
	127.000	50.800	52.388	41.275	3.5	3.3	236 000	300 000	3 200	4 300	**6279**	**6220**	71	65	108	117	3.5	3.3	30.7	0.30	2.0	1.1	2.08	1.22
52.388	92.075	24.608	25.400	19.845	3.5	0.8	84 500	117 000	4 000	5 300	**28584**	**28521**	65	58	83	87	3.5	0.8	20.0	0.38	1.6	0.87	0.435	0.247
	100.000	25.000	22.225	21.824	2.3	2.0	77 000	93 000	3 800	5 300	**377**	**372**	62	58	86	90	2.3	2	21.4	0.34	1.8	0.97	0.392	0.435
	111.125	30.162	26.909	20.638	3.5	3.3	92 500	110 000	3 200	4 300	**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).
The tolerances are listed in Tables 2, 3 and 4 on Pages C184 and C185.

SINGLE-ROW TAPERED ROLLER BEARINGS (INCH DESIGN)

Bore Diameter 53.975 – 58.738 mm





Dynamic Equivalent Load

$P = XF_r + YF_a$

F_a/F_r ≤ 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 $P_0 = F_r$

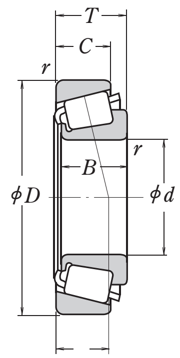
The values of e, Y_1, and Y_0 are given in the table below.

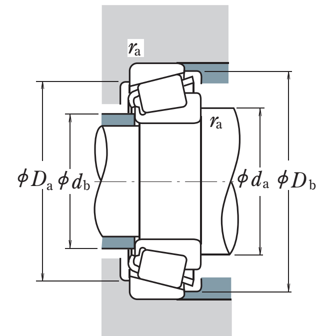
Boundary Dimensions (mm) d	D	T	B	C	Cone r min.	Cup r min.	Basic Load Ratings (N) C_r	C_{0r}	Limiting Speeds (min⁻¹) Grease	Oil	Bearing Numbers CONE	CUP	Abutment and Fillet Dimensions (mm) d_a	d_b	D_a	D_b	Cone r_a max.	Cup r_a max.	Eff. Load Centers (mm) a	Constant e	Axial Load Factors Y_1	Y_0	Mass (kg) approx. CONE	CUP
53.975	104.775	39.688	40.157	33.338	3.5	3.3	148 000	207 000	3 600	4 800	**4595**	**4535**	70	63	90	99	3.5	3.3	27.4	0.34	1.79	0.98	0.989	0.589
	107.950	36.512	36.957	28.575	3.5	3.3	144 000	182 000	3 600	4 800	**539**	**532 X**	68	61	94	100	3.5	3.3	24.3	0.30	2.0	1.1	0.88	0.57
	122.238	33.338	31.750	23.812	3.5	3.3	135 000	156 000	3 000	4 000	**66584**	**66520**	75	68	105	116	3.5	3.3	34.3	0.67	0.90	0.50	1.2	0.558
	123.825	36.512	32.791	25.400	3.5	3.3	143 000	160 000	3 000	4 000	**72212**	**72487**	77	66	102	116	3.5	3.3	37.0	0.74	0.81	0.45	1.16	0.79
	123.825	36.512	32.791	25.400	3.5	3.3	162 000	199 000	2 800	4 000	**72212 C**	**72487**	79	67	102	116	3.5	3.3	38.0	0.74	0.81	0.45	1.27	0.79
	123.825	38.100	36.678	30.162	3.5	3.3	161 000	221 000	3 000	4 000	**557 S**	**552 A**	71	65	109	116	3.5	3.3	28.8	0.35	1.7	0.95	1.49	0.764
	127.000	44.450	44.450	34.925	3.5	3.3	199 000	258 000	3 000	4 000	**65212**	**65500**	77	71	107	119	3.5	3.3	35.0	0.49	1.2	0.68	1.76	1.03
	127.000	50.800	52.388	41.275	3.5	3.3	236 000	300 000	3 200	4 300	**6280**	**6220**	74	67	108	117	3.5	3.3	30.7	0.30	2.0	1.1	1.97	1.22
	130.175	36.512	33.338	23.812	3.5	3.3	133 000	154 000	2 600	3 600	**HM911242**	**HM911210**	79	74	109	124	3.5	3.3	42.2	0.82	0.73	0.40	1.45	0.725
55.000	90.000	23.000	23.000	18.500	1.5	0.5	79 000	111 000	3 800	5 300	**JLM506849**	**JLM506810**	63	61	82	86	1.5	0.5	19.7	0.40	1.5	0.82	0.378	0.186
	95.000	29.000	29.000	23.500	1.5	2.5	111 000	152 000	3 800	5 000	**JM207049**	**JM207010**	64	62	85	91	1.5	2.5	21.3	0.33	1.8	0.99	0.59	0.26
	96.838	21.000	21.946	15.875	2.3	0.8	80 500	100 000	3 600	5 000	**385**	**382 A**	65	61	89	92	2.3	0.8	17.6	0.35	1.7	0.93	0.455	0.179
	110.000	39.000	39.000	32.000	3.0	2.5	177 000	225 000	3 400	4 500	**JH307749**	**JH307710**	71	64	97	104	3	2.5	27.2	0.35	1.7	0.95	1.13	0.567
	115.000	41.021	41.275	31.496	3.0	3.0	172 000	214 000	3 200	4 500	**622 X**	**614 X**	70	64	101	108	3	3	26.6	0.31	1.9	1.1	1.3	0.597
55.562	97.630	24.608	24.608	19.446	3.5	0.8	89 000	129 000	3 600	5 000	**28680**	**28622**	68	62	88	92	3.5	0.8	21.3	0.40	1.5	0.82	0.499	0.27
	122.238	43.658	43.764	36.512	1.3	3.3	198 000	292 000	3 000	4 000	**5566**	**5535**	70	68	106	116	1.3	3.3	29.9	0.36	1.7	0.92	1.76	0.815
	123.825	36.512	32.791	25.400	3.5	3.3	143 000	160 000	3 000	4 000	**72218**	**72487**	78	66	102	116	3.5	3.3	37.0	0.74	0.81	0.45	1.12	0.79
	123.825	36.512	32.791	25.400	3.5	3.3	162 000	199 000	2 800	4 000	**72218 C**	**72487**	80	67	102	116	3.5	3.3	38.0	0.74	0.81	0.45	1.23	0.79
57.150	96.838	21.000	21.946	15.875	3.5	0.8	80 500	100 000	3 600	5 000	**387 A**	**382 A**	69	62	89	92	3.5	0.8	17.6	0.35	1.7	0.93	0.42	0.179
	96.838	21.000	21.946	15.875	2.3	0.8	80 500	100 000	3 600	5 000	**387**	**382 A**	66	62	89	92	2.3	0.8	17.6	0.35	1.7	0.93	0.423	0.179
	96.838	25.400	21.946	20.275	3.5	2.3	80 500	100 000	3 600	5 000	**387 A**	**382 S**	69	62	87	91	3.5	2.3	22.0	0.35	1.7	0.93	0.42	0.249
	98.425	21.000	21.946	17.826	3.5	0.8	80 500	100 000	3 600	5 000	**387 A**	**382**	69	62	90	92	3.5	0.8	17.6	0.35	1.7	0.93	0.42	0.226
	104.775	30.162	29.317	24.605	3.5	3.3	116 000	149 000	3 400	4 800	**469**	**453 X**	70	63	92	98	3.5	3.3	23.1	0.34	1.8	0.98	0.692	0.376
	104.775	30.162	29.317	24.605	2.3	3.3	116 000	149 000	3 400	4 800	**462**	**453 X**	67	63	92	98	2.3	3.3	23.1	0.34	1.8	0.98	0.694	0.376
	104.775	30.162	30.958	23.812	0.8	3.3	130 000	170 000	3 400	4 800	**45289**	**45220**	65	65	93	99	0.8	3.3	21.9	0.33	1.8	0.99	0.752	0.347
	104.775	30.162	30.958	23.812	0.8	0.8	130 000	170 000	3 400	4 800	**45289**	**45221**	65	65	95	99	0.8	0.8	21.9	0.33	1.8	0.99	0.76	0.35
	122.238	33.338	31.750	23.812	3.5	3.3	135 000	156 000	3 000	4 000	**66587**	**66520**	77	71	105	116	3.5	3.3	34.3	0.67	0.90	0.50	1.14	0.558
	123.825	36.512	32.791	25.400	3.5	3.3	162 000	199 000	2 800	4 000	**72225 C**	**72487**	81	67	102	116	3.5	3.3	38.0	0.74	0.81	0.45	1.19	0.79
	123.825	38.100	36.678	30.162	3.5	3.3	161 000	221 000	3 000	4 000	**555 S**	**552 A**	83	68	109	116	3.5	3.3	28.8	0.35	1.7	0.95	1.41	0.764
	140.030	36.512	33.236	23.520	3.5	2.3	152 000	183 000	2 600	3 600	**78225**	**78551**	83	77	117	132	3.5	2.3	44.2	0.87	0.69	0.38	1.67	0.926
	144.983	36.000	33.236	23.007	3.5	3.5	152 000	183 000	2 600	3 600	**78225**	**78571**	83	77	118	132	3.5	3.5	43.6	0.87	0.69	0.38	1.68	1.08
	149.225	53.975	54.229	44.450	3.5	3.3	287 000	410 000	2 600	3 400	**6455**	**6420**	81	75	129	140	3.5	3.3	39.0	0.36	1.7	0.91	3.49	1.63
57.531	96.838	21.000	21.946	15.875	3.5	0.8	80 500	100 000	3 600	5 000	**388 A**	**382 A**	69	63	89	92	3.5	0.8	17.6	0.35	1.7	0.93	0.416	0.179
58.738	112.712	33.338	30.048	26.988	3.5	3.3	120 000	173 000	3 200	4 300	**3981**	**3926**	73	67	98	106	3.5	3.3	28.7	0.40	1.5	0.82	0.899	0.541

Note The tolerances are listed in Tables 2, 3 and 4 on Pages C184 and C185.

SINGLE-ROW TAPERED ROLLER BEARINGS (INCH DESIGN)

Bore Diameter 60.000 – 64.963 mm





Dynamic Equivalent Load

$P=XF_r+YF_a$

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

Static Equivalent Load

$P_0=0.5F_r+Y_0F_a$

When F_r 0.5$F_r+Y_0F_a$, use $P_0=F_r$

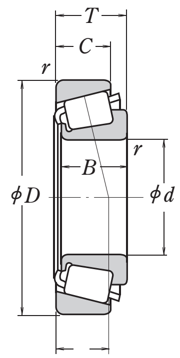
The values of e, Y_1, and Y_0 are given in the table below.

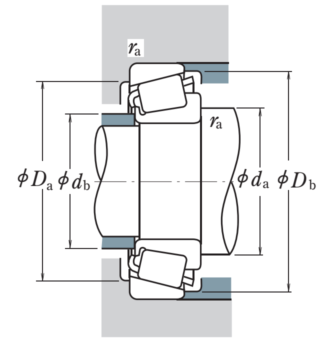
Boundary Dimensions (mm)							Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers		Abutment and Fillet Dimensions (mm)						Eff. Load Centers (mm)	Constant	Axial Load Factors		Mass (kg) approx.	
d	D	T	B	C	Cone r min.	Cup r min.	C_r	C_{0r}	Grease	Oil	CONE	CUP	d_a	d_b	D_a	D_b	Cone r_a max.	Cup r_a max.	a	e	Y_1	Y_0	CONE	CUP
60.000	95.000	24.000	24.000	19.000	5.0	2.5	86 500	125 000	3 600	5 000	**JLM 508748**	**JLM 508710**	75	66	85	91	5	2.5	21.6	0.40	1.5	0.82	0.43	0.20
	104.775	21.433	22.000	15.875	2.3	2.0	83 500	107 000	3 400	4 500	**39236**	**39412**	71	67	96	100	2.3	2	20.0	0.39	1.5	0.85	0.559	0.186
	110.000	22.000	21.996	18.824	0.8	1.3	85 500	113 000	3 200	4 300	**397**	**394 A**	69	68	101	104	0.8	1.3	20.9	0.40	1.5	0.82	0.642	0.263
	122.238	33.338	31.750	23.812	3.5	3.3	135 000	156 000	3 000	4 000	**66585**	**66520**	79	73	105	116	3.5	3.3	34.3	0.67	0.90	0.50	1.07	0.558
60.325	100.000	25.400	25.400	19.845	3.5	3.3	91 000	135 000	3 400	4 800	**28985**	**28921**	73	67	89	96	3.5	3.3	22.9	0.43	1.4	0.78	0.538	0.232
	101.600	25.400	25.400	19.845	3.5	3.3	91 000	135 000	3 400	4 800	**28985**	**28920**	73	67	90	97	3.5	3.3	22.9	0.43	1.4	0.78	0.538	0.272
	122.238	38.100	36.678	30.162	2.3	3.3	161 000	221 000	3 000	4 000	**558**	**553 X**	73	69	108	115	2.3	3.3	28.8	0.35	1.7	0.95	1.33	0.692
	122.238	38.100	38.354	29.718	8.0	1.5	188 000	245 000	3 000	4 000	**HM 212044**	**HM 212010**	85	70	110	116	8	1.5	27.0	0.34	1.8	0.98	1.43	0.604
	122.238	43.658	43.764	36.512	0.8	3.3	198 000	292 000	3 000	4 000	**5582**	**5535**	73	72	106	116	0.8	3.3	29.9	0.36	1.7	0.92	1.61	0.815
	127.000	44.450	44.450	34.925	3.5	3.3	199 000	258 000	3 000	4 000	**65237**	**65500**	82	71	107	119	3.5	3.3	35.0	0.49	1.2	0.68	1.56	1.03
	130.175	41.275	41.275	31.750	3.5	3.3	195 000	263 000	2 800	3 800	**637**	**633**	78	72	116	124	3.5	3.3	29.9	0.36	1.7	0.91	1.87	0.712
	135.755	53.975	56.007	44.450	3.5	3.3	264 000	355 000	2 800	3 800	**6376**	**6320**	81	74	117	126	3.5	3.3	35.0	0.32	1.8	1.0	2.45	1.39
61.912	136.525	46.038	46.038	36.512	3.5	3.3	233 000	370 000	2 600	3 400	**H 715334**	**H 715311**	84	78	119	132	3.5	3.3	37.1	0.47	1.3	0.70	2.51	0.961
	146.050	41.275	39.688	25.400	3.5	3.3	193 000	225 000	2 400	3 400	**H 913842**	**H 913810**	90	82	124	138	3.5	3.3	44.4	0.78	0.77	0.42	2.2	0.898
	152.400	47.625	46.038	31.750	3.5	3.3	237 000	267 000	2 400	3 400	**9180**	**9121**	90	81	130	145	3.5	3.3	44.3	0.66	0.92	0.50	2.77	1.21
63.500	94.458	19.050	19.050	15.083	1.5	1.5	59 000	100 000	3 600	4 800	**L 610549**	**L 610510**	71	69	86	91	1.5	1.5	19.6	0.42	1.4	0.78	0.306	0.154
	104.775	21.433	22.000	15.875	2.0	2.0	83 500	107 000	3 400	4 500	**39250**	**39412**	73	69	96	100	2	2	20.0	0.39	1.5	0.85	0.501	0.186
	107.950	25.400	25.400	19.050	1.5	3.3	90 000	138 000	3 200	4 300	**29586**	**29520**	73	71	96	103	1.5	3.3	24.0	0.46	1.3	0.72	0.661	0.281
	110.000	22.000	21.996	18.824	3.5	1.3	85 500	113 000	3 200	4 300	**395**	**394 A**	77	70	101	104	3.5	1.3	20.9	0.40	1.5	0.82	0.58	0.263
	110.000	22.000	21.996	18.824	1.5	1.3	85 500	113 000	3 200	4 300	**390 A**	**394 A**	73	70	101	104	1.5	1.3	20.9	0.40	1.5	0.82	0.583	0.263
	112.712	30.162	30.048	23.812	3.5	3.2	120 000	173 000	3 200	4 300	**3982**	**3920**	77	71	99	106	3.5	3.2	25.5	0.40	1.5	0.82	0.789	0.454
	112.712	30.162	30.162	23.812	3.5	3.3	142 000	202 000	3 200	4 300	**39585**	**39520**	77	71	101	107	3.5	3.3	23.5	0.34	1.8	0.97	0.899	0.359
	112.712	33.338	30.048	26.988	3.5	3.3	120 000	173 000	3 200	4 300	**3982**	**3926**	78	71	98	106	3.5	3.3	28.7	0.40	1.5	0.82	0.789	0.541
	122.238	38.100	38.354	29.718	7.0	3.3	188 000	245 000	3 000	4 000	**HM 212047**	**HM 212011**	87	73	108	116	7	3.3	26.9	0.34	1.8	0.98	1.34	0.598
	122.238	38.100	38.354	29.718	7.0	1.5	188 000	245 000	3 000	4 000	**HM 212047**	**HM 212010**	87	73	110	116	7	1.5	26.9	0.34	1.8	0.98	1.34	0.604
	122.238	38.100	38.354	29.718	3.5	1.5	188 000	245 000	3 000	4 000	**HM 212046**	**HM 212010**	80	73	110	116	3.5	1.5	26.9	0.34	1.8	0.98	1.35	0.604
	122.238	43.658	43.764	36.512	3.5	3.3	198 000	292 000	3 000	4 000	**5584**	**5535**	81	75	106	116	3.5	3.3	29.9	0.36	1.7	0.92	1.5	0.815
	123.825	38.100	36.678	30.162	3.5	3.3	161 000	221 000	3 000	4 000	**559**	**522 A**	78	73	109	116	3.5	3.3	28.8	0.35	1.7	0.95	1.23	0.764
	127.000	36.512	36.170	28.575	3.5	3.3	166 000	234 000	2 800	3 800	**565**	**563**	80	73	112	120	3.5	3.3	28.3	0.36	1.6	0.91	1.46	0.655
	130.175	41.275	41.275	31.750	3.5	3.3	195 000	263 000	2 800	3 800	**639**	**633**	81	74	116	124	3.5	3.3	29.9	0.36	1.7	0.91	1.77	0.712
	136.525	36.512	33.236	23.520	2.3	3.3	152 000	183 000	2 600	3 600	**78250**	**78537**	85	79	115	130	2.3	3.3	44.2	0.87	0.69	0.38	1.51	0.782
	136.525	41.275	41.275	31.750	3.5	3.3	195 000	263 000	2 800	3 800	**639**	**632**	79	76	119	125	3.5	3.3	29.9	0.36	1.7	0.91	1.77	1.04
	140.030	36.512	33.236	23.520	2.3	2.3	152 000	183 000	2 600	3 600	**78250**	**78551**	85	79	117	132	2.3	2.3	44.2	0.87	0.69	0.38	1.51	0.926
64.963	127.000	36.512	36.170	28.575	3.5	3.3	166 000	234 000	2 800	3 800	**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).
The tolerances are listed in Tables 2, 3 and 4 on Pages C184 and C185.

SINGLE-ROW TAPERED ROLLER BEARINGS (INCH DESIGN)

Bore Diameter 65.000 – 69.850 mm





Dynamic Equivalent Load

$P = XF_r + YF_a$

F_a/F_r 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 $P_0 = F_r$

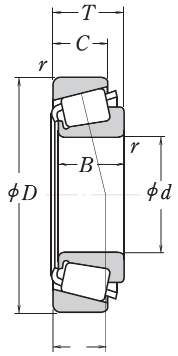
The values of e, Y_1, and Y_0 are given in the table below.

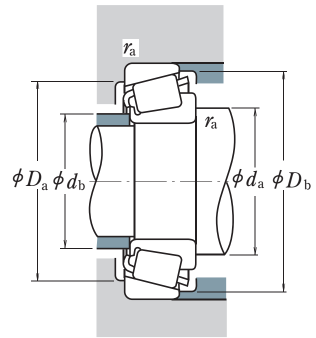
Boundary Dimensions (mm) d	D	T	B	C	Cone r min.	Cup r min.	Basic Load Ratings (N) C_r	C_{0r}	Limiting Speeds (min^{-1}) Grease	Oil	Bearing Numbers CONE	CUP	Abutment and Fillet Dimensions (mm) d_a	d_b	D_a	D_b	Cone r_a max.	Cup r_a max.	Eff. Load Centers (mm) a	Constant e	Axial Load Factors Y_1	Y_0	Mass (kg) approx. CONE	CUP
65.000	105.000	24.000	23.000	18.500	3.0	1.0	93 000	126 000	3 400	4 500	**JLM 710949**	**JLM 710910**	77	71	96	101	3	1	23.7	0.45	1.3	0.73	0.526	0.237
	110.000	28.000	28.000	22.500	3.0	2.5	120 000	173 000	3 200	4 300	**JM 511946**	**JM 511910**	78	72	99	105	3	2.5	24.5	0.40	1.5	0.82	0.72	0.342
	120.000	29.002	29.007	23.444	2.3	3.3	123 000	169 000	3 000	4 000	**478**	**472 A**	77	73	106	114	2.3	3.3	24.3	0.38	1.6	0.86	0.942	0.466
	120.000	39.000	38.500	32.000	3.0	2.5	185 000	249 000	3 000	4 000	**JH 211749**	**JH 211710**	80	74	107	114	3	2.5	27.9	0.34	1.8	0.98	1.25	0.625
65.088	135.755	53.975	56.007	44.450	3.5	3.3	264 000	355 000	2 800	3 800	**6379**	**6320**	84	77	117	126	3.5	3.3	35.0	0.32	1.8	1.0	2.25	1.39
	136.525	46.038	46.038	36.512	3.5	3.3	233 000	370 000	2 600	3 400	**H 715340**	**H 715311**	88	82	118	132	3.5	3.3	37.1	0.47	1.3	0.70	2.4	0.961
66.675	110.000	22.000	21.996	18.824	0.8	1.3	85 500	113 000	3 200	4 300	**395 A**	**394 A**	73	73	101	104	0.8	1.3	20.9	0.40	1.5	0.82	0.528	0.263
	110.000	22.000	21.996	18.824	3.5	1.3	85 500	113 000	3 200	4 300	**395 S**	**394 A**	79	73	101	104	3.5	1.3	20.9	0.40	1.5	0.82	0.524	0.263
	112.712	30.162	30.048	23.812	3.5	3.2	120 000	173 000	3 200	4 300	**3984**	**3920**	80	74	99	106	3.5	3.2	25.5	0.40	1.5	0.82	0.712	0.454
	112.712	30.162	30.048	23.812	5.5	3.2	120 000	173 000	3 200	4 300	**3994**	**3920**	84	74	99	106	5.5	3.2	25.5	0.40	1.5	0.82	0.706	0.454
	112.712	30.162	30.162	23.812	3.5	0.8	142 000	202 000	3 200	4 300	**39590**	**39521**	80	74	103	107	3.5	0.8	23.5	0.34	1.8	0.97	0.822	0.365
	112.712	30.162	30.162	23.812	3.5	3.3	142 000	202 000	3 200	4 300	**39590**	**39520**	80	74	101	107	3.5	3.3	23.5	0.34	1.8	0.97	0.822	0.359
	117.475	30.162	30.162	23.812	3.5	3.3	119 000	179 000	3 000	4 000	**33262**	**33462**	81	75	104	112	3.5	3.3	26.8	0.44	1.4	0.76	0.911	0.442
	122.238	38.100	36.678	30.162	3.5	3.3	161 000	221 000	3 000	4 000	**560**	**553 X**	81	75	108	115	3.5	3.3	28.8	0.35	1.7	0.95	1.14	0.692
	122.238	38.100	38.354	29.718	3.5	1.5	188 000	245 000	3 000	4 000	**HM 212049**	**HM 212010**	82	75	110	116	3.5	1.5	26.9	0.34	1.8	0.98	1.25	0.604
	122.238	38.100	38.354	29.718	3.5	3.3	188 000	245 000	3 000	4 000	**HM 212049**	**HM 212011**	81	74	108	116	3.5	3.3	26.9	0.34	1.8	0.98	1.25	0.598
	123.825	38.100	36.678	30.162	3.5	3.3	161 000	221 000	3 000	4 000	**560**	**552 A**	81	75	109	116	3.5	3.3	28.8	0.35	1.7	0.95	1.14	0.764
	136.525	46.038	46.038	36.512	3.5	3.3	233 000	370 000	2 600	3 400	**H 715341**	**H 715311**	89	83	118	132	3.5	3.3	37.1	0.47	1.3	0.70	2.34	0.961
68.262	110.000	22.000	21.996	18.824	2.3	1.3	85 500	113 000	3 200	4 300	**399 A**	**394 A**	78	74	101	104	2.3	1.3	20.9	0.40	1.5	0.82	0.497	0.263
	120.000	29.795	29.007	24.237	3.5	2.0	123 000	169 000	3 000	4 000	**480**	**472**	83	76	106	113	3.5	2	25.1	0.38	1.6	0.86	0.862	0.493
	122.238	38.100	36.678	30.162	3.5	3.3	161 000	221 000	3 000	4 000	**560 S**	**553 X**	83	76	108	115	3.5	3.3	28.8	0.35	1.7	0.95	1.09	0.692
	127.000	36.512	36.170	28.575	3.5	3.3	166 000	234 000	2 800	3 800	**570**	**563**	83	77	112	120	3.5	3.3	28.3	0.36	1.6	0.91	1.32	0.655
	136.525	41.275	41.275	31.750	3.5	3.3	229 000	297 000	2 600	3 600	**H 414245**	**H 414210**	86	82	121	129	3.5	3.3	30.6	0.36	1.7	0.92	1.95	0.796
	136.525	46.038	46.038	36.512	3.5	3.3	233 000	370 000	2 600	3 400	**H 715343**	**H 715311**	90	84	118	132	3.5	3.3	37.1	0.47	1.3	0.70	2.28	0.961
	152.400	47.625	46.038	31.750	3.5	3.3	237 000	267 000	2 400	3 400	**9185**	**9121**	94	81	130	145	3.5	3.3	44.3	0.66	0.92	0.50	2.53	1.21
69.850	112.712	22.225	21.996	15.875	1.5	0.8	85 000	113 000	3 000	4 000	**LM 613449**	**LM 613410**	78	76	104	107	1.5	0.8	22.1	0.42	1.4	0.79	0.562	0.238
	112.712	25.400	25.400	19.050	1.5	3.3	96 000	152 000	2 800	4 000	**29675**	**29620**	80	77	101	109	1.5	3.3	26.3	0.49	1.2	0.68	0.695	0.273
	117.475	30.162	30.162	23.812	3.5	3.3	119 000	179 000	3 000	4 000	**33275**	**33462**	84	77	104	112	3.5	3.3	26.8	0.44	1.4	0.76	0.83	0.442
	120.000	32.545	32.545	26.195	3.5	3.3	152 000	225 000	3 000	4 000	**47487**	**47420**	84	78	107	114	3.5	3.3	26.0	0.36	1.7	0.92	1.02	0.477
	120.650	25.400	25.400	19.050	1.5	3.3	96 000	152 000	2 800	4 000	**29675**	**29630**	79	78	105	113	1.5	3.3	26.3	0.49	1.2	0.68	0.695	0.489
	127.000	36.512	36.170	28.575	3.5	0.8	166 000	234 000	2 800	3 800	**566**	**563 X**	85	78	114	120	3.5	0.8	28.3	0.36	1.6	0.91	1.27	0.658
	130.175	41.275	41.275	31.750	3.5	3.3	195 000	263 000	2 800	3 800	**643**	**633**	86	80	116	124	3.5	3.3	29.9	0.36	1.7	0.91	1.56	0.712
	146.050	41.275	39.688	25.400	3.5	3.3	193 000	225 000	2 400	3 400	**H 913849**	**H 913810**	95	82	124	138	3.5	3.3	44.4	0.78	0.77	0.42	1.95	0.898
	146.050	41.275	41.275	31.750	3.5	3.3	207 000	296 000	2 400	3 200	**655**	**653**	88	82	131	139	3.5	3.3	33.2	0.41	1.5	0.81	2.35	0.891
	149.225	53.975	54.229	44.450	5.0	3.3	287 000	410 000	2 600	3 400	**6454**	**6420**	94	85	129	140	5	3.3	39.0	0.36	1.7	0.91	2.95	1.63
	150.089	44.450	46.672	36.512	3.5	3.3	265 000	370 000	2 400	3 200	**745 A**	**742**	88	82	134	142	3.5	3.3	32.5	0.33	1.8	1.0	2.82	1.07

Note The tolerances are listed in Tables 2, 3 and 4 on Pages C184 and C185.

SINGLE-ROW TAPERED ROLLER BEARINGS (INCH DESIGN)

Bore Diameter 70.000 – 76.200 mm





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 $P_0 = F_r$

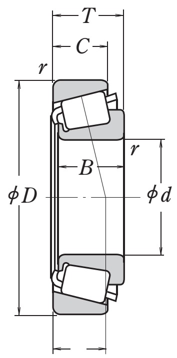
The values of e, Y_1, and Y_0 are given in the table below.

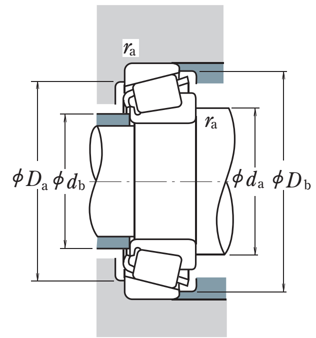
Boundary Dimensions (mm)							Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers		Abutment and Fillet Dimensions (mm)						Eff. Load Centers (mm)	Constant	Axial Load Factors		Mass (kg) approx.	
d	D	T	B	C	Cone r min.	Cup r min.	C_r	C_{0r}	Grease	Oil	CONE	CUP	d_a	d_b	D_a	D_b	Cone r_a max.	Cup r_a max.	a	e	Y_1	Y_0	CONE	CUP
70.000	110.000	26.000	25.000	20.500	1.0	2.5	98 500	152 000	3 000	4 000	**JLM 813049**	**JLM 813010**	78	77	98	105	1	2.5	26.2	0.49	1.2	0.68	0.604	0.304
	115.000	29.000	29.000	23.000	3.0	2.5	126 000	177 000	3 000	4 000	**JM 612949**	**JM 612910**	83	77	103	110	3	2.5	26.4	0.43	1.4	0.77	0.800	0.362
	120.000	29.795	29.007	24.237	2.0	2.0	123 000	169 000	3 000	4 000	**484**	**472**	80	78	106	113	2	2	25.1	0.38	1.6	0.86	0.822	0.493
71.438	117.475	30.162	30.162	23.812	3.5	3.3	119 000	179 000	3 000	4 000	**33281**	**33462**	85	79	104	112	3.5	3.3	26.8	0.44	1.4	0.76	0.789	0.442
	120.000	32.545	32.545	26.195	3.5	3.3	152 000	225 000	3 000	4 000	**47490**	**47420**	86	79	107	114	3.5	3.3	26.0	0.36	1.7	0.92	0.983	0.477
	127.000	36.512	36.170	28.575	6.4	3.3	166 000	234 000	2 800	3 800	**567 S**	**563**	92	80	112	120	6.4	3.3	28.3	0.36	1.6	0.91	1.21	0.655
	127.000	36.512	36.170	28.575	3.5	3.3	166 000	234 000	2 800	3 800	**567 A**	**563**	86	80	112	120	3.5	3.3	28.3	0.36	1.6	0.91	1.23	0.655
	130.175	41.275	41.275	31.750	6.4	3.3	195 000	263 000	2 800	3 800	**645**	**633**	93	81	116	124	6.4	3.3	29.9	0.36	1.7	0.91	1.49	0.712
	136.525	41.275	41.275	31.750	3.5	3.3	195 000	263 000	2 800	3 800	**644**	**632**	87	81	118	125	3.5	3.3	29.9	0.36	1.7	0.91	1.5	1.04
	136.525	41.275	41.275	31.750	3.5	3.3	229 000	297 000	2 600	3 600	**H 414249**	**H 414210**	89	83	121	129	3.5	3.3	30.6	0.36	1.7	0.92	1.83	0.796
	136.525	46.038	46.038	36.512	3.5	3.3	233 000	370 000	2 600	3 400	**H 715345**	**H 715311**	92	84	119	132	3.5	3.3	37.1	0.47	1.3	0.70	2.15	0.961
73.025	112.712	25.400	25.400	19.050	3.5	3.3	96 000	152 000	2 800	4 000	**29685**	**29620**	86	80	101	109	3.5	3.3	26.3	0.49	1.2	0.68	0.62	0.273
	117.475	30.162	30.162	23.812	3.5	3.3	119 000	179 000	3 000	4 000	**33287**	**33462**	87	80	104	112	3.5	3.3	26.8	0.44	1.4	0.76	0.746	0.442
	127.000	36.512	36.170	28.575	3.5	3.3	166 000	234 000	2 800	3 800	**567**	**563**	88	81	112	120	3.5	3.3	28.3	0.36	1.6	0.91	1.17	0.655
	146.050	41.275	41.275	31.750	3.5	3.3	207 000	296 000	2 400	3 200	**657**	**653**	91	85	131	139	3.5	3.3	33.2	0.41	1.5	0.81	2.24	0.891
	149.225	53.975	54.229	44.450	3.5	3.3	287 000	410 000	2 600	3 400	**6460**	**6420**	93	87	129	140	3.5	3.3	39.0	0.36	1.7	0.91	2.8	1.63
73.817	127.000	36.512	36.170	28.575	0.8	3.3	166 000	234 000	2 800	3 800	**568**	**563**	83	82	112	120	0.8	3.3	28.3	0.36	1.6	0.91	1.15	0.655
74.612	150.000	41.275	41.275	31.750	3.5	3.0	207 000	296 000	2 400	3 200	**658**	**653 X**	92	86	133	141	3.5	3	33.2	0.41	1.5	0.81	2.37	0.932
75.000	115.000	25.000	25.000	19.000	3.0	2.5	101 000	150 000	3 000	4 000	**JLM 714149**	**JLM 714110**	87	81	104	110	3	2.5	25.3	0.46	1.3	0.72	0.638	0.272
	120.000	31.000	29.500	25.000	3.0	2.5	129 000	198 000	2 800	3 800	**JM 714249**	**JM 714210**	88	83	108	115	3	2.5	28.8	0.44	1.4	0.74	0.863	0.436
	145.000	51.000	51.000	42.000	3.0	2.5	283 000	410 000	2 600	3 400	**JH 415647**	**JH 415610**	94	89	129	139	3	2.5	36.7	0.36	1.7	0.91	2.64	1.19
76.200	121.442	24.608	23.012	17.462	2.0	2.0	89 000	124 000	2 800	3 800	**34300**	**34478**	86	84	111	116	2	2	26.3	0.45	1.3	0.73	0.65	0.316
	127.000	30.162	31.000	22.225	3.5	3.3	134 000	195 000	2 800	3 800	**42687**	**42620**	90	84	114	121	3.5	3.3	27.3	0.42	1.4	0.79	1.03	0.438
	127.000	30.162	31.001	22.225	6.4	3.3	134 000	195 000	2 800	3 800	**42688**	**42620**	94	84	114	121	6.4	3.3	27.3	0.42	1.4	0.79	1.01	0.438
	133.350	33.338	33.338	26.195	0.8	3.3	154 000	237 000	2 600	3 600	**47680**	**47620**	86	85	119	128	0.8	3.3	29.0	0.40	1.5	0.82	1.39	0.577
	135.733	44.450	46.101	34.925	3.5	3.3	216 000	340 000	2 600	3 600	**5760**	**5735**	94	88	119	130	3.5	3.3	32.9	0.41	1.5	0.81	1.86	0.887
	136.525	30.162	29.769	22.225	3.5	3.3	130 000	192 000	2 600	3 400	**495 A**	**493**	92	86	122	130	3.5	3.3	28.7	0.44	1.4	0.74	1.27	0.55
	136.525	30.162	29.769	22.225	6.4	3.3	130 000	192 000	2 600	3 400	**495 AX**	**493**	98	86	122	130	6.4	3.3	28.7	0.44	1.4	0.74	1.26	0.55
	139.992	36.512	36.098	28.575	3.5	3.3	175 000	260 000	2 600	3 400	**575**	**572**	92	86	125	133	3.5	3.3	31.1	0.40	1.5	0.82	1.61	0.788
	149.225	53.975	54.229	44.450	3.5	3.3	271 000	385 000	2 600	3 400	**6461**	**6420**	96	89	129	140	3.5	3.3	39.0	0.36	1.7	0.91	2.45	1.67
	152.400	39.688	36.322	30.162	3.5	3.2	183 000	285 000	2 200	3 200	**590 A**	**592 A**	95	89	135	145	3.5	3.2	37.1	0.44	1.4	0.75	2.2	1.06
	152.400	41.275	41.275	31.750	3.5	3.3	207 000	296 000	2 400	3 200	**659**	**652**	93	87	134	141	3.5	3.3	33.2	0.41	1.5	0.81	2.11	1.26
	161.925	49.212	46.038	31.750	3.5	3.3	248 000	290 000	2 200	3 000	**9285**	**9220**	103	90	138	153	3.5	3.3	49.8	0.71	0.85	0.47	2.82	1.4
	161.925	53.975	55.100	42.862	3.5	3.3	325 000	480 000	2 200	3 000	**6576**	**6535**	99	92	141	154	3.5	3.3	40.7	0.40	1.5	0.82	3.74	1.67
	161.925	53.975	55.100	42.862	6.4	3.3	325 000	480 000	2 200	3 000	**6575**	**6535**	104	92	141	154	6.4	3.3	40.7	0.40	1.5	0.82	3.73	1.67
	161.925	53.975	55.100	42.862	6.4	0.8	325 000	480 000	2 200	3 000	**6575**	**6536**	104	92	144	154	6.4	0.8	40.7	0.40	1.5	0.82	3.73	1.68

Note The tolerances are listed in Tables 2, 3 and 4 on Pages C184 and C185.

SINGLE-ROW TAPERED ROLLER BEARINGS (INCH DESIGN)

Bore Diameter 76.200 – 83.345 mm





Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \le e$		$F_a/F_r > e$	
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 $P_0 = F_r$

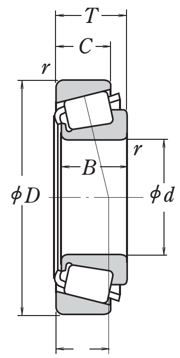
The values of e, Y_1, and Y_0 are given in the table below.

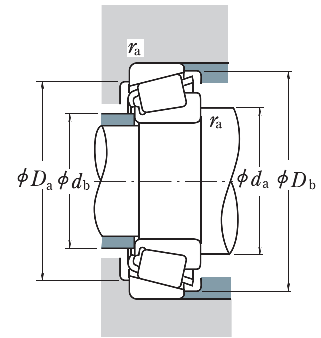
Boundary Dimensions (mm)							Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers		Abutment and Fillet Dimensions (mm)						Eff. Load Centers (mm)	Constant	Axial Load Factors		Mass (kg) approx.	
d	D	T	B	C	Cone r min.	Cup r min.	C_r	C_{0r}	Grease	Oil	CONE	CUP	d_a	d_b	D_a	D_b	Cone r_a max.	Cup r_a max.	a	e	Y_1	Y_0	CONE	CUP
76.200	168.275	53.975	56.363	41.275	6.4	3.3	345 000	470 000	2 200	3 000	**843**	**832**	101	89	149	155	6.4	3.3	35.2	0.30	2.0	1.1	4.11	1.74
	168.275	53.975	56.363	41.275	0.8	3.3	345 000	470 000	2 200	3 000	**837**	**832**	90	89	149	155	0.8	3.3	35.2	0.30	2.0	1.1	4.13	1.74
	171.450	49.212	46.038	31.750	3.5	3.3	257 000	310 000	2 000	2 800	**9380**	**9321**	105	98	147	164	3.5	3.3	54.1	0.76	0.79	0.43	3.47	1.51
	177.800	55.562	50.800	34.925	3.5	3.3	257 000	310 000	2 000	2 800	**9378**	**9320**	105	98	148	164	3.5	3.3	57.3	0.76	0.79	0.43	3.71	2.24
77.788	121.442	24.608	23.012	17.462	3.5	2.0	89 000	124 000	2 800	3 800	**34306**	**34478**	90	84	110	116	3.5	2	26.3	0.45	1.3	0.73	0.612	0.316
	127.000	30.162	31.000	22.225	3.5	3.3	134 000	195 000	2 800	3 800	**42690**	**42620**	91	85	114	121	3.5	3.3	27.3	0.42	1.4	0.79	0.976	0.438
	135.733	44.450	46.101	34.925	3.5	3.3	216 000	340 000	2 600	3 600	**5795**	**5735**	96	89	119	130	3.5	3.3	32.9	0.41	1.5	0.81	1.79	0.887
79.375	146.050	41.275	41.275	31.750	3.5	3.3	207 000	296 000	2 400	3 200	**661**	**653**	96	90	131	139	3.5	3.3	33.2	0.41	1.5	0.81	1.99	0.891
	150.089	44.450	46.672	36.512	3.5	3.3	265 000	370 000	2 400	3 200	**750**	**742**	96	90	134	142	3.5	3.3	32.5	0.33	1.8	1.0	2.42	1.07
80.000	130.000	35.000	34.000	28.500	3.0	2.5	166 000	251 000	2 600	3 600	**JM 515649**	**JM 515610**	94	88	117	125	3	2.5	29.9	0.39	1.5	0.85	1.18	0.583
80.962	136.525	30.162	29.769	22.225	3.5	3.3	130 000	192 000	2 600	3 400	**496**	**493**	95	89	122	130	3.5	3.3	28.7	0.44	1.4	0.74	1.13	0.55
	139.700	36.512	36.098	28.575	3.5	3.3	175 000	260 000	2 600	3 400	**581**	**572 X**	96	90	125	133	3.5	3.3	31.1	0.40	1.5	0.82	1.44	0.774
	139.992	36.512	36.098	28.575	3.5	3.3	175 000	260 000	2 600	3 400	**581**	**572**	96	90	125	133	3.5	3.3	31.1	0.40	1.5	0.82	1.44	0.788
82.550	125.412	25.400	25.400	19.845	3.5	1.5	102 000	164 000	2 600	3 600	**27687**	**27620**	96	89	115	120	3.5	1.5	25.7	0.42	1.4	0.79	0.747	0.348
	133.350	30.162	29.769	22.225	3.5	3.3	130 000	192 000	2 600	3 400	**495**	**492 A**	97	90	120	128	3.5	3.3	28.7	0.44	1.4	0.74	1.08	0.434
	133.350	33.338	33.338	26.195	3.5	3.3	154 000	237 000	2 600	3 600	**47686**	**47620**	97	90	119	128	3.5	3.3	29.0	0.40	1.5	0.82	1.18	0.577
	133.350	33.338	33.338	26.195	0.8	3.3	154 000	237 000	2 600	3 600	**47685**	**47620**	90	90	119	128	0.8	3.3	29.0	0.40	1.5	0.82	1.18	0.577
	133.350	33.338	33.338	26.195	6.8	3.3	154 000	237 000	2 600	3 600	**47687**	**47620**	103	90	119	128	6.8	3.3	29.0	0.40	1.5	0.82	1.16	0.577
	133.350	39.688	39.688	32.545	6.8	3.3	179 000	310 000	2 600	3 600	**HM 516448**	**HM 516410**	105	92	118	128	6.8	3.3	32.4	0.40	1.5	0.82	1.35	0.767
	136.525	30.162	29.769	22.225	3.5	3.3	130 000	192 000	2 600	3 400	**495**	**493**	97	90	122	130	3.5	3.3	28.7	0.44	1.4	0.74	1.08	0.55
	139.700	36.512	36.098	28.575	3.5	3.3	175 000	260 000	2 600	3 400	**580**	**572 X**	98	91	125	133	3.5	3.3	31.1	0.40	1.5	0.82	1.39	0.774
	139.992	36.512	36.098	28.575	3.5	3.3	175 000	260 000	2 600	3 400	**580**	**572**	98	91	125	133	3.5	3.3	31.1	0.40	1.5	0.82	1.39	0.788
	139.992	36.512	36.098	28.575	6.8	3.3	175 000	260 000	2 600	3 400	**582**	**572**	104	91	125	133	6.8	3.3	31.1	0.40	1.5	0.82	1.37	0.788
	146.050	41.275	41.275	31.750	3.5	3.3	207 000	296 000	2 400	3 200	**663**	**653**	99	92	131	139	3.5	3.3	33.2	0.41	1.5	0.81	1.85	0.891
	150.000	44.455	46.672	35.000	3.5	3.3	265 000	370 000	2 400	3 200	**749 A**	**743**	99	93	134	142	3.5	3.3	32.5	0.33	1.8	1.0	2.26	1.04
	150.089	44.450	46.672	36.512	3.5	3.3	265 000	370 000	2 400	3 200	**749 A**	**742**	98	93	135	143	3.5	3.3	32.5	0.33	1.8	1.0	2.26	1.07
	152.400	41.275	41.275	31.750	3.5	3.3	207 000	296 000	2 400	3 200	**663**	**652**	99	92	134	141	3.5	3.3	33.2	0.41	1.5	0.81	1.85	1.26
	161.925	47.625	48.260	38.100	3.5	3.3	274 000	390 000	2 200	3 000	**757**	**752**	100	94	144	150	3.5	3.3	35.6	0.34	1.8	0.97	2.79	1.61
	161.925	53.975	55.100	42.862	3.5	3.3	325 000	480 000	2 200	3 000	**6559**	**6535**	104	98	141	154	3.5	3.3	40.7	0.40	1.5	0.82	3.4	1.67
	168.275	47.625	48.260	38.100	3.5	3.3	274 000	390 000	2 200	3 000	**757**	**753**	100	94	147	150	3.5	3.3	35.6	0.34	1.8	0.97	2.79	2.1
	168.275	53.975	56.363	41.275	3.5	3.3	345 000	470 000	2 200	3 000	**842**	**832**	101	94	149	155	3.5	3.3	35.2	0.30	2.0	1.1	3.76	1.74
83.345	125.412	25.400	25.400	19.845	3.5	1.5	102 000	164 000	2 600	3 600	**27690**	**27620**	96	90	115	120	3.5	1.5	25.7	0.42	1.4	0.79	0.727	0.348
	125.412	25.400	25.400	19.845	0.8	1.5	102 000	164 000	2 600	3 600	**27689**	**27620**	90	90	115	120	0.8	1.5	25.7	0.42	1.4	0.79	0.732	0.348

Note The tolerances are listed in Tables 2, 3 and 4 on Pages C184 and C185.

SINGLE-ROW TAPERED ROLLER BEARINGS (INCH DESIGN)

Bore Diameter 84.138 – 90.488 mm





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 $P_0 = F_r$

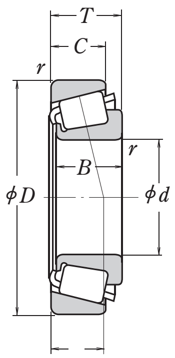
The values of e, Y_1, and Y_0 are given in the table below.

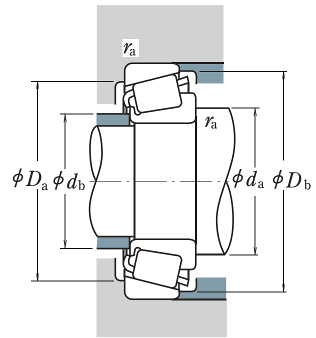
Boundary Dimensions (mm) d	D	T	B	C	Cone r min.	Cup r min.	Basic Load Ratings (N) C_r	C_{0r}	Limiting Speeds (min⁻¹) Grease	Oil	Bearing Numbers CONE	CUP	Abutment and Fillet Dimensions (mm) d_a	d_b	D_a	D_b	Cone r_a max.	Cup r_a max.	Eff. Load Centers (mm) a	Constant e	Axial Load Factors Y_1	Y_0	Mass (kg) approx. CONE	CUP
84.138	136.525	30.162	29.769	22.225	3.5	3.3	130 000	192 000	2 600	3 400	**498**	**493**	98	91	122	130	3.5	3.3	28.7	0.44	1.4	0.74	1.04	0.55
	146.050	41.275	41.275	31.750	3.5	3.3	207 000	296 000	2 400	3 200	**664**	**653**	99	93	131	139	3.5	3.3	33.2	0.41	1.5	0.81	1.79	0.891
	171.450	49.212	46.038	31.750	3.5	3.3	257 000	310 000	2 000	2 800	**9385**	**9321**	111	98	147	164	3.5	3.3	54.1	0.76	0.79	0.43	3.11	1.51
85.000	130.000	30.000	29.000	24.000	6.0	2.5	138 000	222 000	2 600	3 600	**JM 716648**	**JM 716610**	104	92	117	125	6	2.5	29.5	0.44	1.4	0.74	0.931	0.461
	130.000	30.000	29.000	24.000	3.0	2.5	138 000	222 000	2 600	3 600	**JM 716649**	**JM 716610**	98	92	117	125	3	2.5	29.5	0.44	1.4	0.74	0.943	0.461
	140.000	39.000	38.000	31.500	3.0	2.5	202 000	305 000	2 400	3 400	**JHM 516849**	**JHM 516810**	100	94	125	134	3	2.5	33.3	0.41	1.5	0.81	1.55	0.768
	150.000	46.000	46.000	38.000	3.0	2.5	275 000	390 000	2 400	3 200	**JH 217249**	**JH 217210**	101	95	134	142	3	2.5	33.9	0.33	1.8	0.99	2.29	1.09
85.026	150.089	44.450	46.672	36.512	3.5	3.3	265 000	370 000	2 400	3 200	**749**	**742**	101	95	134	142	3.5	3.3	32.5	0.33	1.8	1.0	2.14	1.07
	150.089	44.450	46.672	36.512	5.0	3.3	265 000	370 000	2 400	3 200	**749 S**	**742**	104	95	134	142	5	3.3	32.5	0.33	1.8	1.0	2.14	1.07
85.725	133.350	30.162	29.769	22.225	3.5	3.3	130 000	192 000	2 600	3 400	**497**	**492 A**	99	93	120	128	3.5	3.3	28.7	0.44	1.4	0.74	0.987	0.434
	136.525	30.162	29.769	22.225	3.5	3.3	130 000	192 000	2 600	3 400	**497**	**493**	99	93	122	130	3.5	3.3	28.7	0.44	1.4	0.74	0.987	0.55
	142.138	42.862	42.862	34.133	4.8	3.3	221 000	360 000	2 400	3 400	**HM 617049**	**HM 617010**	106	95	125	137	4.8	3.3	35.4	0.43	1.4	0.76	1.77	0.911
	146.050	41.275	41.275	31.750	6.4	3.3	207 000	296 000	2 400	3 200	**665 A**	**653**	107	95	131	139	6.4	3.3	33.2	0.41	1.5	0.81	1.71	0.891
	146.050	41.275	41.275	31.750	3.5	3.3	207 000	296 000	2 400	3 200	**665**	**653**	102	95	131	139	3.5	3.3	33.2	0.41	1.5	0.81	1.72	0.891
	152.400	39.688	36.322	30.162	3.5	3.2	183 000	285 000	2 200	3 200	**596**	**592 A**	102	96	135	144	3.5	3.2	37.1	0.44	1.4	0.75	1.85	1.06
	161.925	47.625	48.260	38.100	3.5	3.3	274 000	390 000	2 200	3 000	**758**	**752**	103	97	144	150	3.5	3.3	35.6	0.34	1.8	0.97	2.63	1.61
	168.275	41.275	41.275	30.162	3.5	3.3	223 000	345 000	2 000	2 800	**677**	**672**	105	99	149	160	3.5	3.3	38.3	0.47	1.3	0.70	2.91	1.24
87.312	190.500	57.150	57.531	46.038	8.0	3.3	390 000	520 000	1 900	2 600	**HH 221432**	**HH 221410**	118	103	171	179	8	3.3	42.3	0.33	1.8	0.99	5.51	2.24
88.900	149.225	31.750	28.971	24.608	3.0	3.3	140 000	218 000	2 200	3 000	**42350**	**42587**	104	98	134	143	3	3.3	34.9	0.49	1.2	0.67	1.39	0.711
	152.400	39.688	36.322	30.162	3.5	3.2	183 000	285 000	2 200	3 200	**593**	**592 A**	104	98	135	144	3.5	3.2	37.1	0.44	1.4	0.75	1.73	1.06
	152.400	39.688	39.688	30.162	6.4	3.3	253 000	365 000	2 200	3 200	**HM 518445**	**HM 518410**	107	96	137	148	6.4	3.3	33.1	0.40	1.5	0.82	2.11	0.776
	161.925	47.625	48.260	38.100	3.5	3.3	274 000	390 000	2 200	3 000	**759**	**752**	106	99	144	150	3.5	3.3	35.6	0.34	1.8	0.97	2.47	1.61
	161.925	47.625	48.260	38.100	7.0	3.3	274 000	390 000	2 200	3 000	**766**	**752**	113	99	144	150	7	3.3	35.6	0.34	1.8	0.97	2.45	1.61
	161.925	53.975	55.100	42.862	3.5	3.3	325 000	480 000	2 200	3 000	**6580**	**6535**	109	102	141	154	3.5	3.3	40.7	0.40	1.5	0.82	3.03	1.67
	168.275	47.625	48.260	38.100	3.5	3.3	274 000	390 000	2 200	3 000	**759**	**753**	106	99	147	150	3.5	3.3	35.6	0.34	1.8	0.97	2.47	2.1
	168.275	53.975	56.363	41.275	3.5	3.3	345 000	470 000	2 200	3 000	**850**	**832**	106	100	149	155	3.5	3.3	35.2	0.30	2.0	1.1	3.39	1.74
	190.500	57.150	57.531	44.450	8.0	3.3	355 000	500 000	1 900	2 600	**855**	**854**	118	103	170	174	8	3.3	41.8	0.33	1.8	0.99	4.99	2.55
	190.500	57.150	57.531	46.038	8.0	3.3	390 000	520 000	1 900	2 600	**HH 221434**	**HH 221410**	120	105	171	179	8	3.3	42.3	0.33	1.8	0.99	5.41	2.24
90.000	145.000	35.000	34.000	27.000	3.0	2.5	190 000	285 000	2 400	3 200	**JM 718149**	**JM 718110**	105	99	131	139	3	2.5	33.0	0.44	1.4	0.74	1.49	0.66
	147.000	40.000	40.000	32.500	7.0	3.5	229 000	345 000	2 400	3 200	**HM 218248**	**HM 218210**	111	98	133	141	7	3.5	30.8	0.33	1.8	0.99	1.77	0.796
	155.000	44.000	44.000	35.500	3.0	2.5	274 000	395 000	2 200	3 000	**JHM 318448**	**JHM 318410**	106	100	140	148	3	2.5	34.1	0.34	1.7	0.96	2.32	1.01
90.488	161.925	47.625	48.260	38.100	3.5	3.3	274 000	390 000	2 200	3 000	**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).
The tolerances are listed in Tables 2, 3 and 4 on Pages C184 and C185.

SINGLE-ROW TAPERED ROLLER BEARINGS (INCH DESIGN)

Bore Diameter 92.075 – 100.012 mm





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 0.5$F_r + Y_0F_a$, use $P_0 = F_r$

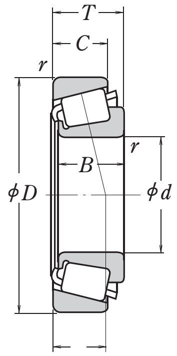
The values of e, Y_1, and Y_0 are given in the table below.

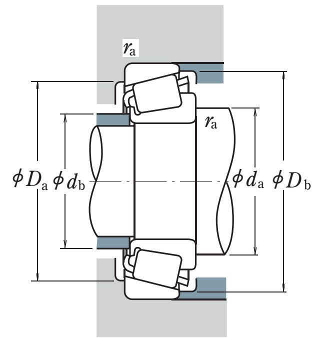
Boundary Dimensions (mm) d	D	T	B	C	Cone r min.	Cup r min.	Basic Load Ratings (N) C_r	C_{0r}	Limiting Speeds (min⁻¹) Grease	Oil	Bearing Numbers CONE	CUP	Abutment and Fillet Dimensions (mm) d_a	d_b	D_a	D_b	Cone r_a max.	Cup r_a max.	Eff. Load Centers (mm) a	Constant e	Axial Load Factors Y_1	Y_0	Mass (kg) approx. CONE	CUP
92.075	146.050	33.338	34.925	26.195	3.5	3.3	169 000	280 000	2 400	3 200	**47890**	**47820**	107	101	131	140	3.5	3.3	32.3	0.45	1.3	0.74	1.46	0.664
	148.430	28.575	28.971	21.433	3.5	3.0	140 000	218 000	2 200	3 000	**42362**	**42584**	107	101	134	142	3.5	3	31.8	0.49	1.2	0.67	1.29	0.553
	152.400	39.688	36.322	30.162	3.5	3.2	183 000	285 000	2 200	3 200	**598**	**592 A**	107	101	135	144	3.5	3.2	37.1	0.44	1.4	0.75	1.6	1.06
	152.400	39.688	36.322	30.162	6.4	3.2	183 000	285 000	2 200	3 200	**598 A**	**592 A**	113	101	135	144	6.4	3.2	37.1	0.44	1.4	0.75	1.59	1.06
	168.275	41.275	41.275	30.162	3.5	3.3	223 000	345 000	2 000	2 800	**681**	**672**	110	104	149	160	3.5	3.3	38.3	0.47	1.3	0.70	2.62	1.24
	190.500	57.150	57.531	44.450	8.0	3.3	355 000	500 000	1 900	2 600	**857**	**854**	121	106	170	174	8	3.3	41.8	0.33	1.8	0.99	4.78	2.55
93.662	148.430	28.575	28.971	21.433	3.0	3.0	140 000	218 000	2 200	3 000	**42368**	**42584**	107	102	134	142	3	3	31.8	0.49	1.2	0.67	1.24	0.553
	149.225	31.750	28.971	24.608	3.0	3.3	140 000	218 000	2 200	3 000	**42368**	**42587**	107	102	134	143	3	3.3	34.9	0.49	1.2	0.67	1.24	0.711
	152.400	39.688	36.322	30.162	3.5	3.2	183 000	285 000	2 200	3 200	**597**	**592 A**	109	102	135	144	3.5	3.2	37.1	0.44	1.4	0.75	1.54	1.06
95.000	150.000	35.000	34.000	27.000	3.0	2.5	183 000	285 000	2 200	3 200	**JM 719149**	**JM 719113**	109	104	135	143	3	2.5	33.4	0.44	1.4	0.75	1.46	0.765
95.250	146.050	33.338	34.925	26.195	3.5	3.3	169 000	280 000	2 400	3 200	**47896**	**47820**	110	103	131	140	3.5	3.3	32.3	0.45	1.3	0.74	1.33	0.664
	148.430	28.575	28.971	21.433	3.0	3.0	140 000	218 000	2 200	3 000	**42375**	**42584**	108	103	134	142	3	3	31.8	0.49	1.2	0.67	1.18	0.553
	149.225	31.750	28.971	24.608	3.5	3.3	140 000	218 000	2 200	3 000	**42376**	**42587**	109	103	134	143	3.5	3.3	34.9	0.49	1.2	0.67	1.18	0.711
	152.400	39.688	36.322	30.162	3.5	3.2	183 000	285 000	2 200	3 200	**594**	**592 A**	110	104	135	144	3.5	3.2	37.1	0.44	1.4	0.75	1.47	1.06
	152.400	39.688	36.322	33.338	3.5	3.3	183 000	285 000	2 200	3 200	**594**	**592**	109	103	135	145	3.5	3.3	37.1	0.44	1.4	0.75	1.47	1.12
	168.275	41.275	41.275	30.162	3.5	3.3	223 000	345 000	2 000	2 800	**683**	**672**	113	106	149	160	3.5	3.3	38.3	0.47	1.3	0.70	2.47	1.24
	171.450	47.625	48.260	38.100	3.5	3.3	282 000	415 000	2 000	2 800	**77375**	**77675**	117	105	152	159	3.5	3.3	37.8	0.37	1.6	0.90	2.91	1.67
	180.975	47.625	48.006	38.100	3.5	3.3	258 000	375 000	2 000	2 600	**776**	**772**	114	107	161	168	3.5	3.3	39.1	0.39	1.6	0.86	3.25	1.99
	190.500	57.150	57.531	44.450	8.0	3.3	355 000	500 000	1 900	2 600	**864**	**854**	123	108	170	174	8	3.3	41.8	0.33	1.8	0.99	4.57	2.55
	190.500	57.150	57.531	46.038	8.0	3.3	390 000	520 000	1 900	2 600	**HH 221440**	**HH 221410**	125	110	171	179	8	3.3	42.3	0.33	1.8	0.99	5.0	2.24
96.838	148.430	28.575	28.971	21.433	3.5	3.0	140 000	218 000	2 200	3 000	**42381**	**42584**	110	104	134	142	3.5	3	31.8	0.49	1.2	0.67	1.13	0.553
	149.225	31.750	28.971	24.606	3.5	3.3	140 000	218 000	2 200	3 000	**42381**	**42587**	111	105	135	143	3.5	3.3	34.9	0.49	1.2	0.67	1.13	0.711
98.425	161.925	36.512	36.116	26.195	3.5	3.3	191 000	310 000	2 000	2 800	**52387**	**52637**	114	108	144	154	3.5	3.3	36.1	0.47	1.3	0.69	1.89	0.942
	168.275	41.275	41.275	30.162	3.5	3.3	223 000	345 000	2 000	2 800	**685**	**672**	116	109	149	160	3.5	3.3	38.3	0.47	1.3	0.70	2.32	1.24
	180.975	47.625	48.006	38.100	3.5	3.3	258 000	375 000	2 000	2 600	**779**	**772**	116	110	161	168	3.5	3.3	39.1	0.39	1.6	0.86	3.06	1.99
	190.500	57.150	57.531	44.450	3.5	3.3	355 000	500 000	1 900	2 600	**866**	**854**	118	111	170	174	3.5	3.3	41.8	0.33	1.8	0.99	4.38	2.55
	190.500	57.150	57.531	46.038	3.5	3.3	390 000	520 000	1 900	2 600	**HH 221442**	**HH 221410**	119	113	171	179	3.5	3.3	42.3	0.33	1.8	0.99	4.81	2.24
99.982	190.500	57.150	57.531	46.038	6.4	3.3	390 000	520 000	1 900	2 600	**HH 221447**	**HH 221410**	126	114	171	179	6.4	3.3	42.3	0.33	1.8	0.99	4.68	2.24
100.000	150.000	32.000	30.000	26.000	2.3	2.3	146 000	235 000	2 200	3 000	**JLM 820048**	**JLM 820012**	111	107	135	144	2.3	2.3	36.8	0.50	1.2	0.66	1.27	0.616
	155.000	36.000	35.000	28.000	3.0	2.5	191 000	325 000	2 000	2 800	**JM 720249**	**JM 720210**	115	109	140	149	3	2.5	36.8	0.47	1.3	0.70	1.68	0.772
	160.000	41.000	40.000	32.000	3.0	2.5	239 000	380 000	2 000	2 800	**JHM 720249**	**JHM 720210**	117	109	143	154	3	2.5	38.2	0.47	1.3	0.70	2.09	0.974
100.012	157.162	36.512	36.116	26.195	3.5	3.3	191 000	310 000	2 000	2 800	**52393**	**52618**	116	109	142	152	3.5	3.3	36.1	0.47	1.3	0.69	1.81	0.702

Note The tolerances are listed in Tables 2, 3 and 4 on Pages C184 and C185.

SINGLE-ROW TAPERED ROLLER BEARINGS (INCH DESIGN)

Bore Diameter 101.600 – 117.475 mm





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 $P_0 = F_r$

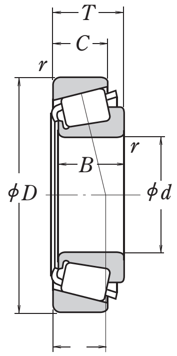
The values of e, Y_1, and Y_0 are given in the table below.

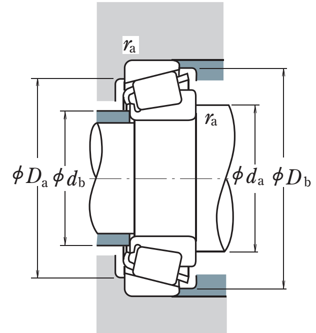
Boundary Dimensions (mm)							Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers		Abutment and Fillet Dimensions (mm)						Eff. Load Centers (mm)	Constant	Axial Load Factors		Mass (kg) approx.	
d	D	T	B	C	Cone r min.	Cup r min.	C_r	C_{0r}	Grease	Oil	CONE	CUP	d_a	d_b	D_a	D_b	Cone r_a max.	Cup r_a max.	a	e	Y_1	Y_0	CONE	CUP
101.600	157.162	36.512	36.116	26.195	3.5	3.3	191 000	310 000	2 000	2 800	**52400**	**52618**	117	111	142	152	3.5	3.3	36.1	0.47	1.3	0.69	1.75	0.702
	161.925	36.512	36.116	26.195	3.5	3.3	191 000	310 000	2 000	2 800	**52400**	**52637**	117	111	144	154	3.5	3.3	36.1	0.47	1.3	0.69	1.75	0.942
	168.275	41.275	41.275	30.162	3.5	3.3	223 000	345 000	2 000	2 800	**687**	**672**	118	112	149	160	3.5	3.3	38.3	0.47	1.3	0.70	2.15	1.24
	180.975	47.625	48.006	38.100	3.5	3.3	258 000	375 000	2 000	2 600	**780**	**772**	119	113	161	168	3.5	3.3	39.1	0.39	1.6	0.86	2.88	1.99
	190.500	57.150	57.531	44.450	8.0	3.3	355 000	500 000	1 900	2 600	**861**	**854**	129	114	170	174	8	3.3	41.8	0.33	1.8	0.99	4.13	2.55
	190.500	57.150	57.531	46.038	8.0	3.3	390 000	520 000	1 900	2 600	**HH 221449**	**HH 221410**	131	116	171	179	8	3.3	42.3	0.33	1.8	0.99	4.55	2.24
	212.725	66.675	66.675	53.975	7.0	3.3	570 000	810 000	1 700	2 200	**HH 224335**	**HH 224310**	132	121	192	202	7	3.3	47.3	0.33	1.8	1.0	8.14	3.06
104.775	180.975	47.625	48.006	38.100	7.0	3.3	258 000	375 000	2 000	2 600	**787**	**772**	129	116	161	168	7	3.3	39.1	0.39	1.6	0.86	2.66	1.99
	180.975	47.625	48.006	38.100	3.5	3.3	258 000	375 000	2 000	2 600	**782**	**772**	122	116	161	168	3.5	3.3	39.1	0.39	1.6	0.86	2.68	1.99
	190.500	47.625	49.212	34.925	3.5	3.3	296 000	465 000	1 800	2 400	**71412**	**71750**	124	118	171	181	3.5	3.3	40.1	0.42	1.4	0.79	4.0	1.71
106.362	165.100	36.512	36.512	26.988	3.5	3.3	195 000	320 000	2 000	2 600	**56418**	**56650**	122	116	149	159	3.5	3.3	38.6	0.50	1.2	0.66	1.87	0.861
107.950	158.750	23.020	21.438	15.875	3.5	3.3	102 000	165 000	2 000	2 800	**37425**	**37625**	122	115	143	152	3.5	3.3	37.0	0.61	0.99	0.54	0.886	0.488
	159.987	34.925	34.925	26.988	3.5	3.3	164 000	315 000	2 000	2 800	**LM 522546**	**LM 522510**	122	116	146	154	3.5	3.3	33.7	0.40	1.5	0.82	1.65	0.784
	161.925	34.925	34.925	26.988	3.5	3.3	164 000	280 000	2 000	2 800	**48190**	**48120**	122	116	146	156	3.5	3.3	38.7	0.51	1.2	0.65	1.59	0.83
	165.100	36.512	36.512	26.988	3.5	3.3	195 000	320 000	2 000	2 600	**56425**	**56650**	123	117	149	159	3.5	3.3	38.6	0.50	1.2	0.66	1.8	0.861
	190.500	47.625	49.212	34.925	3.5	3.3	296 000	465 000	1 800	2 400	**71425**	**71750**	126	120	171	181	3.5	3.3	40.1	0.42	1.4	0.79	3.79	1.71
	212.725	66.675	66.675	53.975	8.0	3.3	570 000	810 000	1 700	2 200	**HH 224340**	**HH 224310**	139	126	192	202	8	3.3	47.3	0.33	1.8	1.0	7.58	3.06
109.987	159.987	34.925	34.925	26.988	3.5	3.3	164 000	315 000	2 000	2 800	**LM 522549**	**LM 522510**	124	118	146	154	3.5	3.3	33.7	0.40	1.5	0.82	1.55	0.784
	159.987	34.925	34.925	26.988	8.0	3.3	164 000	315 000	2 000	2 800	**LM 522548**	**LM 522510**	133	118	146	154	8	3.3	33.7	0.40	1.5	0.82	1.53	0.784
109.992	177.800	41.275	41.275	30.162	3.5	3.3	232 000	375 000	1 800	2 600	**64433**	**64700**	128	121	160	172	3.5	3.3	42.4	0.52	1.2	0.64	2.64	1.11
110.000	165.000	35.000	35.000	26.500	3.0	2.5	195 000	320 000	2 000	2 600	**JM 822049**	**JM 822010**	124	119	149	159	3	2.5	38.3	0.50	1.2	0.66	1.64	0.842
	180.000	47.000	46.000	38.000	3.0	2.5	310 000	490 000	1 900	2 600	**JHM 522649**	**JHM 522610**	127	122	162	172	3	2.5	40.9	0.41	1.5	0.81	3.12	1.51
111.125	190.500	47.625	49.212	34.925	3.5	3.3	296 000	465 000	1 800	2 400	**71437**	**71750**	129	123	171	181	3.5	3.3	40.1	0.42	1.4	0.79	3.58	1.71
114.300	152.400	21.433	21.433	16.670	1.5	1.5	89 500	178 000	2 000	2 800	**L 623149**	**L 623110**	123	121	143	148	1.5	1.5	27.4	0.41	1.5	0.80	0.725	0.344
	177.800	41.275	41.275	30.162	3.5	3.3	232 000	375 000	1 800	2 600	**64450**	**64700**	131	125	160	172	3.5	3.3	42.4	0.52	1.2	0.64	2.39	1.11
	180.000	34.925	31.750	25.400	3.5	0.8	174 000	254 000	1 800	2 400	**68450**	**68709**	130	123	165	172	3.5	0.8	40.0	0.50	1.2	0.66	1.95	1.0
	190.500	47.625	49.212	34.925	3.5	3.3	296 000	465 000	1 800	2 400	**71450**	**71750**	132	125	171	181	3.5	3.3	40.1	0.42	1.4	0.79	3.37	1.71
	212.725	66.675	66.675	53.975	7.0	3.3	475 000	700 000	1 700	2 400	**938**	**932**	141	128	187	193	7	3.3	46.9	0.33	1.8	1.0	6.01	4.11
	212.725	66.675	66.675	53.975	7.0	3.3	570 000	810 000	1 700	2 200	**HH 224346**	**HH 224310**	143	131	192	202	7	3.3	47.3	0.33	1.8	1.0	7.01	3.06
115.087	190.500	47.625	49.212	34.925	3.5	3.3	296 000	465 000	1 800	2 400	**71453**	**71750**	133	126	171	181	3.5	3.3	40.1	0.42	1.4	0.79	3.31	1.71
117.475	180.975	34.925	31.750	25.400	3.5	3.3	174 000	254 000	1 800	2 400	**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). The tolerances are listed in Tables 2, 3 and 4 on Pages C184 and C185.

SINGLE-ROW TAPERED ROLLER BEARINGS (INCH DESIGN)

Bore Diameter 120.000 – 165.100 mm





Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \le e$		$F_a/F_r > e$	
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 $P_0 = F_r$

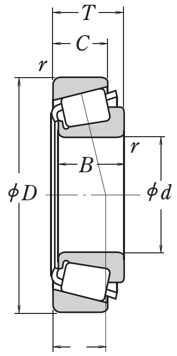
The values of e, Y_1, and Y_0 are given in the table below.

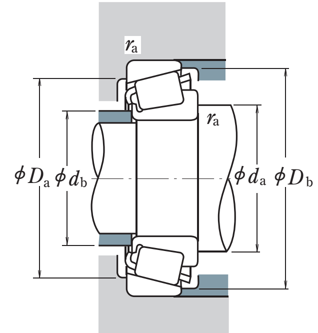
Boundary Dimensions (mm)							Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers		Abutment and Fillet Dimensions (mm)						Eff. Load Centers (mm)	Constant	Axial Load Factors		Mass (kg)	
d	D	T	B	C	Cone r min.	Cup r min.	C_r	C_{0r}	Grease	Oil	CONE	CUP	d_a	d_b	D_a	D_b	Cone r_a max.	Cup r_a max.	a	e	Y_1	Y_0	approx. CONE	approx. CUP
120.000	170.000	25.400	25.400	19.050	3.3	3.3	130 000	219 000	1 900	2 600	**JL 724348**	**JL 724314**	132	127	156	163	3.3	3.3	32.9	0.46	1.3	0.72	1.08	0.591
	174.625	35.720	36.512	27.783	3.5	1.5	212 000	385 000	1 900	2 600	**M 224748**	**M 224710**	135	129	163	168	3.5	1.5	32.2	0.33	1.8	0.99	1.9	0.866
120.650	182.562	39.688	38.100	33.338	3.5	3.3	228 000	445 000	1 800	2 400	**48282**	**48220**	136	133	168	176	3.5	3.3	34.2	0.31	2.0	1.1	2.56	1.14
	206.375	47.625	47.625	34.925	3.3	3.3	320 000	530 000	1 600	2 200	**795**	**792**	139	134	186	198	3.3	3.3	45.7	0.46	1.3	0.72	4.44	1.9
123.825	182.562	39.688	38.100	33.338	3.5	3.3	228 000	445 000	1 800	2 400	**48286**	**48220**	139	133	168	176	3.5	3.3	34.2	0.31	2.0	1.1	2.37	1.14
125.000	175.000	25.400	25.400	18.288	3.3	3.3	134 000	232 000	1 800	2 400	**JL 725346**	**JL 725316**	138	133	161	168	3.3	3.3	34.3	0.48	1.3	0.69	1.19	0.573
127.000	165.895	18.258	17.462	13.495	1.5	1.5	84 500	149 000	1 900	2 600	**LL 225749**	**LL 225710**	135	132	158	160	1.5	1.5	24.2	0.33	1.8	0.99	0.647	0.288
	182.562	39.688	38.100	33.338	3.5	3.3	228 000	445 000	1 800	2 400	**48290**	**48220**	141	135	168	176	3.5	3.3	34.2	0.31	2.0	1.1	2.19	1.14
	196.850	46.038	46.038	38.100	3.5	3.3	315 000	560 000	1 700	2 200	**67388**	**67322**	144	138	180	189	3.5	3.3	39.7	0.34	1.7	0.96	3.74	1.46
	215.900	47.625	47.625	34.925	3.5	3.3	287 000	495 000	1 500	2 000	**74500**	**74850**	148	141	196	208	3.5	3.3	48.4	0.49	1.2	0.68	4.92	1.99
128.588	206.375	47.625	47.625	34.925	3.3	3.3	320 000	530 000	1 600	2 200	**799**	**792**	146	140	186	198	3.3	3.3	45.7	0.46	1.3	0.72	3.86	1.9
130.000	206.375	47.625	47.625	34.925	3.5	3.3	320 000	530 000	1 600	2 200	**797**	**792**	148	141	186	198	3.5	3.3	45.7	0.46	1.3	0.72	3.76	1.9
130.175	203.200	46.038	46.038	38.100	3.5	3.3	315 000	560 000	1 700	2 200	**67389**	**67320**	146	141	183	191	3.5	3.3	39.7	0.34	1.7	0.96	3.51	2.06
	206.375	47.625	47.625	34.925	3.5	3.3	320 000	530 000	1 600	2 200	**799 A**	**792**	148	142	186	198	3.5	3.3	45.7	0.46	1.3	0.72	3.74	1.9
133.350	177.008	25.400	26.195	20.638	1.5	1.5	124 000	258 000	1 800	2 400	**L 327249**	**L 327210**	143	141	167	171	1.5	1.5	29.5	0.35	1.7	0.95	1.18	0.55
	190.500	39.688	39.688	33.338	3.5	3.3	240 000	485 000	1 700	2 200	**48385**	**48320**	148	142	177	184	3.5	3.3	35.9	0.32	1.9	1.0	2.58	1.16
	196.850	46.038	46.038	38.100	3.5	3.3	315 000	560 000	1 700	2 200	**67390**	**67322**	149	143	180	189	3.5	3.3	39.7	0.34	1.7	0.96	3.27	1.46
	215.900	47.625	47.625	34.925	3.5	3.3	287 000	495 000	1 500	2 000	**74525**	**74850**	152	146	196	208	3.5	3.3	48.4	0.49	1.2	0.68	4.44	1.99
136.525	190.500	39.688	39.688	33.338	3.5	3.3	216 000	440 000	1 700	2 200	**48393**	**48320**	151	144	177	184	3.5	3.3	35.9	0.32	1.9	1.0	2.31	1.16
	217.488	47.625	47.625	34.925	3.5	3.3	287 000	495 000	1 500	2 000	**74537**	**74856**	155	148	197	210	3.5	3.3	48.4	0.49	1.2	0.68	4.19	2.13
139.700	187.325	28.575	29.370	23.020	1.5	1.5	153 000	305 000	1 700	2 200	**LM 328448**	**LM 328410**	149	147	176	182	1.5	1.5	31.7	0.36	1.7	0.93	1.59	0.67
	215.900	47.625	47.625	34.925	3.5	3.3	287 000	495 000	1 500	2 000	**74550**	**74850**	158	151	196	208	3.5	3.3	48.4	0.49	1.2	0.68	3.93	1.99
	254.000	66.675	66.675	47.625	7.0	3.3	515 000	830 000	1 300	1 800	**99550**	**99100**	170	156	227	238	7	3.3	55.3	0.41	1.5	0.81	9.99	3.83
142.875	200.025	41.275	39.688	34.130	3.5	3.3	227 000	460 000	1 600	2 200	**48685**	**48620**	158	151	185	193	3.5	3.3	37.6	0.34	1.8	0.98	2.63	1.19
146.050	193.675	28.575	28.575	23.020	1.5	1.5	170 000	355 000	1 600	2 200	**36690**	**36620**	155	154	182	188	1.5	1.5	33.5	0.37	1.6	0.90	1.64	0.725
	236.538	57.150	56.642	44.450	3.5	3.3	455 000	720 000	1 400	1 900	**HM 231140**	**HM 231110**	164	160	217	224	3.5	3.3	45.9	0.32	1.9	1.0	6.07	2.93
	254.000	66.675	66.675	47.625	7.0	3.3	515 000	830 000	1 300	1 800	**99575**	**99100**	175	162	227	238	7	3.3	55.3	0.41	1.5	0.81	9.24	3.83
149.225	254.000	66.675	66.675	47.625	7.0	3.3	515 000	830 000	1 300	1 800	**99587**	**99100**	178	165	227	238	7	3.3	55.3	0.41	1.5	0.81	8.86	3.83
152.400	254.000	66.675	66.675	47.625	7.0	3.3	515 000	830 000	1 300	1 800	**99600**	**99100**	181	167	227	238	7	3.3	55.3	0.41	1.5	0.81	8.46	3.83
158.750	225.425	41.275	39.688	33.338	3.5	3.3	240 000	540 000	1 400	1 900	**46780**	**46720**	176	169	209	218	3.5	3.3	44.3	0.38	1.6	0.86	3.69	1.66
165.100	247.650	47.625	47.625	38.100	3.5	3.3	345 000	705 000	1 300	1 700	**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).
The tolerances are listed in Tables 2, 3 and 4 on Pages C184 and C185.

SINGLE-ROW TAPERED ROLLER BEARINGS (INCH DESIGN)

Bore Diameter 170.000 – 206.375 mm





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 $P_0=F_r$

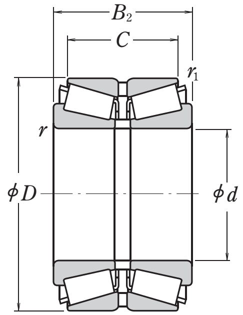
The values of e, Y_1, and Y_0 are given in the table below.

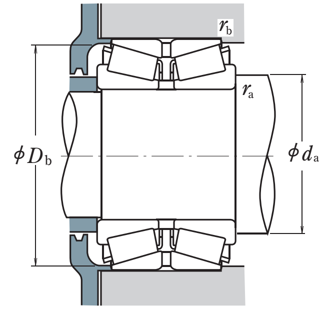
Boundary Dimensions (mm)							Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers		Abutment and Fillet Dimensions (mm)						Eff. Load Centers (mm)	Constant	Axial Load Factors		Mass (kg) approx.	
d	D	T	B	C	Cone r min.	Cup r min.	C_r	C_{0r}	Grease	Oil	CONE	CUP	d_a	d_b	D_a	D_b	Cone r_a max.	Cup r_a max.	a	e	Y_1	Y_0	CONE	CUP
170.000	230.000	39.000	38.000	31.000	3.0	2.5	278 000	520 000	1 300	1 800	**JHM 534149**	**JHM 534110**	184	178	217	224	3	2.5	43.2	0.38	1.6	0.86	3.1	1.3
	240.000	46.000	44.500	37.000	3.0	2.5	380 000	720 000	1 300	1 800	**JM 734449**	**JM 734410**	185	180	222	232	3	2.5	50.5	0.44	1.4	0.75	4.42	2.02
174.625	247.650	47.625	47.625	38.100	3.5	3.3	345 000	705 000	1 300	1 700	**67787**	**67720**	192	185	229	240	3.5	3.3	52.4	0.44	1.4	0.75	4.88	2.33
177.800	227.012	30.162	30.162	23.020	1.5	1.5	181 000	415 000	1 300	1 800	**36990**	**36920**	189	186	214	221	1.5	1.5	42.9	0.44	1.4	0.75	2.1	0.907
	247.650	47.625	47.625	38.100	3.5	3.3	345 000	705 000	1 300	1 700	**67790**	**67720**	194	188	229	240	3.5	3.3	52.4	0.44	1.4	0.75	4.56	2.33
	260.350	53.975	53.975	41.275	3.5	3.3	455 000	835 000	1 200	1 700	**M 236849**	**M 236810**	195	192	241	249	3.5	3.3	47.5	0.33	1.8	0.99	6.49	2.86
190.000	260.000	46.000	44.000	36.500	3.0	2.5	370 000	730 000	1 100	1 600	**JM 738249**	**JM 738210**	206	200	242	252	3	2.5	56.4	0.48	1.3	0.69	4.73	2.2
190.500	266.700	47.625	46.833	38.100	3.5	3.3	345 000	720 000	1 100	1 500	**67885**	**67820**	209	203	246	259	3.5	3.3	57.9	0.48	1.3	0.69	5.4	2.64
200.000	300.000	65.000	62.000	51.000	3.5	2.5	615 000	1 130 000	1 000	1 400	**JHM 840449**	**JHM 840410**	223	215	273	289	3.5	2.5	73.1	0.52	1.2	0.63	10.3	5.19
203.200	282.575	46.038	46.038	36.512	3.5	3.3	365 000	800 000	1 000	1 400	**67983**	**67920**	222	216	260	275	3.5	3.3	61.9	0.51	1.2	0.65	6.03	2.82
206.375	282.575	46.038	46.038	36.512	3.5	3.3	365 000	800 000	1 000	1 400	**67985**	**67920**	224	219	260	275	3.5	3.3	61.9	0.51	1.2	0.65	5.66	2.82

Note The tolerances are listed in Tables 2, 3 and 4 on Pages C184 and C185.

DOUBLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 40 – 90 mm





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

$P_0 = F_r + Y_0 F_a$

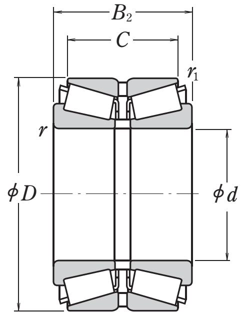
The values of e, Y_2, Y_3, and Y_0 are given in the table below.

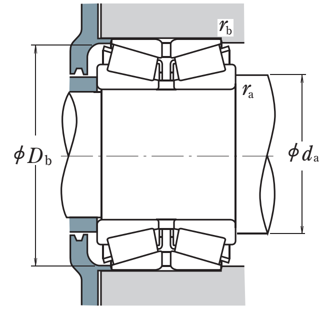
Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers	Abutment and Fillet Dimensions (mm)				Constant	Axial Load Factors			Mass (kg)
d	D	B_2	C	r min.	r_1 min.	C_r	C_{0r}	Grease	Oil		d_a min.	D_b min.	r_a max.	r_b max.	e	Y_2	Y_3	Y_0	approx.
40	80	45	37.5	1.5	0.6	109 000	140 000	3 700	5 100	**HR 40 KBE 42+L**	51	75	1.5	0.6	0.37	2.7	1.8	1.8	0.97
45	85	47	37.5	1.5	0.6	117 000	159 000	3 400	4 700	**HR 45 KBE 42+L**	56	81	1.5	0.6	0.40	2.5	1.7	1.6	1.08
	85	55	43.5	1.5	0.6	143 000	204 000	3 400	4 700	**HR 45 KBE 52X+L**	56	81	1.5	0.6	0.40	2.5	1.7	1.6	1.31
50	90	48	38.5	1.5	0.6	131 000	183 000	3 200	4 400	**HR 50 KBE 042+L**	61	87	1.5	0.6	0.42	2.4	1.6	1.6	1.20
	90	49	39.5	1.5	0.6	131 000	183 000	3 200	4 400	**HR 50 KBE 42+L**	61	87	1.5	0.6	0.42	2.4	1.6	1.6	1.22
	90	55	43.5	1.5	0.6	150 000	218 000	3 200	4 400	**HR 50 KBE 52X+L**	61	87	1.5	0.6	0.42	2.4	1.6	1.6	1.39
	110	64	51.5	2.5	0.6	224 000	297 000	2 700	3 700	**HR 50 KBE 043+L**	65	104	2	0.6	0.35	2.9	2.0	1.9	2.77
55	100	51	41.5	2	0.6	162 000	226 000	2 900	3 900	**HR 55 KBE 042+L**	67	96	2	0.6	0.40	2.5	1.7	1.6	1.59
	100	52	42.5	2	0.6	162 000	226 000	2 900	3 900	**HR 55 KBE 1003+L**	67	96	2	0.6	0.40	2.5	1.7	1.6	1.63
	100	60	48.5	2	0.6	188 000	274 000	2 900	3 900	**HR 55 KBE 52X+L**	67	97	2	0.6	0.40	2.5	1.7	1.6	1.88
	120	70	57	2.5	0.6	256 000	342 000	2 500	3 400	**HR 55 KBE 43+L**	70	113	2	0.6	0.35	2.9	2.0	1.9	3.52
60	110	53	43.5	2	0.6	178 000	246 000	2 700	3 600	**HR 60 KBE 042+L**	72	105	2	0.6	0.40	2.5	1.7	1.6	2.03
	110	66	54.5	2	0.6	225 000	335 000	2 700	3 600	**HR 60 KBE 52X+L**	72	106	2	0.6	0.40	2.5	1.7	1.6	2.52
	130	74	59	3	1	298 000	405 000	2 300	3 200	**HR 60 KBE 43+L**	78	122	2.5	1	0.35	2.9	2.0	1.9	4.40
65	120	56	46.5	2	0.6	210 000	300 000	2 400	3 200	**HR 65 KBE 42+L**	77	115	2	0.6	0.40	2.5	1.7	1.6	2.58
	120	57	47.5	2	0.6	210 000	300 000	2 400	3 200	**HR 65 KBE 1202+L**	77	115	2	0.6	0.40	2.5	1.7	1.6	2.61
	120	73	61.5	2	0.6	269 000	405 000	2 400	3 300	**HR 65 KBE 52X+L**	77	117	2	0.6	0.40	2.5	1.7	1.6	3.35
	140	79	63	3	1	340 000	465 000	2 100	2 900	**HR 65 KBE 43+L**	83	132	2.5	1	0.35	2.9	2.0	1.9	5.42
70	125	57	46.5	2	0.6	227 000	325 000	2 300	3 100	**HR 70 KBE 042+L**	82	120	2	0.6	0.42	2.4	1.6	1.6	2.79
	125	59	48.5	2	0.6	227 000	325 000	2 300	3 100	**HR 70 KBE 42+L**	82	120	2	0.6	0.42	2.4	1.6	1.6	2.85
	125	74	61.5	2	0.6	270 000	410 000	2 300	3 100	**HR 70 KBE 52X+L**	82	121	2	0.6	0.42	2.4	1.6	1.6	3.58
	150	83	67	3	1	390 000	535 000	2 000	2 700	**HR 70 KBE 43+L**	88	142	2.5	1	0.35	2.9	2.0	1.9	6.45
75	130	62	51.5	2	0.6	245 000	365 000	2 200	3 000	**HR 75 KBE 42+L**	87	126	2	0.6	0.44	2.3	1.6	1.5	3.15
	130	74	61.5	2	0.6	283 000	440 000	2 200	3 000	**HR 75 KBE 52X+L**	87	127	2	0.6	0.44	2.3	1.6	1.5	3.73
	160	87	69	3	1	435 000	600 000	1 900	2 500	**HR 75 KBE 043+L**	93	151	2.5	1	0.35	2.9	2.0	1.9	7.66
80	140	61	49	2.5	0.6	269 000	390 000	2 000	2 800	**HR 80 KBE 042+L**	95	134	2	0.6	0.42	2.4	1.6	1.6	3.70
	140	64	51.5	2.5	0.6	269 000	390 000	2 000	2 800	**HR 80 KBE 42+L**	95	134	2	0.6	0.42	2.4	1.6	1.6	3.70
	140	78	63.5	2.5	0.6	330 000	505 000	2 000	2 800	**HR 80 KBE 52X+L**	95	136	2	0.6	0.42	2.4	1.6	1.6	4.59
	170	92	73	3	1	475 000	655 000	1 700	2 400	**HR 80 KBE 043+L**	98	161	2.5	1	0.35	2.9	2.0	1.9	9.02
85	150	70	57	2.5	0.6	315 000	465 000	1 900	2 600	**HR 85 KBE 42+L**	100	143	2	0.6	0.42	2.4	1.6	1.6	4.69
	150	86	69	2.5	0.6	360 000	555 000	1 900	2 600	**HR 85 KBE 52X+L**	100	144	2	0.6	0.42	2.4	1.6	1.6	5.70
	180	98	77	4	1	530 000	745 000	1 600	2 200	**HR 85 KBE 043+L**	106	169	3	1	0.35	2.9	2.0	1.9	10.8
90	160	71	58	2.5	0.6	345 000	510 000	1 800	2 400	**HR 90 KBE 042+L**	105	152	2	0.6	0.42	2.4	1.6	1.6	5.53
	160	74	61	2.5	0.6	345 000	510 000	1 800	2 400	**HR 90 KBE 42+L**	105	152	2	0.6	0.42	2.4	1.6	1.6	5.71
	160	94	77	2.5	0.6	440 000	700 000	1 800	2 400	**HR 90 KBE 52X+L**	105	154	2	0.6	0.42	2.4	1.6	1.6	7.26

Remark For other double-row tapered roller bearings not listed above, please contact NSK.

DOUBLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 90 – 120 mm





Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \le e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

$P_0 = F_r + Y_0 F_a$

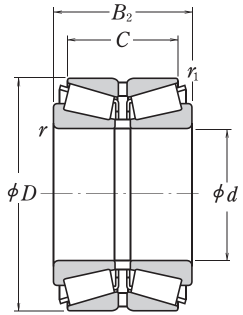
The values of e, Y_2, Y_3, and Y_0 are given in the table below.

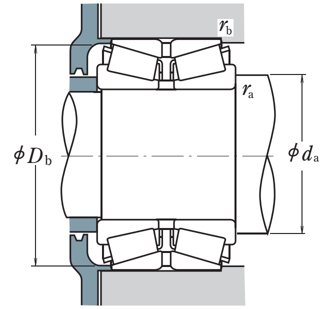
Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers	Abutment and Fillet Dimensions (mm)				Constant	Axial Load Factors			Mass (kg)
d	D	B_2	C	r min.	r_1 min.	C_r	C_{0r}	Grease	Oil		d_a min.	D_b min.	r_a max.	r_b max.	e	Y_2	Y_3	Y_0	approx.
90	190	102	81	4	1	595 000	845 000	1 600	2 100	**HR 90 KBE 043+L**	111	178	3	1	0.35	2.9	2.0	1.9	12.7
	190	144	115	4	1	770 000	1 180 000	1 600	2 200	**HR 90 KBE 1901+L**	111	179	3	1	0.35	2.9	2.0	1.9	17.9
95	170	78	63	3	1	385 000	570 000	1 700	2 300	**HR 95 KBE 42+L**	113	161	2.5	1	0.42	2.4	1.6	1.6	6.75
	170	100	83	3	1	495 000	800 000	1 700	2 300	**HR 95 KBE 52+L**	113	163	2.5	1	0.42	2.4	1.6	1.6	8.60
	200	108	85	4	1	640 000	910 000	1 500	2 000	**HR 95 KBE 43+L**	116	187	3	1	0.35	2.9	2.0	1.9	14.7
100	165	52	46	2.5	0.6	222 000	340 000	1 700	2 300	**100 KBE 31+L**	115	156	2	0.6	0.33	3.0	2.0	2.0	4.04
	180	81	64	3	1	435 000	665 000	1 600	2 200	**HR100 KBE 1805+L**	118	170	2.5	1	0.42	2.4	1.6	1.6	8.16
	180	81	65	3	1	435 000	665 000	1 600	2 200	**HR100 KBE 042+L**	118	170	2.5	1	0.42	2.4	1.6	1.6	8.13
	180	82	66	3	1	435 000	665 000	1 600	2 200	**HR100 KBE 1801+L**	118	170	2.5	1	0.42	2.4	1.6	1.6	8.22
	180	83	67	3	1	435 000	665 000	1 600	2 200	**HR100 KBE 42+L**	118	170	2.5	1	0.42	2.4	1.6	1.6	8.7
	180	105	85	3	1	555 000	905 000	1 600	2 200	**HR100 KBE 1802+L**	118	173	2.5	1	0.42	2.4	1.6	1.6	10.6
	180	107	87	3	1	555 000	905 000	1 600	2 200	**HR100 KBE 52X+L**	118	173	2.5	1	0.42	2.4	1.6	1.6	10.7
	180	110	90	3	1	555 000	905 000	1 600	2 200	**HR100 KBE 1804+L**	118	173	2.5	1	0.42	2.4	1.6	1.6	11
	215	112	87	4	1	725 000	1 050 000	1 400	1 900	HR100 KBE 043+L	121	200	3	1	0.35	2.9	2.0	1.9	18.1
105	190	88	70	3	1	480 000	735 000	1 500	2 000	**HR105 KBE 42X+L**	123	179	2.5	1	0.42	2.4	1.6	1.6	9.76
	190	117	96	3	1	620 000	1 020 000	1 500	2 000	**HR105 KBE 1902+L**	123	182	2.5	1	0.42	2.4	1.6	1.6	13.4
	190	115	95	3	1	620 000	1 020 000	1 500	2 000	**HR105 KBE 52+L**	123	182	2.5	1	0.42	2.4	1.6	1.6	13.1
	225	116	91	4	1	780 000	1 130 000	1 300	1 800	HR105 KBE 043+L	126	209	3	1	0.35	2.9	2.0	1.9	20.4
110	180	56	50	2.5	0.6	264 000	400 000	1 500	2 000	**110 KBE 31+L**	125	172	2	0.6	0.39	2.6	1.7	1.7	5.11
	180	70	56	2.5	0.6	340 000	555 000	1 500	2 000	**110 KBE 031+L**	125	172	2	0.6	0.39	2.6	1.7	1.7	6.33
	180	125	100	2.5	0.6	550 000	1 060 000	1 500	2 100	**110 KBE 1802+L**	125	172	2	0.6	0.26	3.8	2.6	2.5	11.4
	200	90	72	3	1	540 000	840 000	1 400	1 900	**HR110 KBE 42+L**	128	190	2.5	1	0.42	2.4	1.6	1.6	11.2
	200	92	74	3	1	540 000	840 000	1 400	1 900	**HR110 KBE 42X+L**	128	190	2.5	1	0.42	2.4	1.6	1.6	11.5
	200	120	100	3	1	685 000	1 130 000	1 400	1 900	**HR110 KBE 2001+L**	128	193	2.5	1	0.42	2.4	1.6	1.6	15.4
	200	121	101	3	1	685 000	1 130 000	1 400	1 900	**HR110 KBE 52X+L**	128	193	2.5	1	0.42	2.4	1.6	1.6	15.2
	240	118	93	4	1.5	830 000	1 190 000	1 200	1 700	HR110 KBE 043+L	131	223	3	1.5	0.35	2.9	2.0	1.9	23.6
120	180	46	41	2.5	0.6	184 000	296 000	1 500	2 000	**120 KBE 30+L**	135	172	2	0.6	0.40	2.5	1.7	1.6	3.75
	180	58	46	2.5	0.6	260 000	450 000	1 500	2 000	**120 KBE 030+L**	135	172	2	0.6	0.39	2.6	1.7	1.7	4.64
	200	62	55	2.5	0.6	310 000	500 000	1 400	1 800	**120 KBE 31+L**	135	190	2	0.6	0.39	2.6	1.7	1.7	7.35
	200	78	62	2.5	0.6	415 000	690 000	1 400	1 900	**120 KBE 031+L**	135	190	2	0.6	0.39	2.6	1.7	1.7	8.97
	200	100	84	2.5	0.6	515 000	885 000	1 400	1 800	**120 KBE 2001+L**	135	193	2	0.6	0.37	2.7	1.8	1.8	11.3
	215	97	78	3	1	575 000	900 000	1 300	1 800	**HR120 KBE 42X+L**	138	204	2.5	1	0.44	2.3	1.6	1.5	13.7
	215	132	109	3	1	750 000	1 270 000	1 300	1 800	**HR120 KBE 52X+L**	138	207	2.5	1	0.44	2.3	1.6	1.5	18.8
	260	128	101	4	1	915 000	1 310 000	1 100	1 500	**HR120 KBE 43+L**	141	240	3	1	0.35	2.9	2.0	1.9	29.4
	260	188	145	4	1	1 320 000	2 110 000	1 100	1 500	**HR120 KBE 2601+L**	141	242	3	1	0.35	2.9	2.0	1.9	44.6

Remark For other double-row tapered roller bearings not listed above, please contact NSK.

DOUBLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 125 – 150 mm





Dynamic Equivalent Load

$P = XF_r + YF_a$

F_a/F_r e		F_a/F_r e	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

$P_0 = F_r + Y_0 F_a$

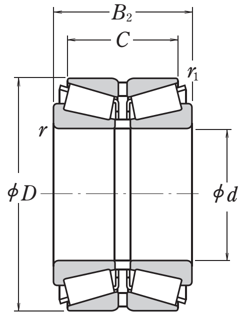
The values of e, Y_2, Y_3, and Y_0 are given in the table below.

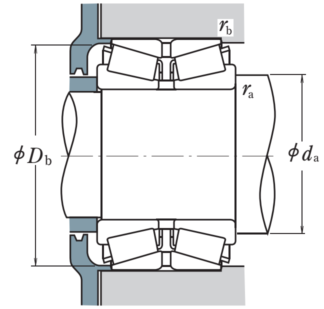
Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers	Abutment and Fillet Dimensions (mm)				Constant	Axial Load Factors			Mass (kg)
d	D	B_2	C	r min.	r_1 min.	C_r	C_{0r}	Grease	Oil		d_a min.	D_b min.	r_a max.	r_b max.	e	Y_2	Y_3	Y_0	approx.
125	210	110	88	4	1	560 000	1 030 000	1 300	1 800	**125 KBE 2101+L**	146	201	3	1	0.43	2.3	1.6	1.5	14.5
130	230	98	78.5	4	1	640 000	1 010 000	1 200	1 600	**HR130 KBE 42+L**	151	220	3	1	0.44	2.3	1.6	1.5	15.8
	230	100	80.5	4	1	640 000	1 010 000	1 200	1 600	**HR130 KBE 2301+L**	151	220	3	1	0.44	2.3	1.6	1.5	15.9
	280	137	107.5	5	1.5	940 000	1 350 000	1 000	1 400	**130 KBE 43+L**	157	258	4	1.5	0.36	2.8	1.9	1.8	35
	230	145	115	4	1	905 000	1 580 000	1 200	1 700	**HR130 KBE 2302+L**	151	221	3	1	0.44	2.3	1.6	1.5	24.1
	230	145	117.5	4	1	905 000	1 580 000	1 200	1 700	**HR130 KBE 52+L**	151	222	3	1	0.44	2.3	1.6	1.5	23.8
	230	150	120	4	1	905 000	1 580 000	1 200	1 700	**HR130 KBE 2303+L**	151	221	3	1	0.44	2.3	1.6	1.5	24.2
140	210	53	47	2.5	0.6	282 000	495 000	1 200	1 700	**140 KBE 30+L**	155	202	2	0.6	0.39	2.6	1.7	1.7	6.02
	210	66	53	2.5	1	305 000	530 000	1 200	1 700	**140 KBE 030+L**	155	202	2	1	0.40	2.5	1.7	1.6	7.02
	210	106	94	2.5	0.6	555 000	1 200 000	1 300	1 700	**140 KBE 2101+L**	155	202	2	0.6	0.33	3.0	2.0	2.0	12.3
	225	68	61	3	1	400 000	630 000	1 200	1 600	**140 KBE 31+L**	158	216	2.5	1	0.39	2.6	1.7	1.7	9.31
	225	84	68	3	1	490 000	850 000	1 200	1 600	**140 KBE 031+L**	158	215	2.5	1	0.39	2.6	1.7	1.7	11.6
	225	85	68	3	1	490 000	850 000	1 200	1 600	**140 KBE 2201+L**	158	215	2.5	1	0.39	2.6	1.7	1.7	11.7
	230	120	94	3	1	685 000	1 270 000	1 200	1 600	**140 KBE 2301+L**	158	220	2.5	1	0.33	3.0	2.0	2.0	17.6
	230	140	110	3	1	820 000	1 550 000	1 200	1 600	**140 KBE 2302+L**	158	221	2.5	1	0.35	2.9	2.0	1.9	20.7
	240	132	106	4	1.5	685 000	1 360 000	1 100	1 500	**140 KBE 2401+L**	161	227	3	1.5	0.44	2.3	1.5	1.5	22.7
	250	102	82.5	4	1	670 000	1 030 000	1 100	1 500	**HR140 KBE 42+L**	161	237	3	1	0.44	2.3	1.6	1.5	18.9
	250	153	125.5	4	1	1 040 000	1 830 000	1 100	1 500	**HR140 KBE 52X+L**	161	241	3	1	0.44	2.3	1.6	1.5	29.6
	300	145	115.5	5	1.5	1 030 000	1 480 000	1 000	1 300	**140 KBE 43+L**	167	275	4	1.5	0.36	2.8	1.9	1.8	42.6
150	225	56	50	3	1	300 000	545 000	1 200	1 600	**150 KBE 30+L**	168	213	2.5	1	0.35	2.9	2.0	1.9	7.41
	225	70	56	3	1	395 000	685 000	1 200	1 600	**150 KBE 030+L**	168	215	2.5	1	0.35	2.9	2.0	1.9	8.70
	250	80	71	3	1	510 000	810 000	1 100	1 400	**150 KBE 31+L**	168	240	2.5	1	0.40	2.5	1.7	1.6	14.2
	250	100	80	3	1	630 000	1 090 000	1 100	1 400	**150 KBE 031+L**	168	238	2.5	1	0.39	2.6	1.7	1.7	17.8
	250	115	95	3	1	745 000	1 320 000	1 100	1 500	**150 KBE 2502+L**	168	238	2.5	1	0.37	2.7	1.8	1.8	20.9
	260	150	115	4	1	815 000	1 520 000	1 100	1 400	**150 KBE 2601+L**	171	242	3	1	0.43	2.3	1.6	1.5	30.0
	270	109	87	4	1	830 000	1 330 000	1 000	1 400	**HR150 KBE 42+L**	171	253	3	1	0.44	2.3	1.6	1.5	24.3
	270	164	130	4	1	1 210 000	2 150 000	1 000	1 400	**HR150 KBE 52X+L**	171	257	3	1	0.44	2.3	1.6	1.5	37.3
	270	174	140	4	1	1 210 000	2 150 000	1 000	1 400	**HR150 KBE 2701+L**	171	257	3	1	0.44	2.3	1.6	1.5	39.7
	320	154	120	5	1.5	1 420 000	2 130 000	900	1 200	HR150 KBE 43+L	177	295	4	1.5	0.35	2.9	2.0	1.9	53.4

Remark For other double-row tapered roller bearings not listed above, please contact NSK.

DOUBLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 160 – 200 mm





Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \le e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

$P_0 = F_r + Y_0F_a$

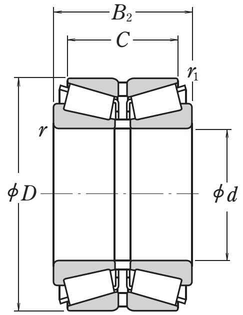
The values of e, Y_2, Y_3, and Y_0 are given in the table below.

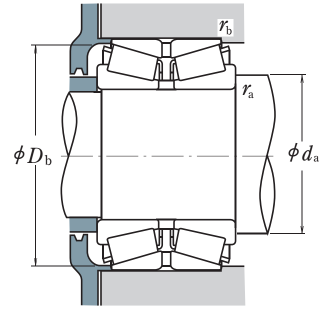
Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers	Abutment and Fillet Dimensions (mm)				Constant	Axial Load Factors			Mass (kg)
d	D	B_2	C	r min.	r_1 min.	C_r	C_{0r}	Grease	Oil		d_a min.	D_b min.	r_a max.	r_b max.	e	Y_2	Y_3	Y_0	approx.
160	240	60	53	3	1	355 000	580 000	1 100	1 500	160 KBE 30+L	178	231	2.5	1	0.37	2.7	1.8	1.8	8.56
	240	75	60	3	1	395 000	710 000	1 100	1 500	160 KBE 030+L	178	230	2.5	1	0.40	2.5	1.7	1.6	10.5
	240	110	90	3	1	650 000	1 290 000	1 100	1 500	160 KBE 2401+L	178	232	2.5	1	0.38	2.6	1.8	1.7	16.2
	270	86	76	3	1	540 000	885 000	1 000	1 300	160 KBE 31+L	178	255	2.5	1	0.40	2.5	1.7	1.6	18.6
	270	108	86	3	1	775 000	1 380 000	1 000	1 300	160 KBE 031+L	178	256	2.5	1	0.39	2.6	1.7	1.7	23.1
	270	140	120	3	1	990 000	1 880 000	1 000	1 300	160 KBE 2701+L	178	261	2.5	1	0.39	2.6	1.7	1.7	30.6
	280	150	125	4	1	1 100 000	2 020 000	1 000	1 300	160 KBE 2801+L	181	266	3	1	0.32	3.2	2.1	2.1	35.9
	290	115	91	4	1	800 000	1 220 000	900	1 300	160 KBE 42+L	181	275	3	1	0.43	2.3	1.6	1.5	28.2
	290	178	144	4	1	1 360 000	2 440 000	1 000	1 300	HR160 KBE 52X+L	181	277	3	1	0.44	2.3	1.6	1.5	47.3
	340	160	126	5	1.5	1 310 000	1 920 000	800	1 100	160 KBE 43+L	187	314	4	1.5	0.36	2.8	1.9	1.8	60.4
165	290	150	125	4	1	1 140 000	2 130 000	900	1 300	165 KBE 2901+L	186	272	3	1	0.33	3.1	2.1	2.0	39.5
170	250	85	65	3	1	435 000	845 000	1 000	1 400	170 KBE 2501+L	188	241	2.5	1	0.44	2.3	1.5	1.5	12.3
	260	67	60	3	1	400 000	700 000	1 000	1 300	170 KBE 30+L	188	248	2.5	1	0.40	2.5	1.7	1.6	11.8
	260	84	67	3	1	575 000	1 030 000	1 000	1 300	170 KBE 030+L	188	249	2.5	1	0.39	2.6	1.7	1.7	14.4
	280	88	78	3	1	630 000	1 040 000	900	1 300	170 KBE 31+L	188	266	2.5	1	0.39	2.6	1.7	1.7	19.7
	280	110	88	3	1	820 000	1 450 000	900	1 300	170 KBE 031+L	188	268	2.5	1	0.39	2.6	1.7	1.7	24.2
	280	150	130	3	1	1 110 000	2 160 000	1 000	1 300	170 KBE 2802+L	188	269	2.5	1	0.39	2.6	1.7	1.7	34.6
	310	192	152	5	1.5	1 590 000	2 910 000	900	1 200	HR170 KBE 52X+L	197	297	4	1.5	0.44	2.3	1.6	1.5	57.3
180	280	74	66	3	1	455 000	810 000	900	1 300	180 KBE 30+L	198	265	2.5	1	0.40	2.5	1.7	1.6	15.4
	280	93	74	3	1	655 000	1 220 000	900	1 200	180 KBE 030+L	198	265	2.5	1	0.35	2.9	2.0	1.9	14.4
	300	96	85	4	1.5	725 000	1 210 000	900	1 200	180 KBE 31+L	201	284	3	1.5	0.39	2.6	1.7	1.7	24.8
	300	120	96	4	1.5	940 000	1 690 000	900	1 200	180 KBE 031+L	201	287	3	1.5	0.39	2.6	1.7	1.7	31.1
	320	127	99	5	1.5	895 000	1 390 000	800	1 200	180 KBE 42+L	207	300	4	1.5	0.44	2.3	1.5	1.5	36.5
	320	192	152	5	1.5	1 640 000	3 050 000	900	1 200	HR180 KBE 52X+L	207	308	4	1.5	0.45	2.2	1.5	1.5	59.2
	340	180	140	5	1.5	1 410 000	2 510 000	800	1 100	180 KBE 3401+L	207	305	4	1.5	0.43	2.3	1.6	1.5	68.1
190	290	75	67	3	1	490 000	845 000	900	1 200	190 KBE 30+L	208	279	2.5	1	0.39	2.6	1.7	1.7	16.2
	290	94	75	3	1	670 000	1 230 000	900	1 200	190 KBE 030+L	208	279	2.5	1	0.40	2.5	1.7	1.6	20.1
	320	104	92	4	1.5	800 000	1 380 000	800	1 100	190 KBE 31+L	211	301	3	1.5	0.40	2.5	1.7	1.6	30.9
	320	130	104	4	1.5	1 070 000	1 960 000	800	1 100	190 KBE 031+L	211	302	3	1.5	0.39	2.6	1.7	1.7	39.0
	340	133	105	5	1.5	990 000	1 580 000	800	1 100	190 KBE 42+L	217	320	4	1.5	0.40	2.5	1.7	1.6	43.9
	340	204	160	5	1.5	1 910 000	3 550 000	800	1 100	HR190 KBE 52X+L	217	327	4	1.5	0.44	2.3	1.6	1.5	70.8
200	310	152	123	3	1	1 300 000	2 740 000	800	1 100	HR200 KBE 3101+L	218	301	2.5	1	0.43	2.3	1.6	1.5	40.1
	320	146	110	5	1.5	990 000	2 120 000	800	1 100	200 KBE 3201+L	227	301	4	1.5	0.52	1.9	1.3	1.3	41.6
	330	180	140	5	1.5	1 390 000	2 730 000	800	1 100	200 KBE 3301+L	227	316	4	1.5	0.42	2.4	1.6	1.6	54.4
	340	112	100	4	1.5	940 000	1 670 000	800	1 000	200 KBE 31+L	221	321	3	1.5	0.40	2.5	1.7	1.6	38.8
	340	140	112	4	1.5	1 260 000	2 250 000	800	1 000	200 KBE 031+L	221	324	3	1.5	0.39	2.6	1.7	1.7	47.0
	360	142	110	5	1.5	1 100 000	1 780 000	700	1 000	200 KBE 42+L	227	338	4	1.5	0.40	2.5	1.7	1.6	52.6
	360	218	174	5	1.5	2 070 000	3 850 000	800	1 000	HR200 KBE 52+L	227	344	4	1.5	0.41	2.5	1.7	1.6	88.3

Remark For other double-row tapered roller bearings not listed above, please contact NSK.

DOUBLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 206 – 260 mm





Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

$P_0 = F_r + Y_0 F_a$

The values of e, Y_2, Y_3, and Y_0 are given in the table below.

Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min^{-1})		Bearing Numbers	Abutment and Fillet Dimensions (mm)				Constant	Axial Load Factors			Mass (kg)
d	D	B_2	C	r min.	r_1 min.	C_r	C_{0r}	Grease	Oil		d_a min.	D_b min.	r_a max.	r_b max.	e	Y_2	Y_3	Y_0	approx.
206	283	102	83	4	1.5	580 000	1 430 000	900	1 200	**206 KBE 2801+L**	227	275	3	1.5	0.51	2.0	1.3	1.3	18.1
210	355	116	103	4	1.5	905 000	1 520 000	700	1 000	**210 KBE 31+L**	231	338	3	1.5	0.46	2.2	1.5	1.4	41.7
220	300	110	88	3	1	730 000	1 710 000	800	1 100	**220 KBE 3001+L**	238	292	2.5	1	0.37	2.7	1.8	1.8	21.2
	340	90	80	4	1.5	695 000	1 280 000	700	1 000	**220 KBE 30+L**	241	324	3	1.5	0.40	2.5	1.7	1.6	27.9
	340	113	90	4	1.5	920 000	1 830 000	700	1 000	**220 KBE 030+L**	241	327	3	1.5	0.40	2.5	1.7	1.6	34.7
	370	120	107	5	1.5	1 110 000	1 940 000	700	1 000	**220 KBE 31+L**	247	345	4	1.5	0.39	2.6	1.7	1.7	48.3
	370	150	120	5	1.5	1 460 000	2 760 000	700	1 000	**220 KBE 031+L**	247	349	4	1.5	0.39	2.6	1.7	1.7	60.2
	400	158	122	5	1.5	1 390 000	2 300 000	600	900	**220 KBE 42+L**	247	371	4	1.5	0.40	2.5	1.7	1.6	74.2
240	360	92	82	4	1.5	780 000	1 490 000	700	900	**240 KBE 30+L**	261	344	3	1.5	0.39	2.6	1.7	1.7	30.1
	360	115	92	4	1.5	1 020 000	2 040 000	700	900	**240 KBE 030+L**	261	344	3	1.5	0.35	2.9	2.0	1.9	37.3
	400	128	114	5	1.5	1 180 000	2 190 000	600	900	**240 KBE 31+L**	267	380	4	1.5	0.43	2.3	1.6	1.5	60.0
	400	160	128	5	1.5	1 620 000	3 050 000	600	900	**240 KBE 031+L**	267	378	4	1.5	0.39	2.6	1.7	1.7	73.6
	400	209	168	5	1.5	2 220 000	4 450 000	600	900	**240 KBE 4003+L**	267	384	4	1.5	0.33	3.0	2.0	2.0	96.4
250	380	98	87	4	1	795 000	1 460 000	600	900	**250 KBE 3801+L**	271	365	3	1	0.40	2.5	1.7	1.6	35.5
260	400	104	92	5	1.5	895 000	1 670 000	600	800	**260 KBE 30+L**	287	379	4	1.5	0.40	2.5	1.7	1.6	43.4
	400	130	104	5	1.5	1 210 000	2 460 000	600	800	**260 KBE 030+L**	287	382	4	1.5	0.40	2.5	1.7	1.6	54.1
	440	144	128	5	1.5	1 540 000	2 760 000	600	800	**260 KBE 31+L**	287	416	4	1.5	0.39	2.6	1.7	1.7	82.5
	440	172	145	5	1.5	1 870 000	3 500 000	600	800	**260 KBE 4401+L**	287	414	4	1.5	0.38	2.6	1.8	1.7	98.1
	440	180	144	5	1.5	2 110 000	4 150 000	600	800	**260 KBE 031+L**	287	416	4	1.5	0.39	2.6	1.7	1.7	104.0

Remark For other double-row tapered roller bearings not listed above, please contact NSK.

7. SPHERICAL ROLLER BEARINGS

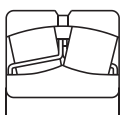
DESIGN, TYPES, AND FEATURES

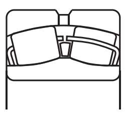
Shown in the figures, types EA, C, CD, CA, which are designed for high load capacity, are available. Types EA, C and CD have pressed steel cages, and type CA has machined brass cages. The EA type bearings listed here are classified as NSKHPS™ bearings, which offer particularly high load-carrying capacity, high limiting speeds, and are highly functional under high-temperature operating conditions of up to 200°C.

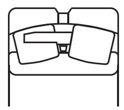
An oil groove and holes are provided in the outer ring to supply lubricant and the bearing numbers are suffixed with E4.

To use bearings with oil grooves and holes, it is recommended to provide an oil groove in the housing bore, since the depth of the groove in the bearing is limited. The number and dimensions of the oil groove and holes are shown in Tables 1 and 2.

When bearings with a hole for a locking pin to prevent outer ring rotation are required, please inform NSK.







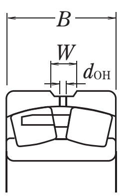


Table 1 Dimensions of Oil Grooves and Holes

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

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 8.16 (Page A172)

PERMISSIBLE MISALIGNMENT

The permissible misalignment of spherical roller bearings varies depending on the size and load, but it 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. Also, 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' (listed in the bearing tables), slippage occurs between the rollers and raceways, which may result in smearing. 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.

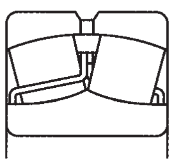
TECHNICAL DATA

Free Space of Spherical Roller Bearings

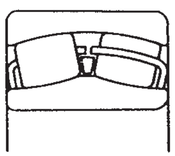
The spherical roller bearing has self-aligning ability and capacity to carry substantially large radial and bi-axial loads. For these reasons, this bearing is used widely in many applications. Application problems include a long span, which causes substantial deflection of the shaft, as well as installation errors and axial misalignment. These bearings may be exposed to a large radial or shock loads. By the way, this bearing is used in plumber blocks.

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 considering the housing internal space.

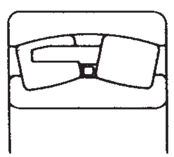
As a reference, the bearing free space for conventional types plus four other types (EA, C, CD, and CA) is shown in Table 1. Under general operating conditions, it is appropriate to pack a large quantity of grease into the bearing internal space and to pack grease into the housing internal space other than the bearing itself, to the extent of 1/3 to 2/3 that of the free space.



EA type



C, CD type



CA type

Table 1 Free Space of Spherical Roller Bearing (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, 22311 to 22324 are EA Type Bearings.
23122 to 23148, 23218 to 23244 are C Type Bearings.
23022 to 23036, 22228 to 22236 are CD Type Bearings.
23038 to 23060, 23152 to 23160, 22238 to 22260,
23248 to 23260, and 22326 to 22360 are CA Type Bearing.

Measurement of Bearing Clearance

For the bearing mounting, the measurement of internal bearing clearance is a most important task. Before handling the bearing and measuring the internal bearing clearance, be sure to wear thin rubber gloves. (If a bearing is touched by a bare hand, the touched part may rust.)

When measuring the internal bearing clearance, pay careful attention so that the rollers are positioned correctly.

1. Measurement of Bearing Clearance

To measure only internal bearing clearance, set the bearing standing upright (vertically) on a flat surface, while holding its outer ring with one hand. While paying attention not to incline the inner and outer rings, stabilize the rollers by turning the inner ring to the right and left by about one half to one full rotation. Adjust rollers until one randomly chosen roller of the double rows is positioned to be exactly at the top. Now, the internal clearance is measured with a thickness gauge. The measurement position and measured point vary slightly depending on the size of the outer ring outside diameter.

1.1 Bearing Outside Diameter Is Smaller Than 200 mm

Insert the thickness gauge between rollers of 2 rows which have a roller positioned exactly at the top of the bearing and outer ring. Now, measure the internal clearance (Δ_r). (Fig. 1)

1.2 Bearing Outside Diameter Is Larger Than 200 mm

Insert the thickness gauge between the rollers of the 2 rows, which each have been positioned to be exactly at the top, and outer ring and between 2 rows of bearing at symmetrical position relative to the bearing center, then measure the respective internal clearance of the bearing. (Fig. 2)

For the internal bearing clearance (Δ_r), take that value measured between 2 rows of just top of bearing and outer ring as respectively Δ_{rT1} and Δ_{rT2} and that value measured just at top of the bearing as Δ_{rT}.

$$\Delta_{rT} = 1/2\ (\Delta_{rT1} + \Delta_{rT2})$$

Among internal clearances between 2 rows of rollers that are symmetrical relative to the bearing center and outer ring, take that measurement between 2 rows of rollers of left side respectively as Δ_{rL1} and Δ_{rL2}. The internal clearance on the left side of the bearing is Δ_{rL}:

$$\Delta_{rL} = 1/2\ (\Delta_{rL1} + \Delta_{rL2})$$

Take that measurement between 2 rows of rollers of right side respectively as Δ_{rR1} and Δ_{rR2}. The internal clearance of the right side of the bearing is Δ_{rR}:

$$\Delta_{rR} = 1/2\ (\Delta_{rR1} + \Delta_{rR2})$$

The internal bearing clearance (Δ_r) is given by the following equation:

$$\Delta_r = 1/2\ (\Delta_{rT} + \Delta_{rL} + \Delta_{rR})$$

2. Measuring Bearing Clearance When Mounted on Shaft or Sleeve

Basically, the measurement of the clearance is taken when the outer ring of bearing hangs down from rollers. At first, while holding the bearing up-right, rotate the outer ring in the clockwise and counter-clockwise directions by one half to one full rotation until both rows have a randomly chosen roller positioned exactly at the bottom. The clearance is measured with a thickness gauge but the measurement point varies slightly depending on the size of the outer ring outside diameter.

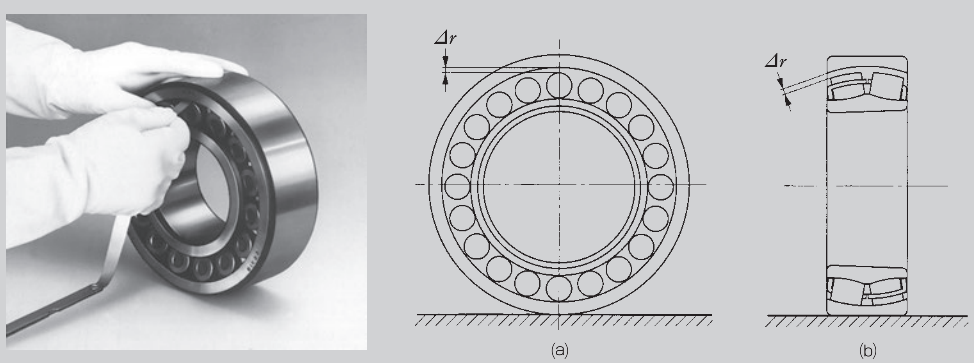


Fig. 1 Clearance Measurement Point (Bearing Outside Diameter: Less Than 200 mm)

2.1 Bearing Outside Diameter Is Smaller Than 200 mm

Insert the thickness gauge between rollers of 2 rows of just at the bottom of the bearing and outer ring and measure the internal clearance (Δ_{rS}).(Fig. 3)

2.2 Bearing Outside Diameter Is Larger Than 200 mm

Insert the thickness gauge between rollers of 2 rows that are positioned just at the bottom of bearing and outer ring and between 2 rows of bearing rollers symmetrical relative to the bearing center, then, measure the respective internal clearance of the bearing. (Fig. 3) For the internal bearing clearance (Δ_r), take the measurement when the roller is positioned exactly at the bottom, since the bearing has 2 rows, two values must be measured. The bearing internal clearance is Δ_{rS1} and Δ_{rS2} while that value measured at the exact bottom of the bearing is Δ_{rS}.

$$\Delta_{rS} = 1/2\ (\Delta_{rS1} + \Delta_{rS2})$$

Among internal clearances between 2 rows of rollers symmetrical relative to the bearing center and outer ring, take that value measured between 2 rows of rollers of left side respectively as Δ_{rL1} and Δ_{rL2} and the internal clearance of left side of bearing as Δ_{rL}.

$$\Delta_{rL} = 1/2\ (\Delta_{rL1} + \Delta_{rL2})$$

The internal clearances measured between 2 rows of rollers on the right side respectively as Δ_{rR1} and Δ_{rR2}. The internal clearance of right side of bearing is Δ_{rR}.

$$\Delta_{rR} = 1/2\ (\Delta_{rR1} + \Delta_{rR2})$$

The internal bearing clearance (Δ_r) is given by the following equation:

$$\Delta_r = 1/2\ (\Delta_{rS} + \Delta_{rL} + \Delta_{rR})$$

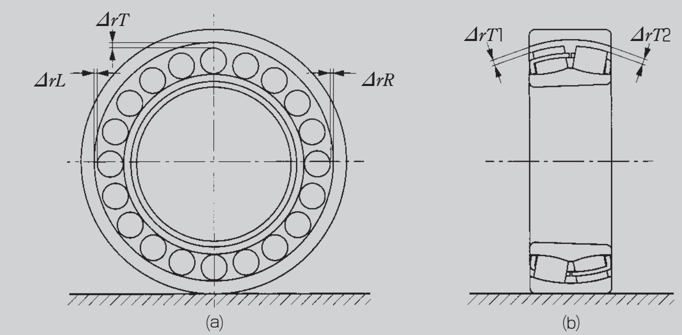


Fig. 2 Clearance Measurement Point (Bearing Outside Diameter: Larger Than 200 mm)

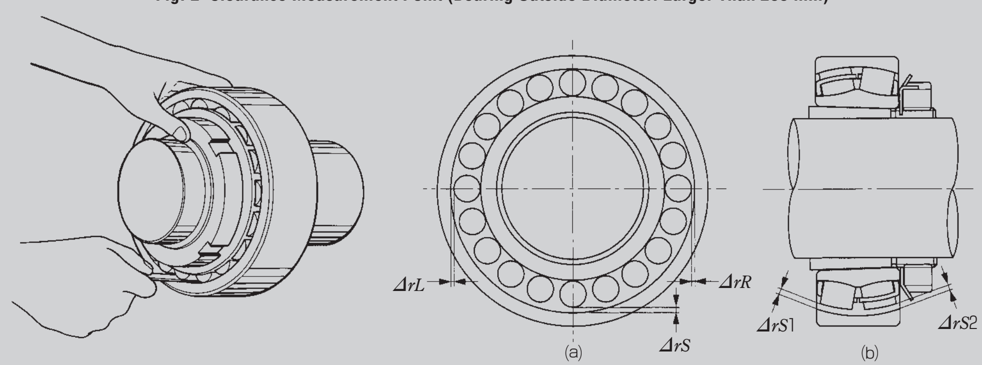


Fig. 3 Clearance Measurement Point

3. Temperature Equilibrium When Taking Measurements

To ensure accurate bearing measurement of the internal clearance or dimensions, the temperature of the measurement instrument and that of the components to be measured must be brought to the same temperature. Especially, if the bearing is mounted by using an oil heating tank or induction heater, then measure the internal clearance only after a complete cool down. For example, if a bearing is brought from the warehouse to the measurement place, the temperature of the stored bearing may still be high, thus, if the clearance or dimension were measured wihtout confirming the bearing temperature, the measured value may be wrong.

For a large bearing with an outer ring outside diameter that is larger than 400 mm, if a clearance or dimension measurement is necessary, it is recommended to leave the unpacked bearing for about 24 hours on the surface plate, before making a clearance or dimension measurement. Put the end face of the bearing on a surface plate prior to measurement to ensure a measurement with both objects at the same temperature.

4. Clearance Adjustment When Mounting Bearing on a Tapered Shaft or Sleeve

Mount the bearing with its inner ring having a tapered bore to the tapered shaft or sleeve (adapter, removable sleeve). When pushing in the bearing to the tapered shaft or sleeve, the inner ring of bearing is widened resulting in increase of "interference" and reduction of internal clearance. It is important to give proper interference and internal clearance when mounting the bearing. Next, we show the reduction amount of the clearance to achieve the proper mounting.

Mounting of spherical roller bearings having tapered bore Table 2

When mounting a bearing, each time the bearing is pushed further onto the tapered shaft or sleeve, measure the variation of internal clearance and repeat the above procedure until the clearance reduction amount to the specified value listed in the Table 2 is attained. This procedure is called "Clearance adjustment" and when the clearance reduction amount is attained, the clearance necessary for bearing running is secured. The confirmation of the clearance reduction amount by measurement with a thickness gauge is very important. Depending on the method of clearance adjustment, the measured value obtained with the thickness gauge may not be correct. Therefore, the following corrective procedure must be executed.

1. In case to heat
   When the temperatures of bearing and shaft are both at the same room temperature, measure again the clearance with the thickness gauge to confirm that the specified value is secured.
2. In case that a lock-washer is used as a turning stopper of the lock nut.
   Prior to bending the tooth of the lock-washer into cutout of lock nut, measure again the clearance with the thickness gauge to confirm that the specified value is secured.
3. In case a hydraulic nut is used
   After removal of the hydraulic nut, mount the lock nut and measure the clearance again to confirm that the specified value remains constant prior to stopping the turning.
4. In case an oil injection pump is used
   Drop to zero the pressure of high pressure oil fed from the oil injection pump so that there is no pressure on bearing or sleeve fitted part. Next, measure the clearance with the thickness gauge to confirm that the specified value remains secured.

Radial Internal Clearance and Clearance Reduction Amount of the Bearing to be Mounted

- When radial internal clearance is CN clearance (normal clearance)
  Perform the clearance adjustment while aiming at a middle value between minimum and maximum clearance reduction amount.
- When radial internal clearance is C3 or C4 clearance
  Perform the clearance adjustment aiming at the maximum clearance reduction amount.

Internal Clearance Adjustment of Tapered-Bore Bearings

Perform the adjustment by measuring the clearance reduction amount with the thickness gauge.

1. For measurement position and measured point, refer to Section 2.(Page C262) of this manual.
2. To mount a bearing on a tapered shaft, perform each time when the bearing is pushed in by the lock nut, end plate, end cap or hydraulic nut.
3. When using an adapter sleeve, perform each time when the bearing is pushed in by the lock nut or hydraulic nut.
4. When using a removable sleeve, perform each time when the removable sleeve is pushed in by the lock nut or hydraulic nut.

When measuring the clearance during those operations, as the outer ring of bearing is hanging down from of rollers, turn the outer ring to right and left by one half to one full rotation while keeping the bearing in its correct posture. Position one randomly chosen roller from each row of rollers to the exact bottom position. Then, insert the thickness gauge to an appropriate place depending on size of the outer ring outside diameter to measure the internal clearance. For the clearance adjustment, the measured value of each clearance measurement shall be recorded.

Table 2 Mounting of Spherical Roller Bearings with Tapered Bores

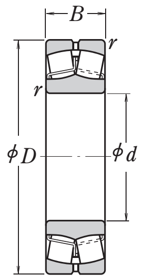
Units : mm

Bearing 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
		0.025	0.030	0.40	0.45	—	—	0.010	0.025	0.035
		0.030	0.035	0.45	0.55	—	—	0.015	0.030	0.045
		0.030	0.035	0.45	0.55	—	—	0.025	0.035	0.060
		0.040	0.045	0.60	0.70	—	—	0.030	0.040	0.075
		0.045	0.055	0.70	0.85	1.75	2.15	0.035	0.050	0.085
		0.050	0.060	0.75	0.90	1.9	2.25	0.045	0.065	0.110
		0.060	0.070	0.90	1.1	2.25	2.75	0.055	0.080	0.130
		0.065	0.080	1.0	1.3	2.5	3.25	0.060	0.100	0.150
		0.070	0.090	1.1	1.4	2.75	3.5	0.070	0.110	0.170
		0.080	0.100	1.3	1.6	3.25	4.0	0.070	0.110	0.190
		0.090	0.110	1.4	1.7	3.5	4.25	0.080	0.130	0.210
		0.100	0.120	1.6	1.9	4.0	4.75	0.090	0.140	0.230
		0.110	0.140	1.7	2.2	4.25	5.5	0.100	0.150	0.250
		0.120	0.150	1.9	2.4	4.75	6.0	0.110	0.160	0.280
		0.140	0.170	2.2	2.7	5.5	6.75	0.120	0.180	0.300
		0.150	0.190	2.4	3.0	6.0	7.5	0.130	0.200	0.330
		0.170	0.210	2.7	3.3	6.75	8.25	0.140	0.220	0.360
		0.190	0.240	3.0	3.7	7.5	9.25	0.160	0.240	0.390
		0.210	0.270	3.4	4.3	8.5	11.0	0.170	0.270	0.410
		0.230	0.300	3.7	4.8	9.25	12.0	0.200	0.310	0.460
		0.260	0.330	4.2	5.3	10.5	13.0	0.220	0.330	0.520
		0.280	0.370	4.5	5.9	11.5	15.0	0.240	0.390	0.590
		0.310	0.410	5.0	6.6	12.5	16.5	0.280	0.430	0.660
		0.340	0.460	5.5	7.4	14.0	18.5	0.310	0.470	0.730
		0.370	0.500	5.9	8.0	15.0	20.0	0.360	0.530	0.800

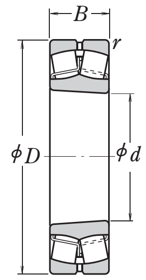
Remarks The values for reduction in radial internal clearance are for bearings with CN clearance.
For bearings with C3 or C4 Clearance, the maximum values listed should be used for the reduction in radial internal clearance.

SPHERICAL ROLLER BEARINGS

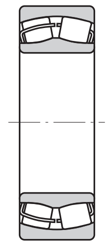
Bore Diameter 20 – 55 mm



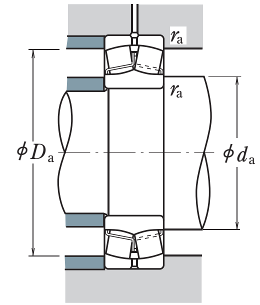
Cylindrical Bore



Tapered Bore



Without an Oil Groove or Holes



Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

$P_0 = F_r + Y_0 F_a$

The values of e, Y_2, Y_3, and Y_0 are given in the table below.

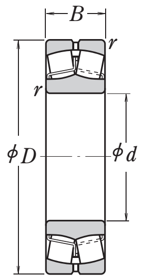
Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min⁻¹)			Bearing Numbers		Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
						Thermal Reference Speed	Limiting Speeds													
d	D	B	r min.	C_r	C_{0r}		Mechanical	Grease	Cylindrical Bore	Tapered Bore([1])	d_a min.	d_a max.	D_a max.	D_a min.	r_a max.	e	Y_2	Y_3	Y_0	approx.
20	52	15	1.1	29 300	26 900	10 000	—	6 300	**21304CDE4**	**21304CDKE4**	27	28	45	42	1	0.31	3.2	2.1	2.1	0.17
25	52	18	1	37 500	37 000	10 000	—	7 100	**22205CE4**	**22205CKE4**	31	31	46	45	1	0.35	2.9	1.9	1.9	0.17
	62	17	1.1	43 000	40 500	9 000	—	5 300	**21305CDE4**	**21305CDKE4**	32	34	55	51	1	0.29	3.4	2.3	2.3	0.26
30	62	20	1	50 000	50 000	8 500	—	6 000	**22206CE4**	**22206CKE4**	36	37	56	54	1	0.33	3.1	2.1	2.0	0.27
	72	19	1.1	55 000	54 000	7 500	—	4 500	**21306CDE4**	**21306CDKE4**	37	40	65	59	1	0.28	3.6	2.4	2.3	0.39
35	72	23	1.1	69 000	71 000	7 500	—	5 300	**22207CE4**	**22207CKE4**	42	43	65	63	1	0.32	3.1	2.1	2.0	0.42
	80	21	1.5	71 500	76 000	7 100	—	4 000	**21307CDE4**	**21307CDKE4**	44	47	71	67	1.5	0.28	3.6	2.4	2.4	0.53
40	80	23	1.1	113 000	99 500	7 100	12 000	6 700	**22208EAE4**	**22208EAKE4**	47	49	73	70	1	0.28	3.6	2.4	2.4	0.50
	90	23	1.5	118 000	111 000	6 700	11 000	6 000	**21308EAE4**	**21308EAKE4**	49	54	81	75	1.5	0.25	3.9	2.7	2.6	0.73
	90	33	1.5	170 000	153 000	5 600	9 000	5 300	**22308EAE4**	**22308EAKE4**	49	52	81	77	1.5	0.35	2.8	1.9	1.9	0.98
45	85	23	1.1	118 000	111 000	6 300	11 000	6 000	**22209EAE4**	**22209EAKE4**	52	54	78	75	1	0.25	3.9	2.7	2.6	0.55
	100	25	1.5	149 000	144 000	6 000	9 000	5 000	**21309EAE4**	**21309EAKE4**	54	65	91	89	1.5	0.23	4.3	2.9	2.8	0.96
	100	36	1.5	207 000	195 000	5 000	8 000	4 500	**22309EAE4**	**22309EAKE4**	54	59	91	86	1.5	0.34	2.9	2.0	1.9	1.34
50	90	23	1.1	124 000	119 000	6 000	9 500	5 600	**22210EAE4**	**22210EAKE4**	57	60	83	81	1	0.24	4.3	2.9	2.8	0.61
	110	27	2	178 000	174 000	5 300	8 000	4 500	**21310EAE4**	**21310EAKE4**	60	72	100	98	2	0.23	4.4	3.0	2.9	1.21
	110	40	2	246 000	234 000	4 800	7 100	4 300	**22310EAE4**	**22310EAKE4**	60	64	100	93	2	0.35	2.8	1.9	1.9	1.78
55	100	25	1.5	149 000	144 000	5 300	9 000	5 300	**22211EAE4**	**22211EAKE4**	64	65	91	89	1.5	0.23	4.3	2.9	2.8	0.81
	120	29	2	178 000	174 000	5 300	8 000	4 500	**21311EAE4**	**21311EAKE4**	65	72	110	98	2	0.23	4.4	3.0	2.9	1.58
	120	43	2	292 000	292 000	4 300	6 000	3 800	**22311EAE4**	**22311EAKE4**	65	73	110	103	2	0.34	2.9	2.0	1.9	2.3

Note ([1]) The suffix K represents bearings with tapered bores (taper 1:12).

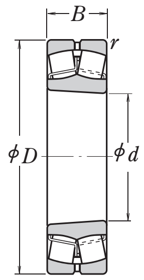
Remarks
1. The bearings denoted by an asterisk ( ) are NSKHPS™ bearings and an oil groove and holes are standard for them.
2. When making a selection of the recommended fit (Tolerance of shaft) on Page A164, in case of NSKHPS™ bearings, the conditions are different.
   The segmentations are: Light Loads(≦$0.05C_r$); Normal Loads(0.05 to $0.10C_r$); and Heavy Loads(>$0.10C_r$).
3. For the dimensions od adapters and withdrawal sleeves, refer to Pages C348 – C349, and C356.

SPHERICAL ROLLER BEARINGS

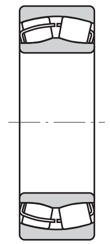
Bore Diameter 60 – 90 mm



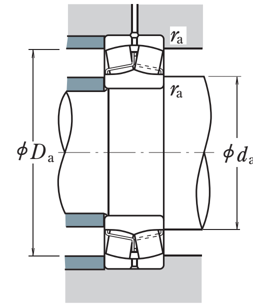
Cylindrical Bore



Tapered Bore



Without an Oil Groove or Holes



Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

$P_0 = F_r + Y_0 F_a$

The values of e, Y_2, Y_3, and Y_0 are given in the table below.

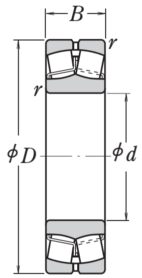
Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min⁻¹)			Bearing Numbers		Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
						Thermal Reference Speed	Limiting Speeds													
d	D	B	r min.	C_r	C_{0r}		Mechanical	Grease	Cylindrical Bore	Tapered Bore(1)	d_a min.	d_a max.	D_a max.	D_a min.	r_a max.	e	Y_2	Y_3	Y_0	approx.
60	95	26	1.1	98 500	141 000	4 800	—	3 600	**23012CE4**	**23012CKE4**	67	68	88	85	1	0.26	3.9	2.6	2.5	0.68
	110	28	1.5	178 000	174 000	5 300	8 000	4 800	**22212EAE4**	**22212EAKE4**	69	72	101	98	1.5	0.23	4.4	3.0	2.9	1.1
	130	31	2.1	238 000	244 000	4 800	6 700	3 800	**21312EAE4**	**21312EAKE4**	72	87	118	117	2	0.22	4.5	3.0	3.0	1.98
	130	46	2.1	340 000	340 000	4 000	5 600	3 600	**22312EAE4**	**22312EAKE4**	72	79	118	111	2	0.34	3.0	2.0	1.9	2.89
65	120	31	1.5	221 000	230 000	4 800	7 500	4 300	**22213EAE4**	**22213EAKE4**	74	80	111	107	1.5	0.24	4.2	2.8	2.7	1.51
	140	33	2.1	264 000	275 000	4 500	6 000	3 600	**21313EAE4**	**21313EAKE4**	77	94	128	126	2	0.22	4.6	3.1	3.0	2.45
	140	48	2.1	375 000	380 000	3 800	5 000	3 200	**22313EAE4**	**22313EAKE4**	77	84	128	119	2	0.33	3.0	2.0	2.0	3.52
70	125	31	1.5	225 000	232 000	4 500	7 100	4 000	**22214EAE4**	**22214EAKE4**	79	84	116	111	1.5	0.23	4.3	2.9	2.8	1.58
	150	35	2.1	310 000	325 000	4 300	5 600	3 200	**21314EAE4**	**21314EAKE4**	82	101	138	135	2	0.22	4.6	3.1	3.0	3.0
	150	51	2.1	425 000	435 000	3 600	4 800	3 000	**22314EAE4**	**22314EAKE4**	82	91	138	129	2	0.33	3.0	2.0	2.0	4.28
75	130	31	1.5	238 000	244 000	4 300	6 700	4 000	**22215EAE4**	**22215EAKE4**	84	87	121	117	1.5	0.22	4.5	3.0	3.0	1.64
	160	37	2.1	310 000	325 000	4 000	5 600	3 200	**21315EAE4**	**21315EAKE4**	87	101	148	134	2	0.22	4.6	3.1	3.0	3.64
	160	55	2.1	485 000	505 000	3 400	4 300	2 800	**22315EAE4**	**22315EAKE4**	87	97	148	137	2	0.33	3.0	2.0	2.0	5.26
80	140	33	2	264 000	275 000	4 000	6 000	3 600	**22216EAE4**	**22216EAKE4**	90	94	130	126	2	0.22	4.6	3.1	3.0	2.01
	170	39	2.1	355 000	375 000	3 800	4 800	3 000	**21316EAE4**	**21316EAKE4**	92	109	158	146	2	0.23	4.4	3.0	2.9	4.32
	170	58	2.1	540 000	565 000	3 200	3 800	2 600	**22316EAE4**	**22316EAKE4**	92	103	158	145	2	0.33	3.0	2.0	2.0	6.23
85	150	36	2	310 000	325 000	4 000	5 600	3 400	**22217EAE4**	**22217EAKE4**	95	101	140	135	2	0.22	4.6	3.1	3.0	2.54
	180	41	3	360 000	395 000	3 800	5 000	3 000	**21317EAE4**	**21317EAKE4**	99	108	166	142	2.5	0.24	4.3	2.9	2.8	5.2
	180	60	3	600 000	630 000	3 000	3 400	2 400	**22317EAE4**	**22317EAKE4**	99	110	166	155	2.5	0.33	3.1	2.1	2.0	7.23
90	160	40	2	360 000	395 000	3 800	5 000	3 200	**22218EAE4**	**22218EAKE4**	100	108	150	142	2	0.24	4.3	2.9	2.8	3.3
	160	52.4	2	340 000	490 000	2 800	—	1 800	**23218CE4**	**23218CKE4**	100	105	150	138	2	0.32	3.2	2.1	2.1	4.51
	190	43	3	415 000	450 000	3 600	4 500	2 800	**21318EAE4**	**21318EAKE4**	104	115	176	152	2.5	0.24	4.3	2.9	2.8	6.1
	190	64	3	665 000	705 000	2 800	3 000	2 400	**22318EAE4**	**22318EAKE4**	104	115	176	163	2.5	0.33	3.1	2.1	2.0	8.56

Note (1) The suffix K represents bearings with tapered bores (taper 1:12).

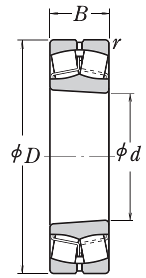
Remarks
1. The bearings denoted by an asterisk ( ) are NSKHPS™ bearings and an oil groove and holes are standard for them.
2. When making a selection of the recommended fit (Tolerance of shaft) on Page A164, in case of NSKHPS™ bearings, the conditions are different.
   The segmentations are: Light Loads(≦0.05C_r); Normal Loads(0.05 to 0.10C_r); and Heavy Loads(>0.10C_r).
3. For the dimensions od adapters and withdrawal sleeves, refer to Pages C349 – C351, and C356 – C357.

SPHERICAL ROLLER BEARINGS

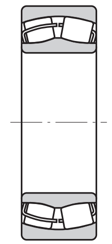
Bore Diameter 95 – 110 mm



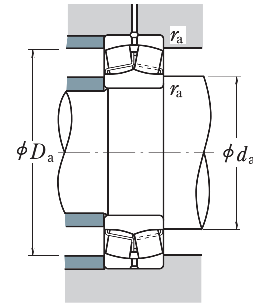
Cylindrical Bore



Tapered Bore



Without an Oil Groove or 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.

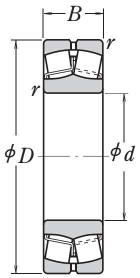
Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min⁻¹)			Bearing Numbers		Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
						Thermal Reference Speed	Limiting Speeds													
d	D	B	r min.	C_r	C_{0r}		Mechanical	Grease	Cylindrical Bore	Tapered Bore[1]	d_a min.	d_a max.	D_a max.	D_a min.	r_a max.	e	Y_2	Y_3	Y_0	approx.
95	170	43	2.1	415 000	450 000	3 800	4 500	3 000	**22219EAE4**	**22219EAKE4**	107	115	158	152	2	0.24	4.3	2.9	2.8	4.04
	170	55.6	2.1	370 000	525 000	2 600	—	1 700	**23219CAME4**	**23219CAMKE4**	107	—	158	146	2	0.32	3.1	2.1	2.0	5.33
	200	45	3	430 000	435 000	3 600	4 800	1 500	**21319CAME4**	**21319CAMKE4**	109	127	186	172	2.5	0.22	4.6	3.1	3.0	6.92
	200	45	3	345 000	435 000	3 600	—	1 500	**21319CE4**	**21319CKE4**	109	127	186	172	2.5	0.22	4.6	3.1	3.0	6.92
	200	67	3	735 000	780 000	2 600	3 000	2 200	**22319EAE4**	**22319EAKE4**	109	121	186	172	2.5	0.33	3.1	2.1	2.0	9.91
100	150	37	1.5	212 000	335 000	3 200	—	2 200	**23020CDE4**	**23020CDKE4**	109	112	141	136	1.5	0.22	4.6	3.1	3.0	2.31
	150	50	1.5	276 000	470 000	2 800	—	1 800	**24020CE4**	**24020CK30E4**	109	110	141	132	1.5	0.30	3.4	2.3	2.2	3.08
	165	52	2	345 000	530 000	2 800	—	1 700	**23120CE4**	**23120CKE4**	110	113	155	144	2	0.30	3.4	2.3	2.2	4.38
	165	65	2	345 000	535 000	2 400	—	1 700	**24120CAME4**	**24120CAMK30E4**	110	—	155	143	2	0.35	2.9	1.9	1.9	5.42
	180	46	2.1	455 000	490 000	3 600	4 300	2 800	**22220EAE4**	**22220EAKE4**	112	119	168	160	2	0.24	4.3	2.9	2.8	4.84
	180	60.3	2.1	525 000	605 000	2 800	3 800	1 600	**23220CAME4**	**23220CAMKE4**	112	118	168	155	2	0.32	3.2	2.1	2.1	6.6
	180	60.3	2.1	420 000	605 000	2 800	—	1 600	**23220CE4**	**23220CKE4**	112	118	168	155	2	0.32	3.2	2.1	2.1	6.6
	215	47	3	495 000	485 000	3 400	4 500	1 400	**21320CAME4**	**21320CAMKE4**	114	133	201	184	2.5	0.21	4.7	3.2	3.1	8.46
	215	47	3	395 000	485 000	3 400	—	1 400	**21320CE4**	**21320CKE4**	114	133	201	184	2.5	0.21	4.7	3.2	3.1	8.46
	215	73	3	750 000	785 000	2 600	3 400	1 700	**22320CAME4**[2]	**22320CAMKE4**[2]	114	130	201	184	2.5	0.33	3.0	2.0	2.0	12.7
110	170	45	2	293 000	465 000	3 200	—	2 000	**23022CDE4**	**23022CDKE4**	120	124	160	153	2	0.24	4.2	2.8	2.8	3.76
	170	60	2	380 000	645 000	2 800	—	1 600	**24022CE4**	**24022CK30E4**	120	121	160	148	2	0.32	3.1	2.1	2.1	4.96
	180	56	2	480 000	630 000	3 200	4 000	1 600	**23122CAME4**	**23122CAMKE4**	120	127	170	158	2	0.28	3.5	2.4	2.3	5.7
	180	56	2	385 000	630 000	3 200	—	1 600	**23122CE4**	**23122CKE4**	120	127	170	158	2	0.28	3.5	2.4	2.3	5.7
	180	69	2	575 000	750 000	2 200	3 400	1 600	**24122CAME4**	**24122CAMK30E4**	120	123	170	154	2	0.36	2.8	1.9	1.8	6.84
	180	69	2	460 000	750 000	2 200	—	1 600	**24122CE4**	**24122CK30E4**	120	123	170	154	2	0.36	2.8	1.9	1.8	6.84
	200	53	2.1	605 000	645 000	3 400	3 400	2 600	**22222EAE4**	**22222EAKE4**	122	129	188	178	2	0.25	4.0	2.7	2.6	6.99
	200	69.8	2.1	645 000	760 000	2 600	3 400	1 500	**23222CAME4**	**23222CAMKE4**	122	130	188	170	2	0.34	3.0	2.0	1.9	9.54
	200	69.8	2.1	515 000	760 000	2 200	—	1 500	**23222CE4**	**23222CKE4**	122	130	188	170	2	0.34	3.0	2.0	1.9	9.54
	240	50	3	565 000	545 000	3 000	4 300	1 300	**21322CAME4**	**21322CAMKE4**	124	—	226	206	2.5	0.22	4.6	3.1	3.0	11.2
	240	80	3	925 000	980 000	2 200	3 000	1 500	**22322CAME4**[2]	**22322CAMKE4**[2]	124	145	226	206	2.5	0.33	3.1	2.1	2.0	17.6

Notes (1) The suffix K or K30 represents bearings with tapered bores (taper 1:12 or 1:30).
(2) EA is also available. Load rating of EA is around 10% higher than CAM's, please consult NSK.

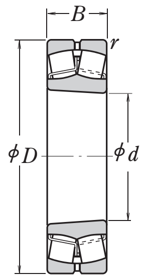
Remarks
1. The bearings denoted by an asterisk ( ) are NSKHPS™ bearings and an oil groove and holes are standard for them.
2. When making a selection of the recommended fit (Tolerance of shaft) on Page A164, in case of NSKHPS™ bearings, the conditions are different.
   The segmentations are: Light Loads(≦0.05C_r); Normal Loads(0.05 to 0.10C_r); and Heavy Loads(>0.10C_r).
3. For the dimensions od adapters and withdrawal sleeves, refer to Pages C351, and C357.

SPHERICAL ROLLER BEARINGS

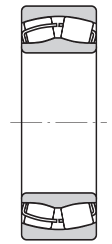
Bore Diameter 120 – 130 mm



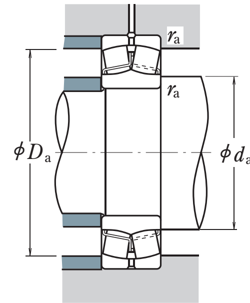
Cylindrical Bore



Tapered Bore



Without an Oil Groove or Holes



Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

$P_0 = F_r + Y_0 F_a$

The values of e, Y_2, Y_3, and Y_0 are given in the table below.

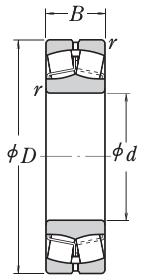
Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min⁻¹)			Bearing Numbers		Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
						Thermal Reference Speed	Limiting Speeds													
d	D	B	r min.	C_r	C_{0r}		Mechanical	Grease	Cylindrical Bore	Tapered Bore(1)	d_a min.	d_a max.	D_a max.	D_a min.	r_a max.	e	Y_2	Y_3	Y_0	approx.
120	180	46	2	395 000	525 000	3 200	4 500	1 800	23024CAME4	23024CAMKE4	130	134	170	163	2	0.22	4.5	3.0	2.9	4.11
	180	46	2	315 000	525 000	3 200	—	1 800	23024CDE4	23024CDKE4	130	134	170	163	2	0.22	4.5	3.0	2.9	4.11
	180	60	2	480 000	680 000	2 600	3 600	1 500	24024CAME4	24024CAMK30E4	130	131	170	158	2	0.32	3.2	2.1	2.1	5.33
	180	60	2	395 000	705 000	2 600	—	1 500	24024CE4	24024CK30E4	130	131	170	158	2	0.32	3.2	2.1	2.1	5.33
	200	62	2	580 000	720 000	2 800	3 600	1 400	23124CAME4	23124CAMKE4	130	138	190	175	2	0.29	3.5	2.4	2.3	7.85
	200	62	2	465 000	720 000	2 800	—	1 400	23124CE4	23124CKE4	130	138	190	175	2	0.29	3.5	2.4	2.3	7.85
	200	80	2	695 000	905 000	2 000	3 000	1 400	24124CAME4	24124CAMK30E4	130	136	190	171	2	0.37	2.7	1.8	1.8	10
	200	80	2	575 000	950 000	2 000	—	1 400	24124CE4	24124CK30E4	130	136	190	171	2	0.37	2.7	1.8	1.8	10
	215	58	2.1	685 000	765 000	3 200	3 000	2 400	22224EAE4	22224EAKE4	132	142	203	190	2	0.25	3.9	2.7	2.6	8.8
	215	76	2.1	790 000	970 000	2 200	3 000	1 300	23224CAME4	23224CAMKE4	132	140	203	182	2	0.34	2.9	2.0	1.9	12.1
	215	76	2.1	630 000	970 000	2 000	—	1 300	23224CE4	23224CKE4	132	140	203	182	2	0.34	2.9	2.0	1.9	12.1
	260	86	3	1060 000	1 120 000	1 900	2 800	1 400	22324CAME4(2)	22324CAMKE4(2)	134	157	246	222	2.5	0.32	3.1	2.1	2.0	22.2
130	200	52	2	500 000	655 000	3 000	3 800	1 700	23026CAME4	23026CAMKE4	140	147	190	180	2	0.23	4.3	2.9	2.8	5.98
	200	52	2	400 000	655 000	3 000	—	1 700	23026CDE4	23026CDKE4	140	147	190	180	2	0.23	4.3	2.9	2.8	5.98
	200	69	2	620 000	865 000	2 200	3 200	1 400	24026CAME4	24026CAMK30E4	140	143	190	175	2	0.31	3.2	2.2	2.1	7.84
	200	69	2	495 000	865 000	2 200	—	1 400	24026CE4	24026CK30E4	140	143	190	175	2	0.31	3.2	2.2	2.1	7.84
	210	64	2	630 000	825 000	2 600	3 400	1 300	23126CAME4	23126CAMKE4	140	149	200	184	2	0.28	3.6	2.4	2.4	8.69
	210	64	2	505 000	825 000	2 600	—	1 300	23126CE4	23126CKE4	140	149	200	184	2	0.28	3.6	2.4	2.4	8.69
	210	80	2	735 000	1 010 000	1 800	2 800	1 300	24126CAME4	24126CAMK30E4	140	146	200	180	2	0.35	2.9	1.9	1.9	10.7
	210	80	2	590 000	1 010 000	1 800	—	1 300	24126CE4	24126CK30E4	140	146	200	180	2	0.35	2.9	1.9	1.9	10.7
	230	64	3	820 000	940 000	2 800	2 600	2 200	22226EAE4	22226EAKE4	144	152	216	204	2.5	0.26	3.8	2.6	2.5	11
	230	80	3	875 000	1 080 000	2 000	2 800	1 200	23226CAME4	23226CAMKE4	144	150	216	196	2.5	0.34	2.9	2.0	1.9	14.3
	230	80	3	700 000	1 080 000	2 000	—	1 200	23226CE4	23226CKE4	144	150	216	196	2.5	0.34	2.9	2.0	1.9	14.3
	280	93	4	1 240 000	1 350 000	1 800	2 600	1 300	22326CAME4	22326CAMKE4	148	166	262	236	3	0.34	2.9	2.0	1.9	28.1
	280	93	4	995 000	1 350 000	1 800	—	1 300	22326CE4	22326CKE4	148	166	262	236	3	0.34	2.9	2.0	1.9	28.1

Notes (1) The suffix K or K30 represents bearings with tapered bores (taper 1:12 or 1:30).
(2) EA is also available. Load rating of EA is around 10% higher than CAM's, please consult NSK.

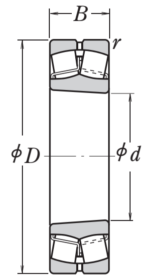
Remarks
1. The bearings denoted by an asterisk ( ) are NSKHPS™ bearings and an oil groove and holes are standard for them.
2. When making a selection of the recommended fit (Tolerance of shaft) on Page A164, in case of NSKHPS™ bearings, the conditions are different.
   The segmentations are: Light Loads(≦0.05C_r); Normal Loads(0.05 to 0.10C_r); and Heavy Loads(>0.10C_r).
3. For the dimensions od adapters and withdrawal sleeves, refer to Pages C351, and C357.

SPHERICAL ROLLER BEARINGS

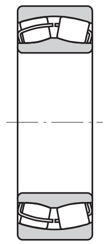
Bore Diameter 140 – 150 mm



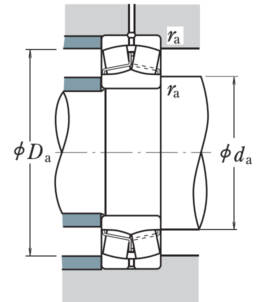
Cylindrical Bore



Tapered Bore



Without an Oil Groove or Holes



Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

$P_0 = F_r + Y_0 F_a$

The values of e, Y_2, Y_3, and Y_0 are given in the table below.

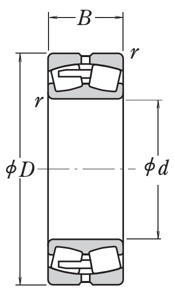
Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min⁻¹)			Bearing Numbers		Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
						Thermal Reference Speed	Limiting Speeds													
d	D	B	r min.	C_r	C_{0r}		Mechanical	Grease	Cylindrical Bore	Tapered Bore([1])	d_a min.	d_a max.	D_a max.	D_a min.	r_a max.	e	Y_2	Y_3	Y_0	approx.
140	210	53	2	525 000	715 000	2 800	3 800	1 600	**23028CAME4**	**23028CAMKE4**	150	157	200	190	2	0.22	4.5	3.0	2.9	6.49
	210	53	2	420 000	715 000	2 800	—	1 600	**23028CDE4**	**23028CDKE4**	150	157	200	190	2	0.22	4.5	3.0	2.9	6.49
	210	69	2	635 000	905 000	2 200	3 000	1 300	**24028CAME4**	**24028CAMK30E4**	150	154	200	186	2	0.29	3.4	2.3	2.2	8.37
	210	69	2	525 000	945 000	2 200	—	1 300	**24028CE4**	**24028CK30E4**	150	154	200	186	2	0.29	3.4	2.3	2.2	8.37
	225	68	2.1	725 000	945 000	2 400	3 200	1 200	**23128CAME4**	**23128CAMKE4**	152	158	213	198	2	0.28	3.6	2.4	2.3	10.5
	225	68	2.1	580 000	945 000	2 400	—	1 200	**23128CE4**	**23128CKE4**	152	158	213	198	2	0.28	3.6	2.4	2.3	10.5
	225	85	2.1	835 000	1 160 000	1 600	2 600	1 200	**24128CAME4**	**24128CAMK30E4**	152	156	213	193	2	0.35	2.9	1.9	1.9	13
	225	85	2.1	670 000	1 160 000	1 600	—	1 200	**24128CE4**	**24128CK30E4**	152	156	213	193	2	0.35	2.9	1.9	1.9	13
	250	68	3	835 000	945 000	2 600	3 200	1 400	**22228CAME4**	**22228CAMKE4**	154	167	236	219	2.5	0.25	4.0	2.7	2.6	14.5
	250	68	3	645 000	930 000	2 600	—	1 400	**22228CDE4**	**22228CDKE4**	154	167	236	219	2.5	0.25	4.0	2.7	2.6	14.5
	250	88	3	1 040 000	1 300 000	1 800	2 600	1 100	**23228CAME4**	**23228CAMKE4**	154	163	236	213	2.5	0.35	2.9	1.9	1.9	18.8
	250	88	3	835 000	1 300 000	1 800	—	1 100	**23228CE4**	**23228CKE4**	154	163	236	213	2.5	0.35	2.9	1.9	1.9	18.8
	300	102	4	1 450 000	1 590 000	1 700	2 400	1 200	**22328CAME4**	**22328CAMKE4**	158	177	282	253	3	0.35	2.9	1.9	1.9	35.4
	300	102	4	1 160 000	1 590 000	1 700	—	1 200	**22328CE4**	**22328CKE4**	158	177	282	253	3	0.35	2.9	1.9	1.9	35.4
150	225	56	2.1	590 000	815 000	2 600	3 600	1 400	**23030CAME4**	**23030CAMKE4**	162	168	213	203	2	0.22	4.6	3.1	3.0	7.9
	225	56	2.1	470 000	815 000	2 600	—	1 400	**23030CDE4**	**23030CDKE4**	162	168	213	203	2	0.22	4.6	3.1	3.0	7.9
	225	75	2.1	740 000	1 090 000	1 900	3 000	1 200	**24030CAME4**	**24030CAMK30E4**	162	165	213	198	2	0.30	3.4	2.3	2.2	10.5
	225	75	2.1	590 000	1 090 000	1 900	—	1 200	**24030CE4**	**24030CK30E4**	162	165	213	198	2	0.30	3.4	2.3	2.2	10.5
	250	80	2.1	905 000	1 180 000	2 200	2 800	1 100	**23130CAME4**	**23130CAMKE4**	162	174	238	218	2	0.30	3.4	2.3	2.2	15.8
	250	80	2.1	725 000	1 180 000	2 200	—	1 100	**23130CE4**	**23130CKE4**	162	174	238	218	2	0.30	3.4	2.3	2.2	15.8
	250	100	2.1	1 070 000	1 450 000	1 400	2 400	1 100	**24130CAME4**	**24130CAMK30E4**	162	169	238	212	2	0.38	2.6	1.8	1.7	19.8
	250	100	2.1	890 000	1 530 000	1 400	—	1 100	**24130CE4**	**24130CK30E4**	162	169	238	212	2	0.38	2.6	1.8	1.7	19.8
	270	73	3	955 000	1 120 000	2 400	3 000	1 300	**22230CAME4**	**22230CAMKE4**	164	179	256	236	2.5	0.26	3.9	2.6	2.5	18.4
	270	73	3	765 000	1 120 000	2 400	—	1 300	**22230CDE4**	**22230CDKE4**	164	179	256	236	2.5	0.26	3.9	2.6	2.5	18.4
	270	96	3	1 220 000	1 560 000	1 700	2 400	1 100	**23230CAME4**	**23230CAMKE4**	164	176	256	230	2.5	0.35	2.9	1.9	1.9	24.2
	270	96	3	975 000	1 560 000	1 700	—	1 100	**23230CE4**	**23230CKE4**	164	176	256	230	2.5	0.35	2.9	1.9	1.9	24.2
	320	108	4	1 530 000	1 690 000	1 600	2 200	1 100	**22330CAME4**	**22330CAMKE4**	168	—	302	270	3	0.35	2.9	1.9	1.9	41.5

Note ([1]) The suffix K or K30 represents bearings with tapered bores (taper 1:12 or 1:30).

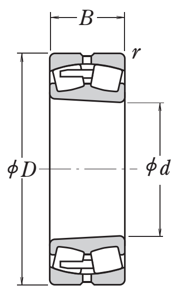
Remarks
1. The bearings denoted by an asterisk ( ) are NSKHPS™ bearings and an oil groove and holes are standard for them.
2. When making a selection of the recommended fit (Tolerance of shaft) on Page A164, in case of NSKHPS™ bearings, the conditions are different.
   The segmentations are: Light Loads(≦$0.05C_r$); Normal Loads(0.05 to $0.10C_r$); and Heavy Loads(>$0.10C_r$).
3. For the dimensions od adapters and withdrawal sleeves, refer to Pages C352, and C357 – C358.

SPHERICAL ROLLER BEARINGS

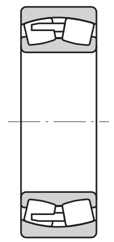
Bore Diameter 160 – 170 mm



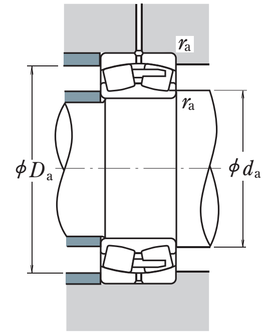
Cylindrical Bore



Tapered Bore



Without an Oil Groove and Holes



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.

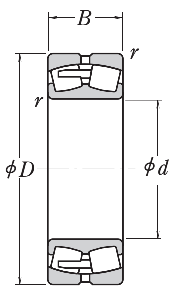
Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min⁻¹)			Bearing Numbers		Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
						Thermal Reference Speed	Limiting Speeds													
d	D	B	r min.	C_r	C_{0r}		Mechanical	Grease	Cylindrical Bore	Tapered Bore(¹)	d_a min.	d_a max.	D_a max.	D_a min.	r_a max.	e	Y_2	Y_3	Y_0	approx.
160	220	45	2	450 000	675 000	3 000	3 200	1 400	23932CAME4	23932CAMKE4	170	—	210	203	2	0.18	5.6	3.8	3.7	4.97
	240	60	2.1	675 000	955 000	2 400	3 200	1 300	23032CAME4	23032CAMKE4	172	179	228	216	2	0.22	4.5	3.0	2.9	9.66
	240	60	2.1	540 000	955 000	2 400	—	1 300	23032CDE4	23032CDKE4	172	179	228	216	2	0.22	4.5	3.0	2.9	9.66
	240	80	2.1	845 000	1 260 000	1 800	2 800	1 100	24032CAME4	24032CAMK30E4	172	177	228	212	2	0.30	3.4	2.3	2.2	12.7
	240	80	2.1	680 000	1 260 000	1 800	—	1 100	24032CE4	24032CK30E4	172	177	228	212	2	0.30	3.4	2.3	2.2	12.7
	270	86	2.1	1 070 000	1 400 000	2 000	2 600	1 000	23132CAME4	23132CAMKE4	172	185	258	234	2	0.30	3.4	2.3	2.2	20.3
	270	86	2.1	855 000	1 400 000	2 000	—	1 000	23132CE4	23132CKE4	172	185	258	234	2	0.30	3.4	2.3	2.2	20.3
	270	109	2.1	1 240 000	1 670 000	1 300	2 200	1 000	24132CAME4	24132CAMK30E4	172	179	258	229	2	0.39	2.6	1.7	1.7	25.4
	270	109	2.1	1 040 000	1 760 000	1 300	—	1 000	24132CE4	24132CK30E4	172	179	258	229	2	0.39	2.6	1.7	1.7	25.4
	290	80	3	1 140 000	1 320 000	2 200	2 800	1 200	22232CAME4	22232CAMKE4	174	190	276	255	2.5	0.26	3.8	2.6	2.5	23.1
	290	80	3	910 000	1 320 000	2 200	—	1 200	22232CDE4	22232CDKE4	174	190	276	255	2.5	0.26	3.8	2.6	2.5	23.1
	290	104	3	1 370 000	1 770 000	1 500	2 200	1 000	23232CAME4	23232CAMKE4	174	189	276	245	2.5	0.34	2.9	2.0	1.9	30.5
	290	104	3	1 100 000	1 770 000	1 500	—	1 000	23232CE4	23232CKE4	174	189	276	245	2.5	0.34	2.9	2.0	1.9	30.5
	340	114	4	1 700 000	1 900 000	1 400	2 200	1 100	22332CAME4	22332CAMKE4	178	—	322	287	3	0.35	2.9	1.9	1.9	49.3
170	230	45	2	450 000	680 000	3 000	3 600	1 400	23934CAME4	23934CAMKE4	180	—	220	213	2	0.17	5.8	3.9	3.8	5.38
	260	67	2.1	795 000	1 090 000	2 200	3 000	1 200	23034CAME4	23034CAMKE4	182	191	248	233	2	0.23	4.3	2.9	2.8	13
	260	67	2.1	640 000	1 090 000	2 200	—	1 200	23034CDE4	23034CDKE4	182	191	248	233	2	0.23	4.3	2.9	2.8	13
	260	90	2.1	1 030 000	1 520 000	1 600	2 400	1 000	24034CAME4	24034CAMK30E4	182	188	248	228	2	0.31	3.2	2.2	2.1	17.3
	260	90	2.1	825 000	1 520 000	1 600	—	1 000	24034CE4	24034CK30E4	182	188	248	228	2	0.31	3.2	2.2	2.1	17.3
	280	88	2.1	1 180 000	1 570 000	1 800	2 600	1 000	23134CAME4	23134CAMKE4	182	194	268	245	2	0.29	3.5	2.3	2.3	21.8
	280	88	2.1	940 000	1 570 000	1 800	—	1 000	23134CE4	23134CKE4	182	194	268	245	2	0.29	3.5	2.3	2.3	21.8
	280	109	2.1	1 280 000	1 770 000	1 200	2 200	1 000	24134CAME4	24134CAMK30E4	182	190	268	239	2	0.37	2.7	1.8	1.8	26.6
	280	109	2.1	1 080 000	1 860 000	1 200	—	1 000	24134CE4	24134CK30E4	182	190	268	239	2	0.37	2.7	1.8	1.8	26.6
	310	86	4	1 240 000	1 500 000	2 000	2 600	1 100	22234CAME4	22234CAMKE4	188	206	292	270	3	0.26	3.8	2.6	2.5	28.8
	310	86	4	990 000	1 500 000	2 000	—	1 100	22234CDE4	22234CDKE4	188	206	292	270	3	0.26	3.8	2.6	2.5	28.8
	310	110	4	1 500 000	1 910 000	1 400	2 200	900	23234CAME4	23234CAMKE4	188	201	292	261	3	0.34	2.9	2.0	1.9	36.4
	310	110	4	1 200 000	1 910 000	1 400	—	900	23234CE4	23234CKE4	188	201	292	261	3	0.34	2.9	2.0	1.9	36.4
	360	120	4	1 970 000	2 110 000	1 300	2 000	1 000	22334CAME4	22334CAMKE4	188	—	342	304	3	0.35	2.9	1.9	1.9	57.9

Note (¹) The suffix K or K30 represents bearings with tapered bores (taper 1:12 or 1:30).

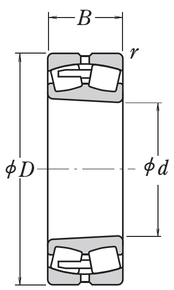
Remarks
1. The bearings denoted by an asterisk ( ) are NSKHPS™ bearings and an oil groove and holes are standard for them.
2. When making a selection of the recommended fit (Tolerance of shaft) on Page A164, in case of NSKHPS™ bearings, the conditions are different.
   The segmentations are: Light Loads(≦0.05C_r); Normal Loads(0.05 to 0.10C_r); and Heavy Loads(>0.10C_r).
3. For the dimensions od adapters and withdrawal sleeves, refer to Pages C352, and C358.

SPHERICAL ROLLER BEARINGS

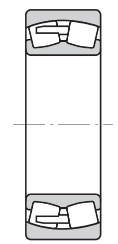
Bore Diameter 180 – 190 mm



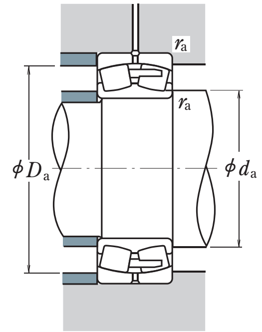
Cylindrical Bore



Tapered Bore



Without an Oil Groove and Holes



Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

$P_0 = F_r + Y_0 F_a$

The values of e, Y_2, Y_3, and Y_0 are given in the table below.

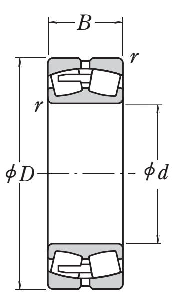
Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min⁻¹)			Bearing Numbers		Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
						Thermal Reference Speed	Limiting Speeds													
d	D	B	r min.	C_r	C_{0r}		Mechanical	Grease	Cylindrical Bore	Tapered Bore(1)	d_a min.	d_a max.	D_a max.	D_a min.	r_a max.	e	Y_2	Y_3	Y_0	approx.
180	250	52	2	590 000	890 000	2 600	3 000	1 200	23936CAME4	23936CAMKE4	190	—	240	230	2	0.18	5.5	3.7	3.6	7.64
	280	74	2.1	935 000	1 270 000	2 000	2 800	1 200	23036CAME4	23036CAMKE4	192	202	268	249	2	0.24	4.2	2.8	2.8	17.1
	280	74	2.1	750 000	1 270 000	2 000	—	1 200	23036CDE4	23036CDKE4	192	202	268	249	2	0.24	4.2	2.8	2.8	17.1
	280	100	2.1	1 210 000	1 750 000	1 500	2 200	950	24036CAME4	24036CAMK30E4	192	200	268	245	2	0.32	3.1	2.1	2.0	22.7
	280	100	2.1	965 000	1 750 000	1 500	—	950	24036CE4	24036CK30E4	192	200	268	245	2	0.32	3.1	2.1	2.0	22.7
	300	96	3	1 320 000	1 760 000	1 700	2 200	900	23136CAME4	23136CAMKE4	194	206	286	260	2.5	0.30	3.4	2.3	2.2	27.5
	300	96	3	1 050 000	1 760 000	1 700	—	900	23136CE4	23136CKE4	194	206	286	260	2.5	0.30	3.4	2.3	2.2	27.5
	300	118	3	1 490 000	2 040 000	1 100	2 000	900	24136CAME4	24136CAMK30E4	194	202	286	255	2.5	0.37	2.7	1.8	1.8	33.1
	300	118	3	1 190 000	2 040 000	1 100	—	900	24136CE4	24136CK30E4	194	202	286	255	2.5	0.37	2.7	1.8	1.8	33.1
	320	86	4	1 280 000	1 540 000	2 000	2 600	1 100	22236CAME4	22236CAMKE4	198	212	302	278	3	0.26	3.9	2.6	2.6	30.2
	320	86	4	1 020 000	1 540 000	2 000	—	1 100	22236CDE4	22236CDKE4	198	212	302	278	3	0.26	3.9	2.6	2.6	30.2
	320	112	4	1 620 000	2 110 000	1 300	2 000	850	23236CAME4	23236CAMKE4	198	211	302	274	3	0.33	3.0	2.0	2.0	38.9
	320	112	4	1 300 000	2 110 000	1 300	—	850	23236CE4	23236CKE4	198	211	302	274	3	0.33	3.0	2.0	2.0	38.9
	380	126	4	2 170 000	2 340 000	1 200	2 000	950	22336CAME4	22336CAMKE4	198	—	362	322	3	0.34	2.9	2.0	1.9	67
190	260	52	2	575 000	875 000	2 600	3 000	1 200	23938CAME4	23938CAMKE4	200	—	250	240	2	0.18	5.7	3.8	3.7	8.03
	290	75	2.1	970 000	1 350 000	2 000	2 600	1 100	23038CAME4	23038CAMKE4	202	—	278	261	2	0.24	4.2	2.8	2.8	17.6
	290	100	2.1	1 220 000	1 840 000	1 400	2 200	900	24038CAME4	24038CAMK30E4	202	210	278	253	2	0.31	3.2	2.2	2.1	24
	290	100	2.1	975 000	1 840 000	1 400	—	900	24038CE4	24038CK30E4	202	210	278	253	2	0.31	3.2	2.2	2.1	24
	320	104	3	1 480 000	2 020 000	1 600	2 200	850	23138CAME4	23138CAMKE4	204	219	306	276	2.5	0.31	3.3	2.2	2.2	34.5
	320	104	3	1 190 000	2 020 000	1 600	—	850	23138CE4	23138CKE4	204	219	306	276	2.5	0.31	3.3	2.2	2.2	34.5
	320	128	3	1 710 000	2 330 000	1 000	1 900	850	24138CAME4	24138CAMK30E4	204	211	306	269	2.5	0.40	2.5	1.7	1.6	41.5
	320	128	3	1 370 000	2 330 000	1 000	—	850	24138CE4	24138CK30E4	204	211	306	269	2.5	0.40	2.5	1.7	1.6	41.5
	340	92	4	1 420 000	1 730 000	1 800	2 400	1 000	22238CAME4	22238CAMKE4	208	—	322	296	3	0.26	3.8	2.6	2.5	35.5
	340	120	4	1 800 000	2 350 000	1 200	1 900	800	23238CAME4	23238CAMKE4	208	222	322	288	3	0.35	2.9	1.9	1.9	47.6
	340	120	4	1 440 000	2 350 000	1 200	—	800	23238CE4	23238CKE4	208	222	322	288	3	0.35	2.9	1.9	1.9	47.6
	400	132	5	2 370 000	2 590 000	1 200	1 900	900	22338CAME4	22338CAMKE4	212	—	378	338	4	0.34	2.9	2.0	1.9	77.6

Note (1) The suffix K or K30 represents bearings with tapered bores (taper 1:12 or 1:30).

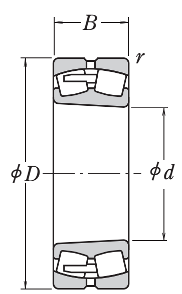
Remarks
1. The bearings denoted by an asterisk ( ) are NSKHPS™ bearings and an oil groove and holes are standard for them.
2. When making a selection of the recommended fit (Tolerance of shaft) on Page A164, in case of NSKHPS™ bearings, the conditions are different. The segmentations are: Light Loads(≦$0.05C_r$); Normal Loads(0.05 to $0.10C_r$); and Heavy Loads(>$0.10C_r$).
3. For the dimensions od adapters and withdrawal sleeves, refer to Pages C353, and C358 – C359.

SPHERICAL ROLLER BEARINGS

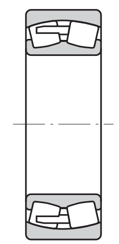
Bore Diameter 200 – 220 mm



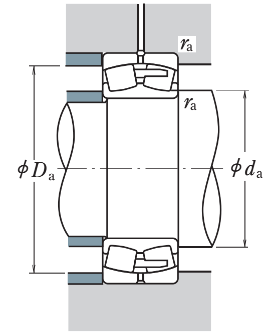
Cylindrical Bore



Tapered Bore



Without an Oil Groove and Holes



Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

$P_0 = F_r + Y_0 F_a$

The values of e, Y_2, Y_3, and Y_0 are given in the table below.

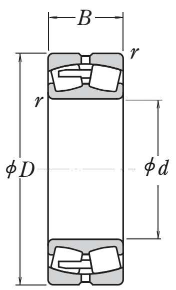
Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min⁻¹)			Bearing Numbers		Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
						Thermal Reference Speed	Limiting Speeds													
d	D	B	r min.	C_r	C_{0r}		Mechanical	Grease	Cylindrical Bore	Tapered Bore([1])	d_a min.	d_a max.	D_a max.	D_a min.	r_a max.	e	Y_2	Y_3	Y_0	approx.
200	280	60	2.1	710 000	1 060 000	2 400	2 600	1 100	**23940CAME4**	**23940CAMKE4**	212	—	268	258	2	0.20	5.1	3.4	3.3	11
	310	82	2.1	1 180 000	1 700 000	1 800	2 400	1 000	**23040CAME4**	**23040CAMKE4**	212	—	298	279	2	0.25	4.0	2.7	2.6	22.6
	310	109	2.1	1 420 000	2 120 000	1 300	2 000	850	**24040CAME4**	**24040CAMK30E4**	212	223	298	271	2	0.32	3.1	2.1	2.0	30.4
	310	109	2.1	1 140 000	2 120 000	1 300	—	850	**24040CE4**	**24040CK30E4**	212	223	298	271	2	0.32	3.1	2.1	2.0	30.4
	340	112	3	1 700 000	2 330 000	1 500	2 000	800	**23140CAME4**	**23140CAMKE4**	214	232	326	293	2.5	0.31	3.2	2.2	2.1	42.7
	340	112	3	1 360 000	2 330 000	1 500	—	800	**23140CE4**	**23140CKE4**	214	232	326	293	2.5	0.31	3.2	2.2	2.1	42.7
	340	140	3	1 960 000	2 660 000	950	1 800	800	**24140CAME4**	**24140CAMK30E4**	214	226	326	290	2.5	0.39	2.6	1.8	1.7	51.3
	340	140	3	1 570 000	2 670 000	950	—	800	**24140CE4**	**24140CK30E4**	214	226	326	290	2.5	0.39	2.6	1.8	1.7	51.3
	360	98	4	1 620 000	2 010 000	1 700	2 200	950	**22240CAME4**	**22240CAMKE4**	218	—	342	315	3	0.26	3.8	2.6	2.5	42.6
	360	128	4	2 070 000	2 750 000	1 100	1 800	750	**23240CAME4**	**23240CAMKE4**	218	237	342	307	3	0.34	2.9	2.0	1.9	57.1
	360	128	4	1 660 000	2 750 000	1 100	—	750	**23240CE4**	**23240CKE4**	218	237	342	307	3	0.34	2.9	2.0	1.9	57.1
	420	138	5	2 500 000	2 990 000	1 000	1 700	850	**22340CAME4**	**22340CAMKE4**	222	—	398	352	4	0.34	2.9	2.0	1.9	92.6
220	300	60	2.1	785 000	1 240 000	2 200	2 600	1 000	**23944CAME4**	**23944CAMKE4**	232	—	288	278	2	0.18	5.7	3.8	3.7	12.2
	340	90	3	1 360 000	1 980 000	1 600	2 200	950	**23044CAME4**	**23044CAMKE4**	234	—	326	302	2.5	0.24	4.1	2.8	2.7	29.7
	340	118	3	1 640 000	2 490 000	1 200	1 900	750	**24044CAME4**	**24044CAMK30E4**	234	244	326	296	2.5	0.31	3.2	2.1	2.1	40.5
	340	118	3	1 360 000	2 600 000	1 200	—	750	**24044CE4**	**24044CK30E4**	234	244	326	296	2.5	0.31	3.2	2.1	2.1	40.5
	370	120	4	1 960 000	2 710 000	1 300	1 800	710	**23144CAME4**	**23144CAMKE4**	238	254	352	320	3	0.30	3.3	2.2	2.2	53
	370	120	4	1 570 000	2 710 000	1 300	—	710	**23144CE4**	**23144CKE4**	238	254	352	320	3	0.30	3.3	2.2	2.2	53
	370	150	4	2 250 000	3 200 000	850	1 600	710	**24144CAME4**	**24144CAMK30E4**	238	248	352	313	3	0.39	2.6	1.7	1.7	66.7
	370	150	4	1 800 000	3 200 000	850	—	710	**24144CE4**	**24144CK30E4**	238	248	352	313	3	0.39	2.6	1.7	1.7	66.7
	400	108	4	1 960 000	2 430 000	1 500	2 000	850	**22244CAME4**	**22244CAMKE4**	238	—	382	348	3	0.27	3.7	2.5	2.4	59
	400	144	4	2 520 000	3 400 000	1 000	1 600	670	**23244CAME4**	**23244CAMKE4**	238	260	382	337	3	0.35	2.9	1.9	1.9	80.4
	400	144	4	2 020 000	3 400 000	850	—	670	**23244CE4**	**23244CKE4**	238	260	382	337	3	0.35	2.9	1.9	1.9	80.4
	460	145	5	2 940 000	3 400 000	950	1 600	750	**22344CAME4**	**22344CAMKE4**	242	—	438	391	4	0.33	3.0	2.0	2.0	116

Note ([1]) The suffix K or K30 represents bearings with tapered bores (taper 1:12 or 1:30).

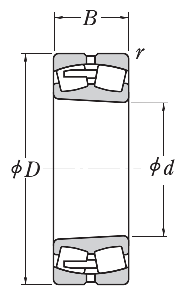
Remarks
1. The bearings denoted by an asterisk ( ) are NSKHPS™ bearings and an oil groove and holes are standard for them.
2. When making a selection of the recommended fit (Tolerance of shaft) on Page A164, in case of NSKHPS™ bearings, the conditions are different.
The segmentations are: Light Loads(≦0.05C_r); Normal Loads(0.05 to 0.10C_r); and Heavy Loads(>0.10C_r).
3. For the dimensions od adapters and withdrawal sleeves, refer to Pages C353, and C359.

SPHERICAL ROLLER BEARINGS

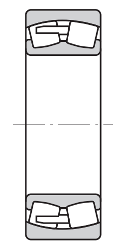
Bore Diameter 240 – 280 mm



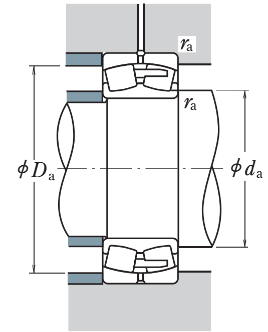
Cylindrical Bore



Tapered Bore



Without an Oil Groove and Holes



Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

$P_0 = F_r + Y_0 F_a$

The values of e, Y_2, Y_3, and Y_0 are given in the table below.

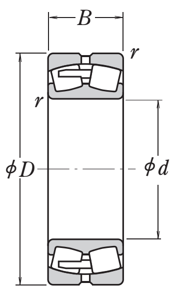
Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min⁻¹)			Bearing Numbers		Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
						Thermal Reference Speed	Limiting Speeds													
d	D	B	r min.	C_r	C_{0r}		Mechanical	Grease	Cylindrical Bore	Tapered Bore(1)	d_a min.	d_a max.	D_a max.	D_a min.	r_a max.	e	Y_2	Y_3	Y_0	approx.
240	320	60	2.1	795 000	1 300 000	1 900	2 600	950	**23948CAME4**	**23948CAMKE4**	252	—	308	298	2	0.17	6.0	4.0	3.9	13.3
	360	92	3	1 450 000	2 140 000	1 500	2 200	850	**23048CAME4**	**23048CAMKE4**	254	—	346	324	2.5	0.24	4.2	2.8	2.7	32.6
	360	118	3	1 730 000	2 730 000	1 100	1 800	710	**24048CAME4**	**24048CAMK30E4**	254	265	346	317	2.5	0.29	3.4	2.3	2.2	43.4
	360	118	3	1 390 000	2 730 000	1 100	—	710	**24048CE4**	**24048CK30E4**	254	265	346	317	2.5	0.29	3.4	2.3	2.2	43.4
	400	128	4	2 230 000	3 100 000	1 200	1 700	670	**23148CAME4**	**23148CAMKE4**	258	275	382	347	3	0.30	3.3	2.2	2.2	66.9
	400	128	4	1 790 000	3 100 000	1 200	—	670	**23148CE4**	**23148CKE4**	258	275	382	347	3	0.30	3.3	2.2	2.2	66.9
	400	160	4	2 660 000	3 800 000	750	1 500	670	**24148CAME4**	**24148CAMK30E4**	258	268	382	341	3	0.38	2.7	1.8	1.8	79.5
	400	160	4	2 130 000	3 800 000	750	—	670	**24148CE4**	**24148CK30E4**	258	268	382	341	3	0.38	2.7	1.8	1.8	79.5
	440	120	4	2 340 000	2 890 000	1 400	1 800	750	**22248CAME4**	**22248CAMKE4**	258	—	422	383	3	0.27	3.7	2.5	2.4	80.2
	440	160	4	3 050 000	4 050 000	850	1 500	630	**23248CAME4**	**23248CAMKE4**	258	—	422	372	3	0.37	2.7	1.8	1.8	106
	500	155	5	3 250 000	3 800 000	850	1 500	670	**22348CAME4**	**22348CAMKE4**	262	—	478	423	4	0.32	3.2	2.1	2.1	147
260	360	75	2.1	1 170 000	1 870 000	1 800	2 200	850	**23952CAME4**	**23952CAMKE4**	272	—	348	333	2	0.19	5.4	3.6	3.5	23
	400	104	4	1 780 000	2 580 000	1 300	1 900	800	**23052CAME4**	**23052CAMKE4**	278	—	382	356	3	0.25	4.1	2.7	2.7	46.6
	400	140	4	2 270 000	3 500 000	950	1 600	630	**24052CAME4**	**24052CAMK30E4**	278	—	382	348	3	0.32	3.1	2.1	2.1	62.6
	440	144	4	2 700 000	3 750 000	1 100	1 500	600	**23152CAME4**	**23152CAMKE4**	278	—	422	380	3	0.32	3.2	2.1	2.1	88.2
	440	180	4	3 200 000	4 700 000	630	1 300	600	**24152CAME4**	**24152CAMK30E4**	278	—	422	371	3	0.39	2.6	1.7	1.7	109
	480	130	5	2 720 000	3 400 000	1 200	1 700	670	**22252CAME4**	**22252CAMKE4**	282	—	458	418	4	0.27	3.7	2.5	2.5	104
	480	174	5	3 400 000	4 550 000	800	1 400	560	**23252CAME4**	**23252CAMKE4**	282	—	458	406	4	0.37	2.7	1.8	1.8	137
	540	165	6	3 900 000	4 600 000	750	1 400	630	**22352CAME4**	**22352CAMKE4**	288	—	512	462	5	0.32	3.2	2.1	2.1	180
280	380	75	2.1	1 160 000	1 950 000	1 600	2 000	800	**23956CAME4**	**23956CAMKE4**	292		368	351	2	0.18	5.7	3.9	3.8	24.5
	420	106	4	1 930 000	2 950 000	1 200	1 800	710	**23056CAME4**	**23056CAMKE4**	298		402	377	3	0.24	4.2	2.8	2.7	50.5
	420	140	4	2 350 000	3 800 000	850	1 500	600	**24056CAME4**	**24056CAMK30E4**	298		402	369	3	0.31	3.3	2.2	2.2	66.4
	460	146	5	2 790 000	4 000 000	1 000	1 500	560	**23156CAME4**	**23156CAMKE4**	302		438	400	4	0.30	3.3	2.2	2.2	94.3
	460	180	5	3 300 000	5 000 000	600	1 300	560	**24156CAME4**	**24156CAMK30E4**	302		438	392	4	0.37	2.7	1.8	1.8	115
	500	130	5	2 850 000	3 650 000	1 100	1 600	630	**22256CAME4**	**22256CAMKE4**	302		478	439	4	0.25	4.0	2.7	2.6	110
	500	176	5	3 600 000	4 900 000	750	1 300	530	**23256CAME4**	**23256CAMKE4**	302		478	425	4	0.35	2.9	1.9	1.9	147
	580	175	6	4 350 000	5 150 000	710	1 300	560	**22356CAME4**	**22356CAMKE4**	308		552	496	5	0.31	3.2	2.1	2.1	221

Note (1) The suffix K or K30 represents bearings with tapered bores (taper 1:12 or 1:30).

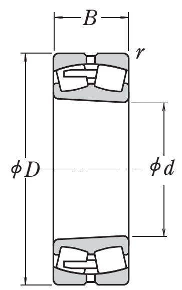
Remarks
1. The bearings denoted by an asterisk ( ) are NSKHPS™ bearings and an oil groove and holes are standard for them.
2. When making a selection of the recommended fit (Tolerance of shaft) on Page A164, in case of NSKHPS™ bearings, the conditions are different.
   The segmentations are: Light Loads(≦0.05C_r); Normal Loads(0.05 to 0.10C_r); and Heavy Loads(>0.10C_r).
3. For the dimensions od adapters and withdrawal sleeves, refer to Pages C353, and C359.

SPHERICAL ROLLER BEARINGS

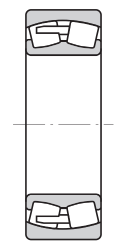
Bore Diameter 300 – 380 mm



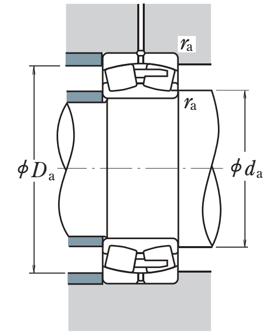
Cylindrical Bore



Tapered Bore



Without an Oil Groove and Holes



Dynamic Equivalent Load

$P=XF_r+YF_a$

$F_a/F_r \leq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

$P_0=F_r+Y_0F_a$

The values of e, Y_2, Y_3, and Y_0 are given in the table below.

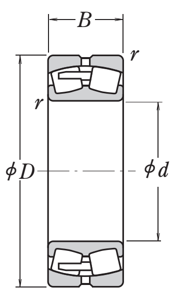
Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min⁻¹)			Bearing Numbers		Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
						Thermal Reference Speed	Limiting Speeds													
d	D	B	r min.	C_r	C_{0r}		Mechanical	Grease	Cylindrical Bore	Tapered Bore(1)	d_a min.	d_a max.	D_a max.	D_a min.	r_a max.	e	Y_2	Y_3	Y_0	approx.
300	420	90	3	1 540 000	2 490 000	1 500	1 800	710	23960CAME4	23960CAMKE4	314		406	386	2.5	0.19	5.2	3.5	3.4	38.2
	460	118	4	2 400 000	3 700 000	1 100	1 600	670	23060CAME4	23060CAMKE4	318		442	413	3	0.24	4.2	2.8	2.7	70.5
	460	160	4	2 890 000	4 600 000	800	1 400	530	24060CAME4	24060CAMK30E4	318		442	400	3	0.32	3.1	2.1	2.0	93.6
	500	160	5	3 350 000	4 800 000	900	1 400	500	23160CAME4	23160CAMKE4	322		478	433	4	0.31	3.3	2.2	2.2	125
	500	200	5	3 900 000	5 800 000	530	1 200	500	24160CAME4	24160CAMK30E4	322		478	423	4	0.38	2.6	1.8	1.7	152
	540	140	5	3 250 000	4 250 000	1 000	1 500	600	22260CAME4	22260CAMKE4	322		518	473	4	0.25	4.0	2.7	2.6	139
	540	192	5	4 250 000	5 900 000	670	1 200	480	23260CAME4	23260CAMKE4	322		518	458	4	0.35	2.9	1.9	1.9	189
320	440	90	3	1 620 000	2 750 000	1 400	1 700	670	23964CAME4	23964CAMKE4	334		426	406	2.5	0.18	5.5	3.7	3.6	40.6
	480	121	4	2 450 000	3 850 000	1 000	1 600	630	23064CAME4	23064CAMKE4	338		462	432	3	0.24	4.2	2.8	2.8	75.6
	480	160	4	3 050 000	5 050 000	710	1 300	500	24064CAME4	24064CAMK30E4	338		462	422	3	0.31	3.3	2.2	2.2	99.7
	540	176	5	3 850 000	5 500 000	800	1 300	480	23164CAME4	23164CAMKE4	342		518	466	4	0.31	3.2	2.1	2.1	162
	540	218	5	4 400 000	6 650 000	500	1 100	480	24164CAME4	24164CAMK30E4	342		518	456	4	0.39	2.6	1.7	1.7	196
	580	150	5	3 750 000	4 850 000	950	1 400	530	22264CAME4	22264CAMKE4	342		558	508	4	0.26	3.9	2.6	2.6	174
	580	208	5	4 850 000	6 900 000	600	1 100	450	23264CAME4	23264CAMKE4	342		558	488	4	0.36	2.8	1.9	1.8	239
340	460	90	3	1 670 000	2 840 000	1 300	1 700	630	23968CAME4	23968CAMKE4	354		446	427	2.5	0.18	5.7	3.8	3.7	42.4
	520	133	5	2 850 000	4 400 000	950	1 500	560	23068CAME4	23068CAMKE4	362		498	465	4	0.24	4.2	2.8	2.8	101
	520	180	5	3 650 000	6 050 000	670	1 200	480	24068CAME4	24068CAMK30E4	362		498	454	4	0.32	3.2	2.1	2.1	135
	580	190	5	4 500 000	6 600 000	710	1 200	430	23168CAME4	23168CAMKE4	362		558	499	4	0.31	3.2	2.1	2.1	206
	580	243	5	5 300 000	7 900 000	450	1 000	430	24168CAME4	24168CAMK30E4	362		558	489	4	0.40	2.5	1.7	1.7	257
	620	224	6	4 400 000	7 800 000	480	—	400	23268CAME4	23268CAMKE4	368		592	521	5	0.36	2.8	1.9	1.8	295
360	480	90	3	1 730 000	3 050 000	1 200	1 700	600	23972CAME4	23972CAMKE4	374		466	447	2.5	0.17	6.0	4.1	4.0	44.7
	540	134	5	2 990 000	4 700 000	900	1 400	530	23072CAME4	23072CAMKE4	382		518	485	4	0.24	4.2	2.8	2.8	106
	540	180	5	3 650 000	6 100 000	630	1 200	450	24072CAME4	24072CAMK30E4	382		518	476	4	0.32	3.2	2.1	2.1	139
	600	192	5	4 800 000	7 100 000	670	1 100	400	23172CAME4	23172CAMKE4	382		578	520	4	0.31	3.2	2.2	2.1	217
	600	243	5	5 250 000	8 000 000	430	1 000	400	24172CAME4	24172CAMK30E4	382		578	507	4	0.40	2.5	1.7	1.7	264
	650	232	6	4 800 000	8 550 000	450	—	380	23272CAME4	23272CAMKE4	388		622	549	5	0.36	2.8	1.9	1.8	342
380	520	106	4	2 340 000	4 100 000	1 100	1 500	530	23976CAME4	23976CAMKE4	398		502	482	3	0.18	5.5	3.7	3.6	65.4
	560	135	5	3 150 000	5 100 000	850	1 400	530	23076CAME4	23076CAMKE4	402		538	506	4	0.22	4.5	3.0	3.0	113
	560	180	5	3 850 000	6 600 000	600	1 200	430	24076CAME4	24076CAMK30E4	402		538	496	4	0.29	3.4	2.3	2.3	148
	620	194	5	4 000 000	7 600 000	530	—	400	23176CAME4	23176CAMKE4	402		598	540	4	0.30	3.3	2.2	2.2	229
	620	243	5	4 350 000	8 450 000	360	—	400	24176CAME4	24176CAMK30E4	402		598	529	4	0.38	2.6	1.8	1.7	275
	680	240	6	5 150 000	9 200 000	430	—	360	23276CAME4	23276CAMKE4	408		652	578	5	0.35	2.9	1.9	1.9	372

Note (1) The suffix K or K30 represents bearings with tapered bores (taper 1:12 or 1:30).

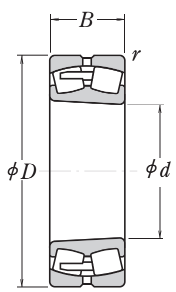
Remarks
1. The bearings denoted by an asterisk ( ) are NSKHPS™ bearings and an oil groove and holes are standard for them.
2. When making a selection of the recommended fit (Tolerance of shaft) on Page A164, in case of NSKHPS™ bearings, the conditions are different.
   The segmentations are: Light Loads(≦0.05C_r); Normal Loads(0.05 to 0.10C_r); and Heavy Loads(>0.10C_r).
3. For the dimensions od adapters and withdrawal sleeves, refer to Pages C354, and C360.

SPHERICAL ROLLER BEARINGS

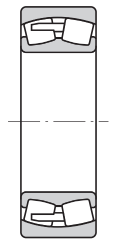
Bore Diameter 400 – 460 mm



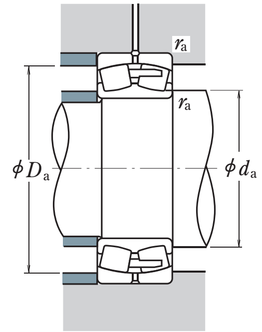
Cylindrical Bore



Tapered Bore



Without an Oil Groove and Holes



Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

$P_0 = F_r + Y_0 F_a$

The values of e, Y_2, Y_3, and Y_0 are given in the table below.

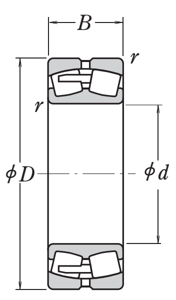
Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min⁻¹)			Bearing Numbers		Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
						Thermal Reference Speed	Limiting Speeds													
d	D	B	r min.	C_r	C_{0r}		Mechanical	Grease	Cylindrical Bore	Tapered Bore([1])	d_a min.	d_a max.	D_a max.	D_a min.	r_a max.	e	Y_2	Y_3	Y_0	approx.
400	540	106	4	2 370 000	4 250 000	1 000	1 400	530	**23980CAME4**	**23980CAMKE4**	418		522	501	3	0.18	5.7	3.9	3.8	69.1
	600	148	5	3 700 000	5 900 000	800	1 300	480	**23080CAME4**	**23080CAMKE4**	422		578	540	4	0.23	4.4	3.0	2.9	146
	600	200	5	4 500 000	7 600 000	560	1 100	400	**24080CAME4**	**24080CAMK30E4**	422		578	527	4	0.31	3.3	2.2	2.2	193
	650	200	6	4 150 000	7 900 000	500	—	380	**23180CAME4**	**23180CAMKE4**	428		622	569	5	0.29	3.4	2.3	2.3	257
	650	250	6	4 950 000	10 100 000	320	—	380	**24180CAME4**	**24180CAMK30E4**	428		622	551	5	0.37	2.7	1.8	1.8	316
	720	256	6	5 800 000	10 400 000	380	—	340	**23280CAME4**	**23280CAMKE4**	428		692	610	5	0.36	2.8	1.9	1.9	449
420	560	106	4	2 340 000	4 250 000	1 000	1 400	500	**23984CAME4**	**23984CAMKE4**	438		542	521	3	0.17	6.0	4.0	3.9	71.6
	620	150	5	2 910 000	5 850 000	670	—	450	**23084CAME4**	**23084CAMKE4**	442		598	562	4	0.23	4.3	2.9	2.8	151
	620	200	5	3 750 000	8 100 000	480	—	380	**24084CAME4**	**24084CAMK30E4**	442		598	549	4	0.31	3.2	2.2	2.1	199
	700	224	6	5 000 000	9 400 000	480	—	340	**23184CAME4**	**23184CAMKE4**	448		672	607	5	0.31	3.3	2.2	2.2	341
	700	280	6	6 000 000	12 000 000	280	—	340	**24184CAME4**	**24184CAMK30E4**	448		672	598	5	0.38	2.6	1.8	1.7	421
	760	272	7.5	6 450 000	11 700 000	360	—	320	**23284CAME4**	**23284CAMKE4**	456		724	644	6	0.35	2.9	1.9	1.9	534
440	600	118	4	2 190 000	4 800 000	630	—	450	**23988CAME4**	**23988CAMKE4**	458		582	555	3	0.18	5.7	3.9	3.8	96.3
	650	157	6	3 150 000	6 350 000	630	—	430	**23088CAME4**	**23088CAMKE4**	468		622	587	5	0.23	4.3	2.9	2.8	173
	650	212	6	4 150 000	9 100 000	450	—	360	**24088CAME4**	**24088CAMK30E4**	468		622	576	5	0.31	3.2	2.1	2.1	237
	720	226	6	5 300 000	10 300 000	430	—	320	**23188CAME4**	**23188CAMKE4**	468		692	627	5	0.3	3.3	2.2	2.2	360
	720	280	6	6 000 000	12 100 000	280	—	320	**24188CAME4**	**24188CAMK30E4**	468		692	617	5	0.37	2.7	1.8	1.8	433
	790	280	7.5	6 900 000	12 800 000	340	—	300	**23288CAME4**	**23288CAMKE4**	476		754	669	6	0.35	2.9	1.9	1.9	594
460	620	118	4	2 220 000	4 950 000	600	—	430	**23992CAME4**	**23992CAMKE4**	478		602	575	3	0.17	5.9	4.0	3.9	100
	680	163	6	3 450 000	7 100 000	600	—	400	**23092CAME4**	**23092CAMKE4**	488		652	615	5	0.22	4.6	3.1	3.0	201
	680	218	6	4 500 000	9 950 000	430	—	340	**24092CAME4**	**24092CAMK30E4**	488		652	604	5	0.29	3.4	2.3	2.3	266
	760	240	7.5	5 700 000	10 900 000	430	—	300	**23192CAME4**	**23192CAMKE4**	496		724	661	6	0.31	3.3	2.2	2.2	423
	760	300	7.5	6 300 000	12 400 000	280	—	300	**24192CAME4**	**24192CAMK30E4**	496		724	646	6	0.39	2.6	1.7	1.7	512
	830	296	7.5	7 350 000	13 700 000	320	—	280	**23292CAME4**	**23292CAMKE4**	496		794	702	6	0.36	2.8	1.9	1.8	691

Note ([1]) The suffix K or K30 represents bearings with tapered bores (taper 1:12 or 1:30).

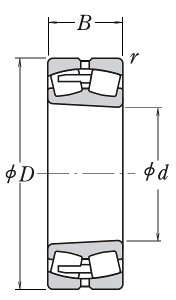
Remarks
1. The bearings denoted by an asterisk ( ) are NSKHPS™ bearings and an oil groove and holes are standard for them.
2. When making a selection of the recommended fit (Tolerance of shaft) on Page A164, in case of NSKHPS™ bearings, the conditions are different.
   The segmentations are: Light Loads(≦0.05C_r); Normal Loads(0.05 to 0.10C_r); and Heavy Loads(>0.10C_r).
3. For the dimensions od adapters and withdrawal sleeves, refer to Pages C354 – C355, and C360 – C361.

SPHERICAL ROLLER BEARINGS

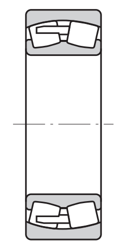
Bore Diameter 480 – 560 mm



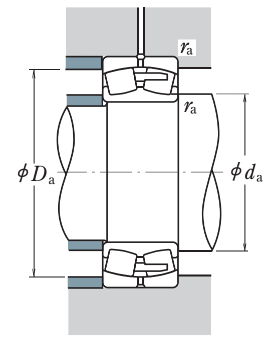
Cylindrical Bore



Tapered Bore



Without an Oil Groove and Holes



Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

$P_0 = F_r + Y_0 F_a$

The values of e, Y_2, Y_3, and Y_0 are given in the table below.

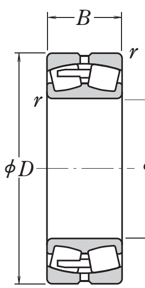
Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min⁻¹)			Bearing Numbers		Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
d	D	B	r min.	C_r	C_{0r}	Thermal Reference Speed	Limiting Speeds Mechanical	Limiting Speeds Grease	Cylindrical Bore	Tapered Bore([1])	d_a min.	d_a max.	D_a max.	D_a min.	r_a max.	e	Y_2	Y_3	Y_0	approx.
480	650	128	5	2 580 000	5 850 000	560	—	400	**23996CAME4**	**23996CAMKE4**	502		628	602	4	0.18	5.7	3.8	3.7	121
	700	165	6	3 800 000	7 950 000	560	—	400	**23096CAME4**	**23096CAMKE4**	508		672	633	5	0.22	4.6	3.1	3.0	211
	700	218	6	4 600 000	10 200 000	400	—	320	**24096CAME4**	**24096CAMK30E4**	508		672	625	5	0.30	3.4	2.3	2.2	270
	790	248	7.5	6 050 000	11 700 000	400	—	300	**23196CAME4**	**23196CAMKE4**	516		754	688	6	0.31	3.3	2.2	2.2	475
	790	308	7.5	7 150 000	14 600 000	240	—	300	**24196CAME4**	**24196CAMK30E4**	516		754	670	6	0.39	2.6	1.7	1.7	567
	870	310	7.5	7 850 000	14 400 000	300	—	260	**23296CAME4**	**23296CAMKE4**	516		834	733	6	0.36	2.8	1.9	1.8	795
500	670	128	5	2 460 000	5 550 000	560	—	400	**239/500CAME4**	**239/500CAMKE4**	522		648	622	4	0.17	6.0	4.0	3.9	124
	720	167	6	3 750 000	8 100 000	530	—	380	**230/500CAME4**	**230/500CAMKE4**	528		692	655	5	0.21	4.8	3.2	3.1	220
	720	218	6	4 450 000	9 900 000	400	—	300	**240/500CAME4**	**240/500CAMK30E4**	528		692	643	5	0.30	3.4	2.3	2.2	276
	830	264	7.5	6 850 000	13 400 000	360	—	280	**231/500CAME4**	**231/500CAMKE4**	536		794	720	6	0.31	3.2	2.2	2.1	567
	830	325	7.5	8 000 000	16 000 000	220	—	280	**241/500CAME4**	**241/500CAMK30E4**	536		794	703	6	0.39	2.6	1.7	1.7	666
	920	336	7.5	9 000 000	16 600 000	280	—	260	**232/500CAME4**	**232/500CAMKE4**	536		884	773	6	0.38	2.7	1.8	1.8	969
530	710	136	5	2 930 000	6 800 000	500	—	360	**239/530CAME4**	**239/530CAMKE4**	552		688	659	4	0.17	6.0	4.0	3.9	149
	780	185	6	4 400 000	9 200 000	500	—	340	**230/530CAME4**	**230/530CAMKE4**	558		752	706	5	0.22	4.6	3.1	3.0	298
	780	250	6	5 400 000	11 800 000	360	—	280	**240/530CAME4**	**240/530CAMK30E4**	558		752	690	5	0.31	3.3	2.2	2.2	390
	870	272	7.5	7 150 000	14 100 000	340	—	260	**231/530CAME4**	**231/530CAMKE4**	566		834	758	6	0.30	3.3	2.2	2.2	628
	870	335	7.5	8 500 000	17 500 000	200	—	260	**241/530CAME4**	**241/530CAMK30E4**	566		834	740	6	0.38	2.6	1.8	1.7	773
	980	355	9.5	10 100 000	18 800 000	260	—	240	**232/530CAME4**	**232/530CAMKE4**	574		936	824	8	0.38	2.7	1.8	1.7	1 170
560	750	140	5	3 100 000	7 250 000	480	—	340	**239/560CAME4**	**239/560CAMKE4**	582		728	697	4	0.16	6.1	4.1	4.0	172
	820	195	6	5 000 000	10 700 000	450	—	320	**230/560CAME4**	**230/560CAMKE4**	588		792	742	5	0.22	4.5	3.0	2.9	344
	820	258	6	5 950 000	13 300 000	340	—	260	**240/560CAME4**	**240/560CAMK30E4**	588		792	729	5	0.30	3.3	2.2	2.2	440
	920	280	7.5	7 850 000	15 500 000	320	—	240	**231/560CAME4**	**231/560CAMKE4**	596		884	804	6	0.30	3.4	2.3	2.2	727
	920	355	7.5	9 400 000	19 600 000	190	—	240	**241/560CAME4**	**241/560CAMK30E4**	596		884	782	6	0.39	2.6	1.8	1.7	886
	1 030	365	9.5	10 900 000	20 500 000	240	—	220	**232/560CAME4**	**232/560CAMKE4**	604		986	870	8	0.36	2.8	1.9	1.8	1 320

Note ([1]) The suffix K or K30 represents bearings with tapered bores (taper 1:12 or 1:30).

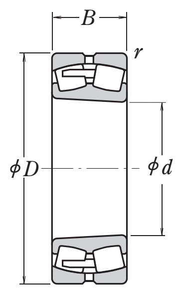
Remark For the dimensions od adapters and withdrawal sleeves, refer to Pages C355, and C361.

SPHERICAL ROLLER BEARINGS

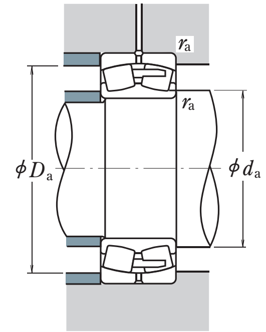
Bore Diameter 600 – 750 mm



Cylindrical Bore



Tapered Bore



Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

$P_0 = F_r + Y_0 F_a$

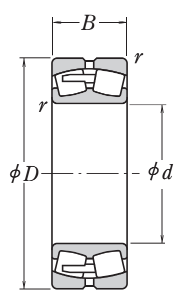
The values of e, Y_2, Y_3, and Y_0 are given in the table below.

Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min⁻¹)			Bearing Numbers		Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
						Thermal Reference Speed	Limiting Speeds													
d	D	B	r min.	C_r	C_{0r}		Mechanical	Grease	Cylindrical Bore	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.
600	800	150	5	3 450 000	8 100 000	450	—	320	**239/600CAME4**	**239/600CAMKE4**	622		778	745	4	0.17	5.9	3.9	3.9	205
	870	200	6	5 450 000	12 200 000	400	—	300	**230/600CAME4**	**230/600CAMKE4**	628		842	794	5	0.21	4.8	3.3	3.2	389
	870	272	6	6 600 000	15 100 000	300	—	240	**240/600CAME4**	**240/600CAMK30E4**	628		842	772	5	0.30	3.3	2.2	2.2	529
	980	300	7.5	8 750 000	17 500 000	280	—	220	231/600CAME4	231/600CAMKE4	636		944	856	6	0.30	3.4	2.3	2.2	898
	980	375	7.5	10 400 000	21 900 000	170	—	220	**241/600CAME4**	**241/600CAMK30E4**	636		944	836	6	0.39	2.6	1.8	1.7	1 050
	1 090	388	9.5	12 700 000	24 900 000	200	—	200	**232/600CAME4**	**232/600CAMKE4**	644		1 046	923	8	0.36	2.8	1.9	1.8	1 590
630	850	165	6	4 000 000	9 350 000	400	—	300	**239/630CAME4**	**239/630CAMKE4**	658		822	786	5	0.18	5.6	3.8	3.7	259
	920	212	7.5	5 900 000	12 700 000	400	—	280	**230/630CAME4**	**230/630CAMKE4**	666		884	835	6	0.22	4.7	3.1	3.1	468
	920	290	7.5	7 550 000	17 700 000	280	—	220	**240/630CAME4**	**240/630CAMK30E4**	666		884	815	6	0.30	3.3	2.2	2.2	637
	1 030	315	7.5	9 600 000	19 400 000	260	—	200	231/630CAME4	231/630CAMKE4	666		994	900	6	0.30	3.4	2.3	2.2	1 040
	1 030	400	7.5	11 300 000	23 900 000	160	—	200	**241/630CAME4**	**241/630CAMK30E4**	666		994	876	6	0.38	2.7	1.8	1.7	1 250
	1 150	412	12	13 400 000	25 600 000	200	—	180	**232/630CAME4**	**232/630CAMKE4**	684		1 096	970	10	0.36	2.8	1.9	1.8	1 850
670	900	170	6	4 350 000	10 300 000	380	—	260	**239/670CAME4**	**239/670CAMKE4**	698		872	836	5	0.17	5.8	3.9	3.8	300
	980	230	7.5	6 850 000	15 000 000	360	—	240	**230/670CAME4**	**230/670CAMKE4**	706		944	891	6	0.22	4.7	3.1	3.1	571
	980	308	7.5	8 450 000	19 500 000	260	—	200	**240/670CAME4**	**240/670CAMK30E4**	706		944	868	6	0.30	3.3	2.2	2.2	773
	1 090	336	7.5	10 600 000	21 600 000	240	—	190	**231/670CAME4**	**231/670CAMKE4**	706		1 054	952	6	0.30	3.3	2.2	2.2	1 230
	1 090	412	7.5	12 400 000	26 500 000	150	—	190	**241/670CAME4**	**241/670CAMK30E4**	706		1 054	934	6	0.37	2.7	1.8	1.8	1 440
	1 220	438	12	14 900 000	28 700 000	180	—	170	**232/670CAME4**	**232/670CAMKE4**	724		1 166	1 024	10	0.37	2.7	1.8	1.8	2 210
710	950	180	6	4 800 000	11 700 000	360	—	240	**239/710CAME4**	**239/710CAMKE4**	738		922	883	5	0.17	5.8	3.9	3.8	352
	1 030	236	7.5	7 100 000	15 800 000	340	—	240	**230/710CAME4**	**230/710CAMKE4**	746		994	936	6	0.22	4.6	3.1	3.0	647
	1 030	315	7.5	8 850 000	20 700 000	240	—	190	**240/710CAME4**	**240/710CAMK30E4**	746		994	916	6	0.29	3.4	2.3	2.2	861
	1 150	438	9.5	13 900 000	30 500 000	130	—	170	**241/710CAME4**	**241/710CAMK30E4**	754		1 106	981	8	0.38	2.6	1.8	1.7	1 730
	1 280	450	12	15 700 000	30 500 000	170	—	160	**232/710CAME4**	**232/710CAMKE4**	764		1 226	1 080	10	0.36	2.8	1.9	1.8	2 470
750	1 000	185	6	5 250 000	12 800 000	320	—	220	**239/750CAME4**	**239/750CAMKE4**	778		972	931	5	0.17	6.0	4.1	4.0	398
	1 090	250	7.5	7 750 000	17 200 000	320	—	220	**230/750CAME4**	**230/750CAMKE4**	786		1 054	990	6	0.22	4.6	3.1	3.0	768
	1 090	335	7.5	10 100 000	24 000 000	220	—	180	**240/750CAME4**	**240/750CAMK30E4**	786		1 054	969	6	0.29	3.4	2.3	2.2	1 030
	1 360	475	15	17 700 000	35 500 000	150	—	140	**232/750CAME4**	**232/750CAMKE4**	814		1 296	1 148	12	0.36	2.8	1.9	1.8	2 980

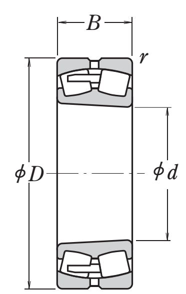
Note (1) The suffix K or K30 represents bearings with tapered bores (taper 1:12 or 1:30).

SPHERICAL ROLLER BEARINGS

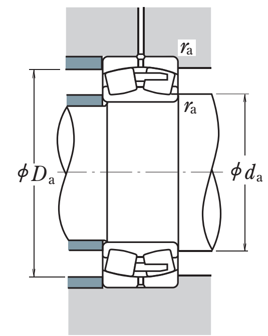
Bore Diameter 800 – 1400 mm



Cylindrical Bore



Tapered Bore



Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leq e$		$F_a/F_r > e$	
X	Y	X	Y
1	Y_3	0.67	Y_2

Static Equivalent Load

$P_0 = F_r + Y_0 F_a$

The values of e, Y_2, Y_3, and Y_0 are given in the table below.

Boundary Dimensions (mm)				Basic Load Ratings (N)		Speeds (min⁻¹)			Bearing Numbers		Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
						Thermal Reference Speed	Limiting Speeds													
d	D	B	r min.	C_r	C_{0r}		Mechanical	Grease	Cylindrical Bore	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.
800	1 060	195	6	5 600 000	13 700 000	300	—	220	**239/800CAME4**	**239/800CAMKE4**	828		1 032	987	5	0.17	6.0	4.0	3.9	462
	1 150	258	7.5	8 350 000	19 100 000	300	—	200	**230/800CAME4**	**230/800CAMKE4**	836		1 114	1 045	6	0.21	4.7	3.2	3.1	870
	1 150	345	7.5	10 900 000	26 300 000	200	—	160	**240/800CAME4**	**240/800CAMK30E4**	836		1 114	1 029	6	0.27	3.7	2.5	2.5	1 130
	1 280	375	9.5	13 800 000	29 200 000	190	—	150	231/800CAME4	231/800CAMKE4	844		1 236	1 127	8	0.28	3.6	2.4	2.3	1 870
	1 420	488	15	20 300 000	41 000 000	130	—	130	**232/800CAME4**	**232/800CAMKE4**	864		1 356	1 208	12	0.35	2.8	1.9	1.9	3 250
850	1 120	200	6	6 100 000	15 200 000	280	—	190	**239/850CAME4**	**239/850CAMKE4**	878		1 092	1 046	5	0.16	6.2	4.2	4.1	523
	1 220	272	7.5	9 300 000	21 400 000	280	—	180	**230/850CAME4**	**230/850CAMKE4**	886		1 184	1 109	6	0.21	4.8	3.2	3.1	1 020
	1 220	365	7.5	11 600 000	28 300 000	190	—	150	**240/850CAME4**	**240/850CAMK30E4**	886		1 184	1 093	6	0.28	3.6	2.4	2.4	1 350
	1 500	515	15	22 300 000	45 500 000	120	—	120	**232/850CAME4**	**232/850CAMKE4**	914		1 436	1 274	12	0.35	2.8	1.9	1.9	3 890
900	1 180	206	6	6 600 000	16 700 000	260	—	180	**239/900CAME4**	**239/900CAMKE4**	928		1 152	1 103	5	0.16	6.4	4.3	4.2	591
	1 280	280	7.5	9 850 000	22 800 000	260	—	160	230/900CAME4	230/900CAMKE4	936		1 244	1 169	6	0.20	4.9	3.3	3.2	1 160
	1 280	375	7.5	12 800 000	31 500 000	170	—	140	**240/900CAME4**	**240/900CAMK30E4**	936		1 244	1 147	6	0.28	3.6	2.4	2.4	1 520
	1 580	515	15	23 400 000	47 500 000	120	—	110	**232/900CAME4**	**232/900CAMKE4**	964		1 516	1 354	12	0.33	3.0	2.0	2.0	4 300
950	1 250	224	7.5	7 600 000	19 900 000	240	—	160	**239/950CAME4**	**239/950CAMKE4**	986		1 214	1 169	6	0.16	6.3	4.2	4.1	732
	1 360	300	7.5	11 300 000	26 500 000	240	—	150	**230/950CAME4**	**230/950CAMKE4**	986		1 324	1 241	6	0.21	4.8	3.2	3.2	1 400
	1 360	412	7.5	14 500 000	36 500 000	160	—	120	**240/950CAME4**	**240/950CAMK30E4**	986		1 324	1 219	6	0.28	3.6	2.4	2.3	1 880
	1 660	530	15	24 700 000	50 500 000	110	—	100	**232/950CAME4**	**232/950CAMKE4**	1 014		1 596	1 428	12	0.32	3.1	2.1	2.1	4 800
1 000	1 320	236	7.5	8 200 000	21 700 000	220	—	150	239/1000CAME4	239/1000CAMKE4	1 036		1 284	1 229	6	0.16	6.4	4.3	4.2	881
	1 420	308	7.5	11 900 000	28 100 000	220	—	140	230/1000CAME4	230/1000CAMKE4	1 036		1 384	1 298	6	0.20	4.9	3.3	3.2	1 560
	1 420	412	7.5	15 300 000	38 500 000	150	—	110	**240/1000CAME4**	**240/1000CAMK30E4**	1 036		1 384	1 275	6	0.27	3.7	2.5	2.4	2 010
1 060	1 400	250	7.5	9 300 000	24 400 000	200	—	130	**239/1060CAME4**	**239/1060CAMKE4**	1 096		1 364	1 302	6	0.16	6.1	4.1	4.0	1 030
	1 500	325	9.5	13 000 000	31 500 000	200	—	120	**230/1060CAME4**	**230/1060CAMKE4**	1 104		1 456	1 368	8	0.21	4.9	3.3	3.2	1 790
	1 500	438	9.5	16 800 000	43 000 000	140	—	100	240/1060CAME4	240/1060CAMK30E4	1 104		1 456	1 346	8	0.28	3.6	2.4	2.4	2 410
1 120	1 580	345	9.5	15 400 000	38 000 000	180	—	110	230/1120CAME4	230/1120CAMKE4	1 164		1 536	1 444	8	0.20	5.0	3.4	3.3	2 120
	1 580	462	9.5	18 700 000	49 500 000	120	—	95	**240/1120CAME4**	**240/1120CAMK30E4**	1 164		1 536	1 421	8	0.27	3.7	2.5	2.5	2 790
1 180	1 660	475	9.5	20 200 000	52 500 000	120	—	85	240/1180CAME4	240/1180CAMK30E4	1 224		1 616	1 494	8	0.27	3.7	2.5	2.4	3 180
1 250	1 750	500	9.5	21 000 000	59 500 000	110	—	75	**240/1250CAME4**	**240/1250CAMK30E4**	1 294		1 706	1 579	8	0.25	4.0	2.7	2.6	3 700
1 320	1 850	530	12	22 600 000	63 500 000	100	—	67	**240/1320CAME4**	**240/1320CAMK30E4**	1 374		1 796	1 656	10	0.26	3.9	2.6	2.6	4 400
1 400	1 950	545	12	24 500 000	65 000 000	95	—	60	**240/1400CAME4**	**240/1400CAMK30E4**	1 454		1 896	1 767	10	0.25	4.0	2.7	2.6	4 900

Note ([1]) The suffix K or K30 represents bearings with tapered bores (taper 1:12 or 1:30).

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.

The 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 a case, the load rating will differ from the one 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

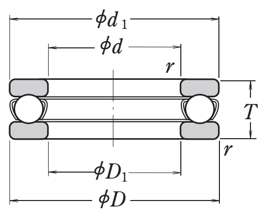
THRUST BALL BEARINGS ....Table 8.4 (Pages A164)
Table 8.6 (Pages A165)

MINIMUM AXIAL LOAD

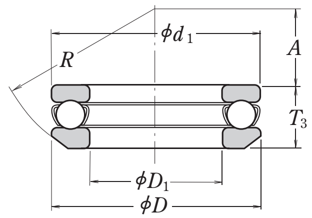
It is necessary to apply some axial load to thrust bearings to prevent slippage between the rolling elements and raceways. For more details, please refer to Page A198.

SINGLE-DIRECTION THRUST BALL BEARINGS

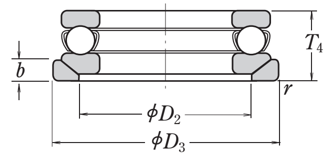
Bore Diameter 10 – 50 mm



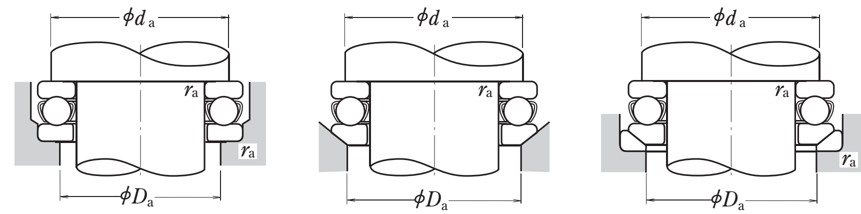
With Flat Seat



With Aligning Seat



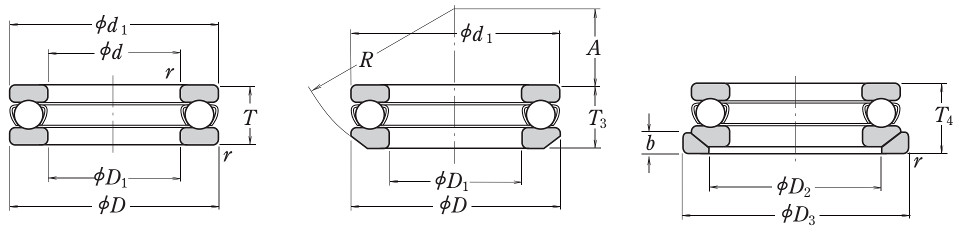
With Aligning Seat Washer



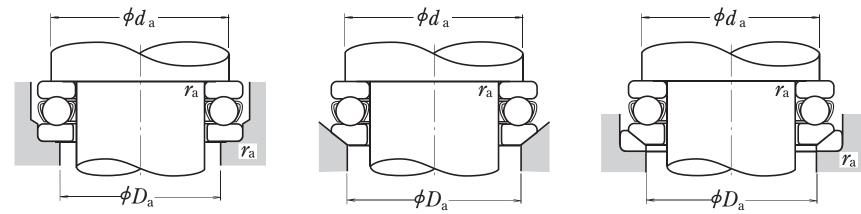
Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers			Dimensions (mm)							Abutment and Fillet Dimensions (mm)			Mass (kg) approx.		
d	D	T	T_3	T_4	r min.	C_a	C_{0a}	Grease	Oil	With Flat Seat	With Aligning Seat	With Aligning Seat Washer	d_1	D_1	D_2	D_3	b	A	R	d_a min.	D_a max.	r_a max.	With Flat Seat	With Aligning Seat	With Aligning Seat Washer
10	24	9	—	—	0.3	10 100	14 000	6 700	10 000	**51100**	—	—	24	11	—	—	—	—	—	18	16	0.3	0.019	—	—
	26	11	11.6	13	0.6	12 800	17 100	6 000	9 000	**51200**	**53200**	**53200 U**	26	12	18	28	3.5	8.5	22	20	16	0.6	0.028	0.029	0.036
12	26	9	—	—	0.3	10 400	15 400	6 700	10 000	**51101**	—	—	26	13	—	—	—	—	—	20	18	0.3	0.021	—	—
	28	11	11.4	13	0.6	13 300	19 000	5 600	8 500	**51201**	**53201**	**53201 U**	28	14	20	30	3.5	11.5	25	22	18	0.6	0.031	0.031	0.039
15	28	9	—	—	0.3	10 600	16 800	6 300	9 500	**51102**	—	—	28	16	—	—	—	—	—	23	20	0.3	0.023	—	—
	32	12	13.3	15	0.6	16 700	24 800	5 000	7 500	**51202**	**53202**	**53202 U**	32	17	24	35	4	12	28	25	22	0.6	0.043	0.048	0.059
17	30	9	—	—	0.3	11 400	19 500	6 000	9 000	**51103**	—	—	30	18	—	—	—	—	—	25	22	0.3	0.025	—	—
	35	12	13.2	15	0.6	17 300	27 300	4 800	7 500	**51203**	**53203**	**53203 U**	35	19	26	38	4	16	32	28	24	0.6	0.050	0.055	0.069
20	35	10	—	—	0.3	15 100	26 600	5 300	8 000	**51104**	—	—	35	21	—	—	—	—	—	29	26	0.3	0.037	—	—
	40	14	14.7	17	0.6	22 500	37 500	4 300	6 300	**51204**	**53204**	**53204 U**	40	22	30	42	5	18	36	32	28	0.6	0.077	0.080	0.096
25	42	11	—	—	0.6	19 700	37 000	4 800	7 100	**51105**	—	—	42	26	—	—	—	—	—	35	32	0.6	0.056	—	—
	47	15	16.7	19	0.6	28 000	50 500	3 800	5 600	**51205**	**53205**	**53205 U**	47	27	36	50	5.5	19	40	38	34	0.6	0.111	0.123	0.151
	52	18	19.8	22	1	36 000	61 500	3 200	5 000	**51305**	**53305**	**53305 U**	52	27	38	55	6	21	45	41	36	1	0.169	0.182	0.224
	60	24	26.4	29	1	56 000	89 500	2 600	4 000	**51405**	**53405**	**53405 U**	60	27	42	62	8	19	50	46	39	1	0.334	0.353	0.426
30	47	11	—	—	0.6	20 600	42 000	4 300	6 700	**51106**	—	—	47	32	—	—	—	—	—	40	37	0.6	0.064	—	—
	52	16	17.8	20	0.6	29 500	58 000	3 400	5 300	**51206**	**53206**	**53206 U**	52	32	42	55	5.5	22	45	43	39	0.6	0.137	0.154	0.183
	60	21	22.6	25	1	43 000	78 500	2 800	4 300	**51306**	**53306**	**53306 U**	60	32	45	62	7	22	50	48	42	1	0.267	0.28	0.336
	70	28	30.1	33	1	73 000	126 000	2 200	3 400	**51406**	**53406**	**53406 U**	70	32	50	75	9	20	56	54	46	1	0.519	0.535	0.666
35	52	12	—	—	0.6	22 100	49 500	4 000	6 000	**51107**	—	—	52	37	—	—	—	—	—	45	42	0.6	0.081	—	—
	62	18	19.9	22	1	39 500	78 000	3 000	4 500	**51207**	**53207**	**53207 U**	62	37	48	65	7	24	50	51	46	1	0.21	0.231	0.292
	68	24	25.6	28	1	56 000	105 000	2 400	3 800	**51307**	**53307**	**53307 U**	68	37	52	72	7.5	24	56	55	48	1	0.386	0.403	0.488
	80	32	34	37	1.1	87 500	155 000	2 000	3 000	**51407**	**53407**	**53407 U**	80	37	58	85	10	23	64	62	53	1	0.769	0.785	0.967
40	60	13	—	—	0.6	27 100	63 000	3 600	5 300	**51108**	—	—	60	42	—	—	—	—	—	52	48	0.6	0.12	—	—
	68	19	20.3	23	1	47 500	98 500	2 800	4 300	**51208**	**53208**	**53208 U**	68	42	55	72	7	28.5	56	57	51	1	0.27	0.289	0.355
	78	26	28.5	31	1	70 000	135 000	2 200	3 400	**51308**	**53308**	**53308 U**	78	42	60	82	8.5	28	64	63	55	1	0.536	0.581	0.704
	90	36	38.2	42	1.1	103 000	188 000	1 700	2 600	**51408**	**53408**	**53408 U**	90	42	65	95	12	26	72	70	60	1	1.1	1.12	1.38
45	65	14	—	—	0.6	28 100	69 000	3 400	5 000	**51109**	—	—	65	47	—	—	—	—	—	57	53	0.6	0.143	—	—
	73	20	21.3	24	1	48 000	105 000	2 600	4 000	**51209**	**53209**	**53209 U**	73	47	60	78	7.5	26	56	62	56	1	0.31	0.333	0.419
	85	28	30.1	33	1	80 500	163 000	2 000	3 000	**51309**	**53309**	**53309 U**	85	47	65	90	10	25	64	69	61	1	0.672	0.702	0.888
	100	39	42.4	46	1.1	128 000	246 000	1 600	2 400	**51409**	**53409**	**53409 U**	100	47	72	105	12.5	29	80	78	67	1	1.46	1.53	1.87
50	70	14	—	—	0.6	29 000	75 500	3 200	4 800	**51110**	—	—	70	52	—	—	—	—	—	62	58	0.6	0.153	—	—
	78	22	23.5	26	1	49 000	111 000	2 400	3 600	**51210**	**53210**	**53210 U**	78	52	62	82	7.5	32.5	64	67	61	1	0.378	0.404	0.504
	95	31	34.3	37	1.1	97 500	202 000	1 800	2 800	**51310**	**53310**	**53310 U**	95	52	72	100	11	28	72	77	68	1	0.931	1.01	1.27
	110	43	45.6	50	1.5	147 000	288 000	1 400	2 200	**51410**	**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

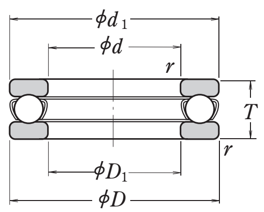


Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers[1]			Dimensions (mm)							Abutment and Fillet Dimensions (mm)			Mass (kg) approx.		
d	D	T	T_3	T_4	r min.	C_a	C_{0a}	Grease	Oil	With Flat Seat	With Aligning Seat	With Aligning Seat Washer	d_1	D_1	D_2	D_3	b	A	R	d_a min.	D_a max.	r_a max.	With Flat Seat	With Aligning Seat	With Aligning Seat Washer
55	78	16	—	—	0.6	35 000	93 000	2 800	4 300	**51111**	—	—	78	57	—	—	—	—	—	69	64	0.6	0.227	—	—
	90	25	27.3	30	1	70 000	159 000	2 200	3 200	**51211**	**53211**	**53211 U**	90	57	72	95	9	35	72	76	69	1	0.599	0.656	0.819
	105	35	39.3	42	1.1	115 000	244 000	1 600	2 400	**51311**	**53311**	**53311 U**	105	57	80	110	11.5	30	80	85	75	1	1.31	1.45	1.78
	120	48	50.5	55	1.5	181 000	350 000	1 300	1 900	**51411**	**53411**	**53411 U**	120	57	88	125	15.5	28	90	94	81	1.5	2.58	2.59	3.16
60	85	17	—	—	1	41 500	113 000	2 600	4 000	**51112**	—	—	85	62	—	—	—	—	—	75	70	1	0.281	—	—
	95	26	28	31	1	71 500	169 000	2 000	3 000	**51212**	**53212**	**53212 U**	95	62	78	100	9	32.5	72	81	74	1	0.673	0.731	0.897
	110	35	38.3	42	1.1	119 000	263 000	1 600	2 400	**51312**	**53312**	**53312 U**	110	62	85	115	11.5	41	90	90	80	1	1.4	1.51	1.83
	130	51	54	58	1.5	202 000	395 000	1 200	1 800	**51412**	**53412**	**53412 U**	130	62	95	135	16	34	100	102	88	1.5	3.16	3.2	3.91
65	90	18	—	—	1	42 000	117 000	2 400	3 800	**51113**	—	—	90	67	—	—	—	—	—	80	75	1	0.324	—	—
	100	27	28.7	32	1	75 500	189 000	1 900	2 800	**51213**	**53213**	**53213 U**	100	67	82	105	9	40	80	86	79	1	0.756	0.812	0.989
	115	36	39.4	43	1.1	123 000	282 000	1 500	2 400	**51313**	**53313**	**53313 U**	115	67	90	120	12.5	38.5	90	95	85	1	1.54	1.67	2.04
	140	56	60.2	65	2	234 000	495 000	1 100	1 700	**51413**	**53413**	**53413 U**	140	68	100	145	17.5	40	112	110	95	2	4.1	4.22	5.13
70	95	18	—	—	1	43 500	127 000	2 400	3 600	**51114**	—	—	95	72	—	—	—	—	—	85	80	1	0.346	—	—
	105	27	28.8	32	1	74 000	189 000	1 900	2 800	**51214**	**53214**	**53214 U**	105	72	88	110	9	38	80	91	84	1	0.793	0.866	1.05
	125	40	44.2	48	1.1	137 000	315 000	1 400	2 000	**51314**	**53314**	**53314 U**	125	72	98	130	13	43	100	103	92	1	2.0	2.2	2.64
	150	60	63.6	69	2	252 000	555 000	1 000	1 500	**51414**	**53414**	**53414 U**	150	73	110	155	19.5	34	112	118	102	2	5.05	5.12	6.21
75	100	19	—	—	1	43 500	131 000	2 200	3 400	**51115**	—	—	100	77	—	—	—	—	—	90	85	1	0.389	—	—
	110	27	28.3	32	1	78 000	209 000	1 800	2 800	**51215**	**53215**	**53215 U**	110	77	92	115	9.5	49	90	96	89	1	0.845	1.27	1.11
	135	44	48.1	52	1.5	159 000	365 000	1 300	1 900	**51315**	**53315**	**53315 U**	135	77	105	140	15	37	100	111	99	1.5	2.6	2.8	3.42
	160	65	69	75	2	254 000	560 000	950	1 400	**51415**	**53415**	**53415 U**	160	78	115	165	21	42	125	125	110	2	6.15	6.23	7.58
80	105	19	—	—	1	45 000	141 000	2 200	3 400	**51116**	—	—	105	82	—	—	—	—	—	95	90	1	0.417	—	—
	115	28	29.5	33	1	79 000	218 000	1 800	2 600	**51216**	**53216**	**53216 U**	115	82	98	120	10	46	90	101	94	1	0.931	1.01	1.23
	140	44	47.6	52	1.5	164 000	395 000	1 300	1 900	**51316**	**53316**	**53316 U**	140	82	110	145	15	50	112	116	104	1.5	2.74	2.94	3.55
	170	68	72.2	78	2.1	272 000	620 000	900	1 300	**51416**	**53416**	**53416 U**	170	83	125	175	22	36	125	133	117	2	7.21	7.33	8.9
85	110	19	—	—	1	46 500	150 000	2 200	3 200	**51117**	—	—	110	87	—	—	—	—	—	100	95	1	0.44	—	—
	125	31	33.1	37	1	96 000	264 000	1 600	2 400	**51217**	**53217**	**53217 U**	125	88	105	130	11	52	100	109	101	1	1.22	1.35	1.63
	150	49	53.1	58	1.5	207 000	490 000	1 100	1 700	**51317**	**53317**	**53317 U**	150	88	115	155	17.5	43	112	124	111	1.5	3.57	3.78	4.67
	180	72	77	83	2.1	310 000	755 000	850	1 300	**51417 X**	**53417 X**	**53417 XU**	177	88	130	185	23	47	140	141	124	2	8.51	8.72	10.4
90	120	22	—	—	1	60 000	190 000	1 900	3 000	**51118**	—	—	120	92	—	—	—	—	—	108	102	1	0.646	—	—
	135	35	38.5	42	1.1	114 000	310 000	1 400	2 200	**51218**	**53218**	**53218 U**	135	93	110	140	13.5	45	100	117	108	1	1.69	1.89	2.38
	155	50	54.6	59	1.5	214 000	525 000	1 100	1 700	**51318**	**53318**	**53318 U**	155	93	120	160	18	40	112	129	116	1.5	3.83	4.11	5.09
	190	77	81.2	88	2.1	330 000	825 000	800	1 200	**51418 X**	**53418 X**	**53418 XU**	187	93	140	195	25.5	40	140	149	131	2	10.2	10.3	12.4
100	135	25	—	—	1	86 000	268 000	1 700	2 600	**51120**	—	—	135	102	—	—	—	—	—	121	114	1	0.96	—	—
	150	38	40.9	45	1.1	135 000	375 000	1 300	2 000	**51220**	**53220**	**53220 U**	150	103	125	155	14	52	112	130	120	1	2.25	2.49	3.03
	170	55	59.2	64	1.5	239 000	595 000	1 000	1 500	**51320**	**53320**	**53320 U**	170	103	135	175	18	46	125	142	128	1.5	4.98	5.31	6.37
	210	85	90	98	3	370 000	985 000	710	1 100	**51420 X**	**53420 X**	**53420 XU**	205	103	155	220	27	50	160	165	145	2.5	14.8	15	18.1

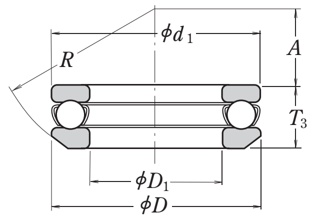
Note (1) The outside diameter d_1 of the shaft washers of all bearing numbers marked X is smaller than the outside diameter D of the housing washers.

SINGLE-DIRECTION THRUST BALL BEARINGS

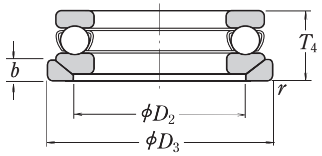
Bore Diameter 110 – 190 mm



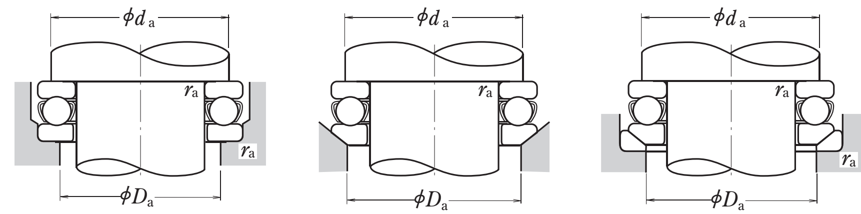
With Flat Seat



With Aligning Seat



With Aligning Seat Washer

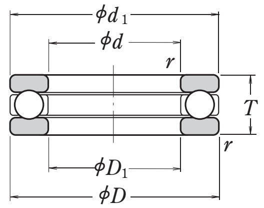


Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min^{-1})		Bearing Numbers(1)			Dimensions (mm)							Abutment and Fillet Dimensions (mm)			Mass (kg) approx.		
d	D	T	T_3	T_4	r min.	C_a	C_{0a}	Grease	Oil	With Flat Seat	With Aligning Seat	With Aligning Seat Washer	d_1	D_1	D_2	D_3	b	A	R	d_a min.	D_a max.	r_a max.	With Flat Seat	With Aligning Seat	With Aligning Seat Washer
110	145	25	—	—	1	88 000	288 000	1 700	2 400	**51122**	—	—	145	112	—	—	—	—	—	131	124	1	1.04	—	—
	160	38	40.2	45	1.1	136 000	395 000	1 300	1 900	**51222**	**53222**	**53222 U**	160	113	135	165	14	65	125	140	130	1	2.42	2.65	3.2
	190	63	67.2	72	2	282 000	755 000	900	1 300	**51322 X**	**53322 X**	**53322 XU**	187	113	150	195	20.5	51	140	158	142	2	7.19	7.55	9.1
	230	95	99.7	109	3	415 000	1 150 000	630	950	**51422 X**	**53422 X**	**53422 XU**	225	113	170	240	29	59	180	181	159	2.5	20	20.5	24.3
120	155	25	—	—	1	90 000	310 000	1 600	2 400	**51124**	—	—	155	122	—	—	—	—	—	141	134	1	1.12	—	—
	170	39	40.8	46	1.1	141 000	430 000	1 200	1 800	**51224**	**53224**	**53224 U**	170	123	145	175	15	61	125	150	140	1	2.7	2.94	3.58
	210	70	74.1	80	2.1	330 000	930 000	800	1 200	**51324 X**	**53324 X**	**53324 XU**	205	123	165	220	22	63	160	173	157	2	9.7	10.1	12.4
	250	102	107.3	118	4	480 000	1 400 000	600	900	**51424 X**	**53424 X**	**53424 XU**	245	123	185	260	32	70	200	196	174	3	26.2	26.5	31.3
130	170	30	—	—	1	105 000	350 000	1 400	2 000	**51126**	—	—	170	132	—	—	—	—	—	154	146	1	1.68	—	—
	190	45	47.9	53	1.5	183 000	550 000	1 100	1 600	**51226 X**	**53226 X**	**53226 XU**	187	133	160	195	17	67	140	166	154	1.5	3.95	4.35	5.33
	225	75	80.3	86	2.1	350 000	1 030 000	750	1 100	**51326 X**	**53326 X**	**53326 XU**	220	134	177	235	26	53	160	186	169	2	12.1	12.7	15.8
	270	110	115.2	128	4	525 000	1 590 000	530	800	**51426 X**	**53426 X**	**53426 XU**	265	134	200	280	38	58	200	212	188	3	32.3	32.4	38.8
140	180	31	—	—	1	107 000	375 000	1 300	2 000	**51128 X**	—	—	178	142	—	—	—	—	—	164	156	1	1.83	—	—
	200	46	48.6	55	1.5	186 000	575 000	1 000	1 500	**51228 X**	**53228 X**	**53228 XU**	197	143	170	210	17	87	160	176	164	1.5	4.3	4.74	5.89
	240	80	84.9	92	2.1	370 000	1 130 000	670	1 000	**51328 X**	**53328 X**	**53328 XU**	235	144	190	250	26	68	180	199	181	2	14.2	16.3	19.5
	280	112	117	131	4	550 000	1 750 000	530	800	**51428 X**	**53428 X**	**53428 XU**	275	144	206	290	38	83	225	222	198	3	34.7	34.8	41.4
150	190	31	—	—	1	110 000	400 000	1 300	1 900	**51130 X**	—	—	188	152	—	—	—	—	—	174	166	1	1.95	—	—
	215	50	53.3	60	1.5	238 000	735 000	950	1 400	**51230 X**	**53230 X**	**53230 XU**	212	153	180	225	20.5	79	160	189	176	1.5	5.52	6.09	7.82
	250	80	83.7	92	2.1	380 000	1 200 000	670	1 000	**51330 X**	**53330 X**	**53330 XU**	245	154	200	260	26	89.5	200	209	191	2	15	17.3	20.5
	300	120	125.9	140	4	620 000	2 010 000	480	710	**51430 X**	**53430 X**	**53430 XU**	295	154	225	310	41	69	225	238	212	3	43.5	43.8	51.9
160	200	31	—	—	1	113 000	425 000	1 200	1 900	**51132 X**	—	—	198	162	—	—	—	—	—	184	176	1	2.07	—	—
	225	51	54.7	61	1.5	249 000	805 000	900	1 400	**51232 X**	**53232 X**	**53232 XU**	222	163	190	235	21	74	160	199	186	1.5	6.04	6.78	8.7
	270	87	91.7	100	3	475 000	1 570 000	600	900	**51332 X**	**53332 X**	**53332 XU**	265	164	215	280	29	77	200	225	205	2.5	19.6	22.3	26.7
	320	130	135.3	150	5	650 000	2 210 000	450	670	**51432 X**	**53432 X**	**53432 XU**	315	164	240	330	41.5	84	250	254	226	4	52.7	52.9	62
170	215	34	—	—	1.1	135 000	510 000	1 100	1 700	**51134 X**	—	—	213	172	—	—	—	—	—	197	188	1	2.72	—	—
	240	55	58.7	65	1.5	280 000	915 000	850	1 300	**51234 X**	**53234 X**	**53234 XU**	237	173	200	250	21.5	91	180	212	198	1.5	7.41	8.21	10.5
	280	87	91.3	100	3	465 000	1 570 000	600	900	**51334 X**	**53334 X**	**53334 XU**	275	174	220	290	29	105	225	235	215	2.5	20.3	23.2	28
	340	135	141	156	5	715 000	2 480 000	430	630	**51434 X**	**53434 X**	**53434 XU**	335	174	255	350	46	74	250	269	241	4	61.2	61.3	73
180	225	34	—	—	1.1	136 000	530 000	1 100	1 700	**51136 X**	—	—	222	183	—	—	—	—	—	207	198	1	2.79	—	—
	250	56	58.2	66	1.5	284 000	955 000	800	1 200	**51236 X**	**53236 X**	**53236 XU**	247	183	210	260	21.5	112	200	222	208	1.5	7.94	8.57	10.8
	300	95	99.3	109	3	480 000	1 680 000	560	850	**51336 X**	**53336 X**	**53336 XU**	295	184	240	310	32	91	225	251	229	2.5	25.9	29.2	34.9
	360	140	148.3	164	5	750 000	2 730 000	400	600	**51436 X**	**53436 X**	**53436 XU**	355	184	270	370	46.5	97	280	285	255	4	70.5	72.1	84.9
190	240	37	—	—	1.1	172 000	655 000	1 000	1 600	**51138 X**	—	—	237	193	—	—	—	—	—	220	210	1	3.6	—	—
	270	62	65.7	73	2	320 000	1 110 000	750	1 100	**51238 X**	**53238 X**	**53238 XU**	267	194	230	280	23	98	200	238	222	2	11.8	12.9	15.7
	320	105	111	121	4	550 000	1 960 000	500	750	**51338 X**	**53338 X**	**53338 XU**	315	195	255	330	33	104	250	266	244	3	36.5	38.1	44.7

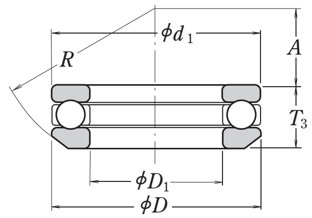
Note (1) The outside diameter d_1 of the shaft washers of all bearing numbers marked X is smaller than the outside diameter D of the housing washers.

■SINGLE-DIRECTION THRUST BALL BEARINGS

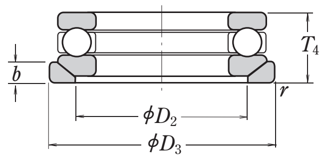
Bore Diameter 200 – 360 mm



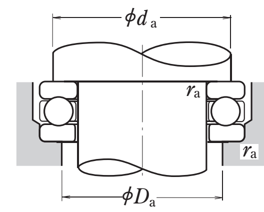
With Flat Seat

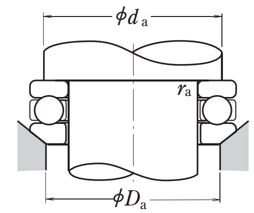


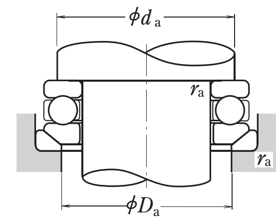
With Aligning Seat



With Aligning Seat Washer





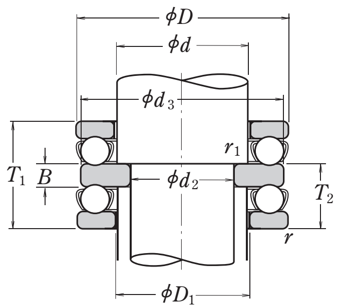


Boundary Dimensions (mm)						Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers[1]			Dimensions (mm)							Abutment and Fillet Dimensions (mm)			Mass(kg) approx.		
d	D	T	T_3	T_4	r min.	C_a	C_{0a}	Grease	Oil	With Flat Seat	With Aligning Seat	With Aligning Seat Washer	d_1	D_1	D_2	D_3	b	A	R	d_a min.	D_a max.	r_a max.	With Flat Seat	With Aligning Seat	With Aligning Seat Washer
200	250	37	—	—	1.1	173 000	675 000	1 000	1 500	**51140 X**	—	—	247	203	—	—	—	—	—	230	220	1	3.75	—	—
	280	62	65.3	74	2	315 000	1 110 000	710	1 100	**51240 X**	**53240 X**	**53240 XU**	277	204	240	290	23	125	225	248	232	2	12.3	13.4	16.1
	340	110	118.4	130	4	600 000	2 220 000	480	710	**51340 X**	**53340 X**	**53340 XU**	335	205	270	350	38	92	250	282	258	3	43.6	46.2	54.8
220	270	37	—	—	1.1	179 000	740 000	950	1 500	**51144 X**	—	—	267	223	—	—	—	—	—	250	240	1	4.09	—	—
	300	63	65.6	75	2	325 000	1 210 000	670	1 000	**51244 X**	**53244 X**	**53244 XU**	297	224	260	310	25	118	225	268	252	2	13.6	14.9	18
240	300	45	—	—	1.5	229 000	935 000	850	1 200	**51148 X**	—	—	297	243	—	—	—	—	—	276	264	1.5	6.55	—	—
	340	78	81.6	92	2.1	420 000	1 650 000	560	850	**51248 X**	**53248 X**	**53248 XU**	335	244	290	350	30	122	250	299	281	2	23.7	25.6	30.7
260	320	45	—	—	1.5	233 000	990 000	800	1 200	**51152 X**	—	—	317	263	—	—	—	—	—	296	284	1.5	7.01	—	—
	360	79	82.8	93	2.1	435 000	1 800 000	560	850	**51252 X**	**53252 X**	**53252 XU**	355	264	305	370	30	152	280	319	301	2	25.1	27.3	33.2
280	350	53	—	—	1.5	315 000	1 310 000	710	1 000	**51156 X**	—	—	347	283	—	—	—	—	—	322	308	1.5	12	—	—
	380	80	85	94	2.1	450 000	1 950 000	530	800	**51256 X**	**53256 X**	**53256 XU**	375	284	325	390	31	143	280	339	321	2	27.1	30.3	37
300	380	62	—	—	2	360 000	1 560 000	600	900	**51160 X**	—	—	376	304	—	—	—	—	—	348	332	2	17.2	—	—
	420	95	100.5	112	3	540 000	2 410 000	450	670	**51260 X**	**53260 X**	**53260 XU**	415	304	360	430	34	164	320	371	349	2.5	43.5	47.7	56.1
320	400	63	—	—	2	365 000	1 660 000	600	900	**51164 X**	—	—	396	324	—	—	—	—	—	368	352	2	18.6	—	—
	440	95	100.5	112	3	585 000	2 680 000	450	670	**51264 X**	**53264 X**	**53264 XU**	435	325	380	450	36	157	320	391	369	2.5	45	49.9	59.4
340	420	64	—	—	2	375 000	1 760 000	560	850	**51168 X**	—	—	416	344	—	—	—	—	—	388	372	2	19.9	—	—
	460	96	100.3	113	3	595 000	2 800 000	430	630	**51268 X**	**53268 X**	**53268 XU**	455	345	400	470	36	199	360	411	389	2.5	47.9	52.7	62
360	440	65	—	—	2	385 000	1 860 000	560	800	**51172 X**	—	—	436	364	—	—	—	—	—	408	392	2	21.5	—	—
	500	110	116.7	130	4	705 000	3 500 000	380	560	**51272 X**	**53272 X**	**53272 XU**	495	365	430	510	43	172	360	442	418	3	68.8	76.3	90.9

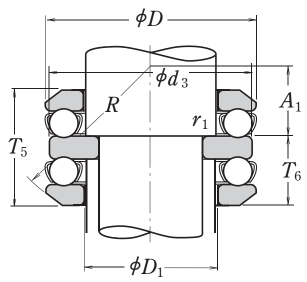
Note [1] The outside diameter d_1 of the shaft washers of all bearing numbers marked X is smaller than the outside diameter D of the housing washers.

DOUBLE-DIRECTION THRUST BALL BEARINGS

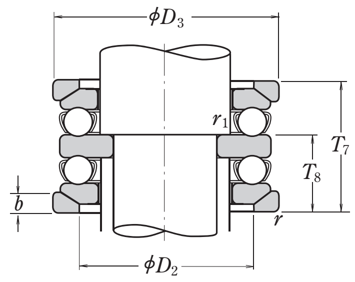
Bore Diameter 10 – 55 mm



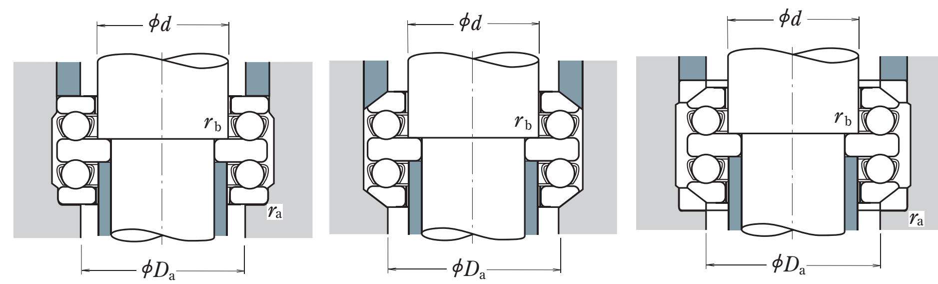
With Flat Seat



With Aligning Seat



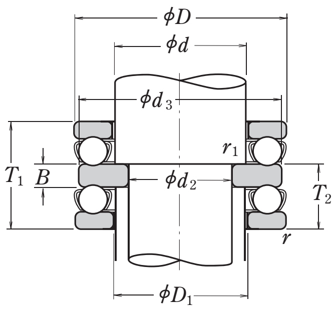
With Aligning Seat Washer



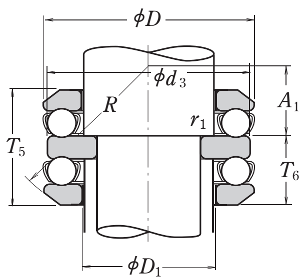
Boundary Dimensions (mm)								Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers			Dimensions (mm)											Abutment and Fillet Dimensions (mm)			Mass (kg) approx.		
d_2	d	D	T_1	T_5	T_7	r min.	r_1 min.	C_a	C_{0a}	Grease	Oil	With Flat Seat	With Aligning Seat	With Aligning Seat Washer	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
10	15	32	22	24.6	28	0.6	0.3	16 700	24 800	4 800	7 100	**52202**	**54202**	**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
15	20	40	26	27.4	32	0.6	0.3	22 500	37 500	4 000	6 000	**52204**	**54204**	**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
	25	60	45	49.8	55	1	0.6	56 000	89 500	2 400	3 600	**52405**	**54405**	**54405 U**	60	27	42	62	28	30.4	33	11	8	15	50	42	1	0.6	0.641	0.68	0.825
20	25	47	28	31.4	36	0.6	0.3	28 000	50 500	3 400	5 300	**52205**	**54205**	**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
	25	52	34	37.6	42	1	0.3	36 000	61 500	3 000	4 500	**52305**	**54305**	**54305 U**	52	27	38	55	21	22.8	25	8	6	18	45	38	1	0.3	0.324	0.35	0.434
	30	70	52	56.2	62	1	0.6	73 000	126 000	2 200	3 200	**52406**	**54406**	**54406 U**	70	32	50	75	32	34.1	37	12	9	16	56	50	1	0.6	0.978	1.01	1.27
25	30	52	29	32.6	37	0.6	0.3	29 500	58 000	3 200	5 000	**52206**	**54206**	**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
	30	60	38	41.2	46	1	0.3	43 000	78 500	2 600	4 000	**52306**	**54306**	**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
	35	80	59	63	69	1.1	0.6	87 500	155 000	1 800	2 800	**52407**	**54407**	**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
30	35	62	34	37.8	42	1	0.3	39 500	78 000	2 800	4 300	**52207**	**54207**	**54207 U**	62	37	48	65	21	22.9	25	8	7	21	50	48	1	0.3	0.406	0.447	0.57
	35	68	44	47.2	52	1	0.3	56 000	105 000	2 400	3 600	**52307**	**54307**	**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
	40	68	36	38.6	44	1	0.6	47 500	98 500	2 600	3 800	**52208**	**54208**	**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
	40	78	49	54	59	1	0.6	70 000	135 000	2 000	3 000	**52308**	**54308**	**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
	40	90	65	69.4	77	1.1	0.6	103 000	188 000	1 700	2 400	**52408**	**54408**	**54408 U**	90	42	65	95	40	42.2	46	15	12	22	72	65	1	0.6	1.98	2.02	2.54
35	45	73	37	39.6	45	1	0.6	48 000	105 000	2 400	3 600	**52209**	**54209**	**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
	45	85	52	56.2	62	1	0.6	80 500	163 000	1 900	2 800	**52309**	**54309**	**54309 U**	85	47	65	90	32	34.1	37	12	10	21	64	65	1	0.6	1.28	1.34	1.71
	45	100	72	78.8	86	1.1	0.6	128 000	246 000	1 500	2 200	**52409**	**54409**	**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
40	50	78	39	42	47	1	0.6	49 000	111 000	2 400	3 400	**52210**	**54210**	**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
	50	95	58	64.6	70	1.1	0.6	97 500	202 000	1 700	2 600	**52310**	**54310**	**54310 U**	95	52	72	100	36	39.3	42	14	11	23	72	72	1	0.6	1.78	1.94	2.46
	50	110	78	83.2	92	1.5	0.6	147 000	288 000	1 400	2 000	**52410**	**54410**	**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
45	55	90	45	49.6	55	1	0.6	70 000	159 000	2 000	3 000	**52211**	**54211**	**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
	55	105	64	72.6	78	1.1	0.6	115 000	244 000	1 500	2 400	**52311**	**54311**	**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
	55	120	87	92	101	1.5	0.6	181 000	350 000	1 200	1 800	**52411**	**54411**	**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
50	60	95	46	50	56	1	0.6	71 500	169 000	1 900	3 000	**52212**	**54212**	**54212 U**	95	62	78	100	28	30	33	10	9	30.5	72	78	1	0.6	1.22	1.33	1.66
	60	110	64	70.6	78	1.1	0.6	119 000	263 000	1 500	2 200	**52312**	**54312**	**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
	60	130	93	99	107	1.5	0.6	202 000	395 000	1 100	1 700	**52412**	**54412**	**54412 U**	130	62	95	135	57	60	64	21	16	28	100	95	1.5	0.6	5.74	5.82	7.24
	65	140	101	109.4	119	2	1	234 000	495 000	1 000	1 600	**52413**	**54413**	**54413 U**	140	68	100	145	62	66.2	71	23	17.5	34	112	100	2	1	7.41	7.66	9.47
55	65	100	47	50.4	57	1	0.6	75 500	189 000	1 900	2 800	**52213**	**54213**	**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
	65	115	65	71.8	79	1.1	0.6	123 000	282 000	1 500	2 200	**52313**	**54313**	**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
	70	105	47	50.6	57	1	1	74 000	189 000	1 800	2 800	**52214**	**54214**	**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
	70	125	72	80.4	88	1.1	1	137 000	315 000	1 300	2 000	**52314**	**54314**	**54314 U**	125	72	98	130	44	48.2	52	16	13	39	100	98	1	1	3.67	4.07	4.95
	70	150	107	114.2	125	2	1	252 000	555 000	1 000	1 500	**52414**	**54414**	**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

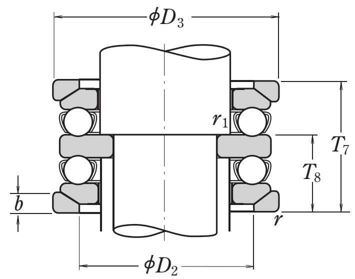
Bore Diameter 60 – 130 mm



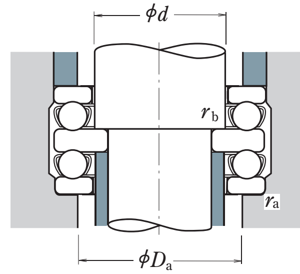
With Flat Seat

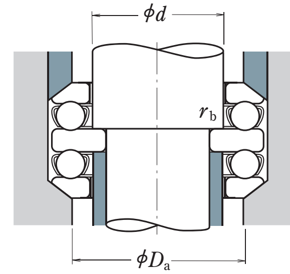


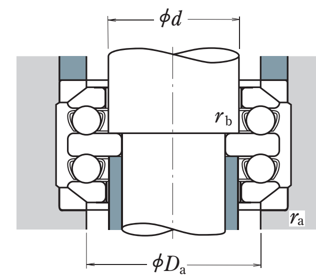
With Aligning Seat



With Aligning Seat Washer





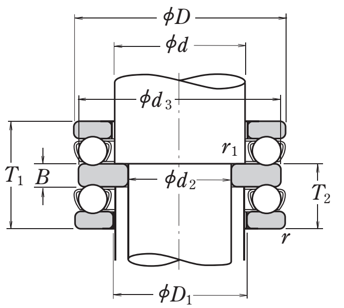


Boundary Dimensions (mm)								Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers[1]			Dimensions (mm)											Abutment and Fillet Dimensions (mm)			Mass(kg) approx.		
d_2	d	D	T_1	T_5	T_7	r min.	r_1 min.	C_a	C_{0a}	Grease	Oil	With Flat Seat	With Aligning Seat	With Aligning Seat Washer	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
60	75	110	47	49.6	57	1	1	78 000	209 000	1 800	2 600	**52215**	**54215**	**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
	75	135	79	87.2	95	1.5	1	159 000	365 000	1 200	1 800	**52315**	**54315**	**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
	75	160	115	123	135	2	1	254 000	560 000	900	1 400	**52415**	**54415**	**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
65	80	115	48	51	58	1	1	79 000	218 000	1 700	2 600	**52216**	**54216**	**54216 U**	115	82	98	120	29	30.5	34	10	10	45	90	98	1	1	1.66	1.78	2.21
	80	140	79	86.2	95	1.5	1	164 000	395 000	1 200	1 800	**52316**	**54316**	**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
	80	170	120	128.4	140	2.1	1	272 000	620 000	850	1 300	**52416**	**54416**	**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
	85	180	128	138	150	2.1	1.1	310 000	755 000	800	1 200	**52417 X**	**54417 X**	**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
70	85	125	55	59.2	67	1	1	96 000	264 000	1 500	2 200	**52217**	**54217**	**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
	85	150	87	95.2	105	1.5	1	207 000	490 000	1 100	1 600	**52317**	**54317**	**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
	90	190	135	143.4	157	2.1	1.1	330 000	825 000	750	1 100	**52418 X**	**54418 X**	**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
75	90	135	62	69	76	1.1	1	114 000	310 000	1 400	2 000	**52218**	**54218**	**54218 U**	135	93	110	140	38	41.5	45	14	13.5	42	100	110	1	1	3.09	3.42	4.39
	90	155	88	97.2	106	1.5	1	214 000	525 000	1 100	1 600	**52318**	**54318**	**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
80	100	210	150	160	176	3	1.1	370 000	985 000	670	1 000	**52420 X**	**54420 X**	**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
85	100	150	67	72.8	81	1.1	1	135 000	375 000	1 300	1 900	**52220**	**54220**	**54220 U**	150	103	125	155	41	43.9	48	15	14	49	112	125	1	1	4.08	4.54	5.64
	100	170	97	105.4	115	1.5	1	239 000	595 000	950	1 500	**52320**	**54320**	**54320 U**	170	103	135	175	59	63.2	68	21	18	42	125	135	1.5	1	8.82	9.47	11.6
90	110	230	166	—	—	3	1.1	415 000	1 150 000	600	900	**52422 X**	—	—	229	113	—	—	101.5	—	—	37	—	—	—	159	2.5	1	35.6	—	—
95	110	160	67	71.4	81	1.1	1	136 000	395 000	1 200	1 800	**52222**	**54222**	**54222 U**	160	113	135	165	41	43.2	48	15	14	62	125	135	1	1	4.39	4.83	5.94
	110	190	110	118.4	128	2	1	282 000	755 000	850	1 300	**52322 X**	**54322 X**	**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
	120	250	177	—	—	4	1.5	515 000	1 540 000	560	850	**52424 X**	—	—	249	123	—	—	108.5	—	—	40	—	—	—	174	3	1.5	47.6	—	—
100	120	170	68	71.6	82	1.1	1.1	141 000	430 000	1 200	1 800	**52224**	**54224**	**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
	120	210	123	131.2	143	2.1	1.1	330 000	930 000	750	1 100	**52324 X**	**54324 X**	**54324 XU**	209.5	123	165	220	75	79.1	85	27	22	58	160	165	2	1	17.6	16.4	22.9
	130	270	192	—	—	4	1.5	525 000	1 590 000	530	800	**52426 X**	—	—	269	134	—	—	117	—	—	42	—	—	—	188	3	1.5	57.8	—	—
110	130	190	80	85.8	96	1.5	1.1	183 000	550 000	1 000	1 500	**52226 X**	**54226 X**	**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
	130	225	130	—	—	2.1	1.1	350 000	1 030 000	710	1 100	**52326 X**	—	—	224	134	—	—	80	—	—	30	—	—	—	169	2	1	21.5	—	—
	140	280	196	—	—	4	1.5	550 000	1 750 000	500	750	**52428 X**	—	—	279	144	—	—	120	—	—	44	—	—	—	198	3	1.5	62.4	—	—
120	140	200	81	86.2	99	1.5	1.1	186 000	575 000	1 000	1 500	**52228 X**	**54228 X**	**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
	140	240	140	—	—	2.1	1.1	370 000	1 130 000	670	1 000	**52328 X**	—	—	239	144	—	—	85.5	—	—	31	—	—	—	181	2	1	24.8	—	—
	150	300	209	—	—	4	2	620 000	2 010 000	480	710	**52430 X**	—	—	299	153	—	—	127.5	—	—	46	—	—	—	212	3	2	77.8	—	—
130	150	215	89	95.6	109	1.5	1.1	238 000	735 000	900	1 300	**52230 X**	**54230 X**	**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
	150	250	140	—	—	2.1	1.1	380 000	1 200 000	630	950	**52330 X**	—	—	249	154	—	—	85.5	—	—	31	—	—	—	191	2	1	30.3	—	—
	160	320	226	—	—	5	2	650 000	2 210 000	430	630	**52432 X**	—	—	319	164	—	—	138	—	—	50	—	—	—	226	4	2	93.6	—	—

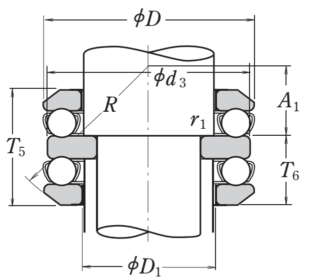
Note (1) The outside diameter d_3 of the central washers of all bearing numbers marked X is smaller than the outside diameter D of the housing washers.

DOUBLE-DIRECTION THRUST BALL BEARINGS

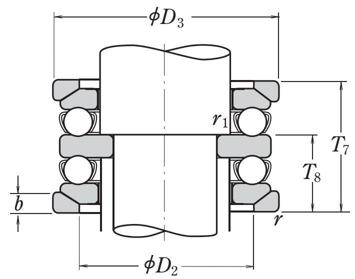
Bore Diameter 135 – 190 mm



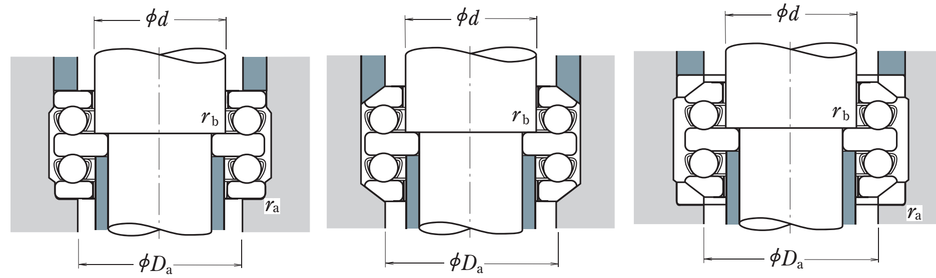
With Flat Seat



With Aligning Seat

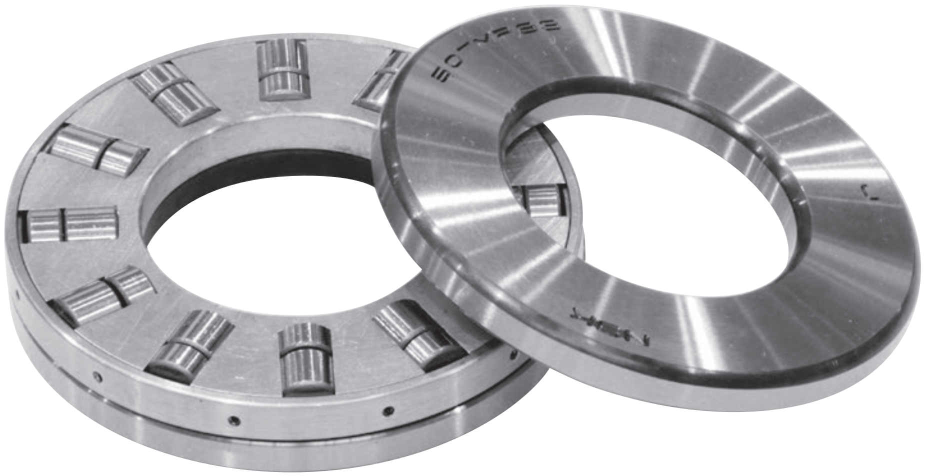


With Aligning Seat Washer



Boundary Dimensions (mm)								Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers[1]			Dimensions (mm)											Abutment and Fillet Dimensions (mm)			Mass(kg) approx.		
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	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
135	170	340	236	—	—	5	2.1	715 000	2 480 000	400	600	**52434 X**	—	—	339	174	—	—	143	—	—	50	—	—	—	240	4	2	110	—	—
140	160	225	90	97.4	110	1.5	1.1	249 000	805 000	850	1 300	**52232 X**	**54232 X**	**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
	160	270	153	—	—	3	1.1	475 000	1 570 000	600	900	**52332 X**	—	—	269	164	—	—	93	—	—	33	—	—	—	205	2.5	1	35.1	—	—
	180	360	245	—	—	5	3	750 000	2 730 000	380	560	**52436 X**	—	—	359	184	—	—	148.5	—	—	52	—	—	—	254	4	2.5	126	—	—
150	170	240	97	104.4	117	1.5	1.1	280 000	915 000	800	1 200	**52234 X**	**54234 X**	**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
	170	280	153	—	—	3	1.1	465 000	1 570 000	560	850	**52334 X**	—	—	279	174	—	—	93	—	—	33	—	—	—	215	2.5	1	40.8	—	—
	180	250	98	102.4	118	1.5	2	284 000	955 000	800	1 200	**52236 X**	**54236 X**	**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
	180	300	165	—	—	3	2	480 000	1 680 000	530	800	**52336 X**	—	—	299	184	—	—	101	—	—	37	—	—	—	229	2.5	2.5	46.3	—	—
160	190	270	109	116.4	131	2	2	320 000	1 110 000	710	1 100	**52238 X**	**54238 X**	**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
	190	320	183	—	—	4	2	550 000	1 960 000	480	710	**52338 X**	—	—	319	195	—	—	111.5	—	—	40	—	—	—	244	3	2	113	—	—
170	200	280	109	115.6	133	2	2	315 000	1 110 000	710	1 000	**52240 X**	**54240 X**	**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
	200	340	192	—	—	4	2	600 000	2 220 000	450	670	**52340 X**	—	—	339	205	—	—	117	—	—	42	—	—	—	258	3	2	78.4	—	—
190	220	300	110	115.2	134	2	2	325 000	1 210 000	670	1 000	**52244 X**	**54244 X**	**54244 XU**	299	224	260	310	67	69.6	79	24	25	114	225	260	2	2	25.2	27.8	34.1

Note (1) The outside diameter d_3 of the central washers of all bearing numbers marked X is smaller than the outside diameter D of the housing washers.



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 they are suitable for heavy loads and have high axial rigidity.

The cages are machined brass.

TOLERANCES AND RUNNING ACCURACY

THRUST CYLINDRICAL ROLLER BEARINGS
.... According to Table 7.6 (Pages A140 to A142)

RECOMMENDED FITS

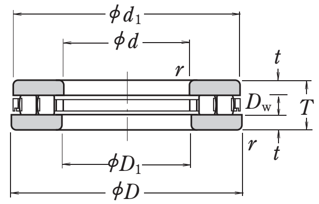
THRUST CYLINDRICAL ROLLER BEARINGS .... Table 8.4 (Pages A164)
Table 8.6 (Pages A165)

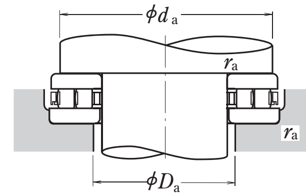
MINIMUM AXIAL LOAD

It is necessary to apply some axial load to thrust bearings to prevent slippage between the rolling elements and raceways. For more details, please refer to Page A198.

THRUST CYLINDRICAL ROLLER BEARINGS

Bore Diameter 35 – 130 mm



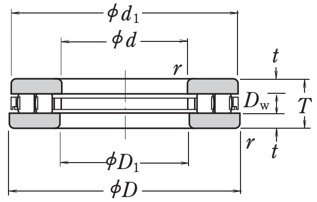


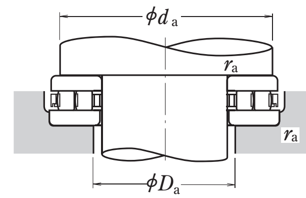
Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers	Dimensions (mm)				Abutment and Fillet Dimensions (mm)			Mass (kg)
d	D	T	r min.	C_a	C_{0a}	Grease	Oil		d_1	D_1	D_w	t	d_a min.	D_a max.	r_a max.	approx.
35	80	32	1.1	95 500	247 000	1 000	3 000	**35 TMP 14**	80	37	12	10	71	46	1	0.97
40	78	22	1	63 000	194 000	1 200	3 600	**40 TMP 93**	78	42	8	7	71	48	1	0.525
45	65	14	0.6	33 000	100 000	1 700	5 000	**45 TMP 11**	65	47	6	4	60	49	0.6	0.144
	85	24	1	71 000	233 000	1 100	3 400	**45 TMP 93**	85	47	8	8	78	53	1	0.665
50	110	27	1.1	139 000	470 000	900	2 800	**50 TMP 74**	109	52	11	8	100	61	1	1.52
	95	27	1.1	113 000	350 000	1 000	3 000	**50 TMP 93**	93	52	11	8	89	57	1	0.94
55	105	30	1.1	134 000	450 000	900	2 600	**55 TMP 93**	105	55.2	11	9.5	98	63	1	1.28
60	95	26	1	99 000	325 000	1 000	3 000	**60 TMP 12**	95	62	10	8	88	67	1	0.735
	110	30	1.1	139 000	480 000	850	2 600	**60 TMP 93**	110	62	11	9.5	103	68	1	1.36
65	100	27	1	110 000	325 000	950	2 800	**65 TMP 12**	100	67	12.5	7.25	93	71	1	0.805
	115	30	1.1	145 000	515 000	850	2 600	**65 TMP 93**	115	65.2	11	9.5	108	73	1	1.44
70	150	36	2	259 000	935 000	670	2 000	**70 TMP 74**	149	72	15	10.5	137	84	2	3.8
	125	34	1.1	191 000	635 000	750	2 200	**70 TMP 93**	125	72	14	10	117	78	1	1.95
75	100	19	1	63 500	221 000	1 100	3 400	**75 TMP 11**	100	77	8	5.5	96	79	1	0.41
	135	36	1.5	209 000	735 000	710	2 200	**75 TMP 93**	135	77	14	11	125	84	1.5	2.42
80	115	28	1	120 000	420 000	900	2 600	**80 TMP 12**	115	82	11	8.5	109	86	1	1.02
	140	36	1.5	208 000	740 000	710	2 000	**80 TMP 93**	138	82	14	11	130	91	1.5	2.54
85	110	19	1	75 000	298 000	1 100	3 200	**85 TMP 11**	110	87	7.5	5.75	105	89	1	0.46
	125	31	1	151 000	485 000	800	2 400	**85 TMP 12**	125	88	14	8.5	118	92	1	1.36
	150	39	1.5	257 000	995 000	630	1 900	**85 TMP 93**	148	87	14	12.5	140	95	1.5	3.2
90	120	22	1	96 000	370 000	950	3 000	**90 TMP 11**	119	91.5	9	6.5	114	95	1	0.725
	155	39	1.5	250 000	885 000	630	1 900	**90 TMP 93**	155	90.2	16	11.5	144	101	1.5	3.3
100	170	42	1.5	292 000	1 110 000	560	1 700	**100 TMP 93**	170	103	16	13	159	110	1.5	4.25
110	160	38	1.1	228 000	855 000	630	1 900	**110 TMP 12**	160	113	15	11.5	150	119	1	2.66
	190	48	2	390 000	1 490 000	500	1 500	**110 TMP 93**	190	113	19	14.5	179	120	2	6.15
120	170	39	1.1	233 000	895 000	600	1 800	**120 TMP 12**	170	123	15	12	160	129	1	2.93
	210	54	2.1	505 000	1 930 000	450	1 400	**120 TMP 93**	210	123	22	16	199	129	2	8.55
130	190	45	1.5	300 000	1 090 000	530	1 600	**130 TMP 12**	187	133	19	13	177	142	1.5	4.5
	225	58	2.1	585 000	2 370 000	430	1 300	**130 TMP 93**	225	133	22	18	214	140	2	10.4
	270	85	4	895 000	3 300 000	320	950	**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.

THRUST CYLINDRICAL ROLLER BEARINGS

Bore Diameter 140 – 320 mm





Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min⁻¹)		Bearing Numbers	Dimensions (mm)				Abutment and Fillet Dimensions (mm)			Mass (kg)
d	D	T	r min.	C_a	C_{0a}	Grease	Oil		d_1	D_1	D_w	t	d_a min.	D_a max.	r_a max.	approx.
140	200	46	2	285 000	1 120 000	500	1 500	**140 TMP 12**	197	143	17	14.5	188	153	2	4.85
	240	60	2.1	610 000	2 360 000	400	1 200	**140 TMP 93**	240	143	25	17.5	226	154	2	12.2
	280	85	4	990 000	3 800 000	300	900	**140 TMP 94**	280	143	32	26.5	262	158	3	27.5
150	215	50	2	375 000	1 500 000	480	1 400	**150 TMP 12**	215	153	19	15.5	202	163	2	6.15
	250	60	2.1	635 000	2 510 000	400	1 200	**150 TMP 93**	250	153	25	17.5	236	165	2	12.8
160	200	31	1	173 000	815 000	630	1 900	**160 TMP 11**	200	162	11	10	191	168	1	2.21
	270	67	3	745 000	3 150 000	360	1 100	**160 TMP 93**	265	164	25	21	255	173	2.5	16.9
170	240	55	1.5	485 000	1 960 000	430	1 300	**170 TMP 12**	237	173	22	16.5	227	182	1.5	8.2
	280	67	3	800 000	3 500 000	340	1 000	**170 TMP 93**	280	173	25	21	265	183	2.5	17.7
180	300	73	3	1 000 000	4 000 000	320	950	**180 TMP 93**	300	185	32	20.5	284	194	2.5	22.5
	360	109	5	1 640 000	6 200 000	240	710	**180 TMP 94**	354	189	45	32	335	205	4	58.2
190	270	62	3	705 000	2 630 000	360	1 100	**190 TMP 12**	266	195	30	16	255	200	2.5	11.8
	320	78	4	1 080 000	4 500 000	300	900	**190 TMP 93**	320	195	32	23	303	205	3	27.6
200	250	37	1.1	365 000	1 690 000	500	1 500	**200 TMP 11**	247	203	17	10	242	207	1	4.1
	340	85	4	1 180 000	5 150 000	280	800	**200 TMP 93**	340	205	32	26.5	322	218	3	34.5
220	270	37	1.1	385 000	1 860 000	480	1 500	**220 TMP 11**	267	223	17	10	262	227	1	4.5
	300	63	2	770 000	3 100 000	340	1 000	**220 TMP 12**	297	224	30	16.5	287	232	2	13.5
240	300	45	1.5	435 000	2 160 000	400	1 200	**240 TMP 11**	297	243	18	13.5	288	251	1.5	7.2
	340	78	2.1	965 000	4 100 000	280	850	**240 TMP 12**	335	244	32	23	322	258	2	23.3
260	320	45	1.5	460 000	2 350 000	400	1 200	**260 TMP 11**	317	263	18	13.5	308	272	1.5	7.75
	360	79	2.1	995 000	4 350 000	280	850	**260 TMP 12**	355	264	32	23.5	342	276	2	25.2
280	350	53	1.5	545 000	2 800 000	340	1 000	**280 TMP 11**	347	283	20	16.5	335	294	1.5	11.6
	380	80	2.1	1 050 000	4 750 000	260	800	**280 TMP 12**	375	284	32	24	362	296	2	27.2
300	380	62	2	795 000	4 000 000	300	900	**300 TMP 11**	376	304	25	18.5	365	315	2	16.7
	420	95	3	1 390 000	6 250 000	220	670	**300 TMP 12**	415	304	38	28.5	398	322	2.5	42
320	400	63	2	820 000	4 250 000	300	900	**320 TMP 11**	396	324	25	19	385	335	2	18
	440	95	3	1 420 000	6 550 000	220	670	**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 are thrust bearings containing tapered rollers. TT-type bearings, which have a rib on the housing washer, can accurately guide the shaft in the radial direction. TTF-type bearings, which have no rib on the housing washer, can tolerate some eccentricity during operation.

Fig 1 TT, 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 design tapered roller thrust bearings, please contact .

MINIMUM AXIAL LOAD

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

USAGE EXAMPLE

Typical structure of Heavy Duty Extruder is shown in Figure 2.

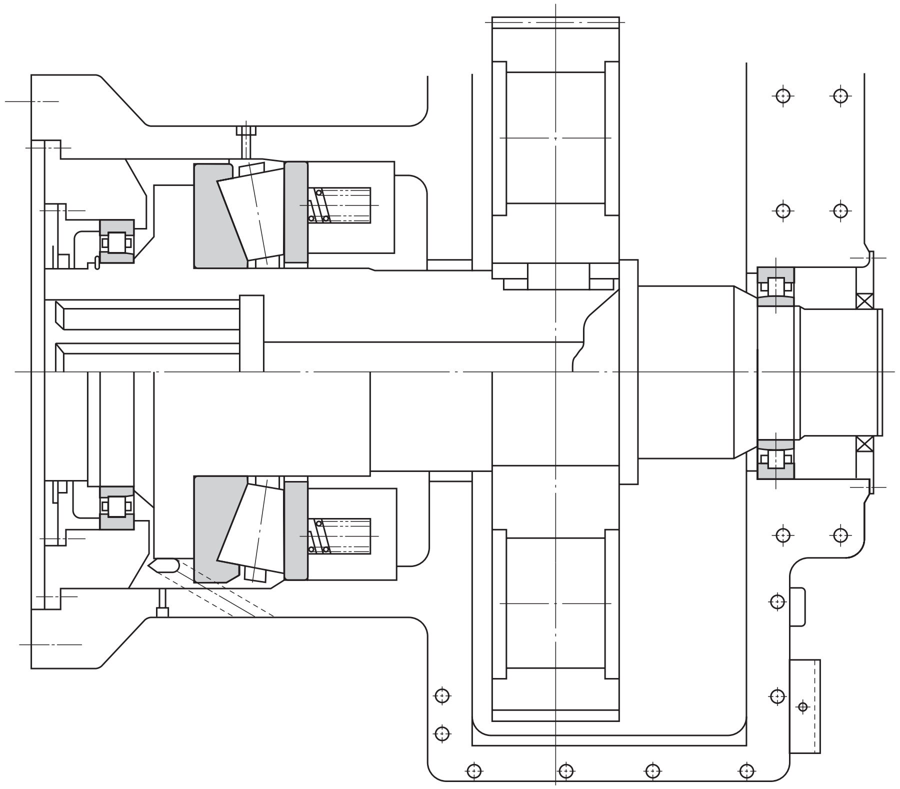
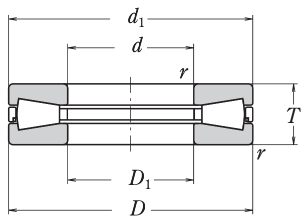
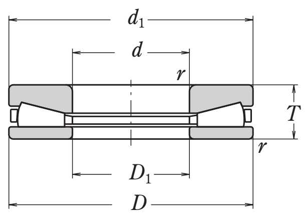


Figure 2 Thrust Tapered Roller Bearing in Heavy Duty Extruder

THRUST TAPERED ROLLER BEARINGS



TT

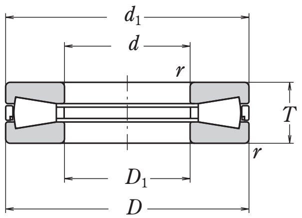


TTF

Boundary Dimensions (mm/inch)				Basic Load Ratings (kN)		Bearing Numbers	Dimensions (mm)		Corner Radius of Shaft or Housing	Mass (kg)
d	D	T	r min.	C_a	C_{0a}		D_1	d_1	r_a max.	approx.
101.600 4.0000	215.900 8.5000	46.038 1.8125	3.3	710	2 900	**101TT2151**	103.200	214.300	3.3	8.9
111.760 4.4000	223.520 8.8000	55.880 2.2000	3.3	790	2 920	**111TT2251**	113.300	221.900	3.3	11.2
114.300 4.5000	250.825 9.8750	53.975 2.1250	4.0	970	4 100	**114TT2551**	114.500	250.825	4.0	14.4
127.000 5.0000	266.700 10.5000	58.738 2.3125	4.8	1 040	4 350	**127TT2551**	128.600	265.100	4.8	17.3
	266.700 10.5000	58.738 2.3125	4.8	1 030	4 500	**127TTF2651**	128.600	265.100	4.8	17.3
128.575 5.0620	265.100 10.4370	63.500 2.5000	6.4	1 040	4 350	**128TT2651**	128.900	265.100	6.4	18.2
130	250	70	2.1	1 100	4 100	**130TTF2501**	130.3	250	2	17
135	245	65	2.1	855	3 100	**135TT2401**	135.3	245	2	14.5
150	300	90	5	1 470	6 300	**150TTF3001**	152	306	4	34.2
152.400 6.0000	317.500 12.5000	69.850 2.7500	6.4	1 470	6 300	**152TTF3151**	152.700	315.900	6.4	28.9
	317.500 12.5000	69.850 2.7500	6.4	1 550	6 700	**152TT3152**	152.400	317.500	6.4	28.9
165.100 6.5000	311.150 12.2500	88.900 3.5000	6.4	1 560	5 250	**165TT3151**	165.400	311.150	6.4	33
168.275 6.6250	304.800 12.0000	69.850 2.7500	6.4	1 230	5 000	**168TTF3051**	169.000	302.500	6.4	24.1

Note Bearings marked are inch design.

THRUST TAPERED ROLLER BEARINGS



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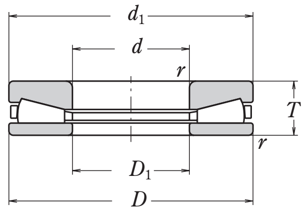
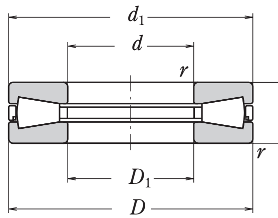


TTF

Boundary Dimensions (mm/inch)				Basic Load Ratings (kN)		Bearing Numbers	Dimensions (mm)		Corner Radius of Shaft or Housing	Mass (kg)
d	D	T	r min.	C_a	C_{0a}		D_1	d_1	r_a max.	approx.
170	320	100	5	1 650	5 550	**170TT3201**	170.5	320	4	39.3
174.625 6.8750	358.775 14.1250	82.550 3.2500	6.4	1 740	7 400	**174TT3551**	174.625	358.775	6.4	43.3
	358.775 14.1250	82.550 3.2500	6.4	1 740	7 400	**174TTF3551**	174.625	358.775	6.4	43.3
177.800 7.0000	368.300 14.5000	82.550 3.2500	8.0	1 900	8 250	**177TT3651**	180.400	365.800	8.0	45.9
203.200 8.0000	419.100 16.5000	92.075 3.6250	9.7	2 530	11 300	**203TT4151**	205.600	416.700	9.7	66.1
	419.100 16.5000	92.075 3.6250	9.7	2 530	11 300	**203TTF4153A**	203.200	419.100	9.7	66.1
	419.100 16.5000	120.650 4.7500	9.7	2 530	11 300	**203TT4152**	205.600	416.700	9.7	86.6
	419.100 16.5000	120.650 4.7500	9.7	2 530	11 300	**203TTF4152**	205.600	416.700	9.7	86.6
206.375 8.1250	419.100 16.5000	120.370 4.7390	C10	2 590	11 700	**206TT4151**	206.375	419.100	6	85.5
228.600 9.0000	482.600 19.0000	104.775 4.1250	11.2	3 350	16 400	**228TT4851**	228.900	482.600	11.2	101
	482.600 19.0000	104.775 4.1250	11.2	3 350	16 400	**228TTF4851**	230.600	480.600	11.2	101
234.950 9.2500	546.100 21.5000	127.000 5.0000	15.9	4 600	21 400	**234TT5451**	237.000	544.000	15.9	165
241	404	110	4	2 200	8 650	**241TTF4002**	241	404	3	61.8
241.300 9.5000	496.888 19.5625	129.000 5.0787	C8	3 450	16 700	**241TT4952**	241.300	496.888	5	130

Note Bearings marked are inch design.

THRUST TAPERED ROLLER BEARINGS



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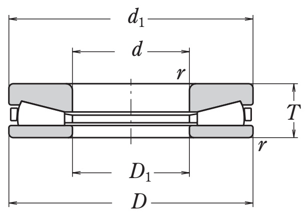
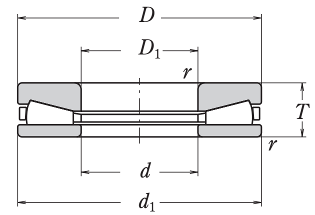


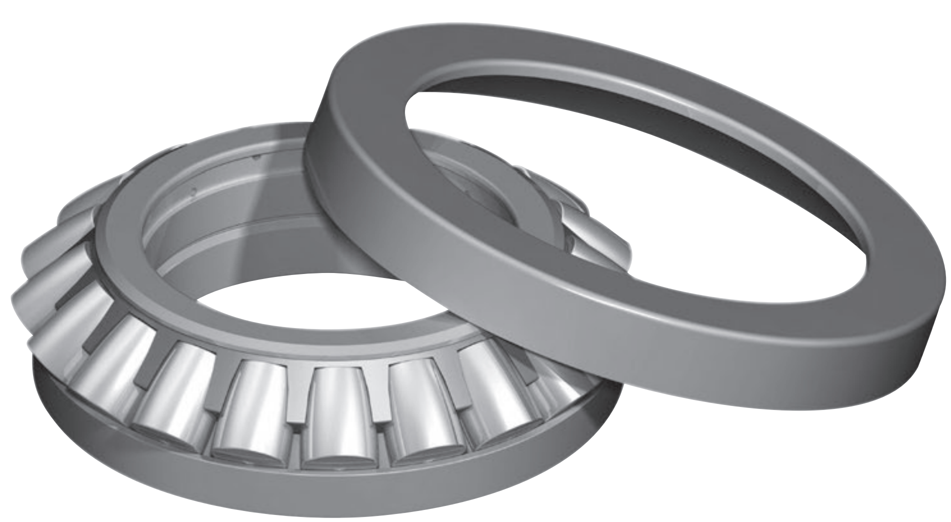
TTF



TTF-1

Boundary Dimensions (mm/inch)				Basic Load Ratings (kN)		Bearing Numbers	Dimensions (mm)		Corner Radius of Shaft or Housing	Mass (kg)
d	D	T	r min.	C_a	C_{0a}		D_1	d_1	r_a max.	approx.
254.000 10.0000	539.750 21.2500	117.475 4.6250	11.2	3 950	18 600	**254TTF5351**	254.000	539.750	11.2	142
260	360	75	2.1	1 110	4 650	**260TTF3601**	260.3	360	2	24.8
273.050 10.7500	552.450 21.7500	133.350 5.2500	C8	4 400	20 700	**273TT5551**	273.050	552.450	5	164
279.400 11.0000	603.250 23.7500	136.525 5.3750	11.2	5 400	25 200	**279TT6051**	279.700	603.250	11.2	208
330	440	85	3	1 300	6 300	**330TTF4401**	331	440	2.5	38.5
340	460	96	3	1 690	7 750	**340TTF4603**	340	460	2.5	49.2
350	460	85	2	1 370	6 600	**350TTF4602A**(1)	351	450	2	40.4
360	470	85	4	1 440	6 950	**360TTF4701**	360.4	470	3	41.4
	600	120	4	3 700	20 100	**360TTF6201**	366	620	3	148
380	550	110	4	2 760	12 100	**380TTF5501**	381	550	3	92.9
406.400 16.0000	711.200 28.0000	146.050 5.7500	9.7	5 900	28 600	**406TT7151**	406.800	711.200	9.7	266
	838.200 33.0000	177.800 7.0000	12.7	8 950	46 500	**406TT8351**	406.800	837.800	12.7	510
431.800 17.0000	863.600 34.0000	228.600 9.0000	10.4	15 100	69 500	**431TTF8651**	435.000	862.000	10.4	683
440	600	105	4	2 720	13 900	**440TTF6001**	440	600	3	93.3
450	570	100	3	2 170	10 500	**450TTF5701**	455	569	2.5	65.4
460	580	90	3	1 890	9 550	**460TTF5801**	465	579	2.5	60
500	630	82	3	2 020	11 600	**500TTF6301**	505	628	2.5	64.3
508	730.25	120.65	6	4 900	26 100	**508TT7301**	509	730.25	5	177
508.000 20.0000	990.600 39.0000	196.850 7.7500	12.7	12 000	65 000	**508TT9951**	508.000	990.600	12.7	760
558	780	120	9.5	4 800	25 500	**558TT7801**	558	780	8	190
558.800 22.0000	1 066.800 42.0000	285.750 11.2500	10.4	21 100	94 500	**558TTF1051**	561.980	1 065.219	10.4	1 260
560	670	85	3	1 950	10 700	**560TTF6701**	565	668	2.5	61.4
600	710	86	3	1 900	10 700	**600TTF7101**	604	710	2.5	66.2

Note Bearings marked are inch design.
(1) For this bearing, the dimensional symbols are defined by Figure TTF-1.



11. THRUST SPHERICAL ROLLER BEARINGS

DESIGN, TYPES, AND FEATURES

THRUST SPHERICAL ROLLER BEARINGS

These are thrust bearings containing convex rollers. They have a self-aligning capability and are free of any influence of mounting error or shaft deflection. Besides the original type, the E type with pressed cages for high load capacity is also available. Their bearing numbers are suffixed by E.

For horizontal shaft or high speed application, machined brass cages are recommended. For details, contact NSK.

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 speed.

The cages in the original type are machined brass.

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

The dimensions related to mounting of thrust spherical roller bearings are listed in the Bearing Table.

If the bearing load is heavy, it is necessary to design the shaft shoulder with ample strength in order to provide sufficient support for the shaft washer.

PERMISSIBLE MISALIGNMENT

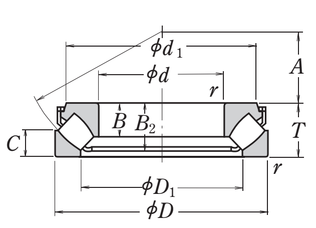
The permissible misalignment of thrust spherical roller bearings varies depending on the size, but it is approximately 0.018 to 0.036 radian (1° to 2°) with average loads.

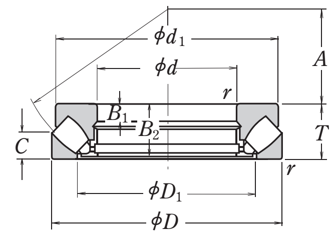
MINIMUM AXIAL LOAD

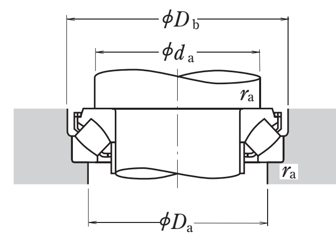
It is necessary to apply some axial load to thrust bearings to prevent slippage between the rolling elements and raceways. For more details, please refer to Page A198.

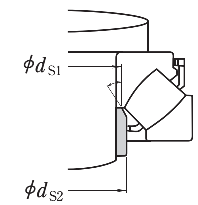
THRUST SPHERICAL ROLLER BEARINGS

Bore Diameter 60 – 200 mm









Dynamic Equivalent Load

$P=1.2F_r+F_a$

Static Equivalent Load

$P_0=2.8F_r+F_a$

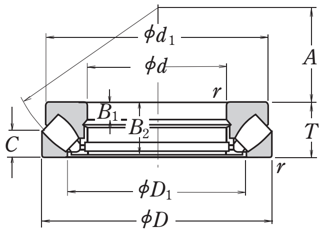
However, $F_r/F_a \leqq 0.55$ must be satisfied.

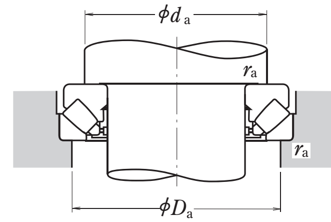
Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min⁻¹)	Bearing Numbers	Dimensions (mm)						Spacer Sleeve Dimensions (mm)		Abutment and Fillet Dimensions (mm)				Mass (kg)
d	D	T	r min.	C_a	C_{0a}	Oil		d_1	D_1	B,B_1	B_2	C	A	d_{S1} max.	d_{S2} max.	d_a(1) min.	D_a max.	D_b min.	r_a max.	approx.
60	130	42	1.5	330 000	885 000	2 600	**29412 E**	114.5	89	27	38	20	38	67	67	90	108	133	1.5	2.55
65	140	45	2	405 000	1 100 000	2 400	**29413 E**	121.5	93	29.5	40.5	22	42	72	72	100	115	143	2	3.2
70	150	48	2	450 000	1 240 000	2 400	**29414 E**	131.5	102	31	43	24	44	78	78	105	125	153	2	3.9
75	160	51	2	515 000	1 430 000	2 200	**29415 E**	138	107	33.5	46	25	47	83	83	115	132	163	2	4.65
80	170	54	2.1	575 000	1 600 000	2 000	**29416 E**	148	114.5	35	48.5	27	50	89	89	120	140	173	2	5.55
85	150	39	1.5	330 000	1 040 000	2 400	**29317 E**	134.5	112	24.5	35.5	19	50	91	91	115	135	153	1.5	2.7
	180	58	2.1	630 000	1 760 000	1 900	**29417 E**	156.5	124	37	51.5	28	54	95	95	130	150	183	2	6.55
90	155	39	1.5	350 000	1 080 000	2 200	**29318 E**	139.5	118	24.5	35	19	52	97	97	120	140	158	1.5	2.83
	190	60	2.1	695 000	1 950 000	1 800	**29418 E**	165.5	129.5	39	54.5	29	56	100	100	135	157	193	2	7.55
100	170	42	1.5	410 000	1 280 000	2 000	**29320 E**	152	128	26.2	38	20.8	58	107	107	130	150	173	1.5	3.6
	210	67	3	840 000	2 400 000	1 600	**29420 E**	185	144	43	59.5	33	62	111	111	150	175	214	2.5	10.3
110	190	48	2	530 000	1 710 000	1 800	**29322 E**	169.5	142.5	30.3	43.5	24	64	117	117	145	165	193	2	5.25
	230	73	3	1 010 000	2 930 000	1 500	**29422 E**	200	157	47	64.5	36	69	121	129	165	190	234	2.5	13.3
120	210	54	2.1	645 000	2 100 000	1 600	**29324 E**	187.5	156.5	34	48.5	27	70	130	130	160	180	214	2	7.3
	250	78	4	1 160 000	3 400 000	1 400	**29424 E**	215	171	50.5	69.5	38	74	132	142	180	205	254	3	16.6
130	225	58	2.1	740 000	2 450 000	1 500	**29326 E**	203.5	168.5	37	53.5	28	76	141	143	170	195	229	2	8.95
	270	85	4	1 330 000	3 900 000	1 200	**29426 E**	235	185	54	74.5	42	81	143	153	195	225	275	3	21.1
140	240	60	2.1	840 000	2 810 000	1 400	**29328 E**	216.5	179	38.5	54	30	82	148	154	185	205	244	2	10.4
	280	85	4	1 370 000	4 200 000	1 200	**29428 E**	244.5	195.5	54	74.5	42	86	153	162	205	235	285	3	22.2
150	250	60	2.1	870 000	2 900 000	1 400	**29330 E**	224	190	38	54.5	29	87	158	163	195	215	254	2	10.8
	300	90	4	1 580 000	4 900 000	1 100	**29430 E**	266	209	58	81	44	92	164	175	220	250	306	3	27.3
160	270	67	3	1 010 000	3 400 000	1 300	**29332 E**	243	203	42	60	33	92	169	176	210	235	275	2.5	14.3
	320	95	5	1 740 000	5 400 000	1 100	**29432 E**	278	224.5	60.5	84.5	46	99	175	189	230	265	326	4	32.1
170	280	67	3	1 050 000	3 500 000	1 200	**29334 E**	252	214.5	42.2	60.5	32	96	178	188	220	245	285	2.5	14.8
	340	103	5	1 680 000	5 800 000	1 000	**29434**	310	243	37	99	50	104	—	—	245	285	—	4	43.5
180	300	73	3	1 230 000	4 200 000	1 100	**29336 E**	270	227	46	65.5	36	103	189	195	235	260	306	2.5	19
	360	109	5	1 870 000	6 500 000	900	**29436**	330	255	39	105	52	110	—	—	260	300	—	4	52
190	320	78	4	1 370 000	4 700 000	1 100	**29338 E**	288.5	244	49	69	38	110	200	211	250	275	326	3	23
	380	115	5	2 100 000	7 450 000	850	**29438**	345	271	41	111	55	117	—	—	275	320	—	4	60
200	280	48	2	540 000	2 310 000	1 500	**29240**	266	236	15	46	24	108	—	—	235	255	—	2	8.55
	340	85	4	1 570 000	5 450 000	1 000	**29340 E**	306.5	257	53.5	75	41	116	211	224	265	295	346	3	28.5
	400	122	5	2 290 000	8 150 000	800	**29440**	365	280	43	117	59	122	—	—	290	335	—	4	69

Note (1) For heavy load applications, a d_a value should be chosen which is large enough to support the shaft washer rib.

THRUST SPHERICAL ROLLER BEARINGS

Bore Diameter 220 – 420 mm





Dynamic Equivalent Load

$P = 1.2F_r + F_a$

Static Equivalent Load

$P_0 = 2.8F_r + F_a$

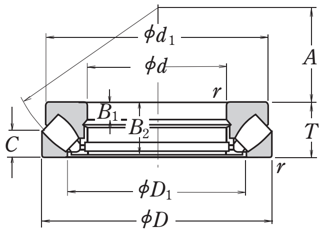
However, $F_r/F_a \leqq 0.55$ must be satisfied.

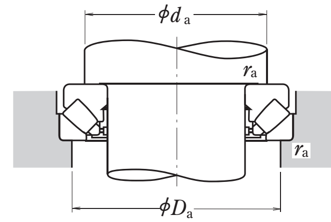
Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min⁻¹)	Bearing Numbers	Dimensions (mm)						Abutment and Fillet Dimensions (mm)			Mass (kg)
d	D	T	r min.	C_a	C_{0a}	Oil		d_1	D_1	B_1	B_2	C	A	d_a(1) min.	D_a max.	r_a max.	approx.
220	300	48	2	560 000	2 500 000	1 400	**29244**	285	254	15	46	24	117	260	275	2	9.2
	360	85	4	1 340 000	5 200 000	950	**29344**	335	280	29	81	41	125	285	315	3	33
	420	122	6	2 350 000	8 650 000	800	**29444**	385	308	43	117	58	132	310	355	5	74
240	340	60	2.1	800 000	3 450 000	1 200	**29248**	325	283	19	57	30	130	285	305	2	16.5
	380	85	4	1 360 000	5 400 000	950	**29348**	355	300	29	81	41	135	300	330	3	35.5
	440	122	6	2 420 000	9 100 000	750	**29448**	405	326	43	117	59	142	330	375	5	79
260	360	60	2.1	855 000	3 850 000	1 200	**29252**	345	302	19	57	30	139	305	325	2	18
	420	95	5	1 700 000	6 800 000	800	**29352**	390	329	32	91	45	148	330	365	4	48.5
	480	132	6	2 820 000	10 700 000	710	**29452**	445	357	48	127	64	154	360	405	5	105
280	380	60	2.1	885 000	4 100 000	1 100	**29256**	365	323	19	57	30	150	325	345	2	19
	440	95	5	1 830 000	7 650 000	800	**29356**	410	348	32	91	46	158	350	390	4	52.5
	520	145	6	3 400 000	13 100 000	630	**29456**	480	384	52	140	68	166	390	440	5	132
	520	145	6	3 950 000	14 900 000	630	**29456 EM**	480	380	52	140	70	166	410	445	5	134
300	420	73	3	1 160 000	5 150 000	950	**29260**	400	353	21	69	38	162	355	380	2.5	30
	480	109	5	2 190 000	9 100 000	710	**29360**	450	379	37	105	50	168	380	420	4	74
	540	145	6	3 500 000	13 700 000	630	**29460**	500	402	52	140	70	175	410	460	5	140
320	440	73	3	1 190 000	5 450 000	950	**29264**	420	372	21	69	38	172	375	400	2.5	32.5
	500	109	5	2 230 000	9 400 000	670	**29364**	470	399	37	105	53	180	400	440	4	77
	580	155	7.5	3 650 000	14 600 000	560	**29464**	555	436	55	149	75	191	435	495	6	175
340	460	73	3	1 230 000	5 750 000	900	**29268**	440	395	21	69	37	183	395	420	2.5	33.5
	540	122	5	2 640 000	11 200 000	630	**29368**	510	428	41	117	59	192	430	470	4	103
	620	170	7.5	4 400 000	17 400 000	530	**29468**	590	462	61	164	82	201	465	530	6	218
360	500	85	4	1 550 000	7 300 000	800	**29272**	480	423	25	81	44	194	420	455	3	51
	560	122	5	2 670 000	11 500 000	600	**29372**	525	448	41	117	59	202	450	495	4	107
	640	170	7.5	4 200 000	17 200 000	500	**29472**	610	480	61	164	82	210	485	550	6	228
	640	170	7.5	5 450 000	20 400 000	500	**29472 EM**	580	474	61	164	83	210	495	550	6	220
380	520	85	4	1 620 000	7 800 000	800	**29276**	496	441	27	81	42	202	440	475	3	52
	600	132	6	3 300 000	14 500 000	560	**29376**	568	477	44	127	63	216	480	525	5	140
	670	175	7.5	4 800 000	19 500 000	480	**29476**	640	504	63	168	85	230	510	575	6	254
400	540	85	4	1 640 000	8 000 000	750	**29280**	517	460	27	81	42	212	460	490	3	55
	620	132	6	3 250 000	14 500 000	530	**29380**	590	494	44	127	64	225	500	550	5	150
	710	185	7.5	5 400 000	22 100 000	450	**29480**	680	536	67	178	89	236	540	610	6	306
420	580	95	5	2 010 000	9 800 000	670	**29284**	553	489	30	91	46	225	490	525	4	72
	650	140	6	3 500 000	15 700 000	500	**29384**	620	520	48	135	68	235	525	575	5	170
	730	185	7.5	5 650 000	23 500 000	450	**29484**	700	556	67	178	89	244	560	630	6	323

Note (1) For heavy load applications, a d_a value should be chosen which is large enough to support the shaft washer rib.

THRUST SPHERICAL ROLLER BEARINGS

Bore Diameter 440 – 500 mm





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.

Boundary Dimensions (mm)				Basic Load Ratings (N)		Limiting Speeds (min⁻¹)	Bearing Numbers	Dimensions (mm)						Abutment and Fillet Dimensions (mm)			Mass (kg)
d	D	T	r min.	C_a	C_{0a}	Oil		d_1	D_1	B_1	B_2	C	A	d_a (1) min.	D_a max.	r_a max.	approx.
440	600	95	5	2 030 000	10 100 000	670	**29288**	575	508	30	91	49	235	510	545	4	77
	680	145	6	3 750 000	16 700 000	480	**29388**	645	548	49	140	70	245	550	600	5	190
	780	206	9.5	6 550 000	27 200 000	400	**29488**	745	588	74	199	100	260	595	670	8	407
	780	206	9.5	8 000 000	31 500 000	400	**29488 EM**	710	577	74	199	101	257	605	675	8	402
460	620	95	5	2 060 000	10 300 000	670	**29292**	592	530	30	91	46	245	530	570	4	80
	710	150	6	4 100 000	18 400 000	450	**29392**	666	567	51	144	72	257	575	630	5	210
	800	206	9.5	6 750 000	28 600 000	380	**29492**	765	608	74	199	100	272	615	690	8	420
480	650	103	5	2 370 000	12 100 000	600	**29296**	624	556	33	99	55	259	555	595	4	97
	730	150	6	4 150 000	19 000 000	450	**29396**	690	590	51	144	72	270	595	650	5	215
	850	224	9.5	7 200 000	31 000 000	360	**29496**	810	638	81	216	108	280	645	730	8	545
500	670	103	5	2 390 000	12 400 000	600	**292/500**	645	574	33	99	55	268	575	615	4	100
	750	150	6	4 350 000	20 400 000	450	**293/500**	715	611	51	144	74	280	615	670	5	220
	870	224	9.5	7 850 000	33 000 000	340	**294/500**	830	661	81	216	107	290	670	750	8	560

Note (1) For heavy load applications, a d_a value should be chosen which is large enough to support the shaft washer rib.

12. NEEDLE ROLLER BEARINGS

DESIGN AND TYPES

For needle roller bearings, there are many designs and types bearings.

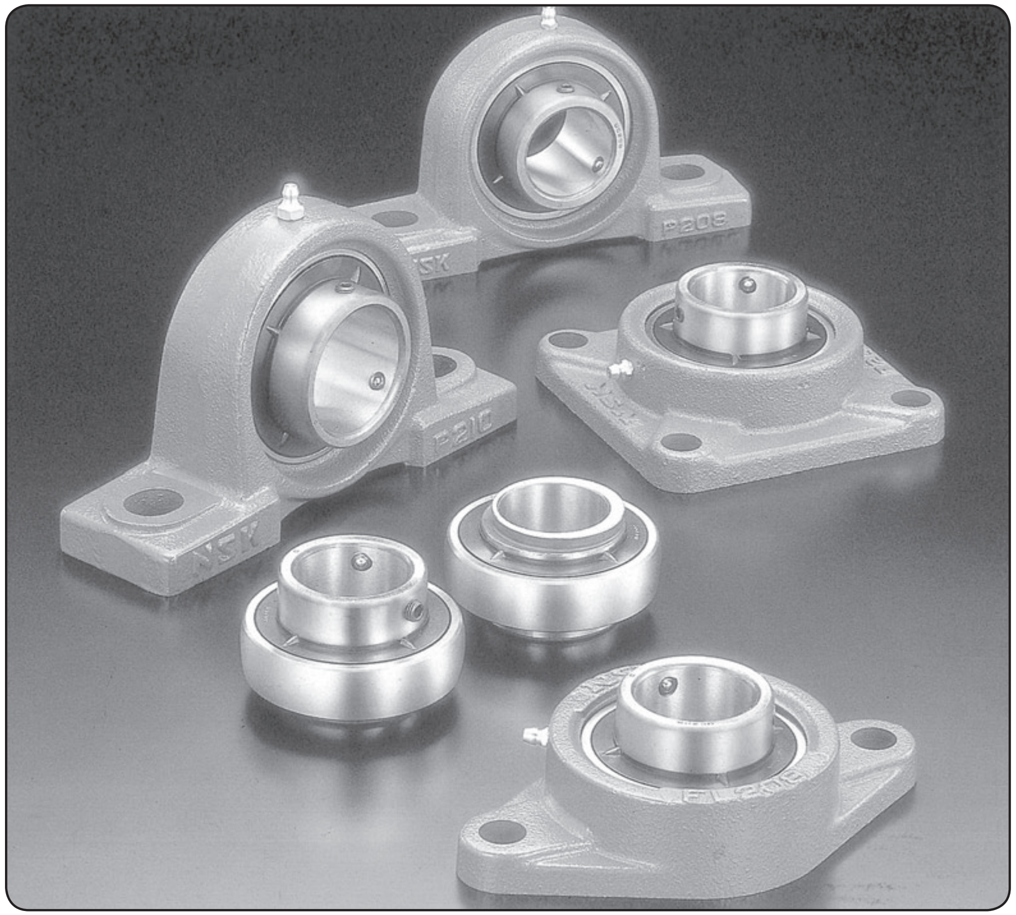
Catalog

Specified catalog, NSK Needle Roller Bearings CAT.No.E1419 lists bearings shown in Table 1. For details, please refer individual specified catalog.

For bearing selection, please contact NSK.

Table1 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 Thurst raceway washers	FNTA, NTA; FB; FTRA, TRA; FTRB, TRB; FTRC, TRC; FTRD, TRD; FTRE, TRE
Needle Rollers	A Type; F Type; P Type; (Pleas refer to B350 page); 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

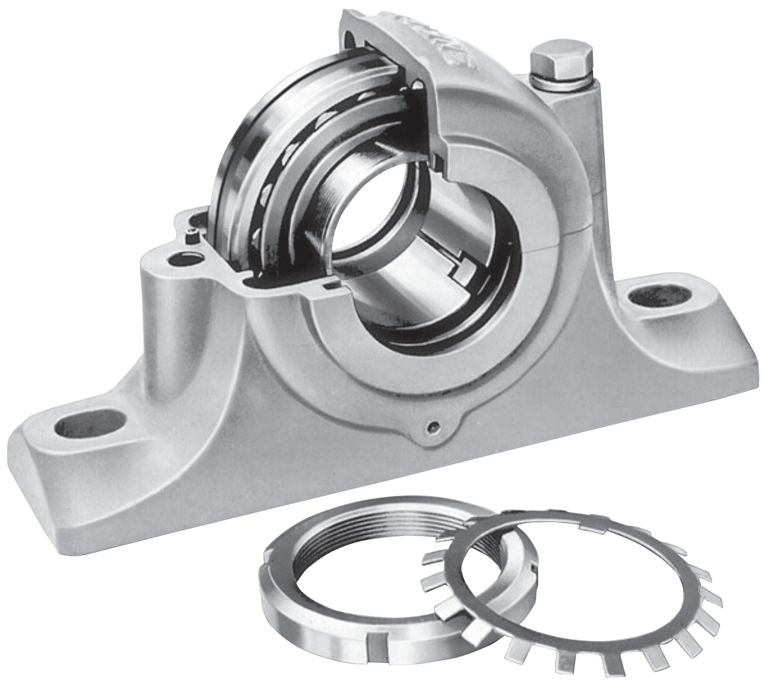


13. BALL BEARING UNITS

DESIGN, TYPES

For ball bearing units, there are many designs and types.
Please refer to specified Catalog below, for more detailed information.
Specified Catalog

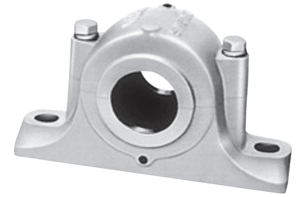
Ball Bearing Units CAT.No. E1154
Ball Bearing Units Steel Series CAT.No. E1232
Ball Bearing Units with Ductile Cast Iron Housing CAT.No. E1233
Triple-Sealed Bearings for Ball Bearing Units CAT.No. E1234
Ball Bearings Units Stainless Series CAT.No. E1235
Ball Bearing Units Hand book CAT.No. E1155



14. PLUMMER BLOCKS

DESIGN, TYPES AND FEATURES

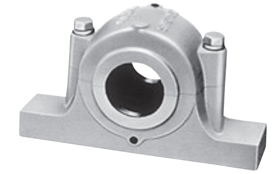
There are numerous types and sizes of plummer blocks.



SN 5
SN 6
SN 30
SN 31
SN 2
SN 3
SN 2C
SN 3C

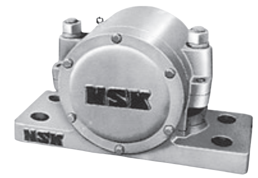
These are the most common type. Models SN30 and SN31 are for medium loads.

For types SN2C and SN3C, the bore diameters on the two sides are different.



SN 5B
SN 6B
SN 30B
SN 31B
SN 2B
SN 3B
SN 2BC
SN 3BC

These have the same dimensions as those of 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.

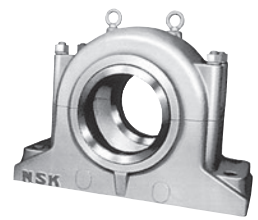


SG 5

Dustproof plummer blocks have a combination of oil seals, labyrinth seals, and oil groove seals, therefore, they are suitable for environments with much dust and other foreign matter.

SD 30S
SD 31S
SD 5
SD 6
SD 2
SD 3
SD 2C
SD 3C

These are large and made for heavy loads. The standard ones have double seals and four mounting bolt holes. For types SD2C and SD3C, the bore diameters on the two sides are different.

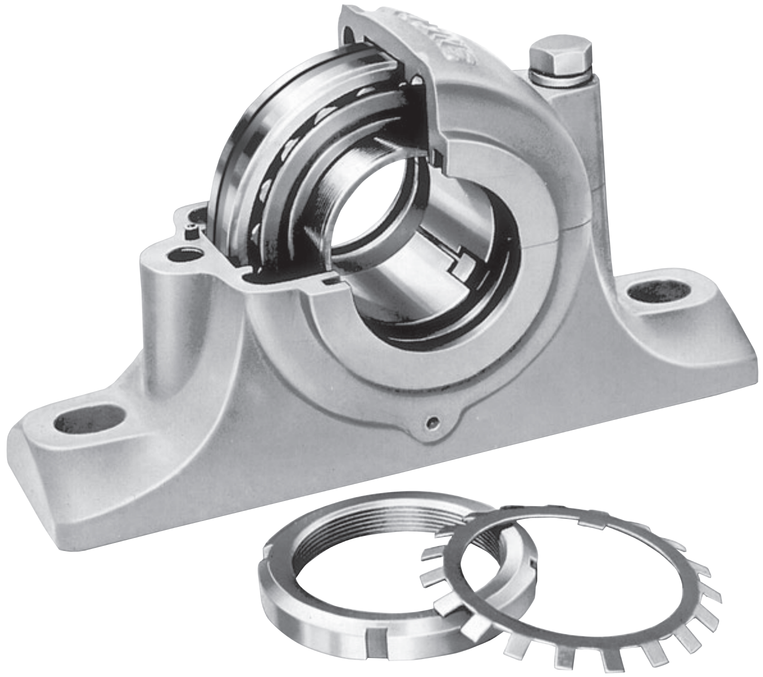


SD31TS
SD32TS

These are provided with labyrinth seals, so they are suitable for high speed applications.

V · C

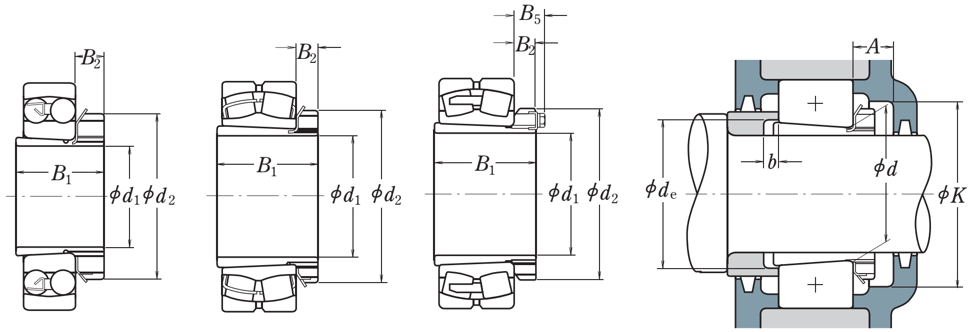
Single-piece plummer blocks (integrated type roller bearing unit)have higher rigidity and precision than split type plummer blocks.



15. ACCESSORIES FOR ROLLING BEARINGS

ADAPTERS FOR ROLLING BEARINGS

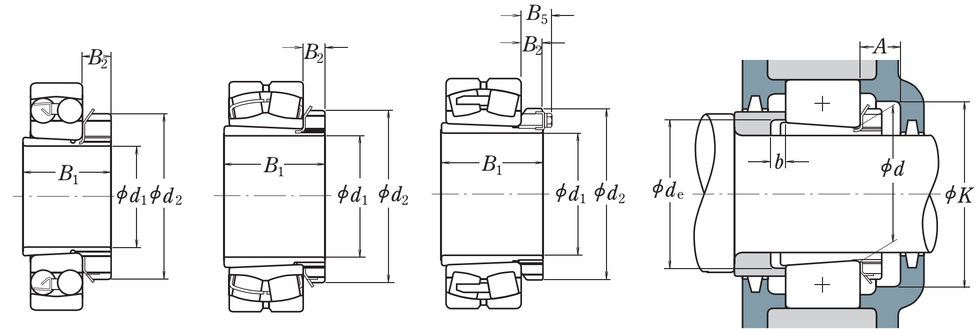
Shaft Diameter 17 – 40 mm



Shaft Diameter (mm) d_1	Nominal Bearing Bore Dia. (mm) d	Nominal Numbers Applicable Bearings		Dimensions (mm) B_1	d_2	B_2	B_5	Adapter Sleeve Numbers	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 The suffix X represents adapter sleeves having narrow slits, for which washers with straight tabs should be used.

Shaft Diameter 45 – 60 mm

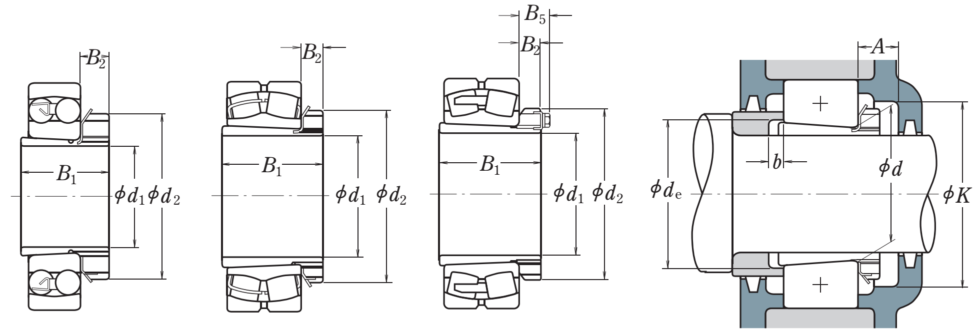


Shaft Diameter (mm) d_1	Nominal Bearing Bore Dia. (mm) d	Nominal Numbers Applicable Bearings		Dimensions (mm) B_1	d_2	B_2	B_5	Adapter Sleeve Numbers	Abutment Dimensions (mm) A min.	K min.	d_e min.	b min.	Mass (kg) approx.
45	50	1210K	+ **H 210X**	35	70	12	—	A 210X	19	76	53	5	0.275
	50	2210K	+ **H 310X**	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 The suffix X represents adapter sleeves having narrow slits, for which washers with straight tabs should be used.

ADAPTERS FOR ROLLING BEARINGS

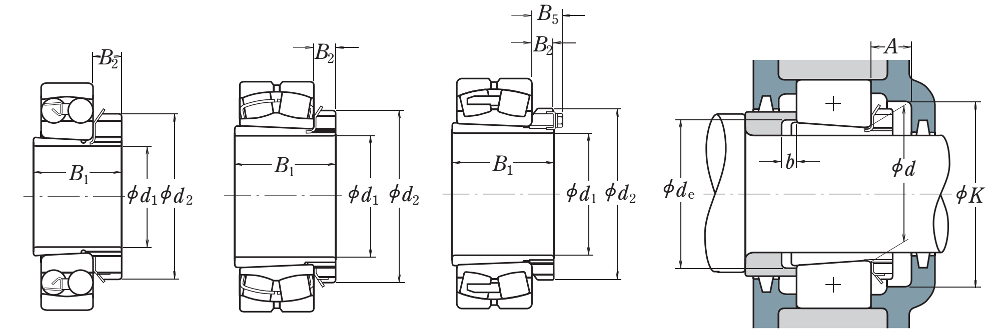
Shaft Diameter 65 – 80 mm



Shaft Diameter (mm) d_1	Nominal Bearing Bore Dia. (mm) d	Nominal Numbers Applicable Bearings		Dimensions (mm) B_1	d_2	B_2	B_5	Adapter Sleeve Numbers	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 The suffix X represents adapter sleeves having narrow slits, for which washers with straight tabs should be used.

Shaft Diameter 85 – 115 mm

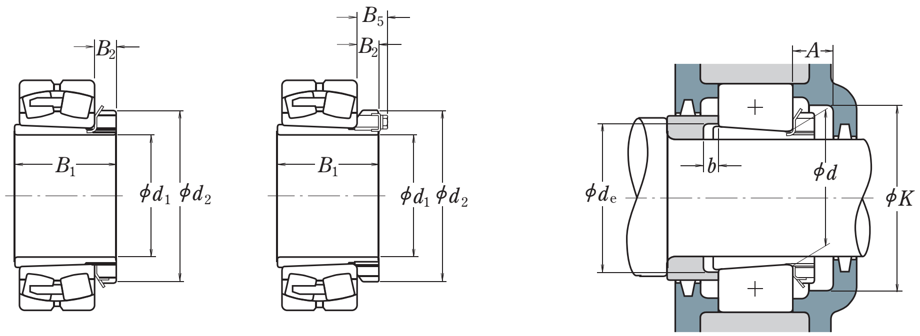


Shaft Diameter (mm) d_1	Nominal Bearing Bore Dia. (mm) d	Nominal Numbers Applicable Bearings		Dimensions (mm) B_1	d_2	B_2	B_5	Adapter Sleeve Numbers	Abutment Dimensions (mm) A min.	K min.	d_e min.	b min.	Mass (kg) approx.
85	95	1219K	+ **H 219X**	55	125	19	—	A 219X	29	145	101	7	1.35
	95	2219K	+ **H 319X**	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 The suffix X represents adapter sleeves having narrow slits, for which washers with straight tabs should be used.

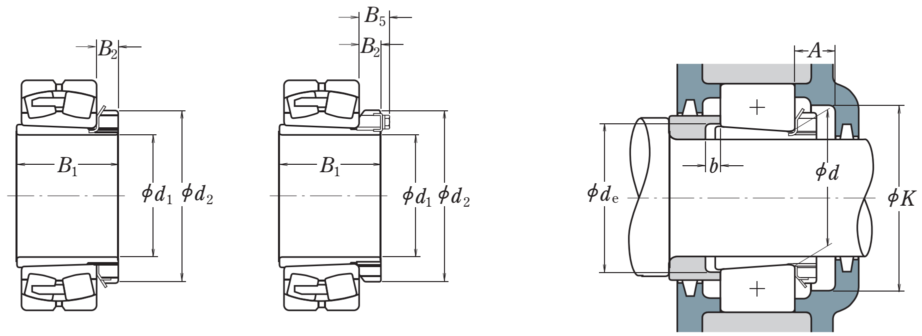
ADAPTERS FOR ROLLING BEARINGS

Shaft Diameter 125 – 170 mm



Shaft Diameter (mm) d_1	Nominal Bearing Bore Dia. (mm) d	Nominal Numbers Applicable Bearings	Dimensions (mm) B_1	d_2	B_2	B_5	Adapter Sleeve Numbers	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

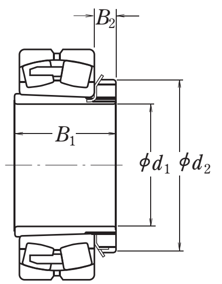
Shaft Diameter 180 – 260 mm

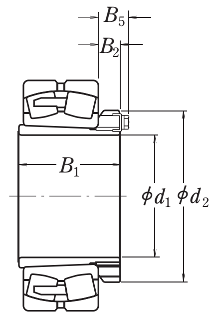


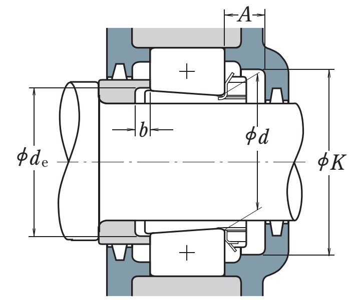
Shaft Diameter (mm) d_1	Nominal Bearing Bore Dia. (mm) d	Nominal Numbers Applicable Bearings	Dimensions (mm) B_1	d_2	B_2	B_5	Adapter Sleeve Numbers	Abutment Dimensions (mm) A min.	K min.	d_e min.	b min.	Mass (kg) approx.
180	200	23940C AKE4 + **H3940**	98	240	32	—	A 3940	46	260	210	10	8.0
	200	23040C AKE4 + **H3040**	120	240	32	—	A 3040	46	280	210	10	9.2
	200	23140C KE4 + **H3140**	150	250	32	—	A 3140	46	280	212	10	12
	200	22240C AKE4 + **H3140**	150	250	32	—	A 3140	46	280	212	24	12
	200	23240C KE4 + **H2340**	176	250	32	—	A 2340	46	280	216	20	14
	200	22340C AKE4 + **H2340**	176	250	32	—	A 2340	46	280	216	10	14
200	220	23944C AKE4 + **H3944**	96	260	30	41	A 3944	55	280	231	10	8.32
	220	23044C AKE4 + **H3044**	128	260	30	41	A 3044	55	320	231	12	10.5
	220	23144C KE4 + **H3144**	158	280	32	44	A 3144	55	320	233	10	14.5
	220	22244C AKE4 + **H3144**	158	280	32	44	A 3144	55	320	233	22	14.5
	220	23244C KE4 + **H2344**	183	280	32	44	A 2344	55	320	236	11	16.5
	220	22344C AKE4 + **H2344**	183	280	32	44	A 2344	55	320	236	10	16.5
220	240	23948C AKE4 + **H3948**	101	290	34	46	A 3948	60	300	251	11	11.2
	240	23048C AKE4 + **H3048**	133	290	34	46	A 3048	60	340	251	11	13
	240	23148C KE4 + **H3148**	169	300	34	46	A 3148	60	340	254	11	17.5
	240	22248C AKE4 + **H3148**	169	300	34	46	A 3148	60	340	254	19	17.5
	240	23248C AKE4 + **H2348**	196	300	34	46	A 2348	60	340	257	6	19.5
	240	22348C AKE4 + **H2348**	196	300	34	46	A 2348	60	340	257	11	19.5
240	260	23952C AKE4 + **H3952**	116	310	34	46	A 3952	60	330	272	11	13.4
	260	23052C AKE4 + **H3052**	147	310	34	46	A 3052	60	370	272	13	15.5
	260	23152C AKE4 + **H3152**	187	330	36	49	A 3152	60	370	276	11	22
	260	22252C AKE4 + **H3152**	187	330	36	49	A 3152	60	370	276	25	22
	260	23252C AKE4 + **H2352**	208	330	36	49	A 2352	60	370	278	2	24
	260	22352C AKE4 + **H2352**	208	330	36	49	A 2352	60	370	278	11	24
260	280	23956C AKE4 + **H3956**	121	330	38	50	A 3956	65	350	292	12	15.5
	280	23056C AKE4 + **H3056**	152	330	38	50	A 3056	65	390	292	12	17.5
	280	23156C AKE4 + **H3156**	192	350	38	51	A 3156	65	390	296	12	24.5
	280	22256C AKE4 + **H3156**	192	350	38	51	A 3156	65	390	296	28	24.5
	280	23256C AKE4 + **H2356**	221	350	38	51	A 2356	65	390	299	11	28
	280	22356C AKE4 + **H2356**	221	350	38	51	A 2356	65	390	299	12	28

ADAPTERS FOR ROLLING BEARINGS

Shaft Diameter 280 – 410 mm

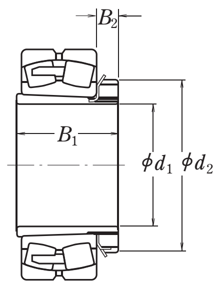


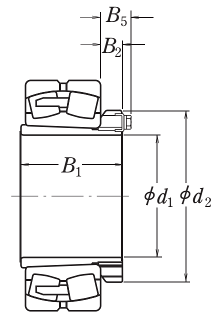


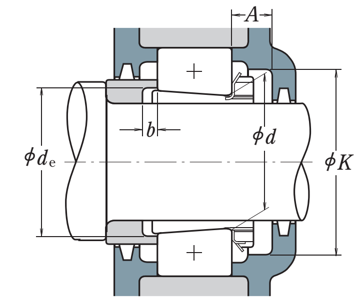


Shaft Diameter (mm) d_1	Nominal Bearing Bore Dia. (mm) d	Nominal Numbers Applicable Bearings	Dimensions (mm) B_1	d_2	B_2	B_5	Adapter Sleeve Numbers	Abutment Dimensions (mm) A min.	K min.	d_e min.	b min.	Mass (kg) approx.
280	300	23960C AKE4 + **H3960**	140	360	42	54	A3960	69	380	313	12	20.7
	300	23060C 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



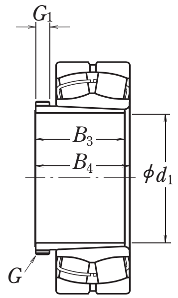




Shaft Diameter (mm) d_1	Nominal Bearing Bore Dia. (mm) d	Nominal Numbers Applicable Bearings	Dimensions (mm) B_1	d_2	B_2	B_5	Adapter Sleeve Numbers	Abutment Dimensions (mm) A min.	K min.	d_e min.	b min.	Mass (kg) approx.
430	460	23992C AKE4 + **H3992**	189	540	60	77	A3992	99	570	478	17	62
	460	23092C 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

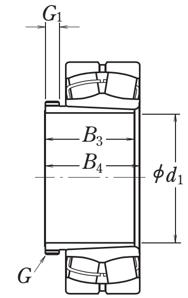
WITHDRAWAL SLEEVES FOR ROLLING BEARINGS

Shaft Diameter 35 – 85 mm



Shaft Diameter (mm) d_1	Nominal Bearing Bore Dia. (mm) d	Nominal Numbers Applicable Bearings	Screw Thread G	Dimensions (mm) B_3	G_1	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

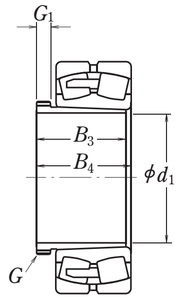
Shaft Diameter 90 – 135 mm



Shaft Diameter (mm) d_1	Nominal Bearing Bore Dia. (mm) d	Nominal Numbers Applicable Bearings	Screw Thread 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

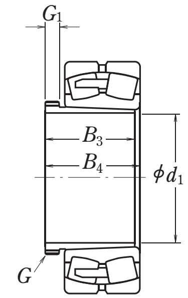
WITHDRAWAL SLEEVES FOR ROLLING BEARINGS

Shaft Diameter 145 – 180 mm



Shaft Diameter (mm) d_1	Nominal Bearing Bore Dia. (mm) d	Nominal Numbers Applicable Bearings	Screw Thread G	Dimensions (mm) B_3	G_1	B_4	Mass (kg) approx.
145	150	23030C DKE4 + **AHX 3030**	M 160 × 3	72	15	77	1.15
	150	24030C K30E4 + **AH 24030**	M 155 × 3	90	15	101	1.11
	150	23130C KE4 + **AHX 3130**	M 165 × 3	96	15	101	1.79
	150	22230C DKE4 + **AHX 3130**	M 165 × 3	96	15	101	1.79
	150	24130C K30E4 + **AH 24130**	M 160 × 3	115	15	126	1.63
	150	23230C KE4 + **AHX 3230**	M 165 × 3	114	17	119	2.22
	150	22330C AKE4 + **AHX 2330**	M 165 × 3	135	24	140	2.82
150	160	23032C DKE4 + **AH 3032**	M 170 × 3	77	16	82	2.05
	160	24032C K30E4 + **AH 24032**	M 170 × 3	95	15	106	2.28
	160	23132C KE4 + **AH 3132**	M 180 × 3	103	16	108	3.2
	160	22232C DKE4 + **AH 3132**	M 180 × 3	103	16	108	3.2
	160	24132C K30E4 + **AH 24132**	M 170 × 3	124	15	135	3.03
	160	23232C KE4 + **AH 3232**	M 180 × 3	124	20	130	4.1
	160	22332C AKE4 + **AH 2332**	M 180 × 3	140	24	146	4.7
160	170	23034C DKE4 + **AH 3034**	M 180 × 3	85	17	90	2.45
	170	24034C K30E4 + **AH 24034**	M 180 × 3	106	16	117	2.74
	170	23134C KE4 + **AH 3134**	M 190 × 3	104	16	109	3.4
	170	22234C DKE4 + **AH 3134**	M 190 × 3	104	16	109	3.4
	170	24134C K30E4 + **AH 24134**	M 180 × 3	125	16	136	3.26
	170	23234C KE4 + **AH 3234**	M 190 × 3	134	24	140	4.8
	170	22334C AKE4 + **AH 2334**	M 190 × 3	146	24	152	5.25
170	180	23036C DKE4 + **AH 3036**	M 190 × 3	92	17	98	2.8
	180	24036C K30E4 + **AH 24036**	M 190 × 3	116	16	127	3.19
	180	23136C KE4 + **AH 3136**	M 200 × 3	116	19	122	4.2
	180	24136C K30E4 + **AH 24136**	M 190 × 3	134	16	145	3.74
	180	22236C DKE4 + **AH 2236**	M 200 × 3	105	17	110	3.75
	180	23236C KE4 + **AH 3236**	M 200 × 3	140	24	146	5.3
	180	22336C AKE4 + **AH 2336**	M 200 × 3	154	26	160	5.85
180	190	23038C AKE4 + **AH 3038**	Tr 205 × 4	96	18	102	3.35
	190	24038C K30E4 + **AH 24038**	M 200 × 3	118	18	131	3.47
	190	23138C KE4 + **AH 3138**	Tr 210 × 4	125	20	131	4.9
	190	24138C K30E4 + **AH 24138**	M 200 × 3	146	18	159	4.38
	190	22238C AKE4 + **AH 2238**	Tr 210 × 4	112	18	117	4.25
	190	23238C KE4 + **AH 3238**	Tr 210 × 4	145	25	152	5.9
	190	22338C AKE4 + **AH 2338**	Tr 210 × 4	160	26	167	6.65

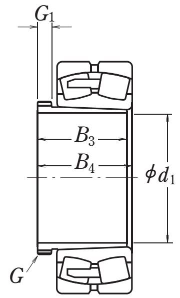
Shaft Diameter 190 – 260 mm



Shaft Diameter (mm) d_1	Nominal Bearing Bore Dia. (mm) d	Nominal Numbers Applicable Bearings	Screw Thread G	Dimensions (mm) B_3	G_1	B_4	Mass (kg) approx.
190	200	23040C AKE4 + **AH 3040**	Tr 215 × 4	102	19	108	3.8
	200	24040C K30E4 + **AH 24040**	Tr 210 × 4	127	18	140	3.92
	200	23140C KE4 + **AH 3140**	Tr 220 × 4	134	21	140	5.5
	200	24140C K30E4 + **AH 24140**	Tr 210 × 4	158	18	171	5.0
	200	22240C AKE4 + **AH 2240**	Tr 220 × 4	118	19	123	4.7
	200	23240C KE4 + **AH 3240**	Tr 220 × 4	153	25	160	6.7
	200	22340C AKE4 + **AH 2340**	Tr 220 × 4	170	30	177	7.55
200	220	23044C AKE4 + **AH 3044**	Tr 235 × 4	111	20	117	7.4
	220	24044C K30E4 + **AH 24044**	Tr 230 × 4	138	20	152	8.23
	220	23144C KE4 + **AH 3144**	Tr 240 × 4	145	23	151	10.5
	220	24144C K30E4 + **AH 24144**	Tr 230 × 4	170	20	184	10.3
	220	22244C AKE4 + **AH 2244**	Tr 240 × 4	130	20	136	9.1
	220	23244C KE4 + **AH 2344**	Tr 240 × 4	181	30	189	13.5
	220	22344C AKE4 + **AH 2344**	Tr 240 × 4	181	30	189	13.5
220	240	23048C AKE4 + **AH 3048**	Tr 260 × 4	116	21	123	8.75
	240	24048C K30E4 + **AH 24048**	Tr 250 × 4	138	20	153	9.0
	240	23148C KE4 + **AH 3148**	Tr 260 × 4	154	25	161	12
	240	24148C K30E4 + **AH 24148**	Tr 260 × 4	180	20	195	12.6
	240	22248C AKE4 + **AH 2248**	Tr 260 × 4	144	21	150	11
	240	23248C AKE4 + **AH 2348**	Tr 260 × 4	189	30	197	15.5
	240	22348C AKE4 + **AH 2348**	Tr 260 × 4	189	30	197	15.5
240	260	23052C AKE4 + **AH 3052**	Tr 280 × 4	128	23	135	10.5
	260	24052C AK30E4 + **AH 24052**	Tr 270 × 4	162	22	178	11.7
	260	23152C AKE4 + **AH 3152**	Tr 290 × 4	172	26	179	16
	260	24152C AK30E4 + **AH 24152**	Tr 280 × 4	202	22	218	15.5
	260	22252C AKE4 + **AH 2252**	Tr 290 × 4	155	23	161	14
	260	23252C AKE4 + **AH 2352**	Tr 290 × 4	205	30	213	19.5
	260	22352C AKE4 + **AH 2352**	Tr 290 × 4	205	30	213	19.5
260	280	23056C AKE4 + **AH 3056**	Tr 300 × 4	131	24	139	12
	280	24056C AK30E4 + **AH 24056**	Tr 290 × 4	162	22	179	12.6
	280	23156C AKE4 + **AH 3156**	Tr 310 × 5	175	28	183	17.5
	280	24156C AK30E4 + **AH 24156**	Tr 300 × 4	202	22	219	16.8
	280	22256C AKE4 + **AH 2256**	Tr 310 × 5	155	24	163	15
	280	23256C AKE4 + **AH 2356**	Tr 310 × 5	212	30	220	21.5
	280	22356C AKE4 + **AH 2356**	Tr 310 × 5	212	30	220	21.5

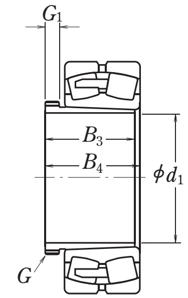
WITHDRAWAL SLEEVES FOR ROLLING BEARINGS

Shaft Diameter 280 – 380 mm



Shaft Diameter (mm) d_1	Nominal Bearing Bore Dia. (mm) d	Nominal Numbers — Applicable Bearings	Nominal Numbers — Sleeve	Screw Thread 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

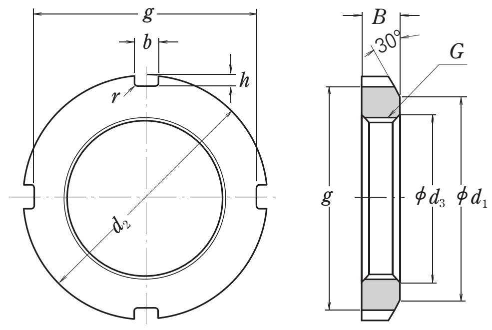
Shaft Diameter 400 – 480 mm



Shaft Diameter (mm) d_1	Nominal Bearing Bore Dia. (mm) d	Nominal Numbers — Applicable Bearings	Nominal Numbers — Sleeve	Screw Thread 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)



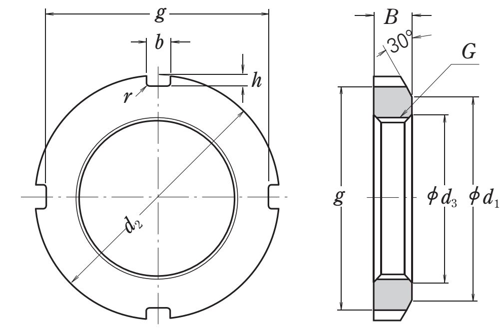
Nut with Washer

Units : mm

Nominal Numbers	Nut Series AN: Screw Threads G	Basic Dimensions d_2	d_1	g	b	h	d_3	B	r max.	Mass (kg) approx.	Reference: Adapter ([1]) Sleeve Bore Dia. Numbers	Washer Numbers	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 sleeve Series A31, A2, A3, and A23.

Remark The basic design and dimensions of screw threads are in accordance with JIS B 0205.



Nut with Washer

Units : mm

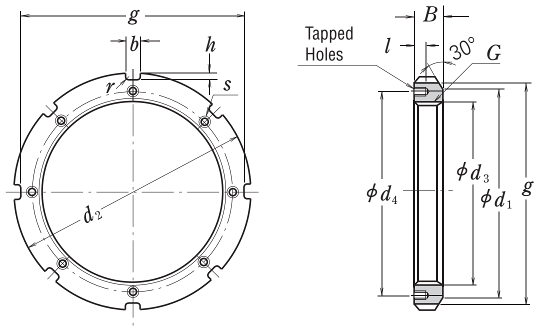
Nominal Numbers	Screw Threads G	Basic Dimensions d_2	d_1	g	b	h	d_3	B	r max.	Mass (kg) approx.	Reference: Adapter ([1]) Sleeve Bore Dia. Numbers	Washer Numbers	Shaft Dia.
Nut Series AN													
AN 26	M 130×2	165	149	155	12	5	131	21	0.7	1.25	26	**AW 26**	130
AN 27	M 135×2	175	160	163	14	6	136	22	0.7	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 sleeve Series A31 and A23.
Series ANL is applicable to adapter sleeve 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

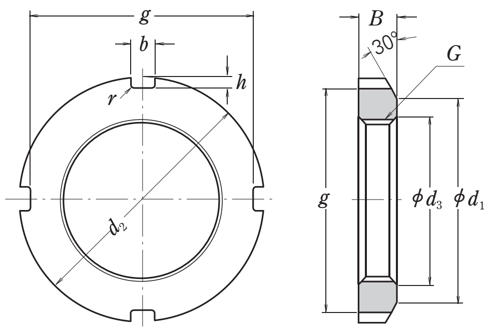
Units : mm

Nominal Numbers	Screw Threads G	Nut Series AN: Basic Dimensions d_2	d_1	g	b	h	d_3	B	r max.	Tapped Holes l	Tapped Holes Screw Threads (S)	d_4	Mass (kg) approx.	Reference: Adapter [1] Sleeve Bore Dia. Numbers	Stopper Numbers	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 sleeve Series A31, A32 and A23. Series ANL is applicable to adapter sleeve 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

Nominal Numbers	Screw Threads G	Nut Series HN: Basic Dimensions d_2	d_1	g	b	h	d_3	B	r max.	Mass (kg) approx.	Reference: Withdrawal Sleeve Numbers 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**			

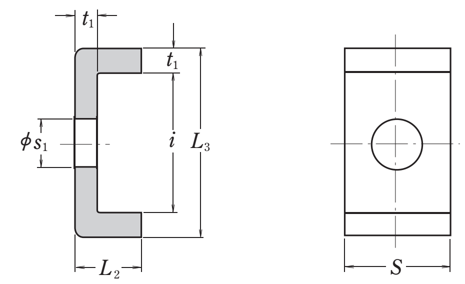
Remarks 1. The basic design and dimensions of screw threads are in accordance with JIS B 0216.
2. The number of notches in the nut may be bigger than that shown in the above figure.

NUTS FOR ROLLING BEARINGS

(Combination of Withdrawal Sleeves and Nuts)

Nominal Numbers	Reference						
	Withdrawal Sleeve Numbers						
	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

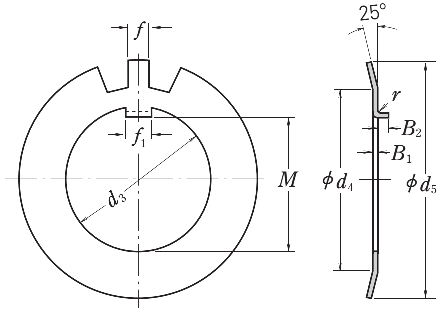
STOPPERS FOR ROLLING BEARINGS



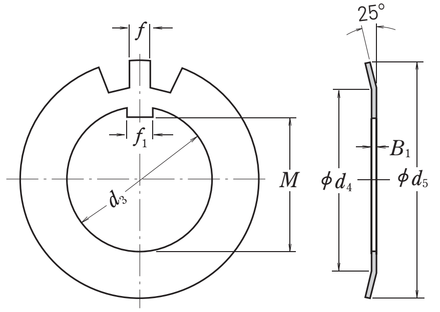
Units : mm

Nominal Numbers	Stopper Series AL							Reference
	Basic Dimensions						Mass (kg) per 100 pcs approx.	Nut Numbers
	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

LOCK-WASHERS FOR ROLLING BEARINGS



Bent-Tab



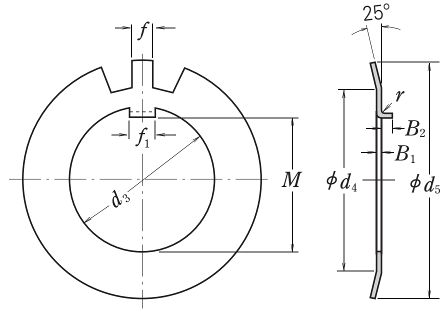
Straight-Tab

Units : mm

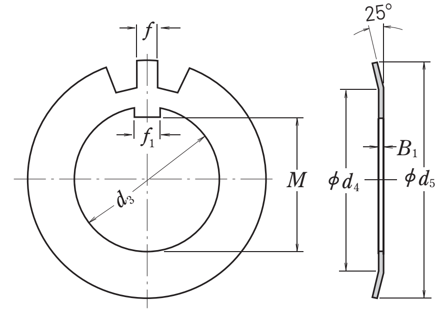
Nominal Numbers		Lock-washer Series AW											Reference		
		Basic Dimensions									No. of Teeth	Mass (kg) per 100 pcs approx.	Adapter (1) Sleeve Bore Dia. Numbers	Nut Numbers	Shaft Dia.
Bent-Tab	Straight-Tab	d_3	M	f_1	B_1	f	d_4	d_5	Bent-Tab r	Bent-Tab B_2					
AW 02	**AW 02 X**	15	13.5	4	1	4	21	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 sleeve Series A31, A2, A3, and A23.

Remark Lock-washers with straight tabs shall be used with adapter sleeves having narrow slits, and for those having wide slits, either type of lock-washer may be used.



Bent-Tab



Straight-Tab

Units : mm

Nominal Numbers		Lock-washer Series AW											Reference		
		Basic Dimensions									No. of Teeth	Mass (kg) per 100 pcs approx.	Adapter (1) Sleeve Bore Dia. Numbers	Nut Numbers	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 sleeve Series A31 and A23.
Series AWL is applicable to adapter sleeve Series A30.

Remark Lock-washers with straight tabs shall be used with adapter sleeves having narrow slits, and for those having wide slits, either type of lock-washer may be used.

(1)　(1)

Part D

INDUSTRY SOLUTIONS

Note (1): Photo courtesy of NIPPON STEEL & SUMITOMO METAL CORPORATION KASHIMA WORKS pamphlet.

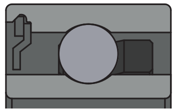
A Product Line that Matches Specific Applications

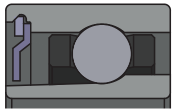
INDUSTRY SOLUTIONS

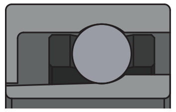
A Product Line that Matches Specific Applications

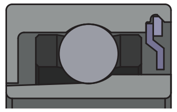
Outstanding Features of Dental Handpiece Bearings

· Bearing-type

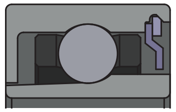

Deep groove type

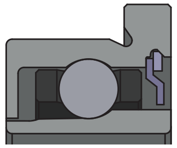

Angular type

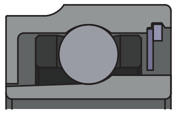

Integral angular type

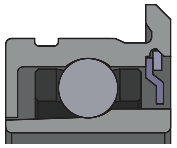

Integral + shield angular type

· Shape


Straight type


Flange type


Groove type


Special type

Long Life and High Corrosion Resistance ES1 Stainless Steel Bearing

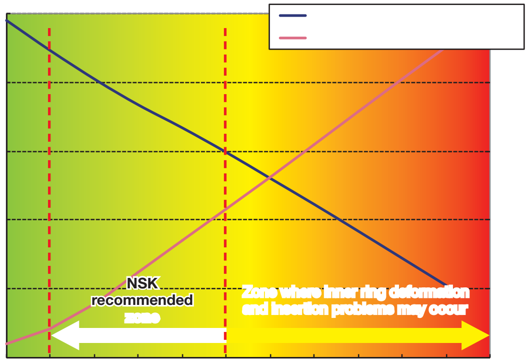
Ultra-high Speed Rotation

Formulation of Bearings for Numbers

(1) B3Z100X:
(2) -H-20SN34: -H-26:
(3) T52C:
C, J, P,
(4) ZS:
(5) CG9:
(6) 7A:
(7) U438:
(8) CF1X: BF7N:

Importance of a Perfect Fitting

- **Shaft material: Martensitic stainless steel (SUS400 family)**



Line-up

		Deep Groove	Angular Contact Bearing					
100 Series	2.380mm	100X	101X	102X	103X		104X	
	2.779mm	100	101A	102A	103A	103B	104A	104
150 Series	2.380mm	150X	151X	152X	153X		154X	
	2.779mm	150	151A	152A	153A	153B	154A	154
200 Series	2.380mm	200X	201X	202X	203X		204X	
	2.779mm	200	201A	202A	203A	203B	204A	204
250 Series	2.779mm	250	251A	252A	253A	253B	254A	254

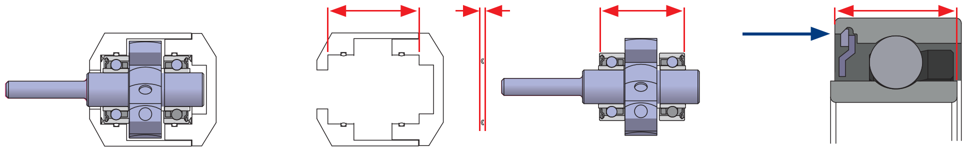
Standard Specifications

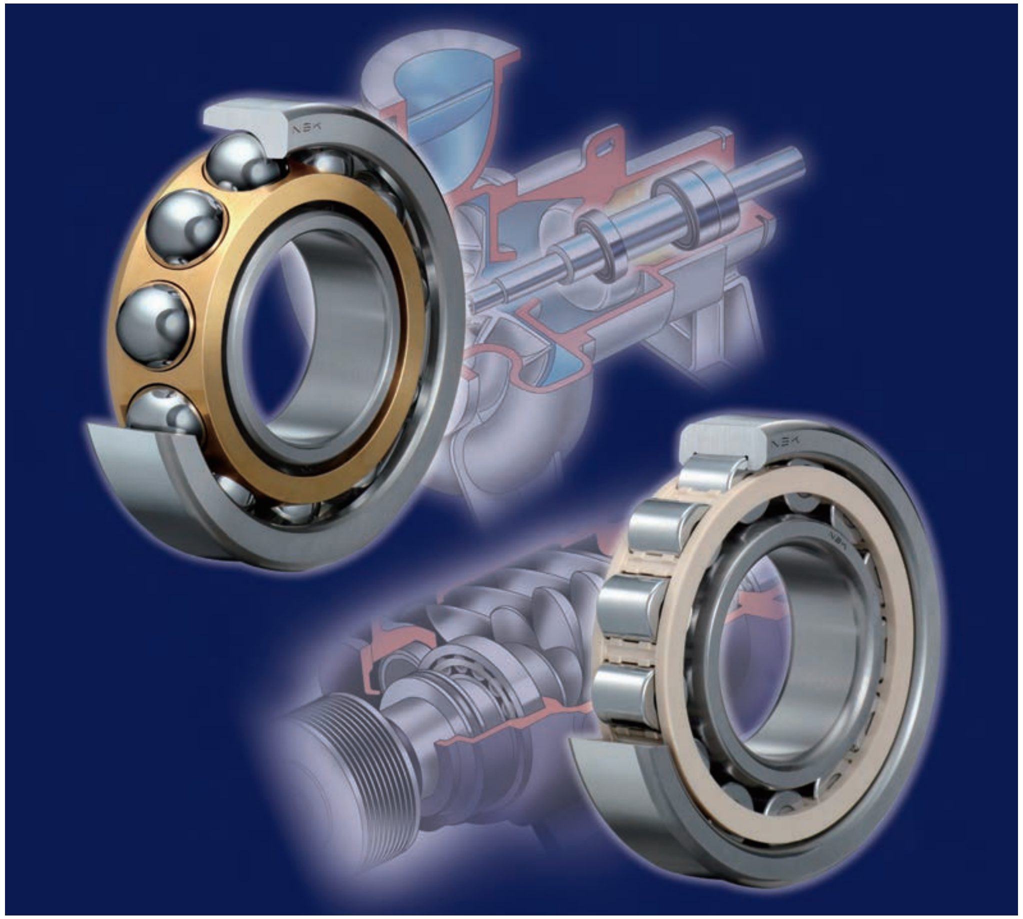
- Ceramic ball bearings
- To maximize bearing performance, NSK has adopted ABEC9(P2) grade tolerance for the inner ring bore
- NSK can supply bearings with two classifications of the inner ring bore diameter tolerance (from -0.0025
- NSK can manufacture bearings with custom laser markings upon request.
- NSK uses the high-safety low-viscosity lubricating oil CF1 as standard specification. Bearings with BF7

Optional Specifications

- Stainless steel ball bearings are also available.
- Bearings with different widths for the outer ring and inner ring are also available.

Preload Stabilization





Bearings for Pumps
A Product Line that Matches Specific Applications

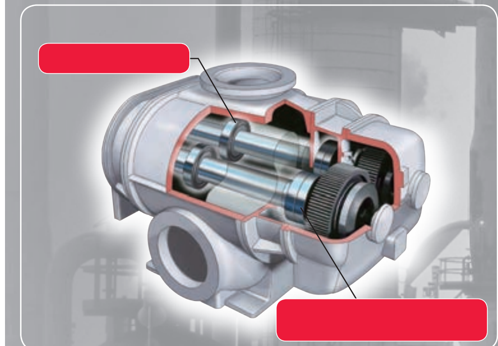
Bearings Table

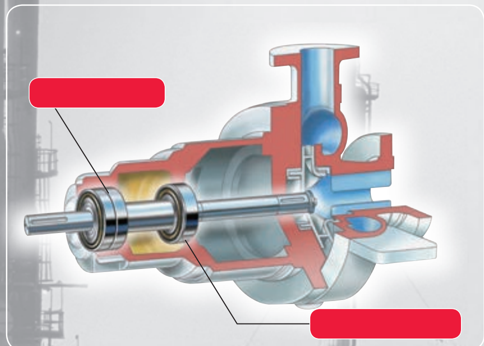
Bearings for Compressors
A Product Line that Matches Specific Applications

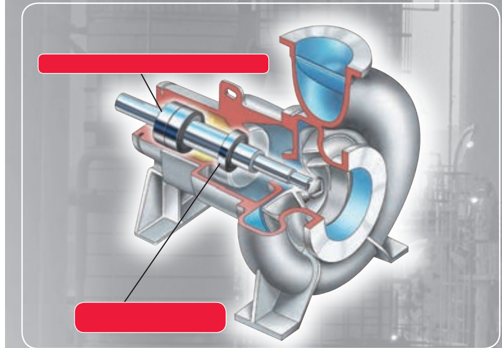
Bearings Table

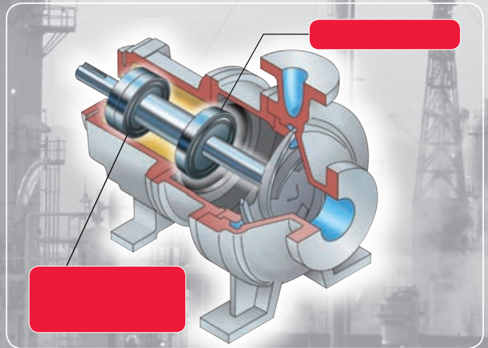
INDUSTRY SOLUTIONS

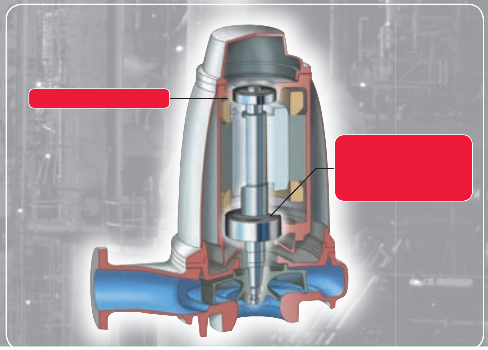
Bearings for Pumps











NSKHPS™ / High Load Capacity Single-Row Angular Contact Ball Bearings

■

■

High Load Capacity Double-Row Angular Contact Ball Bearings

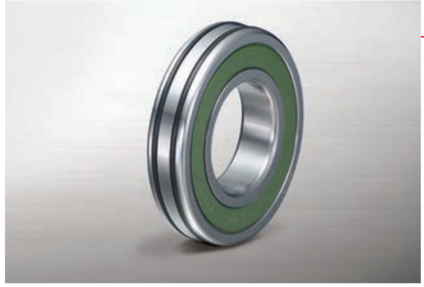
■

■

High Load Capacity Deep Groove Ball Bearings (Open Type)

■

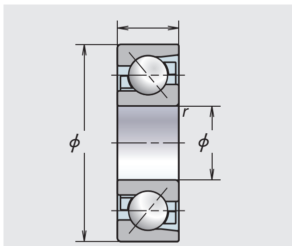
■

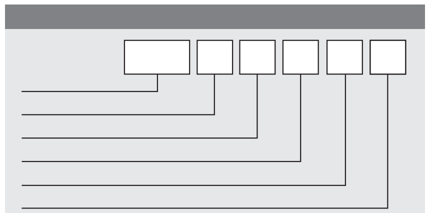


Creep-Free Bearings™

■

■





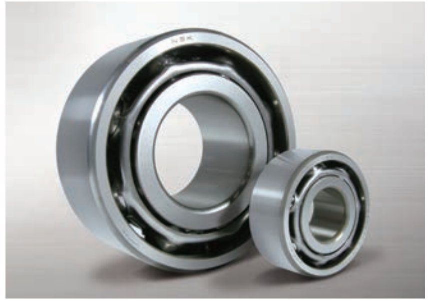
Bearing Numbers	Boundary Dimensions (mm)					Basic Load Ratings (N)		Limiting Speeds (min⁻¹)	
				(min.)	(min.)				
	20	52	15	1.1	0.6	19 800	10 500	13 000	18 000
	25	62	17	1.1	0.6	27 200	14 900	10 000	15 000
	30	62	16	1	0.6	23 700	14 300	10 000	14 000
	30	72	19	1.1	0.6	36 500	20 600	9 000	13 000
	35	72	17	1.1	0.6	32 500	19 600	8 500	12 000
	35	80	21	1.5	1	40 500	24 400	8 000	11 000
	40	80	18	1.1	0.6	38 500	24 500	7 500	11 000
	40	90	23	1.5	1	53 000	33 000	7 100	10 000
	45	85	19	1.1	0.6	40 500	27 100	7 100	10 000
	45	100	25	1.5	1	62 500	39 500	6 300	9 000
	50	90	20	1.1	0.6	42 000	29 700	6 300	9 500
	50	110	27	2	1	78 000	50 500	5 600	8 000
	55	100	21	1.5	1	51 500	37 000	6 000	8 500
	55	120	29	2	1	89 000	58 500	5 000	7 500
	60	110	22	1.5	1	61 500	45 000	5 300	7 500
	60	130	31	2.1	1.1	102 000	68 500	4 800	6 700
	65	120	23	1.5	1	70 000	53 500	4 800	7 100
	65	140	33	2.1	1.1	114 000	77 000	4 300	6 300
	70	125	24	1.5	1	75 500	58 500	4 500	6 700
	70	150	35	2.1	1.1	124 000	87 500	4 000	6 000
	75	130	25	1.5	1	78 500	63 500	4 300	6 300
	75	160	37	2.1	1.1	134 000	98 500	3 800	5 600
	80	140	26	2	1	87 500	70 000	4 000	6 000
	80	170	39	2.1	1.1	144 000	110 000	3 600	5 300
	85	150	28	2	1	96 000	81 500	3 800	5 600
	85	180	41	3	1.1	157 000	133 000	3 400	5 000
	90	160	30	2	1	109 000	93 500	3 600	5 300
	90	190	43	3	1.1	169 000	146 000	3 200	4 500
	95	170	32	2.1	1.1	123 000	107 000	3 400	5 000
	95	200	45	3	1.1	180 000	160 000	3 000	4 500
	100	180	34	2.1	1.1	136 000	122 000	3 200	4 500
	100	215	47	3	1.1	202 000	187 000	2 800	4 000
	105	190	36	2.1	1.1	148 000	133 000	3 000	4 500
	105	225	49	3	1.1	213 000	203 000	2 600	4 000
	110	200	38	2.1	1.1	154 000	144 000	2 800	4 300
	110	240	50	3	1.1	226 000	226 000	2 600	3 800
	120	215	40	2.1	1.1	179 000	177 000	2 600	3 800
	120	260	55	3	1.1	238 000	250 000	2 200	3 400

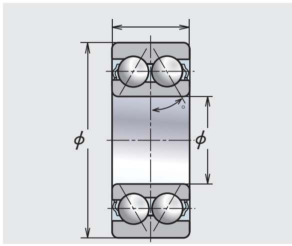
Remarks

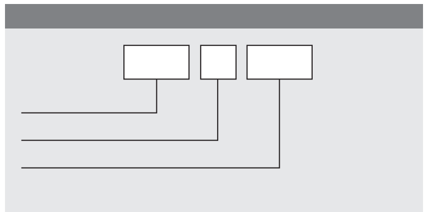
NSKHPS™ angular contact ball bearings with running accuracy to ISO tolerance class 5 and dimensional accuracy to ISO tolerance class 6.

No asterisk refers to high load capacity angular contact ball bearings with running accuracy P6 and dimensional accuracy P6.

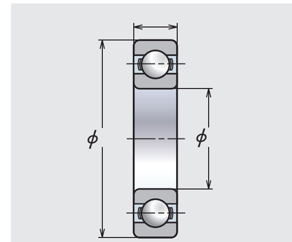
Features of Bearings for Pumps

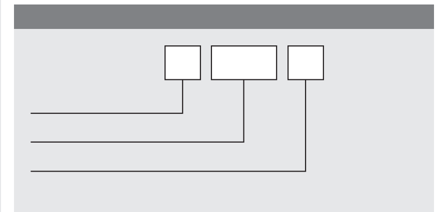




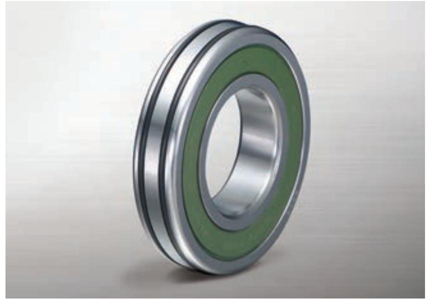


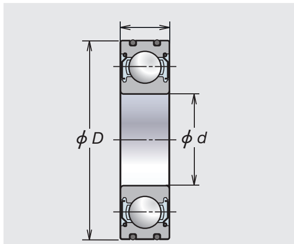
Bearing Numbers	Boundary Dimensions (mm)			Basic Load Ratings (N)	
				(dynamic)	(static)
	25	62	25.4	30 500	20 500
	30	72	30.2	39 500	27 300
	35	80	34.9	49 500	35 000
	40	90	36.5	60 500	44 000
	45	100	39.7	66 500	49 500
	50	110	44.4	85 500	64 500
	55	120	49.2	106 000	82 000
	60	130	54	122 000	95 500
	65	140	58.7	138 000	109 000





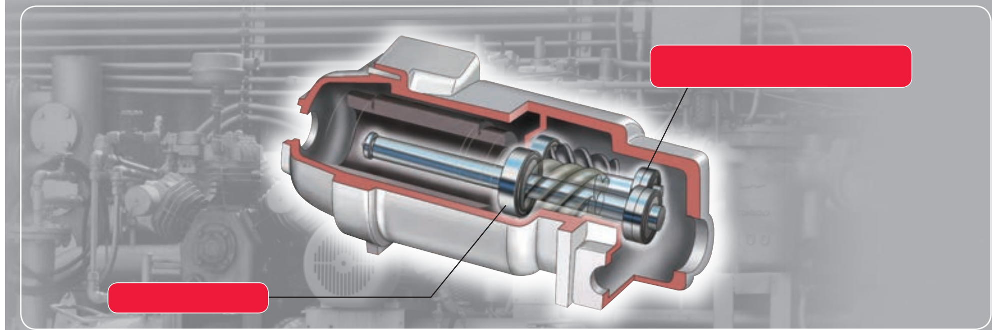
Bearing Numbers	Boundary Dimensions (mm)				Basic Load Ratings (N)	
				(min.)	(dynamic)	(static)
	15	35	11	0.6	8 550	3 950
	15	42	13	1.0	13 300	5 900
	17	40	12	0.6	11 300	5 350
	17	47	14	1.0	15 600	7 100
	20	52	15	1.1	18 200	9 050
	25	52	15	1.0	15 300	8 100
	25	62	17	1.1	23 700	12 200
	30	62	16	1.0	23 300	12 800
	30	72	19	1.1	29 800	15 800
	35	72	17	1.1	28 300	16 000
	35	80	21	1.5	39 500	21 500
	40	80	18	1.1	32 500	19 900
	40	90	23	1.5	47 000	26 200
	45	85	19	1.1	36 500	22 600
	45	100	25	1.5	57 000	34 500
	50	90	20	1.1	39 000	25 800
	50	110	27	2.0	66 500	40 500
	55	100	21	1.5	48 000	32 000
	55	120	29	2.0	78 000	46 000
	60	110	22	1.5	58 000	38 000

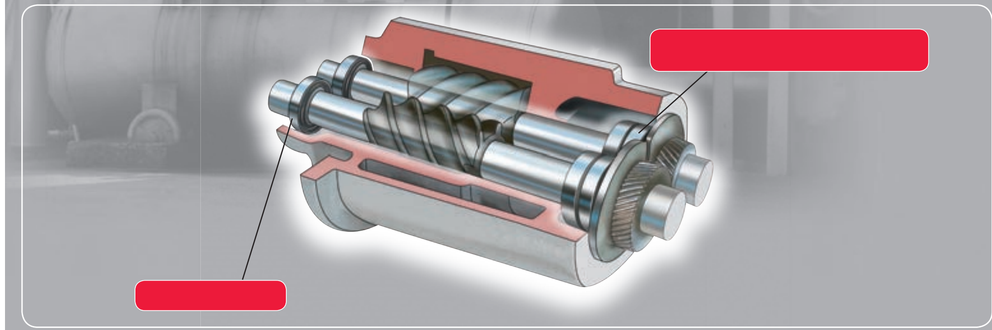


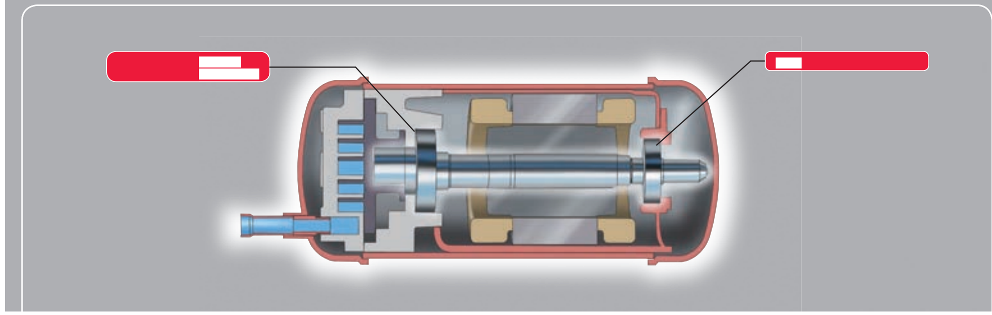


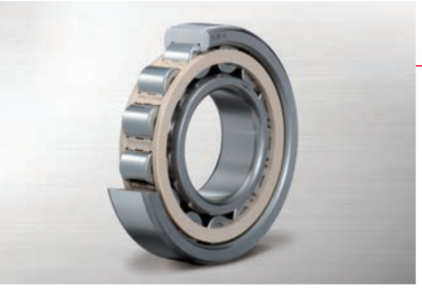
Bearing Numbers	Boundary Dimensions (mm)				Basic Load Ratings (N)	
				(min.)	(dynamic)	(static)
	10	26	8	0.3	4 550	1 970
	10	30	9	0.6	5 100	2 390
	10	35	11	0.6	8 100	3 450
	12	28	8	0.3	5 100	2 370
	12	32	10	0.6	6 800	3 050
	12	37	12	1.0	9 700	4 200
	15	32	9	0.3	5 600	2 830
	15	35	11	0.6	7 650	3 750
	15	42	13	1.0	11 400	5 450
	17	35	10	0.3	6 000	3 250
	17	40	12	0.6	9 550	4 800
	17	47	14	1.0	13 600	6 650
	20	42	12	0.6	9 400	5 000
	20	47	14	1.0	12 800	6 600
	20	52	15	1.1	15 900	7 900
	25	47	12	0.6	10 100	5 850
	25	52	15	1.0	14 000	7 850
	25	62	17	1.1	20 600	11 200
	30	55	13	1.0	13 200	8 300
	30	62	16	1.0	19 500	11 300
	30	72	19	1.1	26 700	15 000
	35	62	14	1.0	16 000	10 300
	35	72	17	1.1	25 700	15 300
	35	80	21	1.5	33 500	19 200
	40	68	15	1.0	16 800	11 500
	40	80	18	1.1	29 100	17 900
	40	90	23	1.5	40 500	24 000
	45	75	16	1.0	20 900	15 200
	45	85	19	1.1	31 500	20 400
	45	100	25	1.5	53 000	32 000

Bearings for Compressors

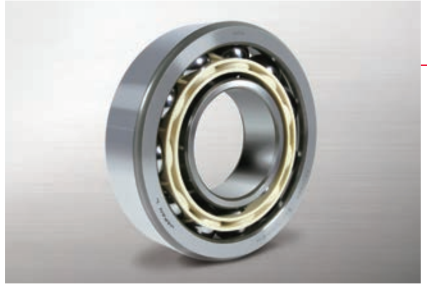




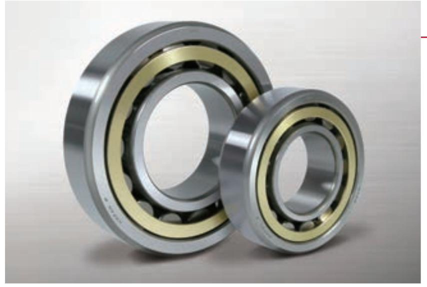




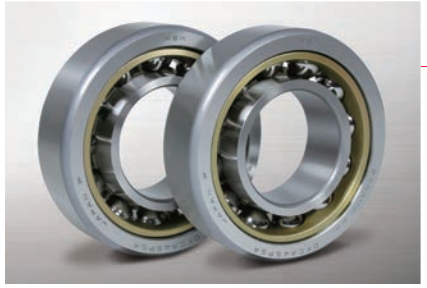
High Load Capacity Cylindrical Roller Bearings (L-PPS cage)



NSKHPS™ Angular Contact Ball Bearings (L-PPS cage)

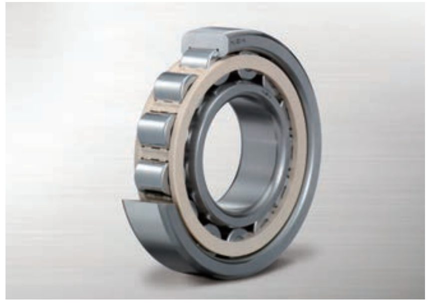


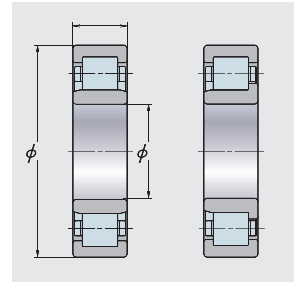
High-Speed Cylindrical Roller Bearings

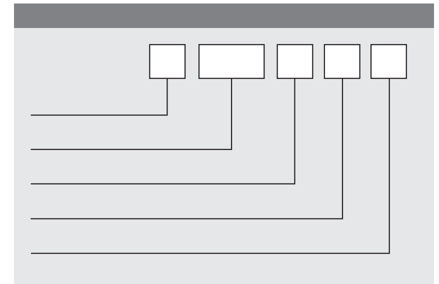


High-Speed Angular Contact Ball Bearings

■Features of Bearings for compressors



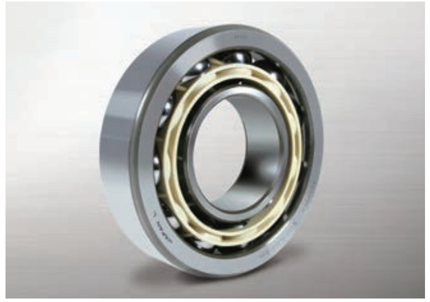


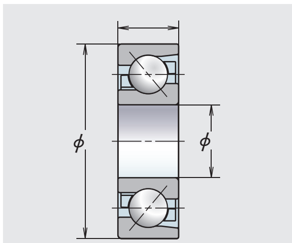


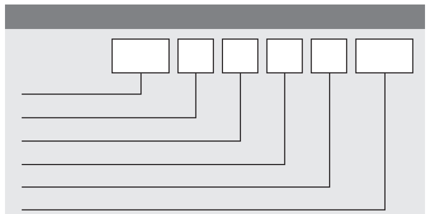
Bearing Numbers	Boundary Dimensions (mm)					Basic Load Ratings (N)	
				(min.)	(min.)	(dynamic)	(static)
	20	47	14	1	0.6	25 700	22 600
	20	52	15	1.1	0.6	31 500	26 900
	20	47	18	1	0.6	30 500	28 300
	20	52	21	1.1	0.6	42 000	39 000
	25	52	15	1	0.6	29 300	27 700
	25	62	17	1.1	1.1	41 500	37 500
	25	52	18	1.	0.6	35 000	34 500
	25	62	24	1.1	1.1	57 000	56 000
	30	62	16	1	0.6	39 000	37 500
	30	72	19	1.1	1.1	53 000	50 000
	30	62	20	1	0.6	49 000	50 000
	30	72	27	1.1	1.1	74 500	77 500
	35	72	17	1.1	0.6	50 500	50 000
	35	80	21	1.5	1.1	66 500	65 500
	35	72	23	1.1	0.6	61 500	65 000
	35	80	31	1.5	1.1	93 000	101 000
	40	80	18	1.1	1.1	55 500	55 500
	40	90	23	1.5	1.5	83 000	81 500
	40	80	23	1.1	1.1	72 500	77 500
	40	90	33	1.5	1.5	114 000	122 000
	45	85	19	1.1	1.1	63 000	66 500
	45	100	25	1.5	1.5	97 500	98 500
	45	85	23	1.1	1.1	76 000	84 500
	45	100	36	1.5	1.5	137 000	153 000
	50	90	20	1.1	1.1	69 000	76 500
	50	110	27	2	2	110 000	113 000
	50	90	23	1.1	1.1	86 500	97 000
	50	110	40	2	2	163 000	187 000
	55	100	21	1.5	1.1	86 500	98 500
	55	120	29	2	2	137 000	143 000
	55	100	25	1.5	1.1	101 000	122 000

Bearing Numbers	Boundary Dimensions (mm)					Basic Load Ratings (N)	
				(min.)	(min.)	(dynamic)	(static)
	55	120	43	2	2	201 000	233 000
	60	110	22	1.5	1.5	97 500	107 000
	60	130	31	2.1	2.1	150 000	157 000
	60	110	28	1.5	1.5	131 000	157 000
	60	130	46	2.1	2.1	222 000	262 000
	65	120	23	1.5	1.5	108 000	119 000
	65	140	33	2.1	2.1	181 000	191 000
	65	120	31	1.5	1.5	149 000	181 000
	65	140	48	2.1	2.1	233 000	265 000
	70	125	24	1.5	1.5	119 000	137 000
	70	150	35	2.1	2.1	205 000	222 000
	70	125	31	1.5	1.5	156 000	194 000
	70	150	51	2.1	2.1	274 000	325 000
	75	130	25	1.5	1.5	130 000	156 000
	75	160	37	2.1	2.1	240 000	263 000
	75	130	31	1.5	1.5	162 000	207 000
	75	160	55	2.1	2.1	330 000	395 000
	80	140	26	2	2	139 000	167 000
	80	170	39	2.1	2.1	256 000	282 000
	80	140	33	2	2	186 000	243 000
	80	170	58	2.1	2.1	355 000	430 000
	85	150	28	2	2	167 000	199 000
	85	150	36	2	2	217 000	279 000
	85	180	60	3	3	395 000	485 000
	90	160	30	2	2	182 000	217 000
	90	160	40	2	2	242 000	315 000
	90	190	64	3	3	435 000	535 000
	100	180	34	2.1	2.1	310 000	305 000
	100	215	47	3	3	380 000	425 000
	100	180	46	2.1	2.1	335 000	445 000
	100	215	73	3	3	570 000	715 000

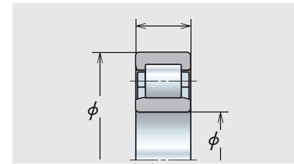
INDUSTRY SOLUTIONS

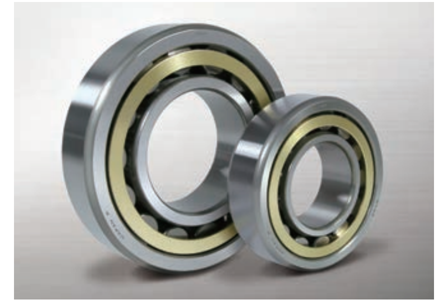






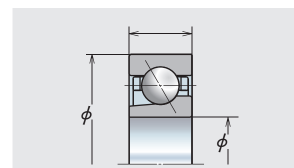
Bearing Numbers	Boundary Dimensions (mm)					Basic Load Ratings (N)		Maximum Rotational Speed (min⁻¹)
				(min.)	(min.)	(dynamic)	(static)	
	12	32	10	0.6	0.3	8 150	3 750	30 000
	12	37	12	1	0.6	11 100	4 950	26 000
	15	35	11	0.6	0.3	9 800	4 800	26 000
	15	42	13	1	0.6	14 300	6 900	22 000
	17	40	12	0.6	0.3	11 600	6 100	22 000
	17	47	14	1	0.6	16 800	8 300	20 000
	20	47	14	1	0.6	15 600	8 150	19 000
	20	52	15	1.1	0.6	19 800	10 500	18 000
	25	52	15	1	0.6	17 600	10 200	17 000
	25	62	17	1.1	0.6	27 200	14 900	15 000
	30	62	16	1	0.6	23 700	14 300	14 000
	30	72	19	1.1	0.6	36 500	20 600	13 000
	35	72	17	1.1	0.6	32 500	19 600	12 000
	35	80	21	1.5	1	40 500	24 400	11 000
	40	80	18	1.1	0.6	38 500	24 500	11 000
	40	90	23	1.5	1	53 000	33 000	10 000
	45	85	19	1.1	0.6	40 500	27 100	10 000
	45	100	25	1.5	1	62 500	39 500	9 000
	50	90	20	1.1	0.6	42 000	29 700	9 500
	50	110	27	2	1	78 000	50 500	8 000
	55	100	21	1.5	1	51 500	37 000	8 500
	55	120	29	2	1	89 000	58 500	7 500
	60	110	22	1.5	1	61 500	45 000	7 500
	60	130	31	2.1	1.1	102 000	68 500	6 700
	65	120	23	1.5	1	70 000	53 500	7 100
	65	140	33	2.1	1.1	114 000	77 000	6 300
	70	125	24	1.5	1	75 500	58 500	6 700
	70	150	35	2.1	1.1	124 000	87 500	6 000
	75	130	25	1.5	1	78 500	63 500	6 300
	80	140	26	2	1	87 500	70 000	6 000

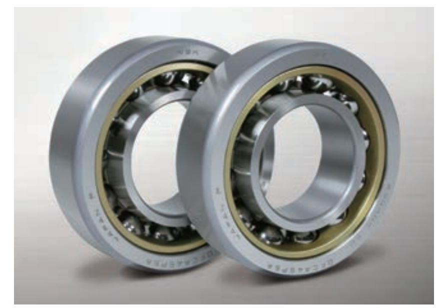




Bearing Numbers	Boundary Dimensions (mm)					Basic Load Ratings (N)	
				(min.)	(min.)	(dynamic)	(static)
	25	52	15	1	0.6	29 300	27 700
	30	62	16	1	0.6	39 000	37 500
	35	72	17	1.1	0.6	50 500	50 000
	40	80	18	1.1	1.1	55 500	55 500
	45	85	19	1.1	1.1	63 000	66 500
	50	90	20	1.1	1.1	69 000	76 500

Remarks 1: Under general forced-lubrication condition
2: Contact NSK for maximum rotational speed, which can vary according to service conditions, and lubricating system.





Bearing Numbers	Boundary Dimensions (mm)					Basic Load Ratings (N)	
				(min.)	(min.)	(dynamic)	(static)
	20	47	14	1	0.6	13 600	7 550
	25	52	15	1	0.6	15 400	9 500
	30	72	19	1.5	0.6	31 500	19 000
	35	80	21	1.5	0.6	39 000	24 000
	40	80	18	1.5	0.6	34 500	24 100
	45	100	25	1.5	1	60 000	40 000
	50	110	27	1	2.5	70 000	47 500

Remarks 1: Under general forced-lubrication condition
2: Contact NSK for maximum rotational speed, which can vary according to service conditions, and lubricating system.

A Product Line that Matches Specific Applications

Bearings Table

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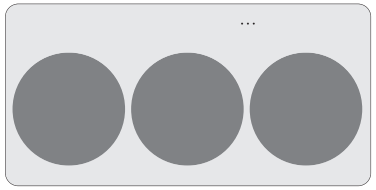
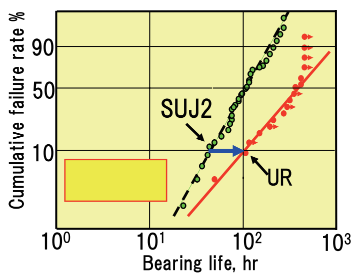
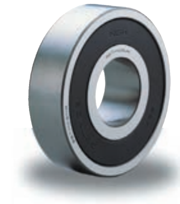
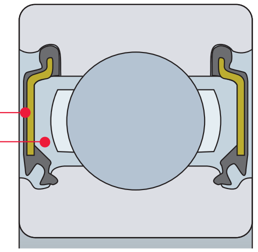
A Product Line that Matches Specific Applications

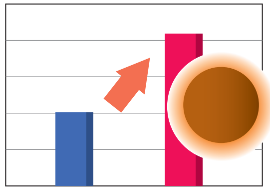
A Product Line that Matches Specific Applications

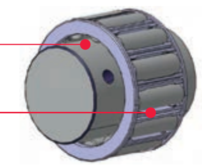


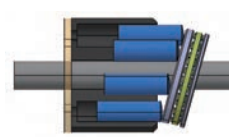




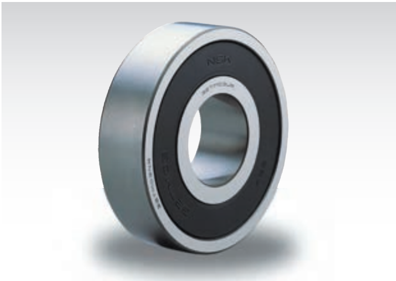


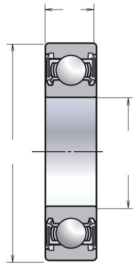


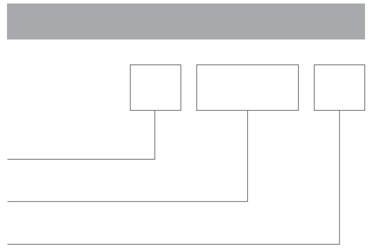




■Sealed Deep Groove Ball Bearings TM Series



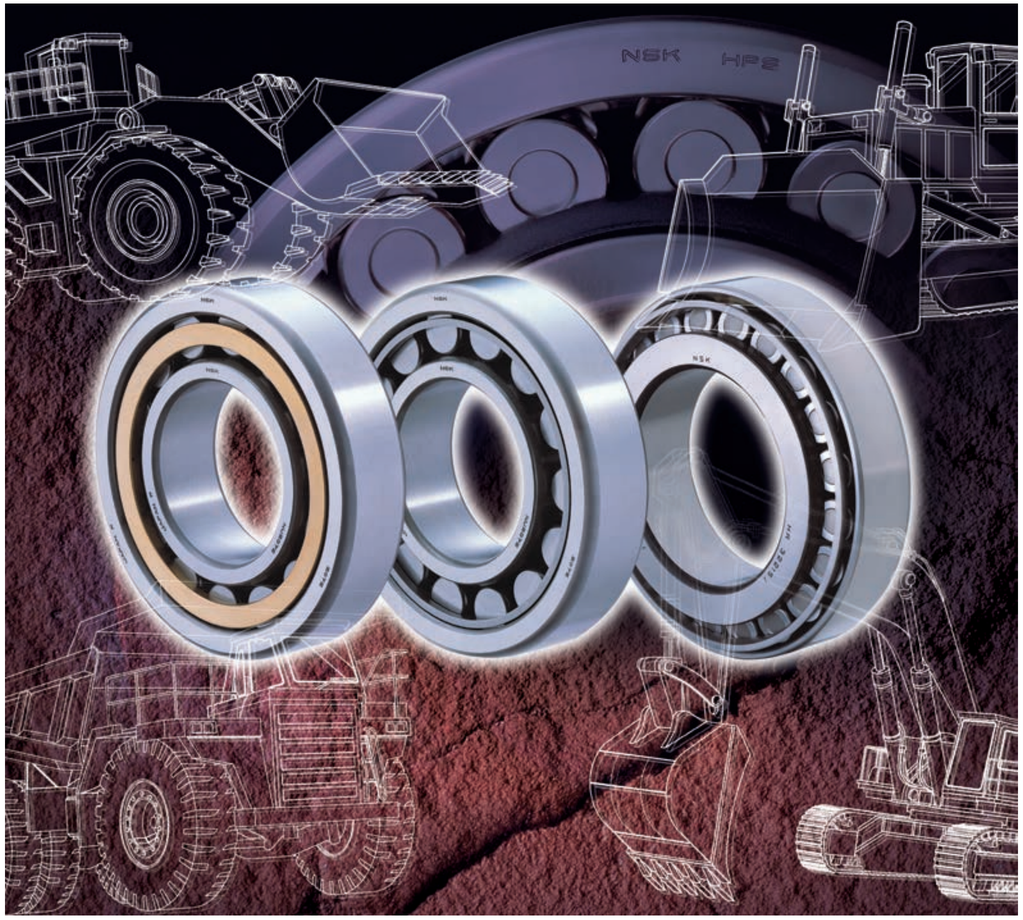




Bearing Numbers	Boundary Dimensions (mm)			Basic Load Ratings (N)	
	17	40	12	9 550	4 800
	17	47	14	13 600	6 650
	20	47	14	12 800	6 600
	20	52	15	15 900	7 900
	22	50	14	12 900	6 800
	22	56	16	18 400	9 250
	25	52	15	14 000	7 850
	25	62	17	20 600	11 200
	28	58	16	16 600	9 500
	28	68	18	26 700	14 000
	30	62	16	19 500	11 300
	30	72	19	26 700	15 000
	32	65	17	20 700	11 600
	32	75	20	29 400	17 000
	35	72	17	25 700	15 300
	35	80	21	33 500	19 200
	40	80	18	29 100	17 800
	40	90	23	40 500	24 000
	45	85	19	31 500	20 400
	45	100	25	53 000	32 000
	50	90	20	35 000	23 200
	50	110	27	62 000	38 500
	55	100	21	43 500	29 300
	55	120	29	71 500	44 500
	60	110	22	52 500	36 000
	60	130	31	82 000	52 000
	65	120	23	57 500	40 000
	65	140	33	92 500	60 000
	70	125	24	62 000	44 000
	70	150	35	104 000	68 000

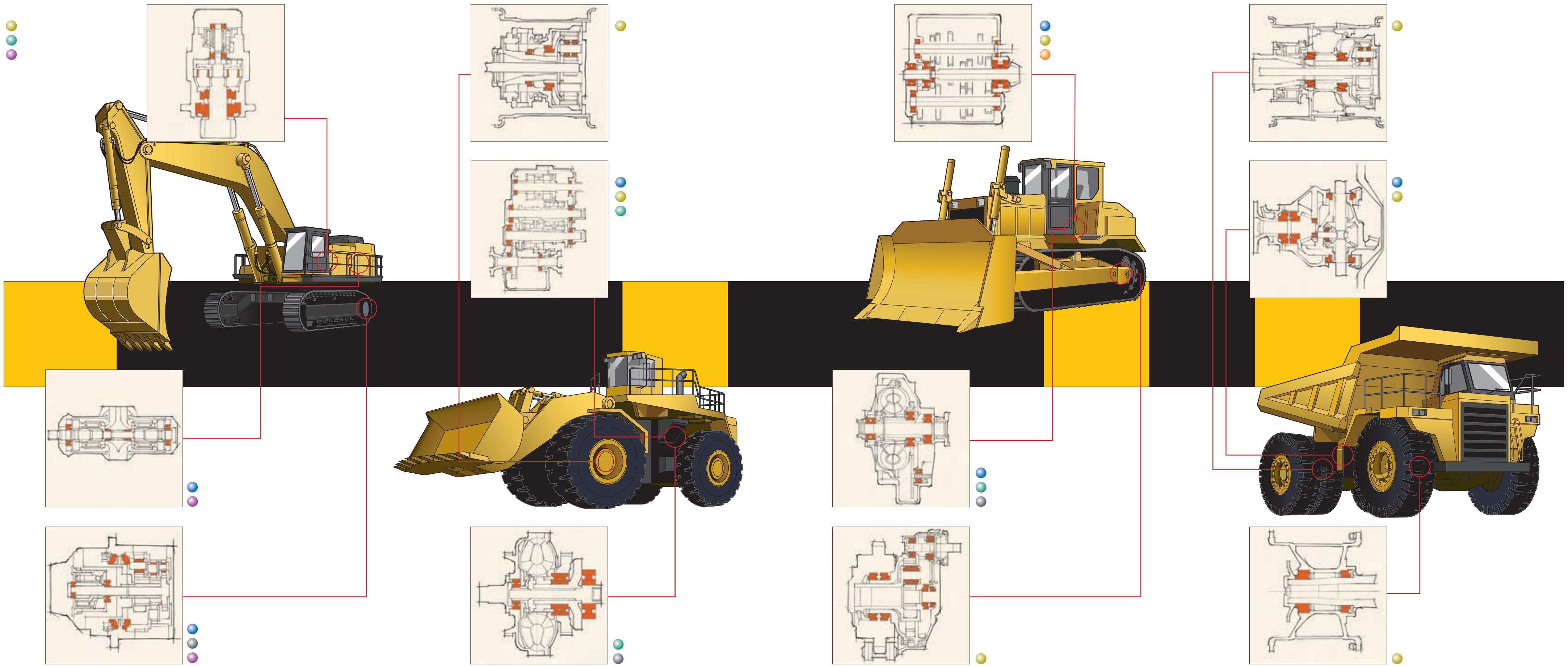
Note Maximum continuous operating temperature for standard nitrile rubber seals is 110°C.

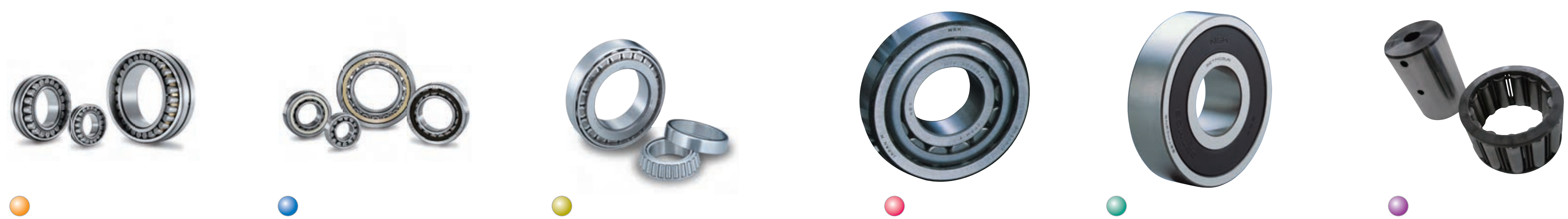
INDUSTRY SOLUTIONS



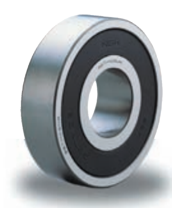
A Product Line that Matches Specific Applications

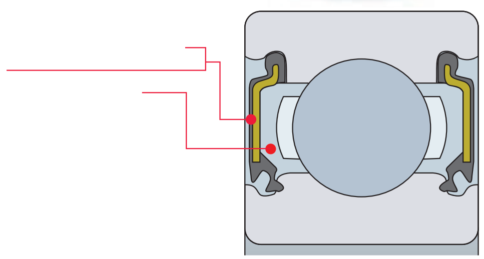
A Product Line that Matches Specific Applications

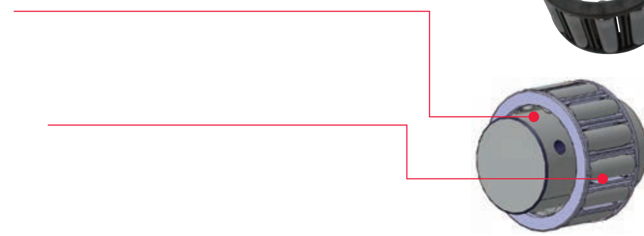


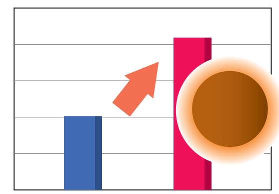


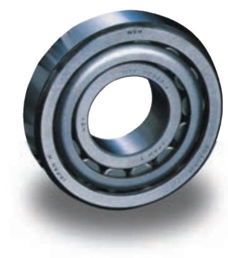
A Product Line that Matches Specific Applications

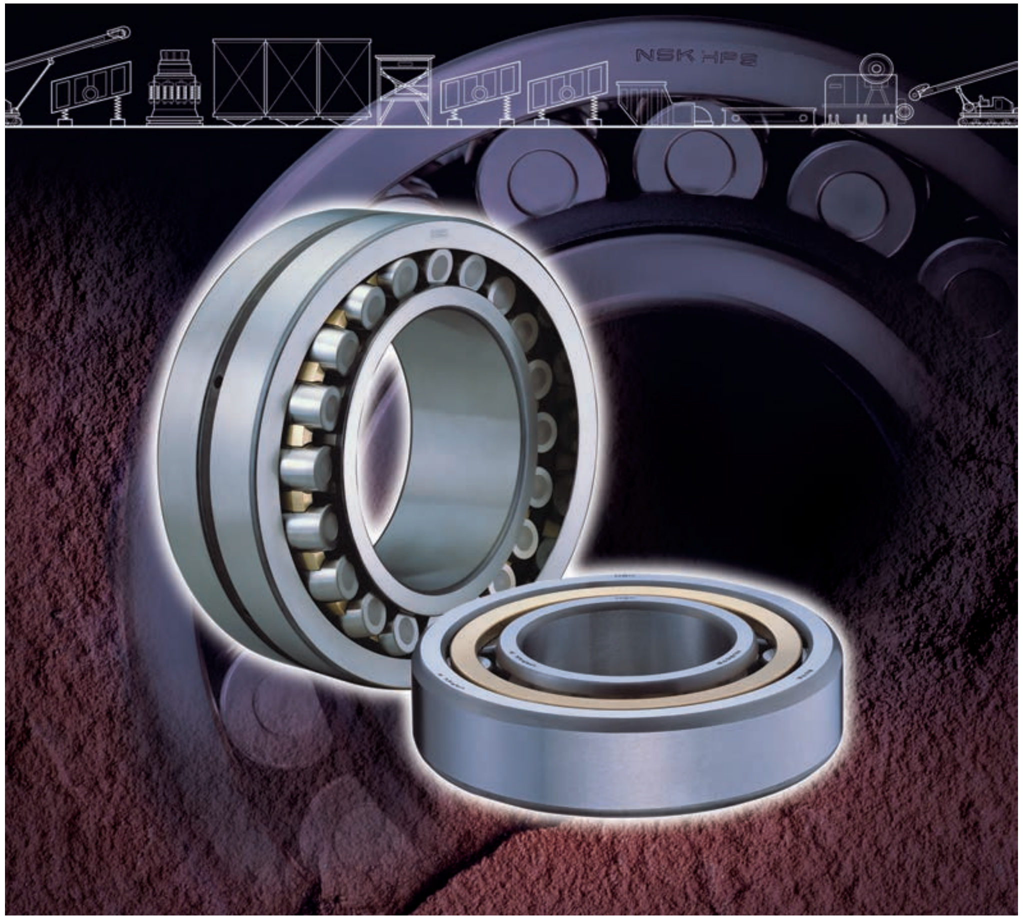










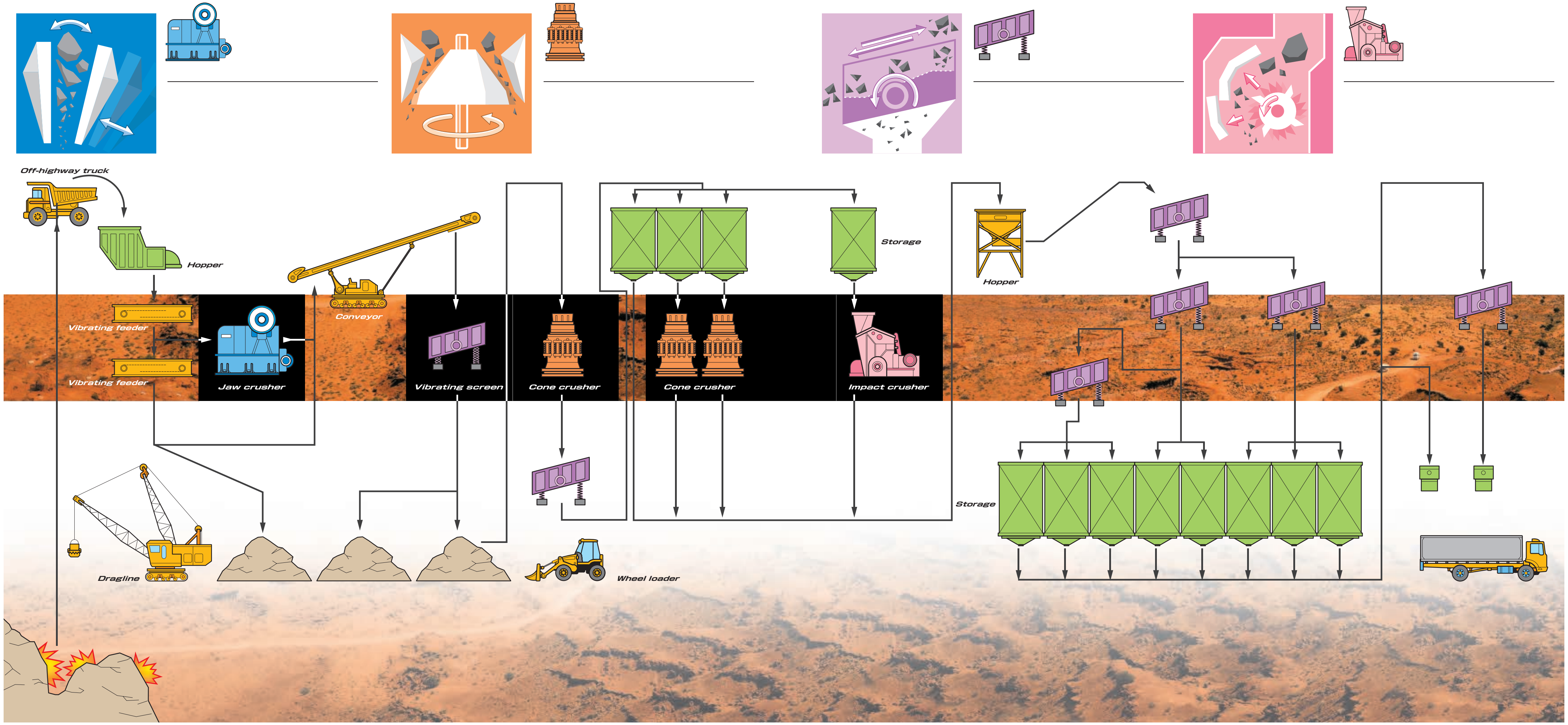


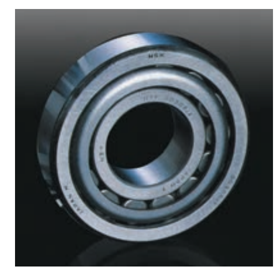
A Product Line that Matches Specific Applications

Bearings Table

INDUSTRY SOLUTIONS

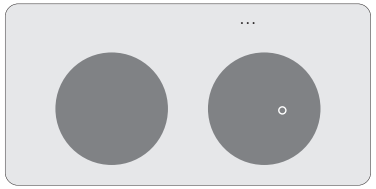
A Product Line that Matches Specific Applications

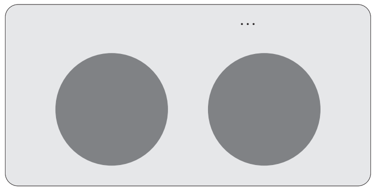


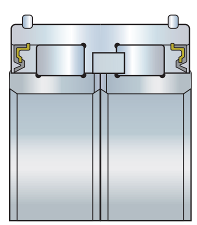


INDUSTRY SOLUTIONS

■A Product Line that Matches Specific Applications



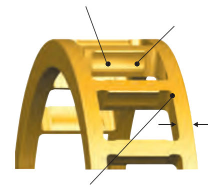


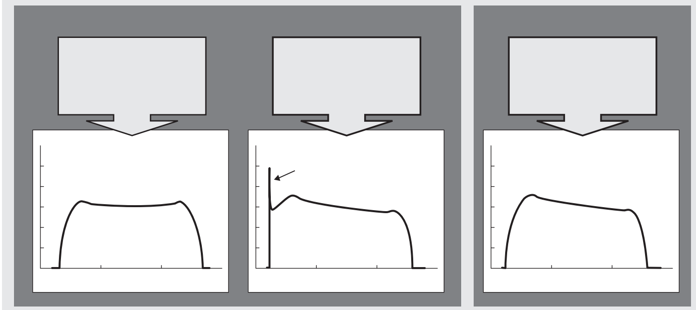


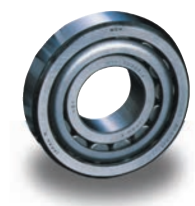
- Highly resistant to heavy or shock loads.
- Long service life for vibrating applications.

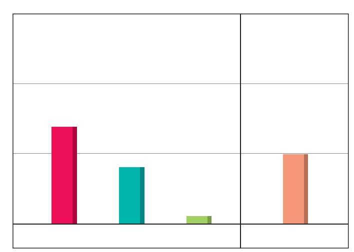
- Excellent self-aligning ability.
- Preventive measure against shaft deflection.

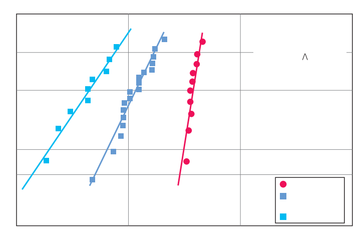
Easy to install











: 223 20 CAM E4 -VS3

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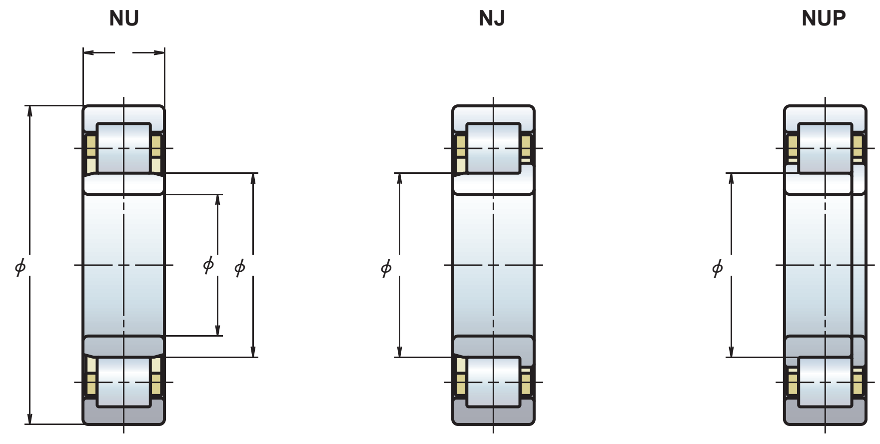
• The dimensional tolerance bearing is set at 1/2 relative to the outer diameter tolerance and the internal

• The radial internal clearance is set at 2/3 relative to the standard.

Bearing Numbers	Basic Load Ratings (N)		Boundary Dimensions (mm)					Radial Clearance (Cylindrical Bore)	
			(mm)	diameter tolerance (μm)	(mm)	diameter tolerance (μm)	(mm)	(μm)	(μm)
( )	152	129	40		90		33	50 to 60	65 to 80
( )	185	167	45	0 -7	100		36	60 to 75	85 to 100
( )	232	211	50		110		40		
( )	261	241	55		120	-5 -13	43	75 to 90	100 to 120
( )	305	288	60		130		46		
( )	330	315	65	0 -9	140		48		
( )	380	370	70		150		51	90 to 110	120 to 145
( )	425	415	75		160		55		
( )	485	480	80		170	-5 -18	58		
( )	520	510	85		180		60	110 to 135	150 to 180
( )	605	595	90		190		64		
( )	655	675	95	0 -12	200		67		
( )	750	785	100		215		73		
( )	925	980	110		240	-10 -23	80	135 to 160	180 to 210
( )	1 060	1 120	120		260		86		
( )	1 240	1 350	130		280		93	160 to 190	205 to 240
( )	1 450	1 590	140		300		102		
( )	1 530	1 690	150	0 -15	320		108	190 to 220	240 to 280
( )	1 700	1 900	160		340		114		
( )	1 970	2 110	170		360	-13 -28	120	200 to 240	260 to 310
( )	2 170	2 340	180		380		126		
( )	2 370	2 590	190	0 -18	400		132	220 to 260	285 to 340

Remark VS( ) : Replace parentheses and indicate "VS3" or "VS4" when ordering.

( )

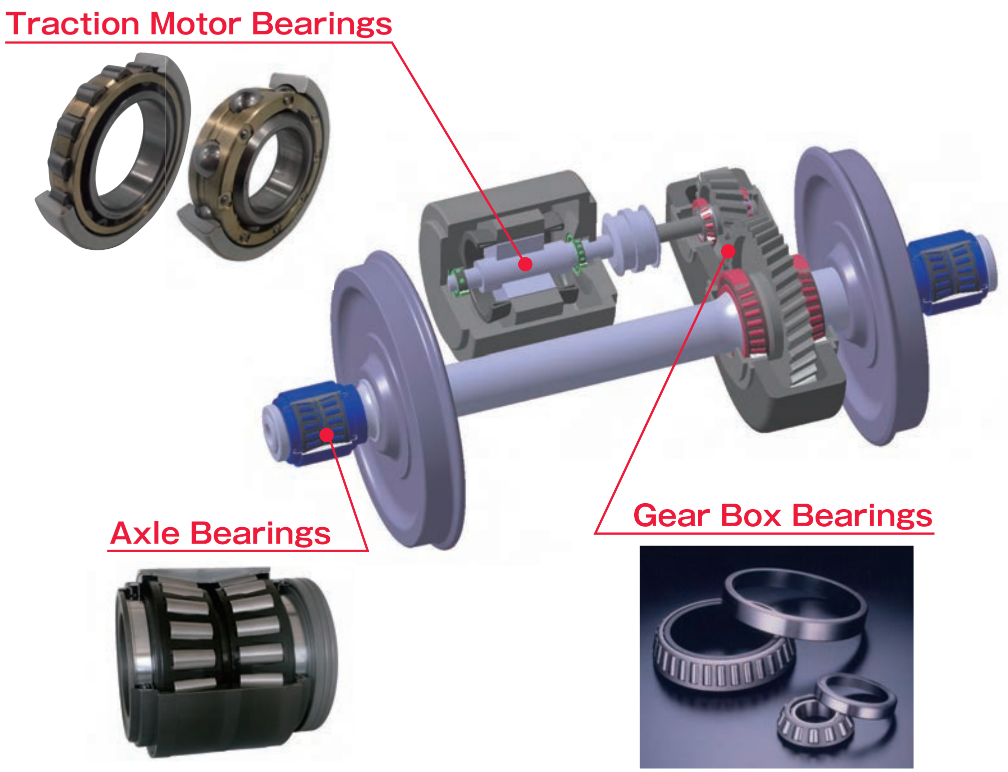


Bearing Numbers		Boundary Dimensions (mm)						Basic Load Ratings (N)	
					min.	min.			
		40	90	33	1.5	1.5	52	114 000	122 000
		45	100	36	1.5	1.5	58.5	137 000	153 000
		50	110	40	2	2	65	163 000	187 000
		55	120	43	2	2	70.5	201 000	233 000
		60	130	46	2	2	77	222 000	262 000
		65	140	48	2.1	2.1	82.5	233 000	265 000
		70	150	51	2.1	2.1	89	274 000	325 000
		75	160	55	2.1	2.1	95	330 000	395 000
		80	170	58	2.1	2.1	101	355 000	430 000
		85	180	60	3	3	108	395 000	485 000
		90	190	64	3	3	113.5	435 000	535 000
		95	200	67	3	3	121.5	460 000	585 000
		100	215	73	3	3	127.5	570 000	715 000
		110	240	80	3	3	143	675 000	880 000
		120	260	86	3	3	154	795 000	1 030 000

A Product Line that Matches Specific Applications

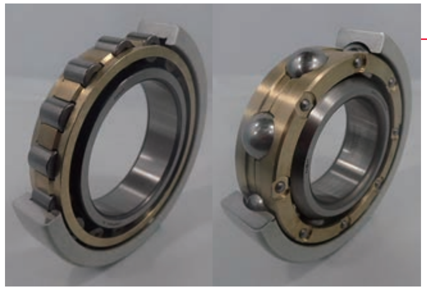
Bearings Table

A Product Line that Matches Specific Applications



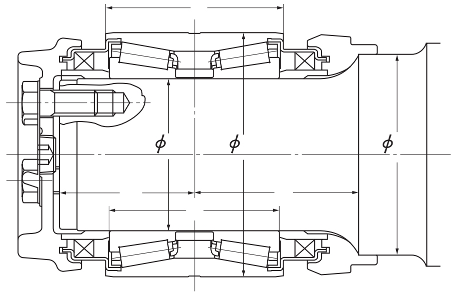
Axle Bearings

Gear Box Bearings

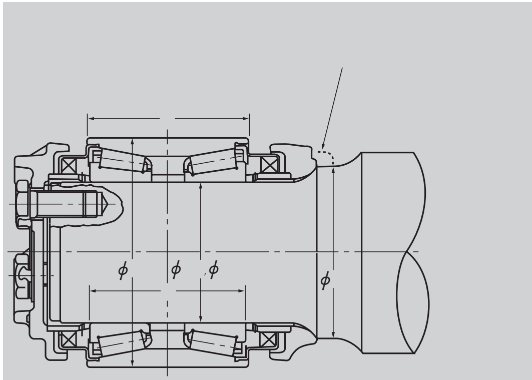


Traction Motor Bearings

Axle Bearings



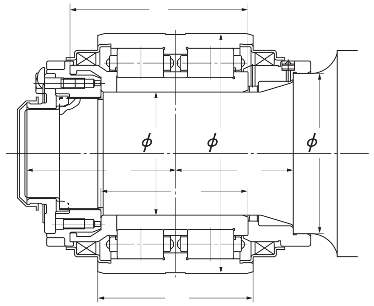
Bearing Numbers	Dimensions (mm)							Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
	90	154	90	80	110	55	80	297 000	480 000
	110	175	130	125	155	105	135	470 000	940 000
	110	188	150	145	150	100	120	605 000	1 110 000
	110	190	150	145	150	100	120	605 000	1 110 000
	110	195	150	145	150	100	120	650 000	1 180 000
	110	205	140	130	150	85	105	745 000	1 270 000
	110	220	145	144	155	112	110	690 000	1 090 000
	115	210	150	145	144	98	117	710 000	1 250 000
	120	195	142	136	155	113	135	645 000	1 290 000
	120	220	145	145	155	120	117	750 000	1 250 000
	120	220	155	155	150	125	100	845 000	1 530 000
	120	220	155	150	149	146.5	117	780 000	1 310 000
	130	208	152	146	165	115	139	660 000	1 350 000
	130	220	155	155	160	168	100	765 000	1 410 000
	130	220	155	155	171	115	140.7	820 000	1 550 000
	130	230	160	150	149	146.5	117	915 000	1 670 000
	130	230	160	150	160	149	117	915 000	1 670 000
	130	240	165	160	160	203.5	117	1 040 000	1 800 000
	130	240	160	160	160	90	101	1 040 000	1 800 000
	150	250	185	179.5	185	122	133	915 000	1 700 000
	185	280	160	155	225	—	115.5	915 000	1 900 000



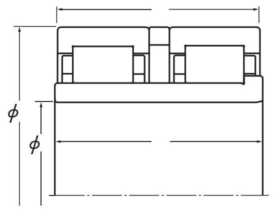
Class	Journal Size	Unit Number	Bearing Numbers	Dimensions mm(upper line) / Inch(lower line) (bearing) max.-min.	(axle) max.-min.					Basic Dynamic Load Rating N (lbf)	Basic Static Load Rating N (lbf)
B	4 1/4 X 8	J-371		101.625-101.600 4.001-4.000	101.702-101.676 4.0040-4.0030	165.100 6 1/2	114.300 4 1/2	106.362 4 3/16	127.000 5	415 000 (93 000)	775 000 (174 000)
C	5 X 9	J-372		119.087-119.062 4.6885-4.6875	119.164-119.139 4.6915-4.6905	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)
D	5 1/2 X 10	J-373		131.775-131.750 5.1880-5.1870	131.864-131.839 5.1915-5.1905	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)
E	6 X 11	J-374		144.475-144.450 5.6880-5.6870	144.564-144.539 5.6915-5.6905	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)
F	6 1/2 X12	J-375		157.175-157.150 6.1880-6.1870	157.264-157.239 6.1915-6.1905	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)
G	7 X 12	J-376		177.812-177.787 7.0005-6.9995	177.902-177.876 7.0040-7.0030	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)

INDUSTRY SOLUTIONS

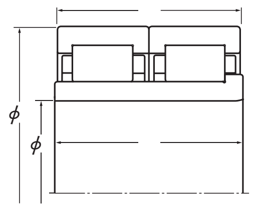
Axle Bearings



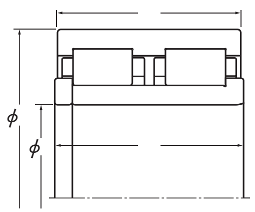
Bearing Numbers	Dimensions (mm)								Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
	100	195	150	175	130	—	120	105	670 000	1 040 000
	110	220	160	154	170	—	135	140	875 000	1 370 000
	110	220	170	182	140	210	128	112	875 000	1 370 000
	120	195	140	134	155	176	135	132	545 000	915 000
	120	215	146	146	—	—	—	—	830 000	1 350 000
	120	220	145	145	155	171	145	117	700 000	1 120 000
	120	220	155	157	150	190	113	100	765 000	1 250 000
	120	220	160	172	160	200	128	112	765 000	1 250 000
	120	220	160	185.5	145	—	128	104	765 000	1 250 000
	120	220	160	204	150	242	128	112	815 000	1 320 000
	120	220	175	175	144	197	118	113	850 000	1 430 000
	120	220	175	182	140	210	128	112	850 000	1 430 000
	120	220	175	182	150	210	128	112	850 000	1 430 000
	120	230	150	142	155	171	145	113	830 000	1 290 000
	120	240	160	162	168	193	158	113	935 000	1 420 000
	120	240	160	162	168	196	120	125	935 000	1 420 000
	120	240	160	164	150	197	128	112	935 000	1 450 000
	120	240	170	180	168	218	130	125	1 020 000	1 580 000
	120	240	170	182	150	205	128	112	1 020 000	1 580 000
	130	220	124	124	—	—	—	—	805 000	1 320 000
	130	230	160	185.5	155	—	128	104	800 000	1 340 000
	130	240	160	160	160	188	100	112	825 000	1 310 000
	130	240	160	160	160	188	118	112	825 000	1 310 000
	130	240	160	160	165	188	116	105	825 000	1 310 000
	130	240	160	160	170	188	131	116	825 000	1 310 000
	130	250	170	170	165	208	95	135	1 030 000	1 610 000
	130	260	175	182	160	212.5	128	112	1 030 000	1 610 000
	130	260	180	182	160	215	128	112	1 030 000	1 610 000
	160	280	159	180	—	—	—	—	1 060 000	1 730 000



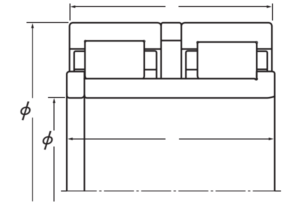
Bearing Numbers	Dimensions (mm)				Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
	85	150	120.0	125	365 000	585 000
	90	160	118.5	130	355 000	530 000
	110	200	150.0	160	625 000	995 000
	110	220	180.0 (80x2)	190	875 000	1 370 000
	120	220	180.0	183	850 000	1 430 000
	120	240	180.0 (80x2)	190	935 000	1 450 000
	120	240	180.0 (80x2)	180	935 000	1 450 000



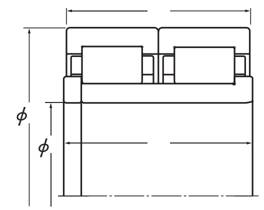
Bearing Numbers	Dimensions (mm)				Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
	110	225	70×2	150	935 000	1 430 000
	120	240	160	180	935 000	1 450 000



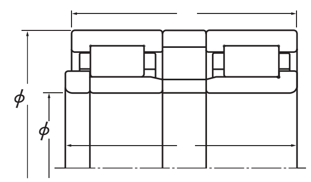
Bearing Number	Dimensions (mm)				Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
	130	260	160	160	1 140 000	1 840 000



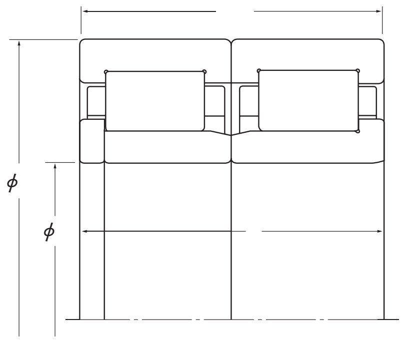
Bearing Numbers	Dimensions (mm)				Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
	95	170	115	125	440 000	685 000
	95	190	125	130	800 000	1 340 000
	100	200	170	170	650 000	1 030 000
	110	220	180	185	875 000	1 370 000
	120	220	160	165	810 000	1 340 000
	120	220	180	183	850 000	1 430 000
	120	230	165	170	945 000	1 460 000
	120	240	180	185	935 000	1 450 000
	120	240	180	185	935 000	1 450 000
	125	235	165	170	945 000	1 470 000
	125	236	165	175.5	960 000	1 500 000
	130	235	165	170	895 000	1 520 000
	130	240	180	185	915 000	1 490 000
	130	260	180	185	1 030 000	1 610 000
	130	260	180	185	1 030 000	1 610 000
	130	265	166	166	1 140 000	1 700 000
	140	250	155	160	865 000	1 480 000
	170	340	230	230	1 660 000	2 760 000



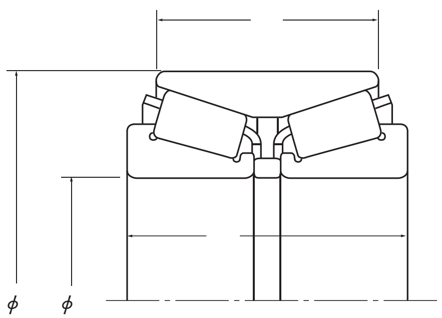
Bearing Numbers	Dimensions (mm)				Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
	120	230	150	177	935 000	1 440 000
	120	230	150	177	885 000	1 340 000



Bearing Number	Dimensions (mm)				Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)
	130	240	198 (80×2)	204	880 000	1 450 000

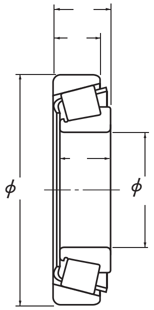


	110	215	73 × 2	73 × 2	800 000	1 240 000
	120	240	80 × 2	80 × 2	910 000	1 400 000
	120	240	80 × 2	80 × 2	960 000	1 500 000
	120	240	80 × 2	80 × 2	960 000	1 500 000
	130	250	80 × 2	80 × 2	1 030 000	1 610 000
	130	250	80 × 2	80 × 2	1 030 000	1 610 000
	130	250	160	160	1 030 000	1 610 000
	130	220	62 × 2	62 × 2	785 000	1 340 000
	130	220	73 × 2	73 × 2	860 000	1 510 000
	150	270	160 (80 × 2)	160 (80 × 2)	1 020 000	1 700 000



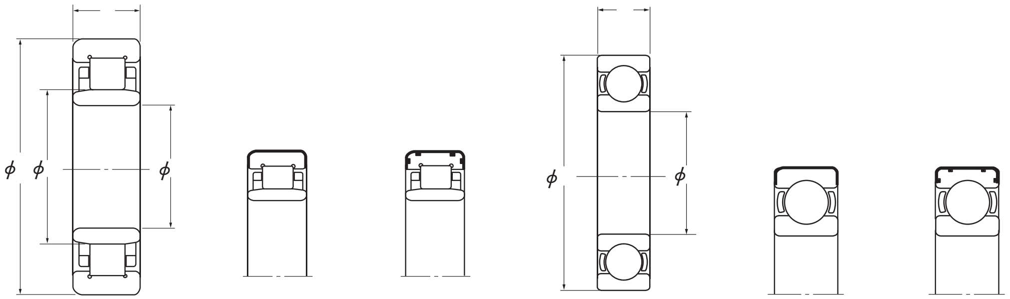
	110	220	115	145	820 000	1 350 000
	120	200	84	100	515 000	865 000
	120	215	109	132	720 000	1 170 000
	120	220	130	155	860 000	1 480 000
	120	220	130	155	860 000	1 480 000
	120	220	130	155	860 000	1 480 000
	130	230	115	145	850 000	1 480 000
	140	230	110	140	820 000	1 550 000
	140	270	95	120	870 000	1 440 000
	150	250	95	115	745 000	1 320 000
	160	270	120	140	860 000	1 510 000
	170	280	130	150	1 110 000	2 160 000
	180	340	140	180	1 410 000	2 510 000

INDUSTRY SOLUTIONS



	60	130	33.5	31	22	127 000	139 000	Gear (P)
	60	130	33.5	31	22	127 000	139 000	Gear (P)
	65	140	36	33	23	147 000	163 000	Gear (P)
	70	150	38	35	25	165 000	185 000	Gear (P)
	70	150	38	35	25	165 000	185 000	Gear (P)
	70	150	38	35	25	165 000	185 000	Gear (P)
	70	150	38	35	25	165 000	185 000	Gear (P)
	70	150	38	35	25	165 000	185 000	Gear (P)
	70	150	38	35	25	165 000	185 000	Gear (P)
	70	150	38	35	25	165 000	185 000	Gear (P)
	70	150	38	35	30	194 000	218 000	Gear (P)
	70	150	40	37	27	172 000	198 000	Gear (P)
	75	160	40	37	27	189 000	224 000	Gear (P)
	75	160	40	37	26	189 000	224 000	Gear (P)
	75	160	40	37	31	209 000	233 000	Gear (P)
	80	170	42.5	39	28	196 000	222 000	Gear (P)
	80	170	42.5	39	28	208 000	241 000	Gear (P)
	80	170	42.5	39	33	235 000	265 000	Gear (P)
	85	180	44.5	41	29	233 000	269 000	Gear (P)
	85	180	44.5	41	34	262 000	300 000	Gear (P)
	85	180	45.5	42	29	244 000	285 000	Gear (P)
	140	300	67.75	62	53	600 000	740 000	Gear (G)
	190	280	49	46	36.5	605 000	1 240 000	Gear (G)
	193.675	282.575	50.800	47.625	36.512	360 000	600 000	Gear (G)
	195	280	58	60	41	410 000	780 000	Gear (G)
	200	280	51	48	41	410 000	780 000	Gear (G)
	200	280	51	48	41	410 000	780 000	Gear (G)
	200	290	49	46	36.5	625 000	1 330 000	Gear (G)
	200	290	55	60	41	410 000	790 000	Gear (G)
	202	290	58	60	41	435 000	855 000	Gear (G)
	205	283	51	48	41	415 000	795 000	Gear (G)
	205	310	60	60	47	545 000	1 020 000	Gear (G)
	205	310	60	60	47	545 000	1 020 000	Gear (G)
	205	310	60	60	47	545 000	1 020 000	Gear (G)
	210	320	70	66	56	665 000	1 180 000	Gear (G)
	215	315	65	70	49	595 000	1 130 000	Gear (G)
	215	315	65	70	49	595 000	1 130 000	Gear (G)
	218	315	65	70	49	595 000	1 130 000	Gear (G)
	220	300	51	48	41	425 000	855 000	Gear (G)
	260	400	87	82	71	1 130 000	2 020 000	Gear (G)

Notes



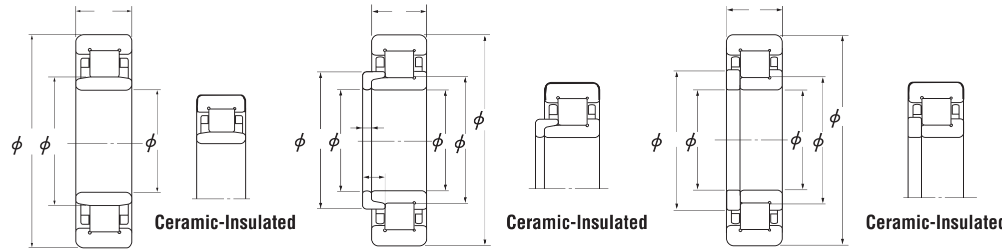
Non-Insulated Ceramic-Insulated PPS-Insulated

Cylindrical Roller Bearing

Non-Insulated Ceramic-Insulated PPS-Insulated

Ball Bearing

	50	90	20	59.5	1.1		80	125	22
	60	110	22	73.5	1.5		50	110	27
	60	130	31	77.0	2.1		50	110	27
	65	120	23	79.6	1.5		50	110	27
	65	140	33	83.5	2.1		55	120	29
	70	125	24	84.5	1.5		50	110	27
							55	120	29
	70	150	35	90.0	2.1		55	120	29
	75	130	25	88.5	1.5		55	120	29
							60	130	31
	75	160	37	95.5	2.1		55	120	29
							60	130	31
							70	150	35
	75	190	45	104.5	3.0		65	140	33
	80	140	26	95.3	2.0		60	130	31
	80	170	39	103.0	2.1		60	130	31
	80	200	48	110.0	3.0		65	140	33
	85	150	28	101.8	2.0		85	150	28
	90	160	30	107.0	2.0		90	160	30
	95	170	32	113.5	2.1		95	170	32



Ceramic-Insulated Ceramic-Insulated Ceramic-Insulated

Non-Insulated
Cylindrical Roller Bearing (NU Type)

Non-Insulated
Cylindrical Roller Bearing (NH Type)

Non-Insulated
Cylindrical Roller Bearing (NUP Type)

120	215	40	143.5	2.1		E	320 000	395 000
130	230	40	153.5	3.0		E	345 000	425 000

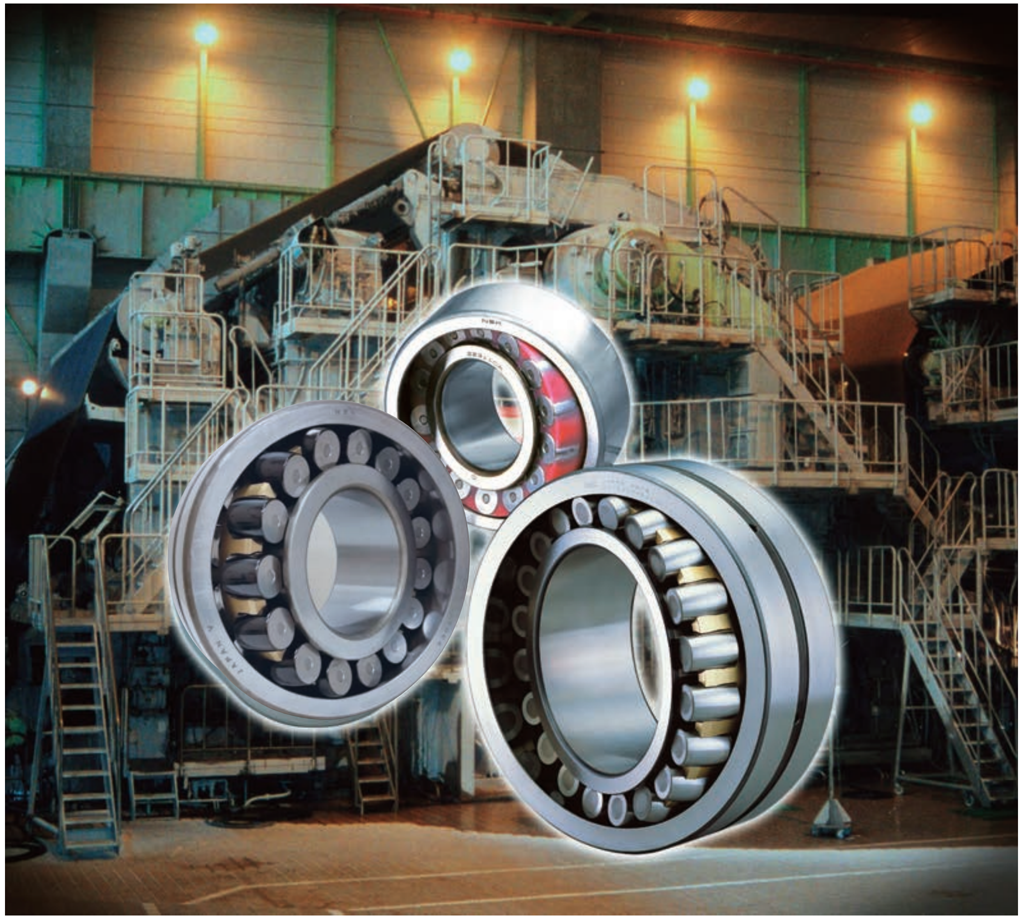
Note

90	190	43	113.5	3		E	315 000	355 000
100	215	47	127.5	3		E	380 000	425 000
110	240	50	143.0	3		E	425 000	485 000
120	260	55	154.0	3		E	530 000	610 000
130	280	58	165.0	4		B	655 000	795 000
			167.0			E	615 000	735 000
140	300	62	180.0	4		E	665 000	795 000
			178.0			F	705 000	860 000
150	320	65	193.0	4		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		E	860 000	1 050 000
180	380	75	231.0	4		E	985 000	1 230 000

Note

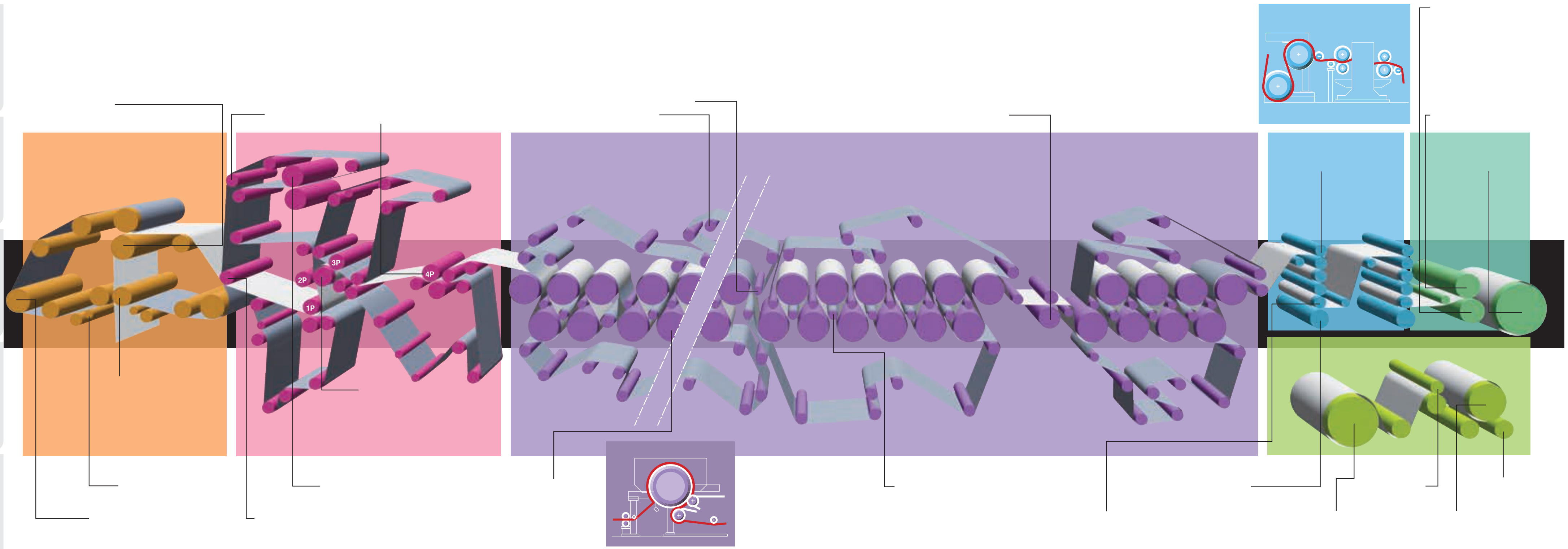
80	170	39	101.0	111.8	17.0	11.0	2.1		E	256 000	282 000
90	190	43	115.0	125.0	21.0	12.0	3.0		—	240 000	265 000
			113.5	124.2	18.5				E	315 000	355 000
90	190	43	115.0	125.0	—	—	3.0		B	240 000	265 000
			113.5	124.2					E	315 000	355 000
100	215	47	129.5	140.5	22.5	13.0	3.0		A	310 000	355 000
			129.5	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		E	425 000	485 000
120	260	55	154.0	168.5	23.5	14.0	3.0		—	475 000	550 000
130	280	58	167.0	182.0	24.0	14.0	4.0		—	560 000	665 000
				181.0					E	615 000	735 000
140	300	62	180.0	196.0	26.0	15.0	4.0		—	615 000	745 000

Note



A Product Line that Matches Specific Applications

A Product Line that Matches Specific Applications



A Product Line that Matches Specific Applications

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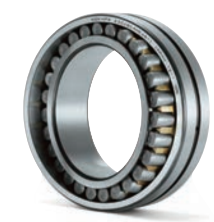

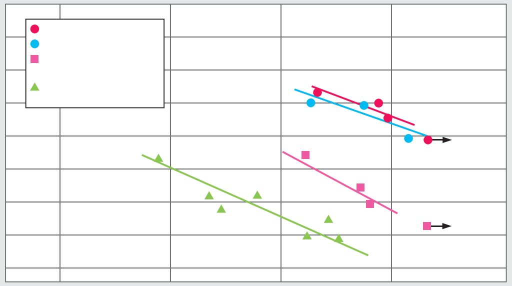

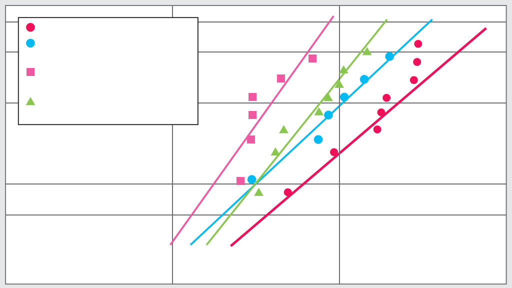

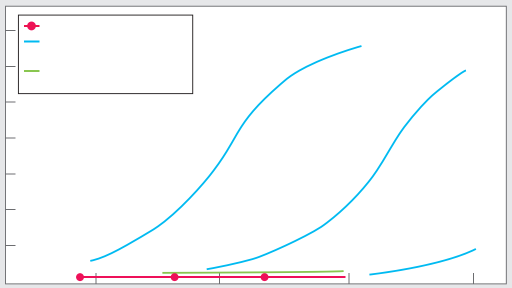

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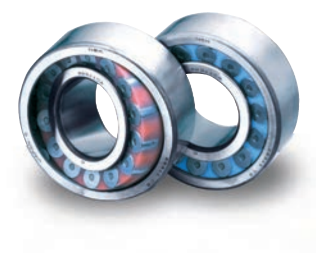
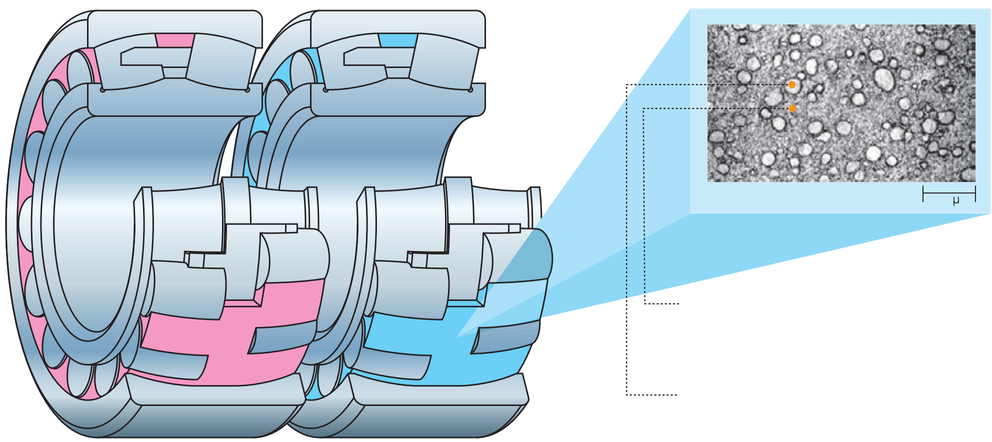
INDUSTRY SOLUTIONS

A Product Line that Matches Specific Applications





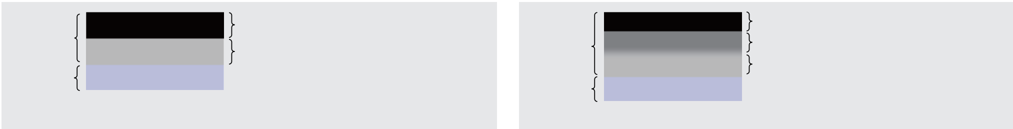
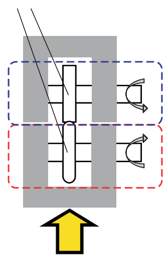


Fig. 1



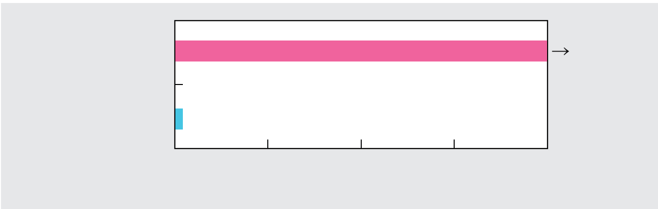
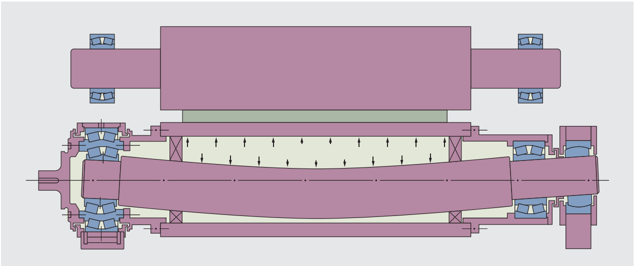
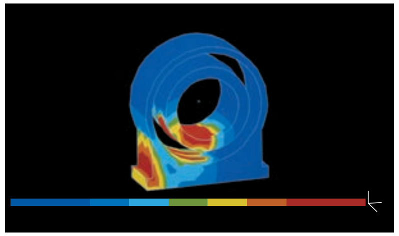
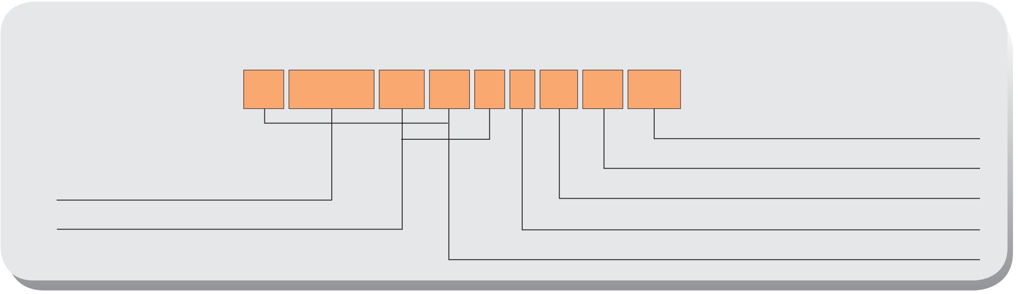


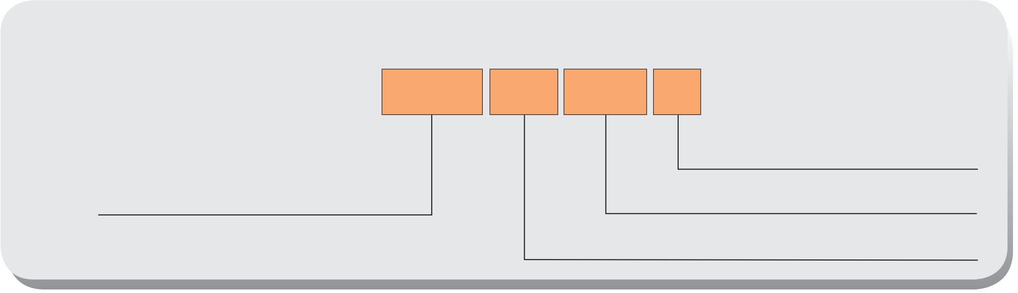
Fig. 2

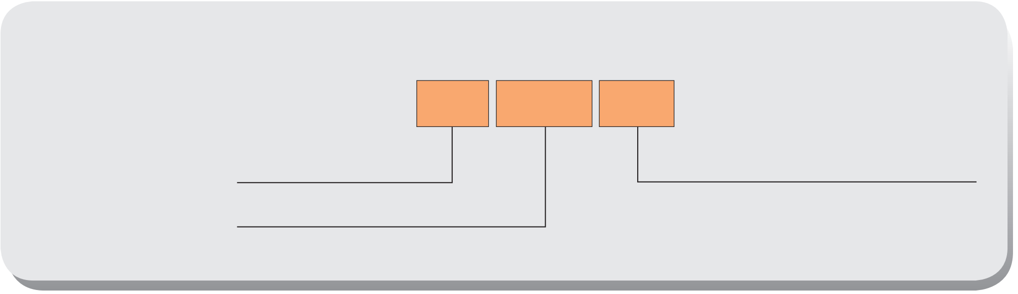
A Product Line that Matches Specific Applications







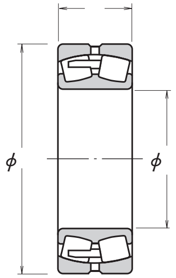




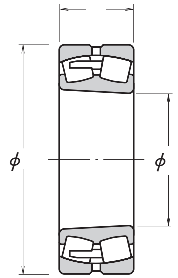
INDUSTRY SOLUTIONS

Spherical Roller Bearings TL Series

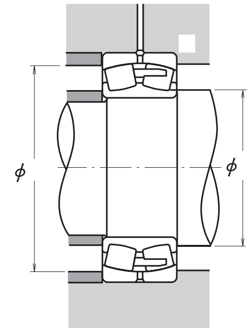
Bore Diameter



Cylindrical Bore



Tapered Bore



Dynamic Equivalent Load

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1	3	0.67	2

Static Equivalent Load

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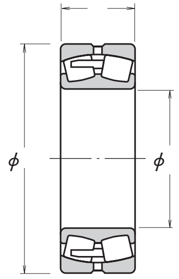
90	33	1.5	122	129	12 400	13 200		49	—	81	77	1.5	0.38	2.6	1.8	1.7	1.0
120	43	2	209	241	21 300	24 600		65	—	110	103	2	0.36	2.8	1.9	1.8	2.3
130	46	2.1	246	288	25 100	29 400		72	—	118	111	2	0.36	2.8	1.9	1.9	2.9
140	48	2.1	375	380	38 000	38 500		77	84	128	119	2	0.33	3.0	2.0	2.0	3.5
150	51	2.1	425	435	43 500	44 000		82	91	138	129	2	0.33	3.0	2.0	2.0	4.3
130	31	2.1	340	415	34 500	42 000		87	—	148	134	2	0.35	2.9	2.0	1.9	3.6
170	58	2.1	390	480	39 500	48 500		92	—	158	145	2	0.35	2.9	2.0	1.9	6.2
190	64	3	665	705	68 000	72 000		104	115	176	163	2.5	0.33	3.1	2.1	2.0	8.6
200	67	3	525	675	53 500	68 500		109	—	186	172	2.5	0.35	2.9	1.9	1.9	9.9
215	73	3	860	930	88 000	94 500		114	130	201	184	2.5	0.33	3.0	2.0	2.0	12.7
170	45	2	293	465	29 900	47 500		120	124	160	153	2	0.24	4.2	2.8	2.8	3.76
200	69.8	2.1	515	760	52 500	77 500		122	130	188	170	2	0.34	3.0	2.0	1.9	9.54
240	80	3	1 030	1 120	105 000	115 000		124	145	226	206	2.5	0.30	3.1	2.1	2.0	17.6
260	86	3	1 190	1 320	122 000	134 000		134	157	246	222	2.5	0.32	3.1	2.1	2.0	22.2
280	93	4	995	1 350	101 000	137 000		148	—	262	236	3	0.34	2.9	2.0	1.9	27.8
210	53	2	420	715	43 000	73 000		150	157	200	190	2	0.22	4.5	3.0	2.9	6.49
250	68	3	645	930	65 500	95 000		154	167	236	219	2.5	0.25	4.0	2.7	2.6	14.5
250	88	3	835	1 300	85 000	133 000		154	163	236	213	2.5	0.25	2.9	1.9	1.9	18.8
225	56	2.1	470	815	48 000	83 000		162	168	213	203	2	0.22	4.6	3.1	3.0	7.9
225	56	2.1	470	815	48 000	83 000		162	—	213	203	2	0.22	4.6	3.1	3.0	7.9
250	80	2.1	725	1 180	74 000	121 000		162	—	238	218	2	0.3	3.4	2.3	2.2	15.8
270	73	3	765	1 120	78 000	114 000		164	179	256	236	2.5	0.26	3.9	2.6	2.5	18.4
320	108	4	1 220	1 690	125 000	172 000		168	—	302	270	3	0.35	2.9	1.9	1.9	41.5
240	60	2.1	540	955	55 000	97 500		172	179	228	216	2	0.22	4.5	3.0	2.9	9.66
290	80	3	910	1 320	93 000	135 000		174	190	276	255	2.5	0.26	3.8	2.6	2.5	23.1
290	104	3	1 100	1 770	112 000	180 000		174	189	276	245	2.5	0.34	2.9	2.0	1.9	30.5

Note

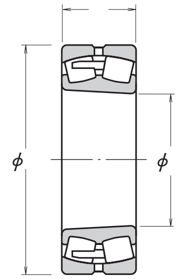
Remark

Spherical Roller Bearings TL Series

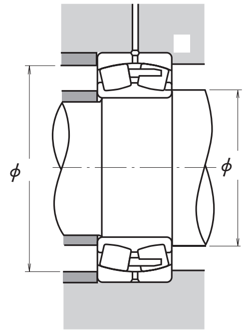
Bore Diameter



Cylindrical Bore



Tapered Bore



Dynamic Equivalent Load

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Static Equivalent Load

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230	45	2	350	660	35 500	67 500	180	—	220	213	2	0.17	5.8	3.9	3.8	5.38
260	67	2.1	640	1 090	65 000	112 000	182	191	248	233	2	0.23	4.3	2.9	2.9	13
280	88	2.1	940	1 570	96 000	160 000	182	—	268	245	2	0.29	3.5	2.3	2.3	21
360	120	4	1 580	2 110	161 000	215 000	188	—	342	304	3	0.35	2.9	1.9	1.9	57.9
280	74	2.1	750	1 270	76 000	129 000	192	202	268	249	2	0.24	4.2	2.8	2.8	17.1
320	112	4	1 300	2 110	133 000	215 000	198	—	302	274	3	0.35	2.9	1.9	1.9	38.5
290	75	2.1	775	1 350	79 000	138 000	202	—	278	261	2	0.24	4.2	2.8	2.8	17.6
320	104	3	1 190	2 020	121 000	206 000	204	—	306	276	3.5	0.31	3.2	2.2	2.1	34
340	92	4	1 140	1 730	116 000	176 000	208	—	322	296	3	0.26	3.8	2.6	2.5	35.5
340	120	4	1 440	2 350	147 000	240 000	208	—	322	288	3	0.35	2.9	1.9	1.9	46.5
400	132	5	1 890	2 590	193 000	264 000	212	—	378	338	4	0.34	2.9	2.0	1.9	77.6
310	82	2.1	940	1 700	96 000	174 000	212	—	298	279	2	0.25	4.0	2.7	2.6	22.6
340	112	3	1 360	2 330	139 000	238 000	214	—	326	293	2.5	0.32	3.2	2.1	2.1	41.5
360	98	4	1 300	2 010	133 000	204 000	218	—	342	315	3	0.26	3.8	2.6	2.5	42.6
360	128	4	1 660	2 750	169 000	281 000	218	—	342	307	3	0.35	2.9	1.9	1.9	57
340	90	3	1 090	1 980	111 000	202 000	234	—	326	302	2.5	0.24	4.1	2.8	2.7	29.7
370	120	4	1 570	2 710	160 000	276 000	238	—	352	320	3	0.31	3.2	2.2	2.1	52
400	108	4	1 570	2 430	160 000	247 000	238	—	382	348	3	0.27	3.7	2.5	2.4	59
400	144	4	2 520	3 400	257 000	350 000	238	—	382	337	3	0.36	2.8	1.9	1.8	79.5
460	145	5	2 350	3 400	240 000	345 000	242	—	438	391	4	0.33	3.0	2.0	2.0	116
320	60	2.1	635	1 300	65 000	133 000	252	—	308	298	2	0.17	6.0	4.0	3.9	13.3
350	92	3	1 160	2 140	118 000	218 000	254	—	346	324	2.5	0.24	4.2	2.8	2.7	32.6
400	128	4	1 790	3 100	182 000	320 000	258	—	382	347	3	0.31	3.3	2.2	2.2	64.5
500	155	5	2 600	3 800	265 000	385 000	262	—	478	423	4	0.32	3.2	2.1	2.1	147
350	75	2.1	930	1 870	95 000	191 000	272	—	348	333	2	0.19	5.4	3.6	3.5	23
400	104	4	1 430	2 580	145 000	263 000	278	—	382	356	3	0.25	4.1	2.7	2.7	46.6
440	144	4	2 160	3 750	221 000	385 000	278	—	422	380	3	0.32	3.2	2.1	2.1	88.2

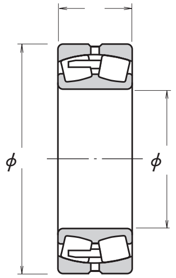
Note

Remark

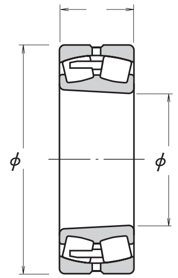
INDUSTRY SOLUTIONS

Spherical Roller Bearings TL Series

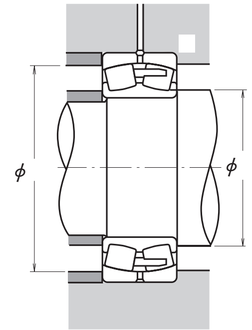
Bore Diameter



Cylindrical Bore



Tapered Bore



Dynamic Equivalent Load

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1	3	0.67	2

Static Equivalent Load

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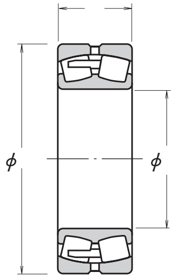
380	75	2.1	925	1 950	94 500	199 000	292	—	368	351	2	0.18	5.7	3.9	3.8	24.5
420	106	4	1 540	2 950	157 000	300 000	298	—	402	377	3	0.24	4.2	2.8	2.7	50.5
460	146	5	2 230	4 000	228 000	410 000	302	—	438	400	4	0.3	3.3	2.2	2.2	94.3
500	176	5	2 880	4 900	294 000	500 000	302	—	478	425	4	0.35	2.9	1.9	1.9	147
420	90	3	1 230	2 490	125 000	254 000	314	—	406	386	2.5	0.19	5.2	3.5	3.4	38.2
460	118	4	1 920	3 700	196 000	375 000	318	—	442	413	3	0.24	4.2	2.8	2.7	70.5
500	160	5	2 670	4 800	273 000	490 000	322	—	478	433	4	0.31	3.3	2.2	2.2	125
540	192	5	3 400	5 900	350 000	600 000	322	—	518	458	4	0.35	2.9	1.9	1.9	189
540	176	5	3 050	5 500	315 000	560 000	342	—	518	466	4	0.31	3.2	2.1	2.1	162
520	133	5	2 280	4 400	232 000	445 000	362	—	458	465	4	0.24	4.2	2.8	2.8	101
580	190	5	3 600	6 600	370 000	670 000	362	—	558	499	4	0.31	3.2	2.1	2.1	206
540	134	4	2 390	4 700	244 000	480 000	382	—	518	485	4	0.24	4.2	2.8	2.8	106
520	106	4	1 870	4 100	190 000	420 000	398	—	502	482	3	0.18	5.5	3.7	3.6	65.4
600	148	5	2 970	5 900	305 000	605 000	422	—	578	540	4	0.23	4.4	3.0	2.9	146
560	106	4	1 870	4 250	191 000	430 000	438	—	542	521	3	0.17	6.0	4.0	3.9	71.6
650	157	6	3 150	6 350	320 000	645 000	468	—	622	587	5	0.23	4.3	2.9	2.8	173
620	118	4	2 220	4 950	227 000	505 000	478	—	602	573	3	0.17	5.9	4.0	3.9	100
670	128	5	2 460	5 550	250 000	565 000	522	—	648	622	4	0.17	6.0	4.0	3.9	124

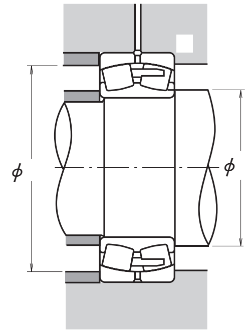
Note

Remark

Bore Diameter



Cylindrical Bore



Dynamic Equivalent Load

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1	3	0.67	2

Static Equivalent Load

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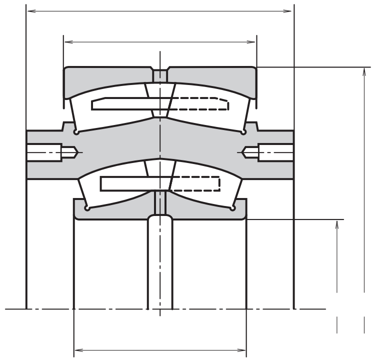
80	21	1.5	71	76	7 250	7 750		44	—	71	67	1.5	0.29	3.5	2.3	2.3	0.52
90	23	1.5	82	93	8 350	9 500		49	—	81	80	1.5	0.25	4.0	2.7	2.6	0.72
90	33	1.5	122	129	12 400	13 200		49	—	81	77	1.5	0.38	2.6	1.8	1.7	1.00
85	23	1.1	778	88	7 950	9 000		52	—	78	75	1	0.28	3.6	2.4	2.4	0.57
100	36	1.5	148	167	15 100	17 100		54	—	91	85	1.5	0.36	2.8	1.9	1.8	1.24
90	23	1.1	82	93	8 350	9 500		57	—	83	80	1	0.25	4.0	2.7	2.6	0.67
120	43	2	209	241	21 300	24 600		65	—	110	103	2	0.36	2.8	1.9	1.8	2.30
110	28	1.5	127	154	12 900	15 700		69	—	101	97	1.5	0.25	4.0	2.7	2.6	1.13
120	31	1.5	152	190	15 500	19 300		74	—	111	106	1.5	0.26	3.9	2.6	2.6	1.46
140	48	2.1	265	315	27 000	32 500		77	—	128	117	2	0.35	2.9	1.9	1.9	3.56
140	48	2.1	265	315	27 000	32 500		77	—	128	117	2	0.35	2.9	1.9	1.9	3.56
125	31	1.5	163	205	16 600	20 900		79	—	116	111	1.5	0.25	4.0	2.7	2.7	1.46
160	55	2.1	340	415	34 500	42 000		87	—	148	135	2	0.35	2.9	2.0	1.9	5.26
140	33	2	181	232	18 500	23 700		90	—	130	124	2	0.24	4.3	2.9	2.8	2.14
150	36	2	215	276	21 900	28 200		95	—	140	134	2	0.24	4.3	2.9	2.8	2.60
160	40	2	256	340	26 200	34 500		100	—	150	142	2	0.25	4.1	2.7	2.7	3.44
170	43	2.1	296	395	30 000	40 000		107	—	158	150	2	0.25	4.1	2.7	2.7	3.87
165	52	2	345	530	35 500	54 000		110	—	155	144	2	0.30	3.4	2.3	2.2	4.14
215	73	3	600	785	61 500	80 000		114	—	201	183	2.5	0.35	2.9	1.9	1.9	12.7
200	53	2.1	425	585	43 500	59 500		122	—	188	176	2	0.24	4.2	2.8	2.7	7.23
180	46	2	315	525	32 000	53 500		130	—	170	163	2	0.22	4.5	3.0	2.9	4.15
200	62	2	465	720	47 500	73 500		130	—	190	175	2	0.29	3.5	2.4	2.3	7.94
230	64	3	565	815	57 500	83 000		144	—	216	203	2.5	0.26	3.9	2.6	2.6	11.0
220	45	2	360	675	37 000	69 000		170	—	210	203	2	0.18	5.6	3.8	3.7	4.97

Remark



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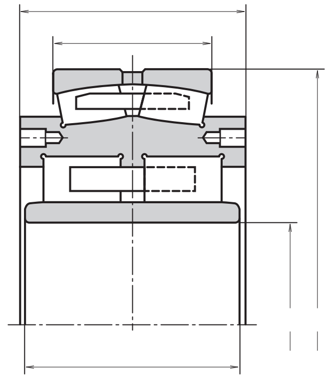

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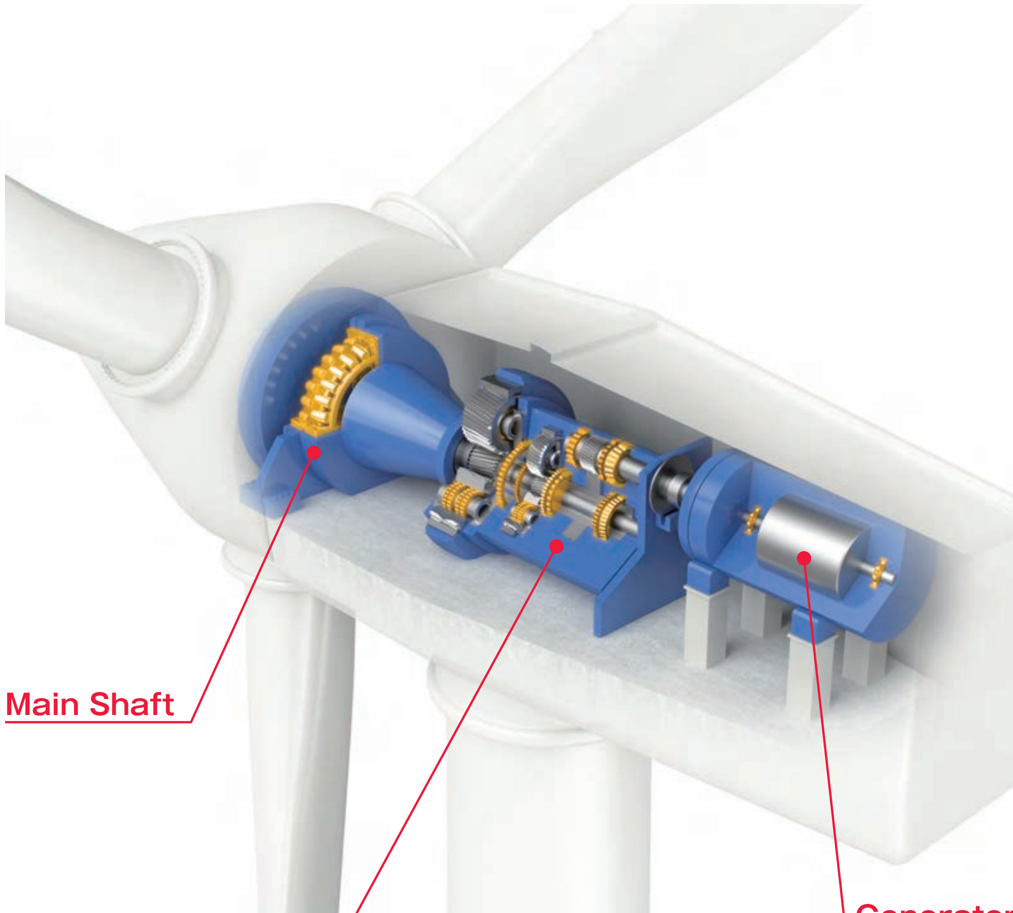
	180	480	140	160	215.9	175
	200	520	160	180	241.3	230
	220	600	180	200	279.4	330
	240	620	200	200	279.4	410
	260	680	218	218	317.5	490
	280	720	218	218	317.5	525
	300	780	243	250	342.9	735
	320	820	258	258	368.3	840
	340	870	280	272	393.7	1 050
	380	980	240	308	431.8	1 370
	180	460	153	118	160	127
	240	600	205	160	225	285

A Product Line that Matches Specific Applications

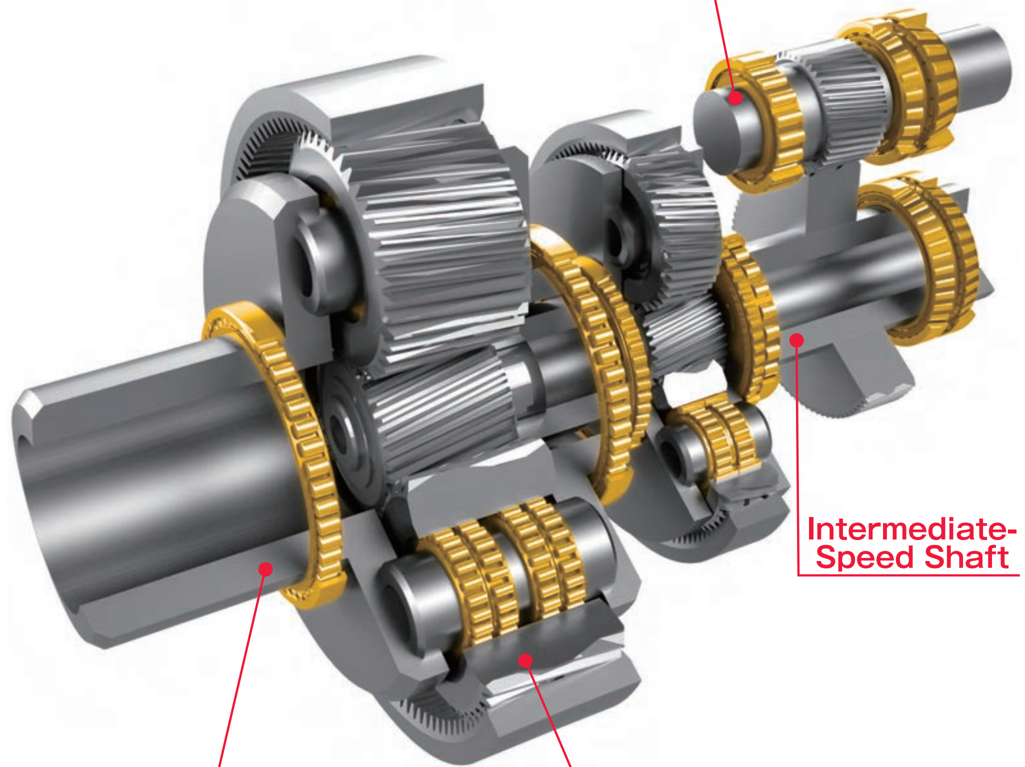
INDUSTRY SOLUTIONS

A Product Line that Matches Specific Applications

A Perspective View of A Nacell



A Perspective View of A Gear Box

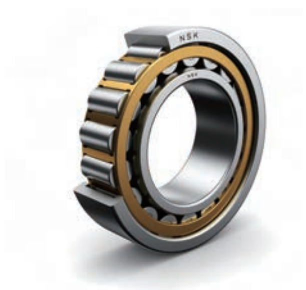


Spherical Roller Bearings-CA Series

■

Full-Complement Cylindrical Roller Bearings NCF Series(Single-Row), NNCF(Double-Row)

■ ( )



High Load Capacity Cylindrical Roller Bearings-XM Series

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High-Load Capacity Tapered Roller Bearings-HR Series

■

Four-Point Contact Ball Bearings-QJ Series

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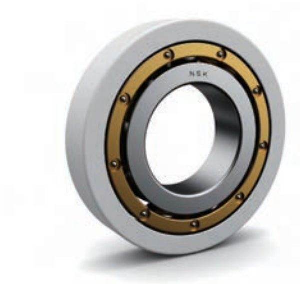

Ceramic-Coated Insulated Bearings

■

Super-TF™ Bearings

AWS-TF™ Bearings

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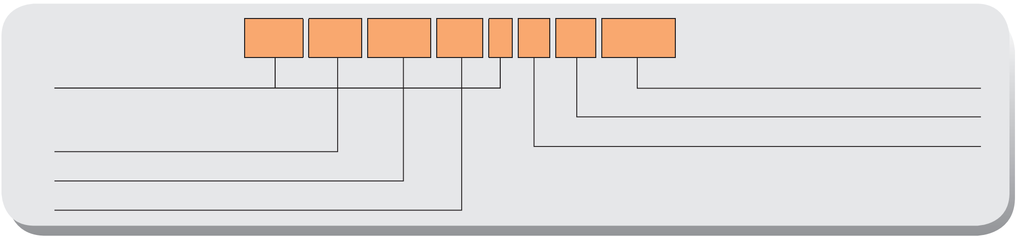
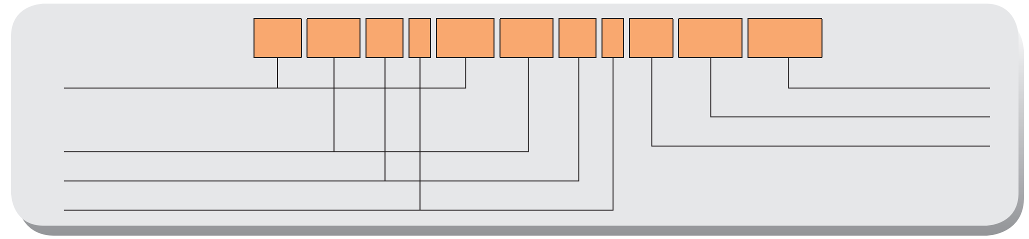
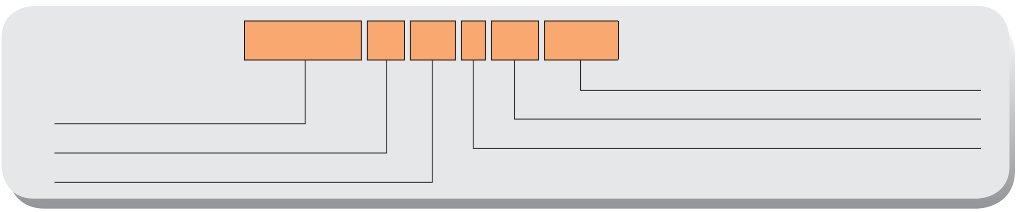
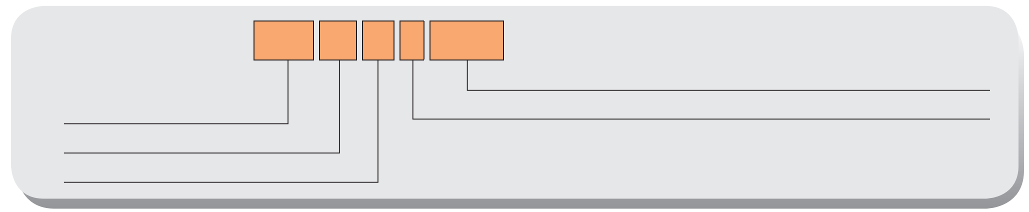
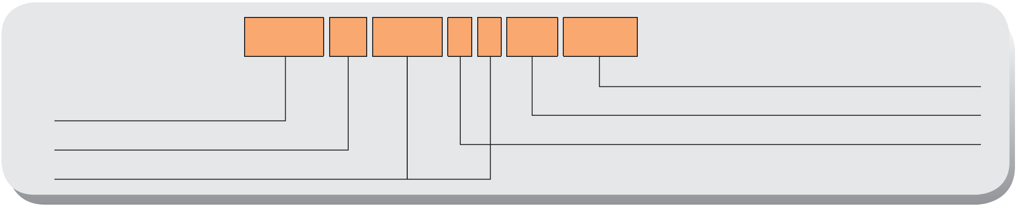
Examples Product Symbol

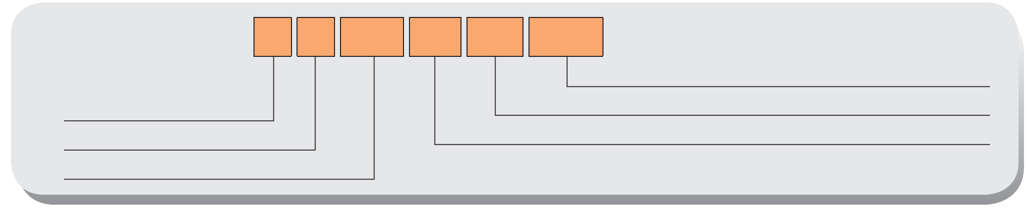












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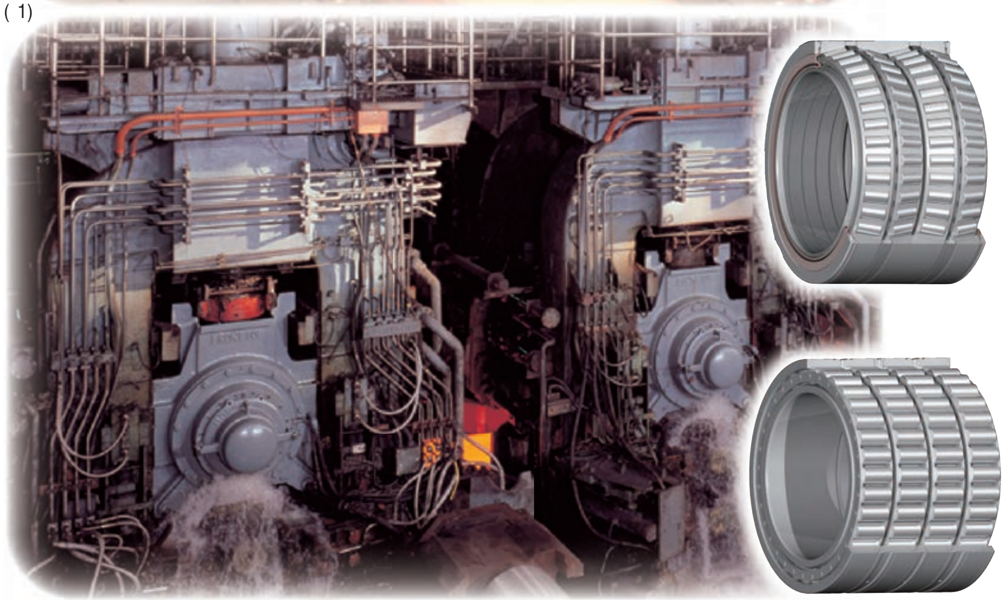

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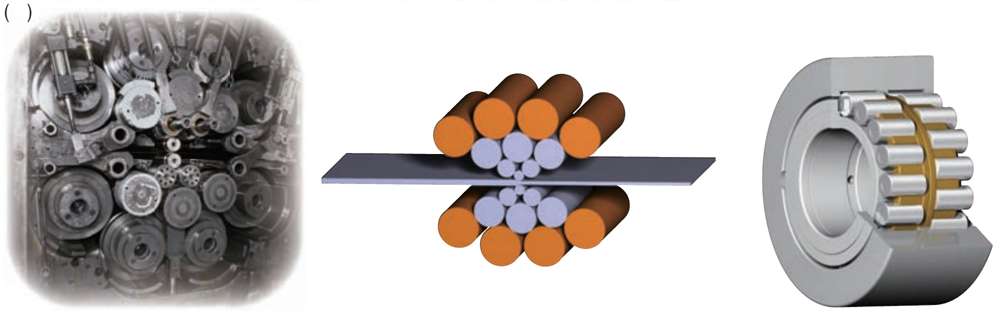
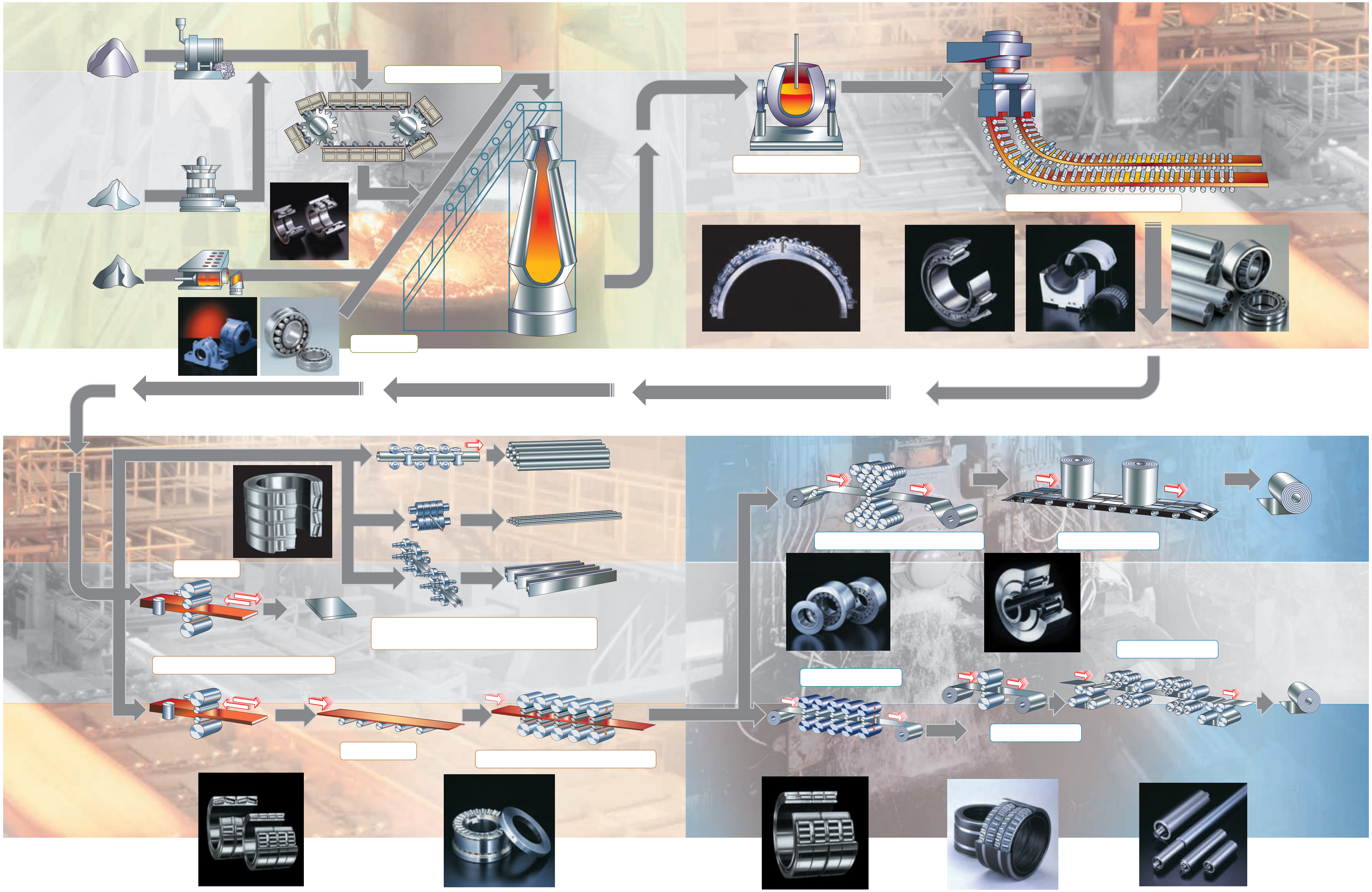
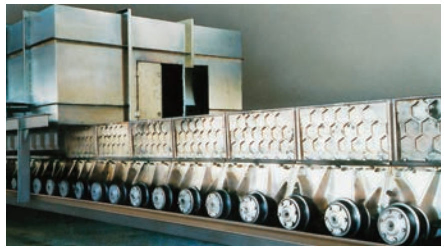


Notes (1): Photo courtesy of NIPPON STEEL & SUMITOMO METAL CORPORATION KASHIMA WORKS pamphlet.
(2): Photo courtesy of Nippon Steel & Sumikin Stainless Steel Corporation.

A complete product line for all steel mill processes delivers improved productivity and lowered maintenance costs, with long life and highly reliable bearings.





Benefits

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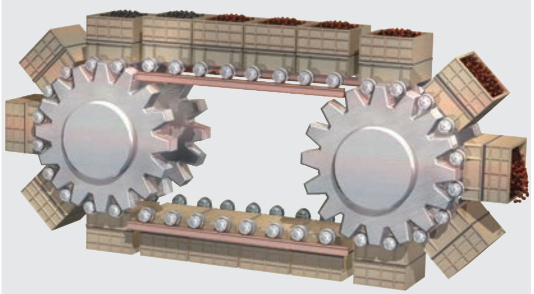

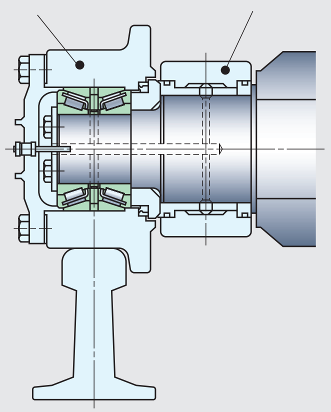

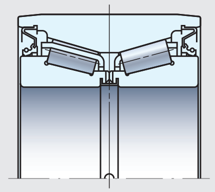

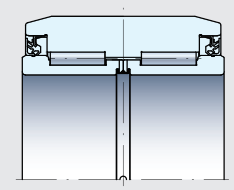

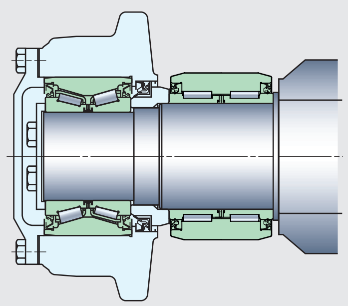

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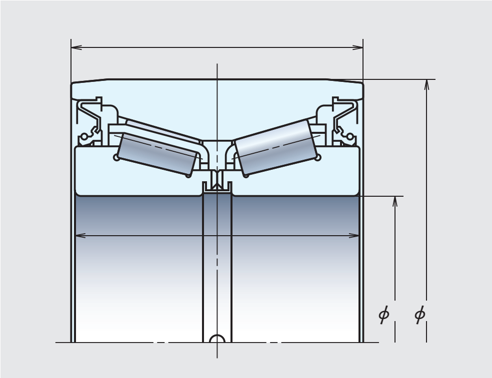


Bearing Numbers	Boundary Dimensions(mm)			Basic Load Ratings(kN)
		(min)	(min)	

Remark Other bearings are available. Please contact NSK for additional information.

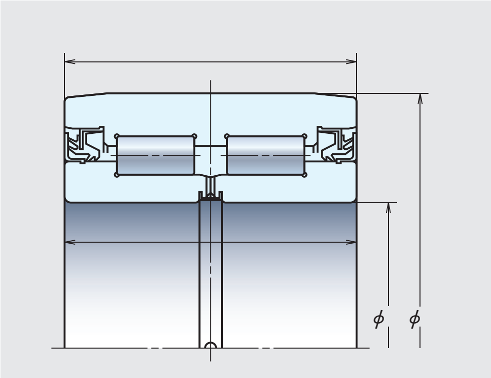


Fig. 1

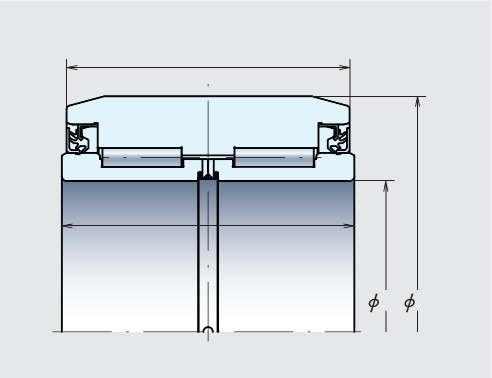
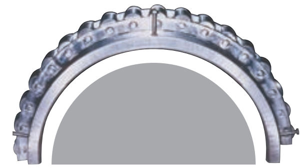


Fig. 2

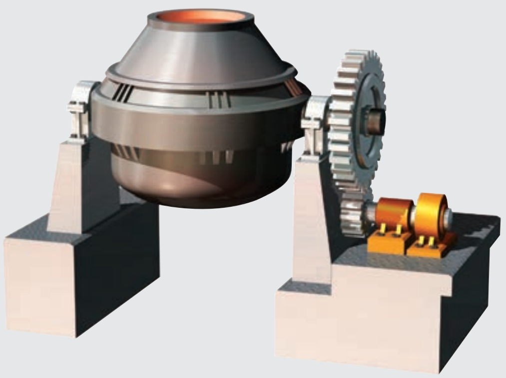
Bearing Numbers	Boundary Dimensions(mm)		Basic Load Ratings(kN)	Fig.
		(min)		

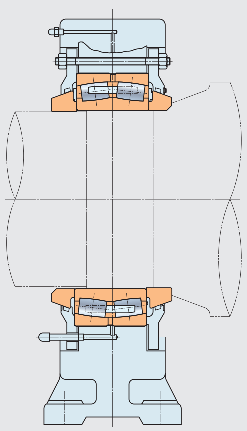
Remark Other bearings are available. Please contact NSK for additional information.

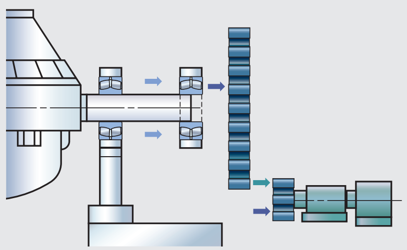


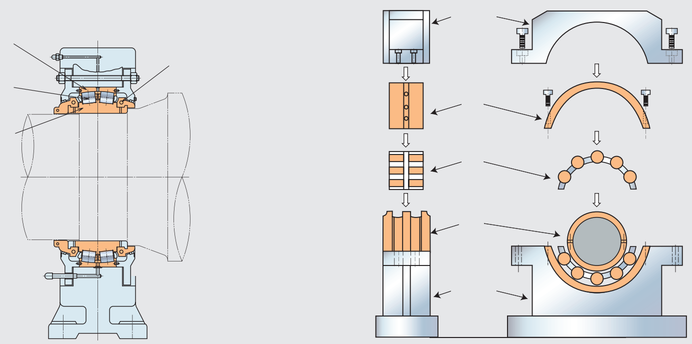
(1)

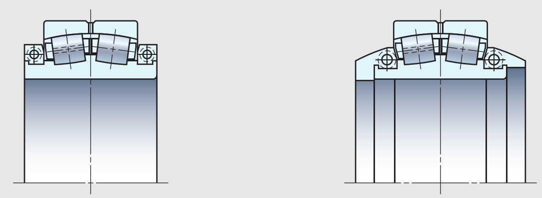
Benefits ❶ ❷ ❸

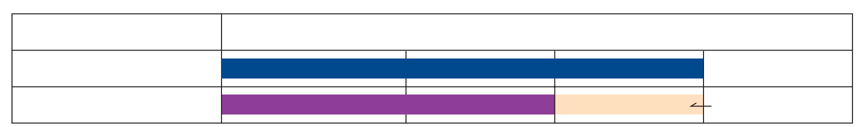












Note (1): Photo courtesy of NIPPON STEEL & SUMITOMO METAL CORPORATION KASHIMA WORKS pamphlet.

■Bearings for BOFs and Converters

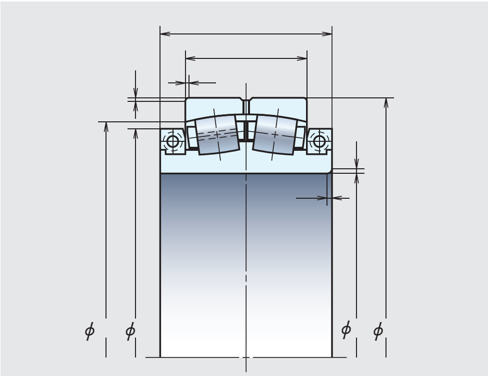


Fig. 1

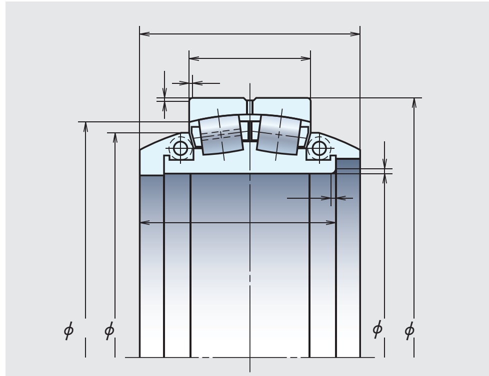


Fig. 2 Clamp Ring with Tangential Seal Surface

Bearing Numbers	Boundary Dimensions (mm)									Basic Load Ratings (kN)		Fig.
								(min)	(min)			
	750	1 000	250	355	—	905	914.4	6	7.5	6 800	18 300	1
	850	1 120	272	385	—	1 015	1 025	6	6	8 000	21 600	1
	900	1 250	285	410	—	1 100	1 142	7.5	19	9 850	24 200	1
	950	1 400	300	520	600	1 182	1 265	7.5	28	12 300	27 900	2
	1 120	1 580	320	632.5	697.5	1 400	1 445	9.5	30	13 200	32 000	2
	1 200	1 700	410	780	780	1 470	1 536	9.5	31	17 300	43 500	2
	1 200	1 700	410	660	730	1 470	1 536	9.5	19	17 300	43 500	2
	1 320	1 850	530	815	814	1 600	1 670	12	31	22 500	63 500	2
	1 400	1 900	530	880	880	1 680	1 710	12	31	22 800	65 000	2
	1 400	1 900	530	810	860	1 680	1 710	12	31	22 800	65 000	2

Remarks 1. The shapes of bearings marked are not exactly the same as shown in Fig. 2.
2. Other bearings are available. Please contact NSK for additional information.

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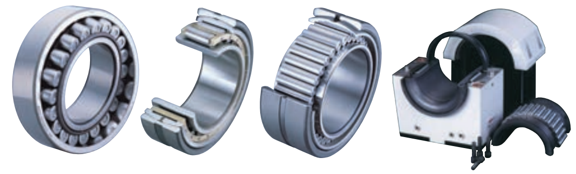
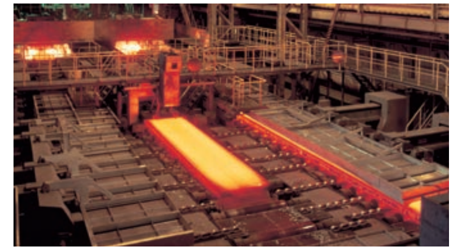
Benefits ❶ ❷





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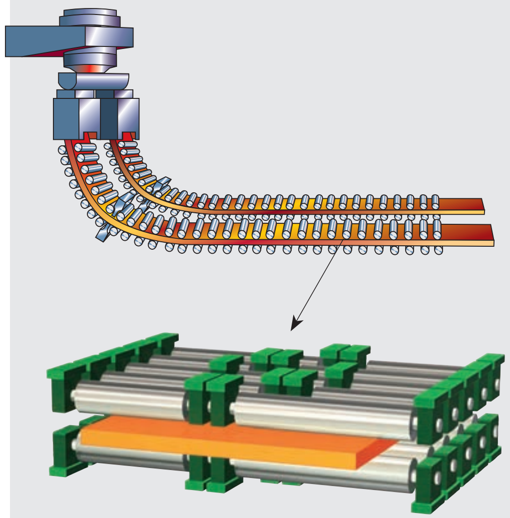
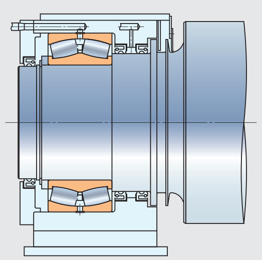
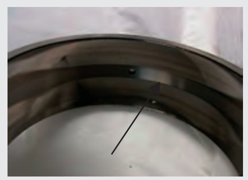
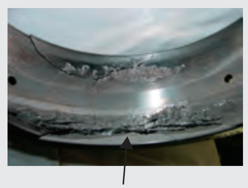
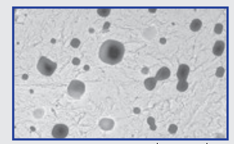


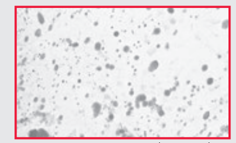




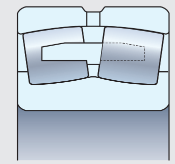


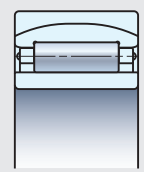


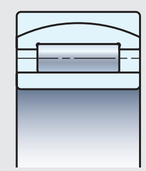
SUJ2 1μm

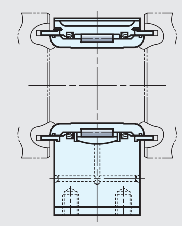


SWR 1μm



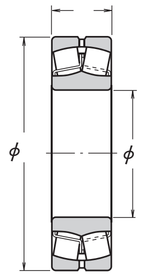






Note (1): Photo courtesy of NIPPON STEEL & SUMITOMO METAL CORPORATION KASHIMA WORKS pamphlet.

Bore Diameter



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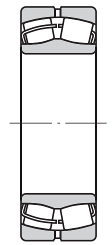

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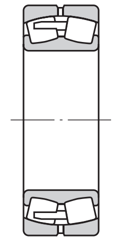

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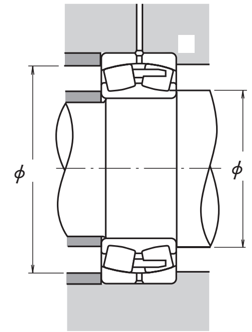

Dynamic Equivalent Load

= +

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1	3	0.67	2

Static Equivalent Load

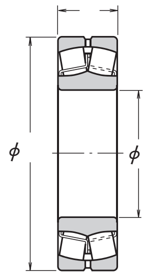
= +

The values of , , , and are given in the table below.

Boundary Dimensions (mm)			Basic Load Ratings (kN)		(kgf)		Bearing Numbers	Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
		min.						min.	max.	max.	min.	max.					approx.
80	23	1.1	90.5	99.5	9 200	10 100		47	49	73	70	1	0.28	3.6	2.4	2.4	0.5
90	33	1.5	136	153	13 900	15 600		49	—	81	77	1.5	0.38	2.6	1.8	1.7	1.0
90	23	1.1	99	119	10 100	12 100		57	60	83	81	1	0.24	4.3	2.9	2.8	0.61
100	25	1.5	119	144	12 100	14 600		64	65	91	89	1.5	0.23	4.3	2.9	2.8	0.81
120	29	2	142	174	14 500	17 800		65	72	110	98	2	0.23	4.4	3.0	2.9	1.58
95	26	1.1	98.5	141	10 000	14 400		67	68	88	85	1	0.26	3.9	2.6	2.5	0.68
110	28	1.5	142	174	14 500	17 800		69	72	101	98	1.5	0.23	4.4	3.0	2.9	1.1
110	28	1.5	178	154	18 100	15 700		69	—	101	97	1.5	0.25	4.0	2.7	2.6	1.17
130	31	2.1	190	244	19 400	24 900		72	87	118	117	2	0.22	4.5	3.0	3.0	1.98
130	46	2.1	246	288	25 100	29 400		72	—	118	111	2	0.36	2.8	1.9	1.9	2.9
120	31	1.5	152	190	15 500	19 300		74	—	111	106	1.5	0.26	3.9	2.6	2.6	1.57
140	48	2.1	265	315	27 000	32 500		77	—	128	117	2	0.35	2.9	1.9	1.9	3.56
125	31	1.5	225	232	22 900	23 600		79	84	116	111	1.5	0.23	4.3	2.9	2.8	1.58
125	31	1.5	163	205	16 600	20 900		79	—	116	111	1.5	0.25	4.0	2.7	2.7	1.64
130	31	1.5	238	244	24 200	24 900		84	87	121	117	1.5	0.22	4.5	3.0	3.0	1.64
140	33	2	264	275	27 000	28 000		90	94	130	126	2	0.22	4.6	3.1	3.0	2.01
170	39	2.1	355	375	36 000	38 000		92	109	158	146	2	0.23	4.4	3.0	2.9	4.32
170	58	2.1	390	480	39 500	48 500		92	—	158	145	2	0.35	2.9	2.0	1.9	6.2
150	36	2	310	325	320	33 500		95	101	140	135	2	0.22	4.6	3.1	3.0	2.54
160	40	2	360	395	37 000	40 000		100	108	150	142	2	0.24	4.3	2.9	2.8	3.3
160	52.4	2	340	490	34 500	50 000		100	105	150	138	2	0.32	3.2	2.1	2.1	4.51
190	64	3	665	705	68 000	72 000		104	115	176	163	2.5	0.33	3.1	2.1	2.0	8.56
170	43	2.1	296	395	30 000	40 000		107	—	158	150	2	0.25	4.1	2.7	2.7	4.19
150	37	1.5	212	335	21 600	34 500		109	112	141	136	1.5	0.22	4.6	3.1	3.0	2.31
150	50	1.5	276	470	28 100	48 000		109	110	141	132	1.5	0.30	3.4	2.3	2.2	3.08
165	65	2	345	535	35 500	54 000		110	113	155	144	2	0.30	3.4	2.3	2.2	4.38
180	46	2.1	455	490	46 500	50 000		112	119	168	160	2	0.24	4.3	2.9	2.8	4.84

Bearings for Continuous Casting Machines

Bore Diameter 110 – 140 mm



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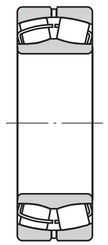

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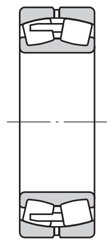

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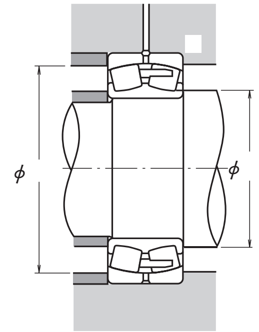

Dynamic Equivalent Load

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1	3	0.67	2

Static Equivalent Load

= +

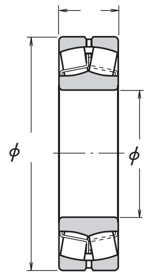
The values of , , , and are given in the table below.

Boundary Dimensions (mm)				Basic Load Ratings (kN)		{kgf}		Bearing Numbers	Abutment and Fillet Dimensions (mm)					Constant	Axial Load Factors			Mass (kg)
			min.						min.	max.	max.	min.	max.					approx.
110	170	45	2	293	465	29 900	47 500	**23022SWRCDE4**	120	124	160	153	2	0.24	4.2	2.8	2.8	3.76
	170	45	2	293	465	30 900	47 500	**23022SWRCAME4**	120	—	160	153	2	0.24	4.2	2.8	2.8	3.74
	170	60	2	380	645	38 500	66 000	**24022SWRCE4**	120	121	160	148	2	0.32	3.1	2.1	2.1	4.96
	180	56	2	480	630	49 000	64 000	**23122SWRCAME4**	120	—	170	158	2	0.28	3.5	2.4	2.3	5.67
	180	69	2	460	750	47 000	76 500	**24122SWRCE4**	120	123	170	154	2	0.36	2.8	1.9	1.8	6.84
	200	53	2.1	605	645	61 500	66 000	**22222SWREAE4**	122	129	188	178	2	0.25	4.0	2.7	2.6	6.99
	200	53	2.1	425	585	43 500	59 500	**22222SWRCAME4**	122	—	188	176	2	0.24	4.2	2.8	2.7	7.26
	200	69.8	2.1	645	760	65 000	77 500	**23222SWRCAME4**	122	—	188	170	2	0.34	3.0	2.0	1.9	9.58
	240	80	3	1030	1120	10 500	115 000	**22322SWREAE4**	124	145	226	206	2.5	0.33	3.1	2.1	2.0	17.6
120	180	46	2	315	525	32 000	53 500	**23024SWRCDE4**	130	134	170	163	2	0.22	4.5	3.0	2.9	4.11
	180	46	2	395	525	40 000	53 500	**23024SWRCAME4**	130	—	170	163	2	0.22	4.5	3.0	2.9	4.11
	180	60	2	395	705	40 500	72 000	**24024SWRCE4**	130	131	170	158	2	0.32	3.2	2.1	2.1	5.33
	180	60	2	480	680	49 000	69 000	**24024SWRCAME4**	130	131	170	158	2	0.32	3.2	2.1	2.1	5.33
	200	80	2	575	950	58 500	96 500	**24124SWRCE4**	130	136	190	171	2	0.37	2.7	1.8	1.8	10
	200	80	2	695	905	70 500	92 000	**24124SWRCAME4**	130	—	190	171	2	0.37	2.7	1.8	1.8	9.86
	215	58	2.1	490	690	50 000	70 000	**22224SWRCAME4**	132	—	203	189	2	0.25	4.1	2.7	2.7	9.05
	215	76	2.1	790	970	80 500	99 000	**23224SWRCAME4**	132	—	203	182	2	0.34	2.9	2.0	1.9	12
	260	86	3	845	1 120	80 600	115 000	**22324SWRCAME4**	134	—	246	219	2.5	0.35	2.9	2.0	1.9	22.3
130	200	52	2	400	655	40 500	67 000	**23026SWRCDE4**	140	147	190	180	2	0.23	4.3	2.9	2.9	5.98
	200	69	2	495	865	50 500	88 000	**24026SWRCE4**	140	143	190	175	2	0.31	3.2	2.2	2.1	7.84
	200	69	2	620	865	60 300	88 000	**24026SWRCAME4**	140	—	190	175	2	0.31	3.2	2.2	2.1	7.83
	210	80	2	590	1 010	60 000	103 000	**24126SWRCE4**	140	146	200	180	2	0.35	2.9	1.9	1.9	10.7
	210	80	2	590	1 010	60 000	103 000	**24126SWRCAME4**	140	—	200	180	2	0.37	2.7	1.8	1.8	10.6
	230	64	3	820	940	83 500	96 000	**22226SWREAE4**	144	152	216	204	2.5	0.26	3.8	2.6	2.5	11
	230	64	3	565	815	57 500	83 000	**22226SWRCAME4**	144	—	216	203	2.5	0.26	3.9	2.6	2.6	11.3
	230	80	3	875	1 080	89 500	110 000	**23226SWRCAME4**	144	—	216	196	2.5	0.34	2.9	2.0	1.9	14.3
140	210	53	2	420	715	43 000	73 000	**23028SWRCDE4**	150	157	200	190	2	0.22	4.5	3.0	2.9	6.49
	210	69	2	525	945	53 500	96 500	**24028SWRCE4**	150	154	200	186	2	0.29	3.4	2.3	2.2	8.37
	210	69	2	635	905	64 500	92 500	**24028SWRCAME4**	150	—	200	186	2	0.31	3.2	2.2	2.1	8.32

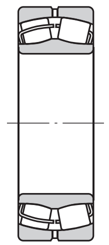
INDUSTRY SOLUTIONS

Bearings for Continuous Casting Machines

Bore Diameter 140 – 180 mm



EA



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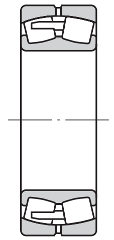

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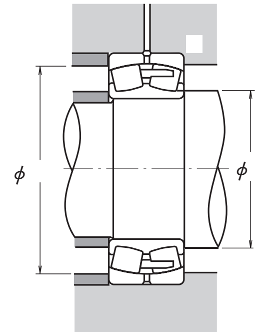

Dynamic Equivalent Load

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1	3	0.67	2

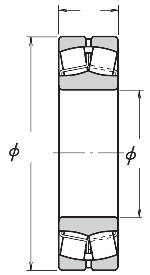
Static Equivalent Load

= +

The values of , , and are given in the table below.

Boundary Dimensions (mm)				Basic Load Ratings (kN)		(kgf)		Bearing Numbers	Abutment		and Fillet Dimensions (mm)			Constant	Axial Load Factors			Mass (kg)
			min.						min.	max.	max.	min.	max.					approx.
140	225	68	2.1	725	945	73 500	96 500	**23128SWRCAME4**	152	—	213	198	2	0.28	3.6	2.4	2.3	10.5
	225	85	2.1	670	1 160	68 500	118 000	**24128SWRCE4**	152	156	213	193	2	0.35	2.9	1.9	1.9	13
	225	85	2.1	835	1 160	85 500	118 000	**24128SWRCAME4**	152	—	213	192	2	0.37	2.7	1.8	1.8	12.9
	250	68	3	645	930	65 500	95 000	**22228SWRCDE4**	154	167	236	219	2.5	0.25	4.0	2.7	2.6	14.5
	250	68	3	835	945	85 500	96 500	**22228SWRCAME4**	154	—	236	221	2.5	0.26	3.9	2.6	2.5	14.2
	250	88	3	835	1 300	85 000	133 000	**23228SWRCAME4**	154	—	236	213	2.5	0.35	2.9	2.0	1.9	18.8
150	225	56	2.1	470	815	48 000	83 000	**23030SWRCDE4**	162	168	213	203	2	0.22	4.6	3.1	3.0	7.9
	225	75	2.1	590	1 090	60 500	111 000	**24030SWRCE4**	162	165	213	198	2	0.30	3.4	2.3	2.2	10.5
	225	75	2.1	740	1 090	75 500	111 000	**24030SWRCAME4**	162	—	213	198	2	0.30	3.4	2.3	2.2	10.4
	250	80	2.1	725	1 180	74 000	121 000	**23130SWRCE4**	162	174	238	218	2	0.30	3.4	2.3	2.2	15.8
	250	100	2.1	890	1 530	91 000	156 000	**24130SWRCE4**	162	169	238	212	2	0.38	2.6	1.8	1.7	19.8
	270	73	3	765	1 120	78 000	114 000	**22230SWRCDE4**	164	179	256	236	2.5	0.26	3.9	2.6	2.5	18.4
	270	96	3	975	1 560	99 500	159 000	**23230SWRCE4**	164	176	256	230	2.5	0.35	2.9	1.9	1.9	24.2
160	240	60	2.1	540	955	55 000	97 500	**23032SWRCDE4**	172	179	228	216	2	0.22	4.5	3.0	2.9	9.66
	240	80	2.1	680	1 260	69 000	128 000	**24032SWRCE4**	172	177	228	212	2	0.30	3.4	2.3	2.2	12.7
	240	80	2.1	845	1 260	86 500	128 000	**24032SWRCAE3**	172	—	228	212	2	0.30	3.4	2.3	2.2	12.3
	270	109	2.1	1 040	1 760	106 000	179 000	**24132SWRCE4**	172	179	258	229	2	0.39	2.6	1.7	1.7	25.4
	290	80	3	910	1 320	93 000	135 000	**22232SWRCDE4**	174	190	276	255	2.5	0.26	3.8	2.6	2.5	23.1
	290	80	3	1 140	1 320	116 000	135 000	**22232SWRCAME4**	174	—	276	255	2.5	0.26	3.8	2.6	2.5	23.1
170	260	67	2.1	640	1 090	65 000	112 000	**23034SWRCDE4**	182	191	248	233	2	0.23	4.3	2.9	2.8	13
	260	90	2.1	825	1 520	84 000	155 000	**24034SWRCE4**	182	188	248	228	2	0.31	3.2	2.2	2.1	17.3
	280	88	2.1	940	1 570	96 000	160 000	**23134SWRCAME4**	182	—	268	245	2	0.29	3.5	2.3	2.3	21.6
	280	109	2.1	1 080	1 860	110 000	190 000	**24134SWRCE4**	182	190	268	239	2	0.37	2.7	1.8	1.8	26.6
	310	86	4	990	1 500	101 000	153 000	**22234SWRCDE4**	188	206	292	270	3	0.26	3.8	2.6	2.5	28.8
	310	110	4	1 200	1 910	122 000	195 000	**23234SWRCE4**	188	201	292	261	3	0.34	2.9	2.0	1.9	36.4
180	280	74	2.1	750	1 270	76 000	129 000	**23036SWRCDE4**	192	202	26	249	2	0.24	4.2	2.8	2.8	17.1
	280	100	2.1	965	1 750	98 500	178 000	**24036SWRCE4**	192	200	268	245	2	0.32	3.1	2.1	2.0	22.7
	280	100	2.1	1 210	1 750	123 000	178 000	**24036SWRCAME4**	192	—	268	245	2	0.32	3.1	2.1	2.0	22.5
	300	96	3	1 320	1 760	134 000	180 000	**23136SWRCAME4**	194	—	286	260	2.5	0.31	3.3	2.2	2.2	27.4
	300	118	3	1 190	2 040	121 000	208 000	**24136SWRCE4**	194	202	286	255	2.5	0.37	2.7	1.8	1.8	33.1
	300	118	3	1 490	2 040	152 000	208 000	**24136SWRCAME4**	194	—	286	255	2.5	0.37	2.7	1.8	1.8	33
	320	86	4	1 020	1 540	104 000	157 000	**22236SWRCDE4**	198	212	302	278	3	0.26	3.9	2.6	2.6	30.2

Bore Diameter 190 – 240 mm



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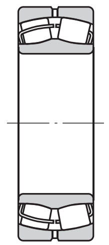
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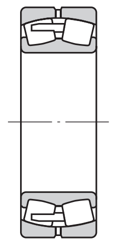
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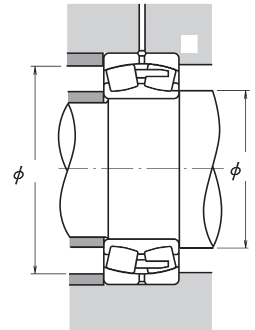

Dynamic Equivalent Load

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1	3	0.67	2

Static Equivalent Load

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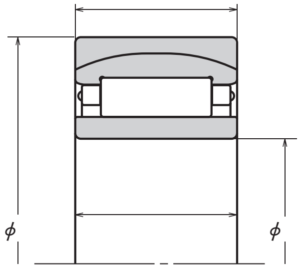
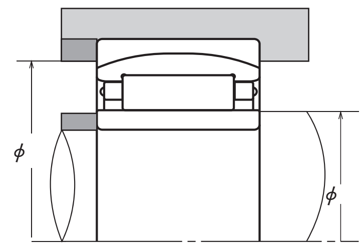
The values of , , and are given in the table below.

Boundary Dimensions (mm)				Basic Load Ratings (kN)		{kgf}		Bearing Numbers	Abutment		and Fillet Dimensions (mm)			Constant	Axial Load Factors			Mass (kg)
			min.						min.	max.	max.	min.	max.					approx.
190	290	75	2.1	970	1 350	99 000	138 000	**23038SWRCAME4**	202	—	278	261	2	0.24	4.2	2.8	2.8	17.6
	290	100	2.1	975	1 840	99 500	188 000	**24038SWRCE4**	202	210	278	253	2	0.31	3.2	3.2	2.1	24
	290	100	2.1	1 220	1 840	124 000	188 000	**24038SWRCAME4**	202	—	278	253	2	0.32	3.1	2.1	2.0	23.8
	320	128	3	1 370	2 330	140 000	238 000	**24138SWRCE4**	204	211	306	269	2.5	0.4	2.5	1.7	1.6	41.5
	320	128	3	1 710	2 330	175 000	238 000	**24138SWRCAME4**	204	—	306	269	2.5	0.38	2.6	1.8	1.7	40.9
	340	92	4	1 140	1 730	116 000	176 000	**22238SWRCAME4**	208	—	322	296	3	0.26	3.8	2.6	2.5	35.5
	340	120	4	1 440	2 350	147 000	240 000	**23238SWRCE4**	208	222	322	288	3	0.35	2.9	1.9	1.9	47.6
200	310	82	2.1	1 180	1 700	120 000	174 000	**23040SWRCAME4**	212	—	298	279	2	0.25	4.0	2.7	2.6	22.6
	310	109	2.1	1 140	2 120	116 000	216 000	**24040SWRCE4**	212	223	298	271	2	0.32	3.1	2.1	2.0	30.4
	310	109	2.1	1 420	2 120	145 000	216 000	**24040SWRCAME4**	212	—	298	271	2	0.33	3.0	2.0	2.0	30.2
	340	140	3	1 570	2 670	160 000	272 000	**24140SWRCE4**	214	226	326	290	2.5	0.39	2.6	1.8	1.7	51.3
	340	140	3	1 960	2 660	199 000	271 000	**24140SWRCAME4**	214	—	326	290	2.5	0.39	2.5	1.7	1.7	50.8
	360	98	4	1 300	2 010	133 000	204 000	**22240SWRCAME4**	218	—	342	315	3	0.26	3.8	2.6	2.5	42.6
220	340	90	3	1 360	1 980	139 000	202 000	**23044SWRCAME4**	234	—	326	302	2.5	0.24	4.1	2.8	2.7	29.7
	340	118	3	1 640	2 490	168 000	265 000	**24044SWRCE4**	234	244	326	296	2.5	0.31	3.2	2.1	2.1	40.5
	340	118	3	1 310	2 490	134 000	254 000	**24044SWRCAME4**	234	—	326	296	2.5	0.32	3.2	2.1	2.1	39
	370	150	4	1 800	3 200	183 000	325 000	**24144SWRCE4**	238	248	352	313	3	0.39	2.6	1.7	1.7	66.7
	370	150	4	1 800	3 200	183 000	325 000	**24144SWRCAME4**	238	—	352	313	3	0.39	2.6	1.7	1.7	64.3
	400	108	4	1 570	2 430	160 000	247 000	**22244SWRCAME4**	238	—	382	348	3	0.27	3.7	2.5	2.4	59
	400	144	4	2 010	3 400	206 000	350 000	**23244SWRCE4**	238	260	382	337	3	0.35	2.9	1.9	1.9	80.4
240	360	118	3	1 730	2 730	176 000	278 000	**24048SWRCAME4**	254	—	346	317	2.5	0.30	3.3	2.2	2.2	42.2
	400	160	4	2 660	3 800	272 000	385 000	**24148SWRCAME4**	258	—	382	341	3	0.38	2.7	1.8	1.8	79.6

Bearings for Continuous Casting Machines

Bore Diameter 90 – 240 mm
With Cage

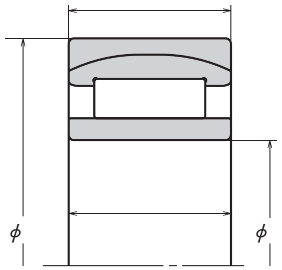


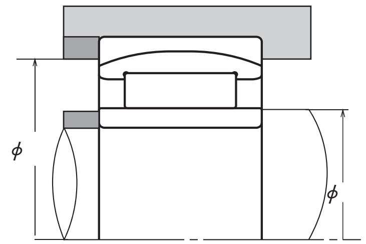


Boundary Dimensions (mm)						Basic Load Ratings (kN)		Bearing Numbers	Abutment and Fillet Dimensions (mm)		
				min.	min.				min.	max.	min.
90	160	56	50	1.1	2	220	335	**90RUB1601P**	99	105	143
	170	68	52.4	2	2	270	375	**90RUB1702P**	99	106	153
	190	64	64	3	3	340	490	**90RUB1908P**	103	109	166
100	165	52	52	2	1.1	221	385	**100RUB31AP**	106.5	113	147
	165	58	52	2	1.1	221	385	**100RUB1602P**	106.5	113	147
	180	46	46	2.1	2.1	251	375	**100RUB22P**	111	117	163
	215	73	73	3	1.5	435	595	**100RUB23P**	108	125	190
110	170	75	45	1.1	1.1	191	325	**110RUB1701P**	116.5	121	155
120	180	46	46	2.5	2.5	215	415	**120RUB30P**	132	133	165
	180	76	46	2	2	215	415	**120RUB1801P**	129	133	166
	200	80	80	2	2	370	680	**120RUB41P**	129	136	174
124.96	255	133	66	2.1	5	430	590	**125RUB2502P**	144.96	154	229
130	200	79	52	2	2	261	440	**130RUB2001P**	139	144	184
	230	90	90	3	3	540	930	**130RUB2301P**	143	149	200
140	250	68	68	3	3	480	740	**140RUB22P**	153	161	227
150	250	100	100	2.1	2.1	540	1 040	**150RUB41P**	161	169	219
	270	130	96	3	3	690	1 210	**150RUB2702P**	163	172	236
180	280	100	100	2.1	2.1	635	1 300	**180RUB40P**	191	200	250
	300	136	96	3	3	630	1 250	**180RUB3002P**	193	203	260
	300	158	118	3	3	755	1 460	**180RUB3001P**	193	203	260
	320	140	112	4	4	950	1 690	**180RUB3201P**	196	207	279
200	310	82	82	2.5	2.5	635	1 210	**200RUB30P**	213	222	286
	310	109	109	2.1	2.1	770	1 540	**200RUB40P**	211	222	280
	340	140	140	3	3	1 080	2 200	**200RUB41P**	213	229	295
220	380	120	120	4	4	1 090	1 950	**220RUB3801P**	236	251	341
	400	108	108	4	4	1 040	1 770	**220RUB22E1P**	236	255	358
240	400	150	128	4	4	1 260	2 500	**240RUB4001P**	256	269	362

INDUSTRY SOLUTIONS

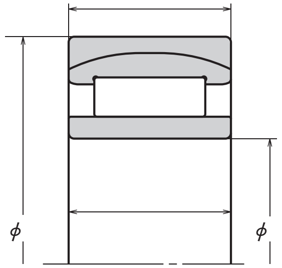
Bore Diameter 50 – 110 mm
Full-Complement

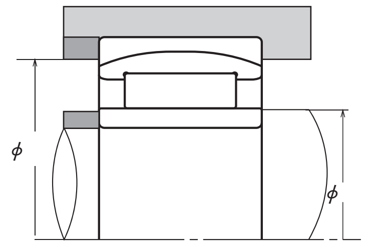




Boundary Dimensions (mm)						Basic Load Ratings (kN)		Bearing Numbers	Abutment and Fillet Dimensions (mm)		
				min.	min.				min.	max.	min.
50	90	23	23	1.5	1.5	69.5	104	**50RUB22PV**	57	58	80
	110	40	40	2	2	140	295	**50RUB23PV**	59	70	94
55	90	32	32	1.1	1.1	82	195	**55RUB9001PV**	61.5	62.5	80
	100	25	25	1.5	1.5	88	121	**55RUB22APV**	62	63	90
65	120	31	31	1.5	1.5	131	200	**65RUB22PV**	73	75	107
	140	48	48	2.1	2.1	221	440	**65RUB23PV**	76	85	121
70	125	31	31	1.5	1.5	127	213	**70RUB22APV**	78	85	113
75	130	31	31	1.5	1.5	151	248	**75RUB22APV**	83	85	118
85	150	65	65	2.5	2.5	286	595	**85RUB1501P**	97	98	130
90	150	72	60	1.5	1	262	575	**90RUB1501PV**	95	101	131
	190	64	64	3	1.5	415	780	**90RUB23APV**	98	116	168
100	150	50	50	2	2	230	530	**100RUB40PV**	108	109	134
	150	66	50	2	2	230	530	**100RUB1501PV**	108	109	134
	165	52	52	2	2	272	550	**100RUB31PV**	109	113	147
	180	46	46	2.1	2.1	277	545	**100RUB22APV**	111	123	164
	180	60.3	60.3	2.1	2.1	360	650	**100RUB32PV**	111	116	160
103	180	60	60	2	2	330	790	**103RUB1801PV**	112	132	163
110	170	45	45	2	2	246	565	**110RUB30A1PV**	119	123	155
	170	60	60	2	2	300	735	**110RUB40PV**	119	123	151
	180	56	56	2.5	2.5	335	670	**110RUB31A1PV**	123	124	161
	180	69	69	2	2	385	835	**110RUB41A2PV**	119	123	157
	200	53	53	2.5	2.1	380	625	**110RUB22APV**	121	130	180

Bore Diameter 120 – 160 mm
Full-Complement





Boundary Dimensions (mm)						Basic Load Ratings (kN)		Bearing Numbers	Abutment and Fillet Dimensions (mm)		
				min.	min.				min.	max.	min.
120	180	46	46	2	2	275	625	**120RUB30B2PV**	129	132	165
	180	60	60	2	2	330	790	**120RUB40A2PV**	129	132	163
	180	80	60	2	2	330	790	**120RUB1803PV**	129	132	163
	200	80	80	2.5	2.5	470	1 040	**20RUB41A1PV**	133	137	174
	225	58	58	2.5	2.5	460	690	**120RUB2201APV**	133	138	204
130	200	69	69	2	2	410	955	**130RUB40A1PV**	139	143	180
	210	64	64	2	2	415	865	**130RUB31APV**	139	144	189
	210	80	80	2	2	510	1 130	**130RUB41A2PV**	139	144	184
	230	64	64	3	3	495	840	**130RUB22APV**	143	151	208
	230	80	80	3	3	585	1 090	**130RUB32APV**	143	146	204
140	210	53	53	2	2	365	885	**140RUB30A2PV**	149	155	194
	210	69	69	2	2	420	990	**140RUB40APV**	149	152	190
	225	68	68	2.1	2.1	485	1 000	**140RUB31APV**	151	156	203
	225	85	85	2.1	2.1	575	1 310	**140RUB41A1PV**	151	156	200
	250	68	68	3	3	510	1 110	**140RUB22APV**	153	172	227
	250	88	88	3	3	670	1 500	**140RUB32PV**	153	170	221
150	225	56	56	2.5	2.5	390	840	**150RUB30APV**	163	166	208
	225	75	75	2.1	2.1	485	1 210	**150RUB40A1PV**	161	165	203
	225	92	75	2.1	2.1	465	1 160	**150RUB2201PV**	161	164	203
	250	80	80	2.1	2.1	595	1 290	**150RUB31APV**	161	170	221
	250	100	100	2.1	2.1	710	1 620	**150RUB41APV**	161	170	219
	270	96	96	3	3	815	1 640	**150RUB32APV**	163	174	236
160	240	80	80	2.1	2.1	530	1 330	**160RUB40A1PV**	171	176	217
	240	85	80	2.1	2.1	530	1 330	**160RUB2402PV**	171	176	217
	270	109	109	2.1	2.1	855	1 830	**160RUB41AE2PV**	171	181	237

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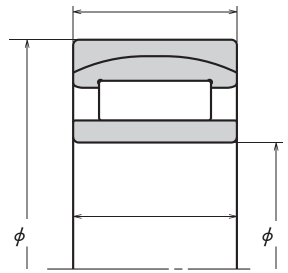
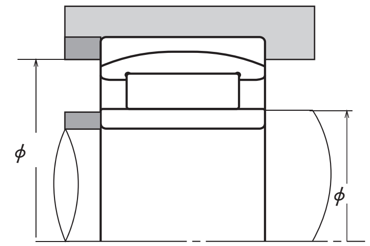
Bore Diameter 170 – 240 mm
Full-Complement





Boundary Dimensions (mm)						Basic Load Ratings (kN)		Bearing Numbers	Abutment and Fillet Dimensions (mm)		
				min.	min.				min.	max.	min.
170	260	67	67	2.1	2.1	555	1 130	**170RUB30APV**	181	188	239
	260	90	90	2.1	2.1	655	1 580	**170RUB40A1PV**	181	188	233
	310	110	110	4	4	1 060	2 090	**170RUB32APV**	186	195	273
180	280	100	100	2.5	2.5	785	1 870	**180RUB40APV**	193	198	250
	300	118	118	3	3	940	2 120	**180RUB41APV**	193	202	260
	320	112	112	4	4	1 090	2 190	**180RUB32APV**	196	204	279
190	290	100	100	2.1	2.1	850	2 100	**190RUB40A1PV**	201	210	260
	320	104	104	3	3	1 050	2 240	**190RUB31APV**	203	214	286
	340	120	120	4	4	1 210	2 430	**190RUB32APV**	206	218	297
200	310	109	109	2.1	2.1	1 030	2 550	**200RUB40A1PV**	211	219	280
	340	112	112	3	3	1 160	2 470	**200RUB31APV**	213	230	305
	340	140	140	3	3	1 340	3 100	**200RUB41APV**	213	230	295
220	340	90	90	3	3	905	2 020	**220RUB30PV**	233	243	313
	340	118	118	3	3	1 110	2 630	**220RUB40APV**	233	243	308
	340	135	118	3	3	1 010	2 670	**220RUB3401PV**	233	247	308
	370	150	150	4	4	1 510	3 500	**220RUB41APV**	236	248	322
240	400	128	128	4	4	1 540	3 400	**240RUB31APV**	256	271	362

Bearings for Continuous Casting Machines

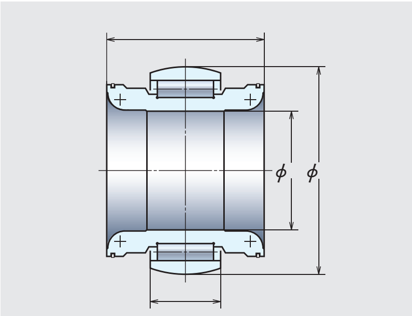


Fig. 1

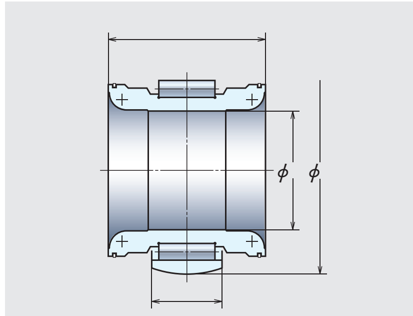
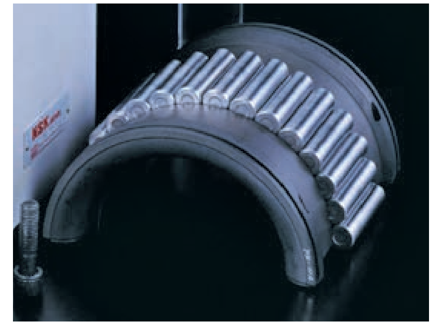


Fig. 2

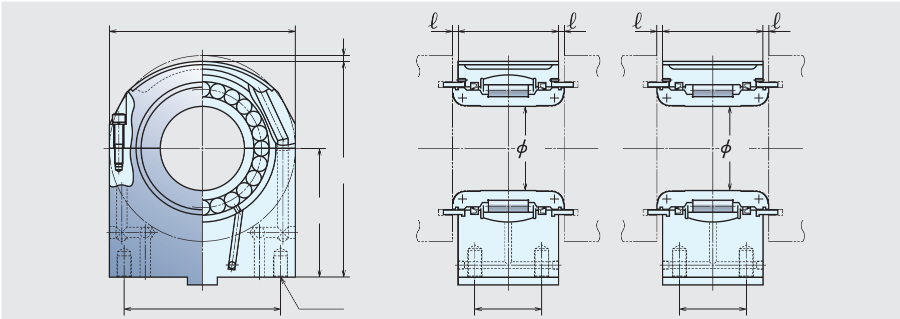


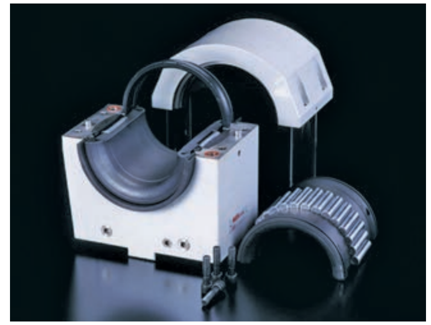
Bearing Numbers	Boundary Dimensions (mm)					Basic Load Ratings (kN)		Roll Diameter (mm)	Fig.
100RNPH1801	100	185	169	74	15	475	950	225	2
110RNPH1801	110	180	137	49	15	272	570	230	2
110RNPH1803	110	185	154	76	20	450	1 070	230	2
110RNPH2001	110	200	179	80	20	535	1 090	250	2
115RNPH2001	115	205	202	98	15	625	1 460	240	2
120RNPH1901	120	195	157	66	20	410	950	250	2
120RNPH2001	120	205	179	80	20	560	1 220	255	2
130RNP2001	130	205	139	60	20	455	1 030	270	1
130RNP2101	130	215	174	75	20	540	1 190	280	1
130RNPH2105	130	215	143	60	20	460	975	250	2
130RNPH2107	130	215	174	75	20	550	1 230	250	2
130RNPH2201	130	225	189	90	20	670	1 460	280	2
130RNPH2202	130	220	186	79	20	555	1 370	280	2
135RNPH2101	135	215	183	84	20	570	1 350	250	2
135RNPH2102	135	210	183	84	20	515	1 350	250	2
140RNPH2102	140	215	162	60	20	415	950	270	2
140RNPH2103	140	215	189	74	2.5	490	1 170	265	2
140RNPH2302	140	235	194	84	20	665	1 530	285	2
140RNP2401	140	245	184	85	20	710	1 510	310	1
145RNPH2201	145	225	179	76	20	560	1 340	280	2
145RNPH2303	145	232	196	84	20	630	1 440	280	2
145RNPH2401	145	240	208	89	20	765	1 780	295	2
150RNPH2303	150	230	199	78	2.5	555	1 340	280	2
150RNPH2401	150	245	159	80	20	680	1 550	280	2
150RNPH2403	150	240	195	84	18	690	1 630	290	2
150RNPH2503	150	250	169	70	20	640	1 500	300	2
150RNPH2505	150	250	208	89	20	780	1 840	295	2
150RNPH2601	150	265	187	98	20	900	1 950	320	2
150RNPH2702	150	275	199	100	20	945	1 970	330	2
155RNPH2401	155	245	199	88	20	740	1 720	300	2
160RNPH2502	160	255	199	90	20	735	1 730	310	2
160RNPH2504	160	255	189	86	20	745	1 780	305	2
160RNPH2601	160	265	200	82	20	745	1 700	320	2
160RNPH2703	160	275	214	100	25	945	2 190	325	2
170RNPH2601	170	265	214	100	20	880	2 050	330	2
180RNPH2901	180	290	214	85	20	880	2 050	335	2

Remark Other bearings are available. Please contact NSK for additional information.

INDUSTRY SOLUTIONS

Bearings for Continuous Casting Machines

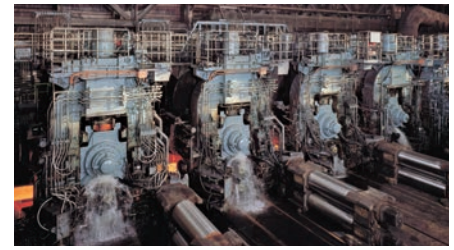




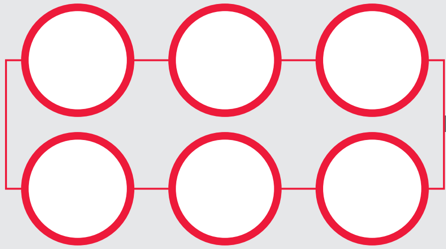
Bearing Numbers	Shaft Diameter(mm)	Boundary Dimensions (mm)									
							ℓ				
	100	235	152	132	10	234.5	9	165	100	4	M20
	110	230	120	160	10	265	9.5	140	—	2	M30
	110	230	135	180	10	285	10	170	—	2	M30
	110	250	156	150	11.5	263.5	12	—	—	1	M36
	115	245	183	190	10	300	10	150	—	2	M24
	120	250	142	165	11.5	278.5	9	190	90	4	M24
	120	255	162	230	10	347.5	9	205	100	4	M24
	130	265	118	190	11.5	313.5	11	195	65	4	M30
	130	280	156	160	10	290	9.5	200	100	4	M24
	130	270	132	197	9	313	6	220	93	4	3/4-10UNC
	130	265	175	145	10	260	7.5	210	120	4	M16
	130	280	172	180	11.5	308.5	9	220	110	4	M30
	130	265	171	175	12.5	295	8	230	90	4	M20
	135	270	160	160	10	275	12	180	130	4	M20
	135	250	160	160	10	275	12	150	130	4	M20
	140	270	145	180	10	305	9.5	170	—	2	M30
	140	265	174	175	7.5	300	8	230	130	4	M20
	140	285	179	175	12.5	305	8	250	97.5	4	M20
	140	310	166	175	10	320	9.5	220	110	4	M24
	145	280	162	250	10	380	9	220	100	4	M30
	145	280	183	260	10	390	7	220	123	4	M30
	145	295	195	270	10	407.5	7	230	130	4	M30
	150	280	184	175	10	305	8	230	140	4	M20
	150	330	144	310	10	440	8	350	260	4	ϕ33
	150	305	180	205.5	14.5	336	8	230	120	4	M24
	150	300	150	180	10	320	10	195	90	4	M30
	150	295	193	310	10	447.5	8	215	126	4	M30
	150	320	168	220	15	365	10	240	90	4	M36
	150	330	182	220	11.5	373.5	9	260	110	4	M36
	155	300	182	260	10	400	9	240	110	4	M30
	160	310	178	185	16.5	323.5	11	150	—	2	M30
	160	305	174	217	12.5	357	8	255	135	4	3/4-10UNC
	160	330	185	225	20	365	8	250	130	4	M24
	160	340	199	200	15.5	347	8	290	130	4	M20
	170	320	194	290.5	10	445.5	10.5	260	340	4	ϕ26
	180	335	150	217.5	10	375	10	240	82	4	M30

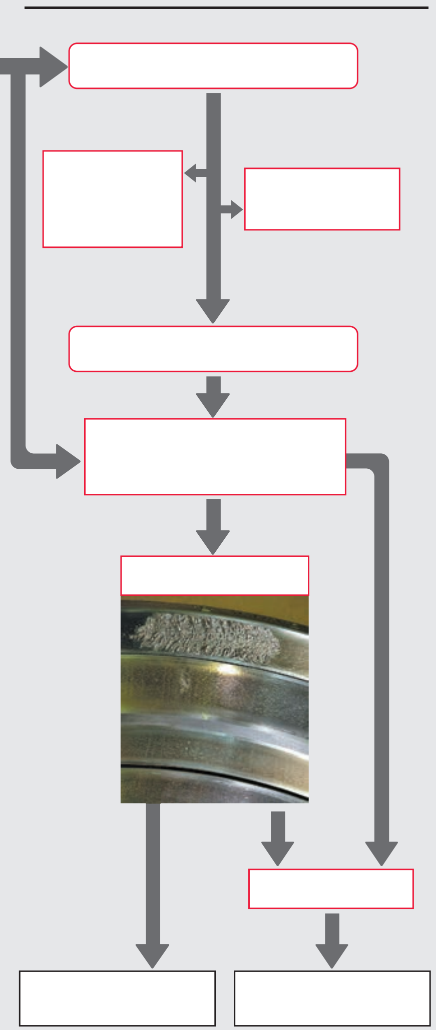
Remark Other bearings are available. Please contact NSK for additional information.

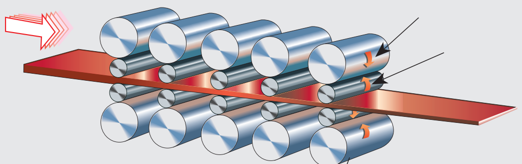
Benefits ❶ ❷ ❸

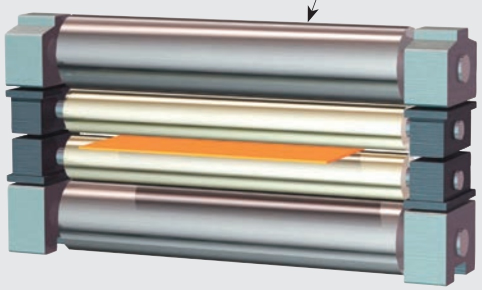


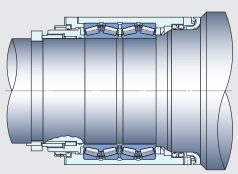
(1)

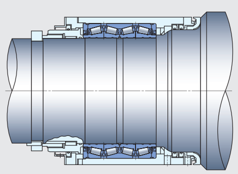


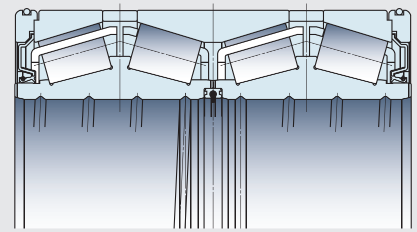


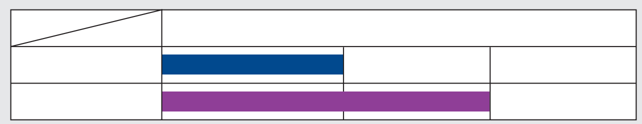


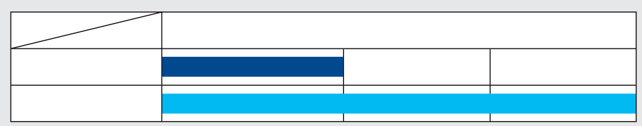












Note (1): Photo courtesy of NIPPON STEEL & SUMITOMO METAL CORPORATION KASHIMA WORKS pamphlet.

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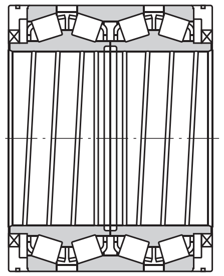
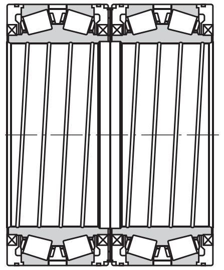
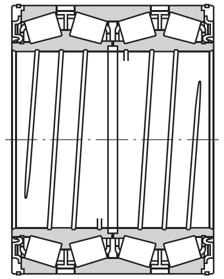


Basic Design of Two Seal Type (KVE) Figure 1



Basic Design of Four Seal Type (KVE) Figure 2



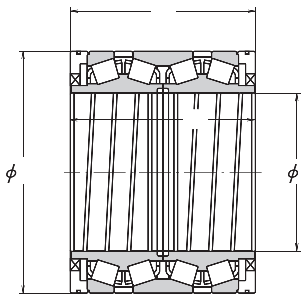
Basic Design of Two Seal Type (KVS) Figure 3

	Variations of Bearing in Figure 1
1-1	Oil holes in cup spacers
1-2	Without intermediate bore seal (for dry rolling)
1-3	Without intermediate bore seal, with holes in cup spacers
1-4	With cone spacer, with intermediate bore seal
1-5	For vertical roll (special cup spacers)

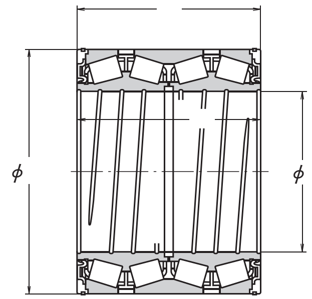
	Variations of Bearing in Figure 2
2-1	Oil holes in cup spacers
2-2	Clearance between cone faces

	Variations of Bearing in Figure 3
3-1	Oil holes in cup spacers

Bore Diameter



KVE



KVS

Dynamic Equivalent Load

= +

≦		>	
1	3	0.67	2

Static Equivalent Load

= +

Where ≒

The values of , , and are given in the table below.

Boundary Dimensions (mm/inch)					Basic Load Ratings (kN)		{kgf}		Bearing Numbers STF Series	Bearing Numbers WTF Series	Figure( )	Constant	Axial Load Factors		Mass (kg)
			min.	min.											approx.
200.025	320.000	320.000	1.0	3.0	1 450	2 420	148 000	247 000			1-2	0.36	2.8	1.9	47.8
7.8750	12.5984	12.5984													
210	240	240	1	2.5	990	2 270	101 000	231 000			1-1	0.32	3.2	2.1	26.1
240	175	175	2.5	2.5	1 020	2 000	103 000	204 000			3	0.32	3.2	2.1	23
269.875	230.000	230.000	2.0	3.3	1 460	3 200	149 000	325 000			1-1	0.29	3.4	2.3	43.6
10.6250	9.0551	9.0551													
288.925	177.800	177.800	0.8	3.3	1 070	2 350	109 000	239 000			3	0.49	2.1	1.4	38
11.3750	7.0000	7.0000													
330.2	263.525	269.875	1.5	3.3	2 290	4 550	233 000	465 000			3	0.46	2.2	1.5	77
13.0000	10.3750	10.6250													
295	315	315	1	2.5	1 410	3 450	144 000	350 000			2-1	0.40	2.5	1.7	61.2
295	335	335	1	2.5	1 410	3 450	144 000	350 000			2-1	0.40	2.5	1.7	65
300	270	270	2.5	2.5	1 650	4 000	168 000	410 000			1-2	0.41	2.5	1.7	56.5
320	290	290	1.5	2.5	1 970	4 500	201 000	460 000			1	0.33	3.0	2.0	78.7
330	260	260	4	3	2 330	4 800	237 000	490 000			3	0.40	2.5	1.7	76
320	230	230	1	2	1 510	3 300	154 000	335 000			1	0.41	2.4	1.6	59.9
400.050	296.875	296.875	3.3	3.3	2 410	4 250	246 000	435 000			1	0.46	2.2	1.5	161
15.7500	11.6880	11.6880													
327.025	196.850	196.850	1.5	3.3	1 550	3 200	158 000	325 000			3	0.46	2.2	1.5	49
12.8750	7.7500	7.7500													
320	250	250	3	3	1 510	3 700	154 000	375 000			1	0.33	3.0	2.0	56.3
338	248	248	2	3	1 820	4 000	185 000	405 000			1	0.43	2.3	1.6	70.6
338	290	290	2	3	2 120	5 000	216 000	510 000			1	0.42	2.4	1.6	82.6
327.025	193.680	193.680	1.5	3	1 370	3 300	148 000	325 000			3	0.40	2.5	1.7	43
12.8750	7.6250	7.6250													
345	310	310	2	3	2 700	6 650	275 000	680 000			3	0.40	2.5	1.7	85
365	270	270	2.5	3	2 210	4 650	225 000	475 000			1	0.33	3.0	2.0	96
365	270	270	2.5	3	2 210	4 650	225 000	475 000			1-1	0.33	3.0	2.0	96

Remark The bearings denoted by an asterisk ( ) are inch design.

Note (1) Refer to pages D130 and D131.

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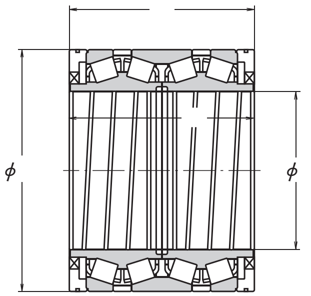
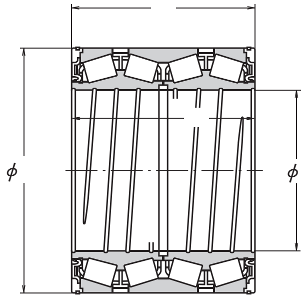
Bore Diameter



KVE



KVS

Dynamic Equivalent Load

= +

≦		>	
1	3	0.67	2

Static Equivalent Load

= +

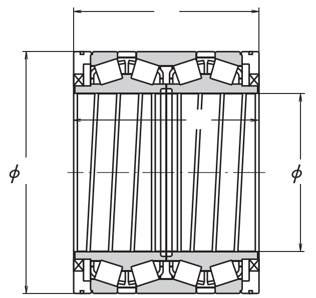
Where ≒

The values of , , and are given in the table below.

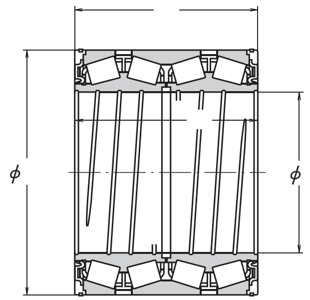
Boundary Dimensions (mm/inch)					Basic Load Ratings (kN)		{kgf}		Bearing Numbers STF Series	Bearing Numbers WTF Series	Fig-ure( )	Constant	Axial Load Factors		Mass (kg)
			min.	min.											approx.
358.775	269.875	269.875	1.5	3.3	2 420	5 500	247 000	560 000			3	0.40	2.5	1.7	86
14.1250	10.6250	10.6250													
365	340	340	2.7	4	2 960	7 350	300 000	750 000			3	0.40	2.5	1.7	110
365	340	340	2.5	4	2 960	7 350	300 000	750 000			3	0.40	2.5	1.7	110
422.275	314.325	317.500	6.4	3.3	3 600	7 050	370 000	720 000			3	0.33	3.0	2.0	170
16.6250	12.3750	12.5000													
355.600	230.188	228.600	1.5	3.3	1 960	4 600	200 000	470 000			3	0.35	2.9	1.9	62
14.0000	9.0625	9.0000													
393.700	269.875	269.875	1.5	3.3	2 720	6 100	277 000	620 000			3	0.45	2.2	1.5	105
15.5000	10.6251	10.6251													
393.700	269.875	269.875	1.5	6.4	2 720	6 100	277 000	620 000			3	0.45	2.2	1.5	102
15.5000	10.6250	10.6250													
393.700	270.630	269.875	1.5	6.4	2 290	5 150	233 000	525 000			1	0.41	2.5	1.7	105
15.5000	10.6547	10.6250													
393.7	320	320	1.5	6.4	3 100	7 350	315 000	745 000			3	0.40	2.5	1.7	120
410	420	420	1	6.4	3 300	7 400	335 000	755 000			2	0.42	2.4	1.6	190
380	290	290	1.5	3	2 230	5 350	227 000	545 000			1-4	0.37	2.7	1.8	96.2
395	340	340	1.5	2.5	2 950	7 050	300 000	720 000			1	0.40	2.5	1.7	133
395	340	340	1.5	2.5	2 950	7 050	300 000	720 000			1	0.40	2.5	1.7	133
410	268	268	1.5	6.4	2 330	4 600	237 000	470 000			1-4	0.33	3.0	2.0	121
412	340	340	3	3	3 300	7 400	335 000	755 000			1-1	0.42	2.4	1.6	156
400	346	346	3	4	3 250	8 400	330 000	855 000			3	0.40	2.5	1.7	112
438.048	280.990	279.400	3.3	3.3	3 100	6 750	315 000	690 000			3	0.45	2.2	1.5	132
17.2460	11.6260	11.0000													
438.048	281.740	279.400	3.3	3.3	2 630	5 600	268 000	570 000			1-2	0.47	2.1	1.4	140
17.2460	11.0921	11.0000													
419.100	269.875	269.875	1.5	6.4	2 850	6 550	291 000	665 000			3	0.33	3.0	2.0	111
16.5000	10.6250	10.6250													
412.648	266.700	266.700	1.5	3.3	2 760	6 500	281 000	665 000			3	0.33	3.0	2.0	100
16.2460	10.5000	10.5000													

Remark The bearings denoted by an asterisk ( ) are inch design.
Note (1) Refer to pages D130 and D131.

Bore Diameter



KVE



KVS

Dynamic Equivalent Load

= +

≦		>	
1	3	0.67	2

Static Equivalent Load

= +

Where ≑

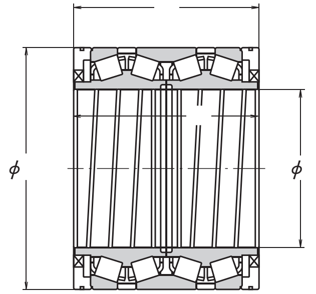
The values of , , and are given in the table below.

Boundary Dimensions (mm/inch)					Basic Load Ratings (kN)		{kgf}		Bearing Numbers STF Series	Bearing Numbers WTF Series	Fig-ure( )	Constant	Axial Load Factors		Mass (kg)
			min.	min.											approx.
430	310	310	3	3	3 350	8 200	345 000	835 000			3	0.46	2.2	1.5	140
430	350	350	2.7	3	3 700	9 550	375 000	970 000			3	0.46	2.2	1.5	155
422.275	269.875	269.875	1.5	3.3	2 740	6 750	279 000	690 000			3	0.34	3.0	2.0	100
16.6250	10.6250	10.6250													
447.675	367.000	367.000	2.5	3.0	3 450	8 100	350 000	825 000			1	0.46	2.2	1.5	184
17.6250	14.4488	14.4488													
457.098	254.000	254.000	1.5	3.3	2 430	6 700	289 000	685 000			3	0.45	2.2	1.5	110
17.9960	10.0000	10.0000													
457.098	299.000	299.000	1.5	3.3	2 830	6 950	289 000	705 000			1	0.46	2.2	1.5	137
17.9960	11.7717	11.7717													
457.200	252.412	252.412	1.5	3.3	2 650	6 750	270 000	685 000			3	0.32	3.2	2.1	98
18.0000	9.9375	9.9375													
545	360	360	2.5	5	3 600	9 050	365 000	920 000			1-1	0.47	2.1	1.4	255
546.100	288.925	288.925	1.5	6.4	3 950	9 450	400 000	965 000			3	0.48	2.1	1.4	184
21.5000	11.3750	11.3750													
546.100	346.000	346.000	0.5	6.4	2 560	5 800	261 000	590 000			2-1	0.47	2.1	1.4	231
21.5000	13.6221	13.6221													
590	395	375	2.5	5	3 550	8 200	365 000	835 000			1-1	0.80	1.3	0.8	332
590	510	510	4	4	5 450	14 300	555 000	1 460 000			2-1	0.38	2.7	1.8	396
620	454	454	4	6	6 500	15 700	665 000	1 600 000			1-1	0.33	3.0	2.0	435
595	368	368	4	5	5 550	15 000	565 000	1 520 000			3	0.33	3.0	2.0	272
596.900	276.225	279.400	1.5	3.3	4 000	9 850	405 000	1 010 000			3	0.47	2.2	1.4	206
23.5000	10.8750	11.0000													
590	470	470	2.5	5	4 900	14 100	500 000	1 440 000			1-1	0.28	3.6	2.4	322
615	435	435	3	5	4 650	12 800	470 000	1 310 000			2-2	0.32	3.2	2.1	323
678	574	574	3	5	8 400	21 500	860 000	2 190 000			2-1	0.34	3.0	2.0	662
615.950	330.200	330.200	4.3	6.4	4 900	13 500	500 000	1 370 000			3	0.33	3.1	2.1	235
24.2500	13.0000	13.0000													

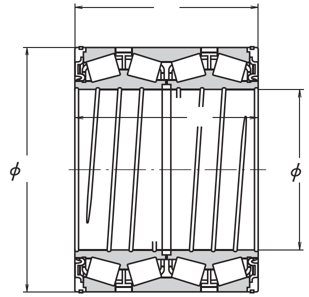
Remark The bearings denoted by an asterisk ( ) are inch design.

Note ([1]) Refer to pages D130 and D131.

Bore Diameter



KVE



KVS

Dynamic Equivalent Load

= +

≦		>	
1	3	0.67	2

Static Equivalent Load

= +

Where ≒

The values of , , and are given in the table below.

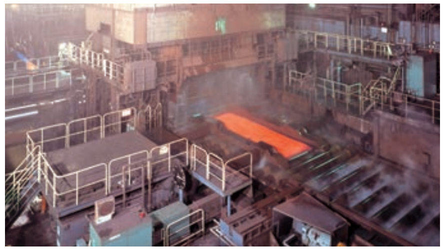
Boundary Dimensions (mm/inch)					Basic Load Ratings (kN)		(kgf)		Bearing Numbers STF Series	Bearing Numbers WTF Series	Fig-ure( )	Constant	Axial Load Factors		Mass (kg)
			min.	min.											approx.
615.950 24.2500	330.200 13.0000	330.200 13.0000	4.3	6.4	3 650	9 650	370 000	985 000			1	0.37	2.7	1.8	243
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			1	0.38	2.7	1.8	302
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			1-5	0.37	2.7	1.8	392
622.300 24.5000	365.125 14.3750	365.125 14.3750	3.8	6.4	3 450	8 950	350 000	915 000			2	0.29	3.5	2.3	272
625	435	435	3	5	4 550	12 500	465 000	1 280 000			2-2	0.32	3.2	2.1	329
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			1	0.41	2.4	1.6	321
735	535	535	5	6	8 800	22 700	900 000	2 310 000			1-1	0.33	3.0	2.0	726
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			1-3	0.35	2.9	1.9	625
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			1	0.33	3.0	2.0	1 110
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			4	0.35	2.9	1.9	1 110
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			1	0.42	2.4	1.6	452
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			1	0.38	2.6	1.8	585
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			1-1	0.44	2.3	1.5	681
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			1	0.38	2.6	1.8	675
1 015	700	700	4	6	13 500	41 000	1 380 000	4 150 000			2-1	0.40	2.5	1.7	1 460
1 160	565	565	5	6	13 900	33 500	1 420 000	3 400 000			1	0.40	2.5	1.7	1 890

Remark The bearings denoted by an asterisk ( ) are inch design.

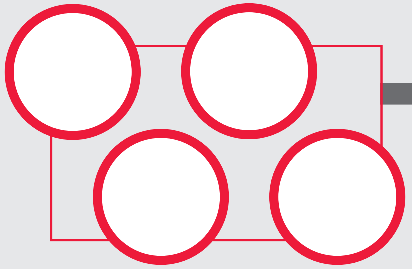
Note ([1]) Refer to pages D130 and D131.

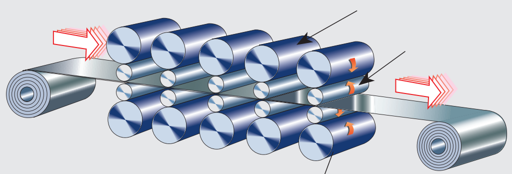
INDUSTRY SOLUTIONS

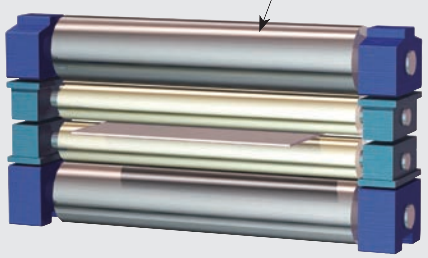
Benefits ❶ ❷ ❸

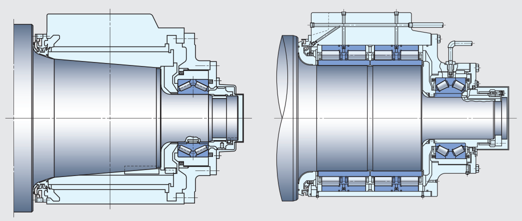


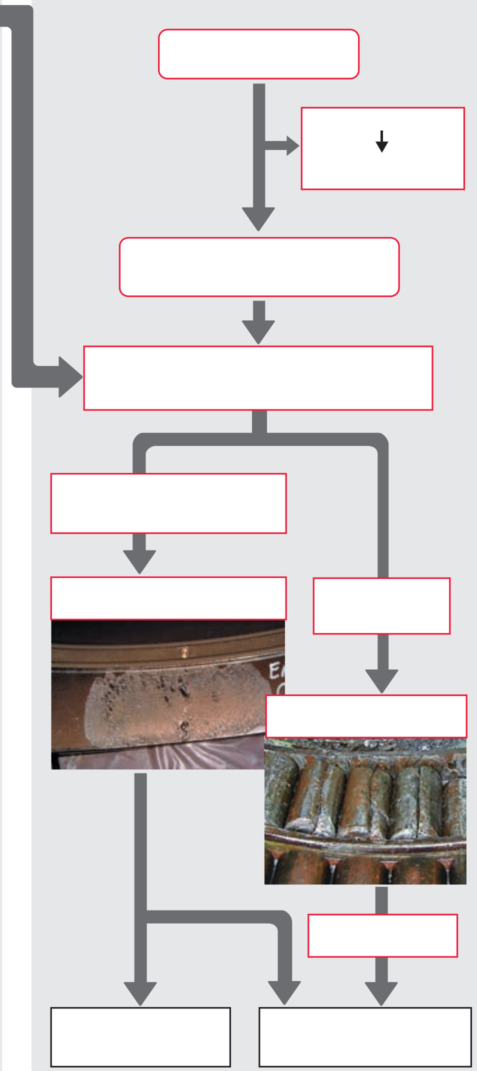
(1)

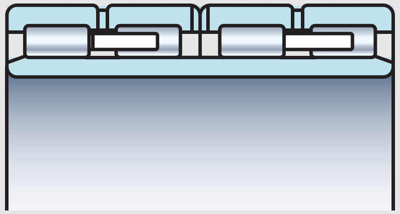


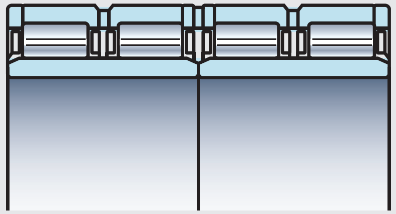


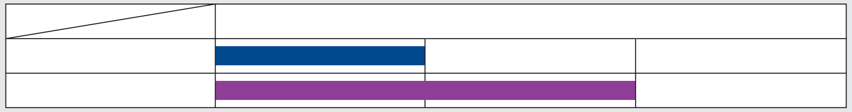


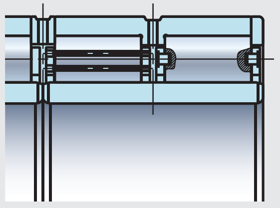


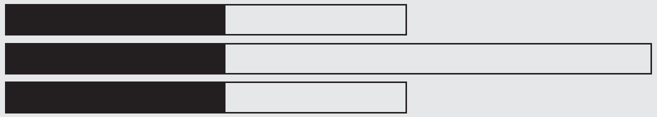












Note (1): Photo courtesy of NIPPON STEEL & SUMITOMO METAL CORPORATION KASHIMA WORKS pamphlet.

INDUSTRY SOLUTIONS

Cylindrical Bore

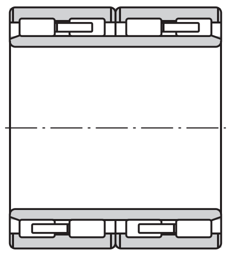


Figure 1

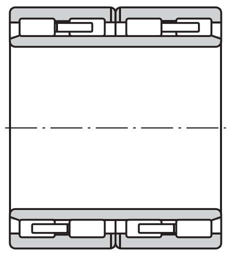


Figure 2

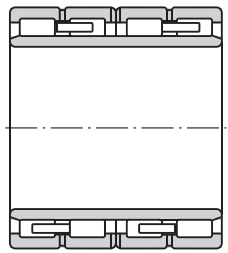


Figure 3

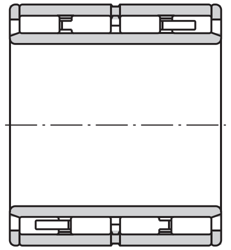


Figure 4

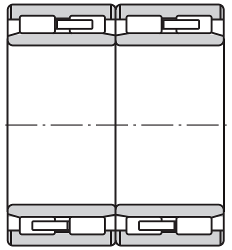


Figure 5

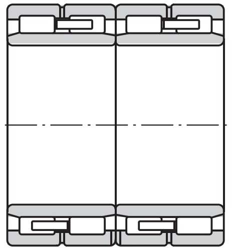


Figure 6

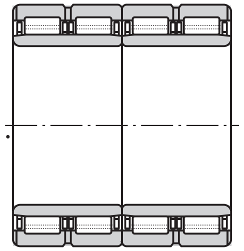


Figure 7

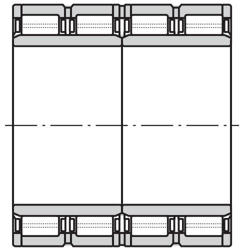


Figure 8

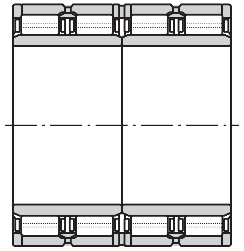


Figure 9

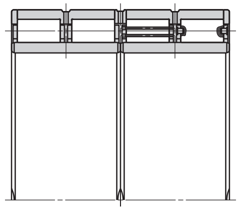


Figure 8SP

Tapered Bore

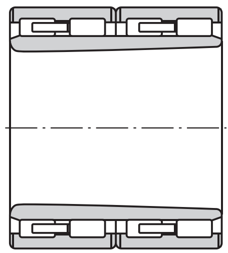


Figure 10

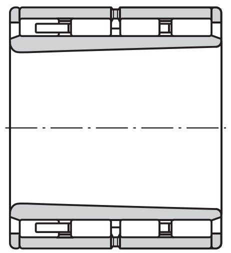


Figure 11

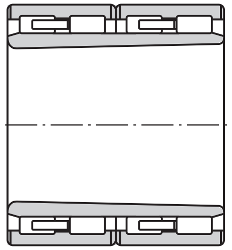


Figure 12

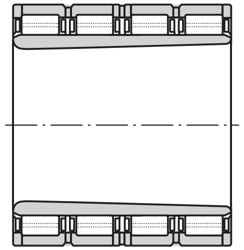
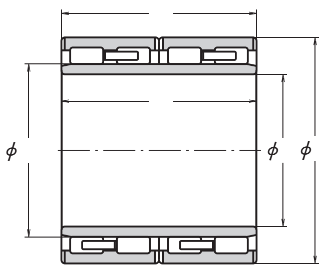
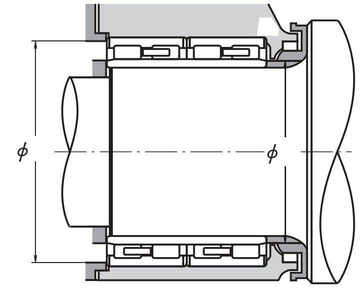


Figure 13

Bore Diameter

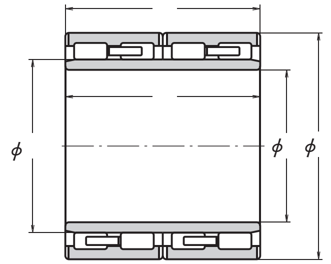


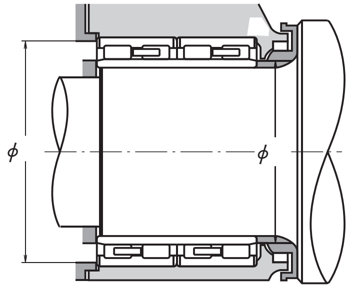


Boundary Dimensions (mm)						Basic Load Ratings (kN)		Bearing Numbers	Figure( )	Abutment and Fillet Dimensions (mm)				Mass (kg)
				min.	min.							max.	max.	approx.
140	104	104	111	1.5	1.1	400	820		3	110	130	1.5	1	4.8
160	120	120	124	1.1	1.1	560	1 080		3	119	150	1	1	7.9
170	120	120	127	2	2	615	1 100		1	122	157	2	2	9.9
165	87	87	134.5	1.1	1.1	365	725		1	130	155	1	1	5.4
180	105	105	136	2	2	530	880		1	132	167	2	2	8.9
215	174	174	147	2.1	2.1	1 060	1 600		1	134	199	2	2	26.6
174.625	150.812	150.812	139.5	1.5	2	735	1 580		1	138	163	1.5	1.5	10.5
203.2	127	127	147.5	2	1.5	705	1 110		1	139	190	2	2	15.4
200	125	125	149	2	2	700	1 190		1	142	187	2	2	14
200	104	104	149	2	2	570	950		1	142	187	2	2	11.7
210	116	116	160	2	2	640	1 130		1	152	196	2	2	13.9
210	155	155	166	1.5	1.5	925	1 920		1	157	197	1.5	1.5	17.8
225	156	156	169	2	2	975	1 820		1	158	211	2	2	23
220	150	150	168	2	2	900	1 700		1	163	206	2	2	20
225	150	150	168.5	1.5	2.1	970	1 810		1	162	209	1.5	2	20.8
225	136	136	168.776	2.1	2.1	820	1 460		1	165	209	2	2	18.6
230	130	130	174	2.1	2.1	845	1 520		1	165	214	2	2	19.6
230	156	156	174	2	2	965	1 810		1	163	216	2	2	23.6
220	180	180	176	2	2	1 050	2 410		2	173	206	2	2	20.6
230	130	130	178	2	2	780	1 340		1	173	216	2	2	16.4
230	168	168	179	2	2	900	2 050		1	173	216	2	2	23.0
230	168	168	180	2	2	1 040	2 200		1	173	216	2	2	22.7
230	180	180	178	2	2	1 080	2 280		2	173	216	2	2	24.2
240	120	120	183	2.1	2.1	745	1 320		1	175	224	2	2	18.8
240	170	170	183	2	2	1 080	2 050		1	173	226	2	2	26.6
240	145	145	180.016	2.1	2.1	920	1 600		1	175	224	2	2	22.3

Note ( ) Refer to pages D142 and D143.

Bore Diameter

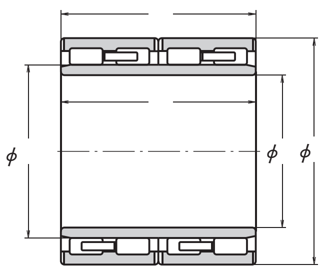
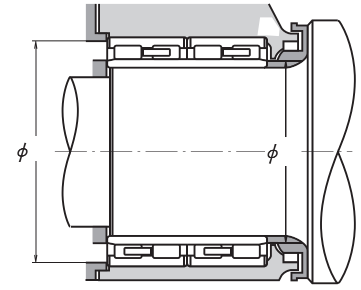




225.45	168.3	168.3	180.975	1.5	2.5	1 010	2 220	5	177	209	1.5	2	19.4
230	120	120	187	2	2	755	1 610	1	183	216	2	2	14
240	160	160	190	2	2	1 000	2 130	1	183	226	2	2	22.8
250	168	168	192	2.1	2.1	1 210	2 320	1	185	234	2	2	27.4
250	170	170	192	2.1	2.1	1 210	2 320	1	185	234	2	2	27.7
255	180	180	193	2.1	2.1	1 310	2 500	1	185	239	2	2	31.5
260	150	150	195	2.1	2.1	1 030	1 840	1	185	244	2	2	28.2
250	156	156	200	2	2	1 020	2 230	1	193	236	2	2	23.4
260	168	168	202	2.1	2.1	1 150	2 300	1	195	244	2	2	29.2
265	180	180	204	2.1	2.1	1 340	2 690	1	195	248	2	2	33.7
265	180	180	203	2.1	2.1	1 230	2 420	1	195	248	2	2	33.4
280	180	180	205.085	2.1	2.1	1 410	2 490	3	195	263	2	2	40.9
260	168	168	212	2	2	1 140	2 600	1	203	245	2	2	26.6
270	200	200	212	2.1	2.1	1 470	3 100	1	206	253	2	2	36
270	170	170	213	2.1	2.1	1 290	2 610	1	206	253	2	2	30.4
270	170	170	212	2	2	1 290	2 610	1	203	255	2	2	30.6
280	200	200	214	2.1	2.1	1 480	2 920	1	206	263	2	2	41.3
250	200	200	215	1	1	900	2 500	SP	210	240	1	1	22.3
270	170	170	222	2.1	2.1	1 120	2 590	1	216	253	2	2	27.9
270	200	200	222.25	2.1	2.1	1 330	3 250	SP	216	253	2	2	34.4
280	200	200	224	2.1	2.1	1 410	3 200	1	216	263	2	2	38.3
280	200	200	222	2.1	2.1	1 410	3 200	1	216	263	2	2	38.6
280	190	190	223	2.1	2.1	1 350	3 050	1	216	263	2	2	36.4
280	170	170	223	2.1	2.1	1 150	2 460	1	216	263	2	2	32.3
280	200	200	222	2.1	2.1	1 500	3 200	1	216	263	2	2	37.8
290	192	192	226	2.1	2.1	1 420	3 000	1	216	273	2	2	42.3
310	230	230	229	2.1	2.1	1 840	3 500	1	216	293	2	2	63.7
320	216	216	231	3	3	2 120	3 900	4	218	300	4	4	69.9

Notes

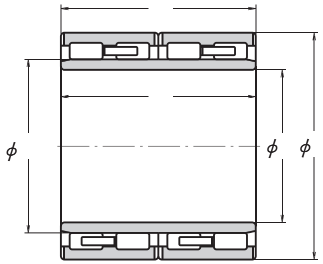
Bore Diameter

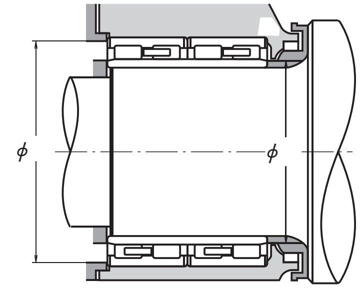



290	192	192	236	2.1	2.1	1 400	3 350	1	226	273	2	2	39
300	210	210	234	2	2	1 750	3 600	1	224	285	2	2	47.4
310	183	183	244.5	1.5	1	1 480	3 150	4	233	298	1.5	1	45.3
310	192	192	247	2.1	2.1	1 540	3 450	1	236	293	2	2	46.1
310	225	225	245	2.1	2.1	1 740	3 900	1	236	293	2	2	52.9
310	192	192	246	2.1	2.1	1 540	3 450	1	236	293	2	2	46.2
310	192	192	246	2.1	2.1	1 660	3 550	1	236	293	2	2	46.0
310	225	225	244	2.1	2.1	1 900	4 100	1	236	293	2	2	53.0
320	210	210	248	2.1	2.1	1 790	3 650	1	236	302	2	2	56
320	210	210	249	2.1	2.1	1 850	3 600	1	236	302	2	2	54.9
320	210	210	246	2.1	2.1	1 900	3 750	SP	236	302	2	2	57
320.675	241.3	241.3	251	2.1	2.1	1 990	4 350	2	238	303	2	2	65
330	206	206	260	2.1	2.1	1 760	3 900	1	246	312	2	2	58.2
330	206	206	258	2.1	2.1	1 870	3 950	1	246	312	2	2	57.3
340	260	260	261	3	3	2 390	5 100	1	248	320	2.5	2.5	81
365	250	250	266	3	3	2 310	4 300	5	248	344	2.5	2.5	98.3
330	220	220	270	3	3	1 770	4 400	1	259	310	2.5	2.5	57.7
330	220	220	264	3	3	1 840	4 100	3	259	310	2.5	2.5	55.1
340	220	220	268	3	3	1 890	3 900	1	259	320	2.5	2.5	61.7
360	220	220	272	3	3	2 250	4 350	2	259	340	2.5	2.5	77.8
340	230	230	276	4	4	2 030	4 750	1	272	317	3	3	60.3
350	220	220	278	3	3	1 930	4 200	1	269	330	2.5	2.5	64.8
368	218	218	290	2.1	1.1	2 010	4 350	4	277	354	2	1	76.7
355	260	260	286	2.1	2.1	2 090	5 000	5	277	337	2	2	74.5
370	220	220	292	3	3	2 050	4 450	1	279	349	2.5	2.5	76
370	220	220	290	3	3	2 220	4 450	1	279	349	2.5	2.5	73.5
370	260	260	290	3	3	2 720	5 950	1	279	349	2.5	2.5	89.3
380	280	280	294	3	3	2 820	6 250	1	279	359	2.5	2.5	107
400	290	290	296	4	4	3 250	6 350	1	282	376	3	3	133

Notes

Bore Diameter

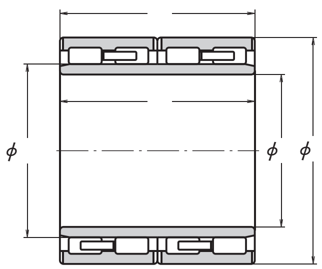


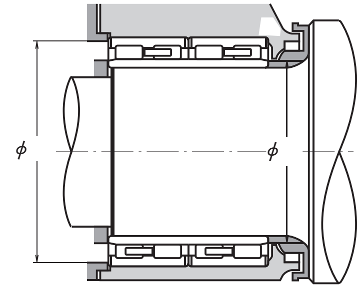


380	230	230	298	2.1	2.1	2 330	5 050		1	287	361	2	2	83
390	220	220	312	3	3	2 120	4 800		1	299	369	2.5	2.5	80.9
390	240	240	312	3	3	2 360	5 500		1	299	369	2.5	2.5	88.5
390	275	275	308	3	1.1	2 860	6 450		1	299	375	2.5	1	100
390	220	220	312	3	3	2 280	5 100		1	299	369	2.5	2.5	81.6
390	275	275	308	Spec.	1.1	2 860	6 450		SP	298	375	2	1	99.5
390	275	275	308	Spec.	3	2 860	6 450		6	298	369	2	2.5	99.2
400	285	285	316	3	3	3 000	6 950		5	299	379	2.5	2.5	117
390	234	234	320	3	3	2 270	5 600		1	310	369	2.5	2.5	79.7
410	240	240	320	3	3	2 570	5 450		1	310	389	2.5	2.5	99
410	240	240	321	3	3	2 600	5 250		1	310	389	2.5	2.5	97.1
420	300	300	327	3	3	3 300	7 500		1	310	398	2.5	2.5	138
400	300	300	328	2	2	2 720	6 900		5	316	383	2	2	103
420	240	240	332	3	3	2 670	5 750		1	320	398	2.5	2.5	101
420	300	300	332	3	3	3 200	7 200		3	320	398	2.5	2.5	127
420	300	300	332	Spec.	1.5	3 550	8 350		SP	319	403	2	1.5	132
420	300	300	332	2	2	3 200	7 200		5	316	402	2	2	128
420	300	300	338	3	3	3 300	8 050		1	330	398	2.5	2.5	119
430	240	240	344.5	3	3	2 610	5 950		1	330	408	2.5	2.5	107
440	240	240	351	4	4	2 490	5 350		1	343	415	3	3	104
450	240	240	358	3	3	2 760	6 150		1	340	428	2.5	2.5	120
450	240	240	355	3	3	2 710	5 750		1	340	428	2.5	2.5	117
460	340	340	360	3	3	3 850	8 700		3	340	438	2.5	2.5	184
460	240	240	364	3	3	2 820	6 100		5	340	438	2.5	2.5	131
480	350	350	364	4	1.5	4 850	10 500		8	343	462	3	1.5	232
430	230	230	358	3	3	2 340	5 850		1	350	408	2.5	2.5	86.3
440	200	200	360	3	3	2 160	4 750		3	350	418	2.5	2.5	83.8
460	340	340	365	4	4	3 550	8 650		1	353	435	3	3	174
460	340	340	365	4	2.5	4 150	9 750		SP	353	439	3	2	172

Notes

Bore Diameter

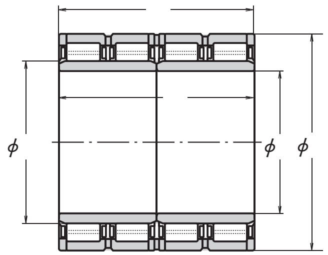


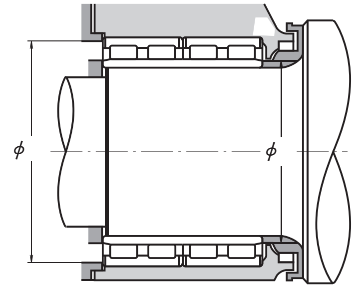


450	250	250	371	3	3	2 720	6 750	1	361	428	2.5	2.5	108
450	250	250	368	3	3	2 720	6 750	3	361	428	2.5	2.5	108
480	350	350	378	4	4	4 050	9 400	1	364	454	3	3	198
480	350	350	378	Spec.	1.5	4 600	11 100	1	355	462	2.9	1.5	208
490	300	300	379	5	5	3 750	8 200	1	368	460	4	4	186
480	350	350	376	3	3	4 400	10 300	6	366	457	2.5	2.5	190
500	380	380	389	5	5	4 850	11 100	6	378	470	4	4	237
480	290	290	394	3	3	3 250	8 300	1	381	457	2.5	2.5	146
500	250	250	394	3	3	3 450	7 250	5	381	477	2.5	2.5	146
510	370	370	400	4	4	4 500	10 100	1	384	484	3	3	234
480	250	250	401	3	3	2 830	7 350	1	391	457	2.5	2.5	116
520	380	380	409	4	2	6 000	14 400	SP	394	500	3	2	263
520	380	380	409	Spec.	1.5	5 600	13 300	SP	393	501	3	1.5	252
540	400	400	415	4	4	5 250	12 000	1	394	513	3	3	311
500	290	290	414	3	3	3 350	8 800	1	401	477	2.5	2.5	153
520	290	290	418	4	4	3 750	8 850	1	404	493	3	3	181
520	280	280	417	4	4	3 650	8 450	1	404	493	3	3	174
540	340	340	424	5	5	4 700	10 900	4	408	509	4	4	259
540	400	400	424	5	5	5 050	12 000	3	408	509	4	4	280
540	400	400	422	5	2	6 000	14 400	8	408	520	4	2	305
540	400	400	424	5	2	5 750	13 800	SP	408	520	4	2	294
510	290	290	424	3	3	3 400	9 000	1	412	487	2.5	2.5	156
550	400	400	434	5	5	5 150	12 400	6	419	519	4	4	303
520	250	250	432	4	4	3 000	7 700	3	425	493	3	3	136
550	300	300	441	4	4	4 150	9 750	1	425	523	3	3	212
560	400	400	446	5	5	5 650	13 600	8	429	529	4	4	308
560	410	410	445	5	2	6 550	16 500	8M	429	539	4	2	315
560	400	400	446	5	5	4 750	11 300	6	429	529	4	4	304
560	410	410	445	5	2	6 550	16 500	8	429	539	4	2	315

Notes

Bore Diameter





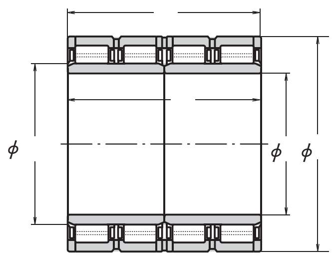
609.6	304.8	304.8	460	5	5	4 650	9 150	1	435	577	4	4	307
600	440	440	460	5	5	7 350	16 600	8	439	568	4	4	438
560	280	280	457	4	4	3 800	9 250	1	445	533	3	3	190
560	400	400	458	4	4	4 950	13 000	6	445	533	3	3	270
600	440	440	470	5	2	7 100	17 200	8	449	579	4	4	419
600	440	440	465	5	5	7 300	17 200	8	449	568	4	4	402
591	420	420	476	4	4	6 350	16 100	8	455	563	3	3	347
591	420	420	476	4	4	5 200	13 400	5	455	563	3	3	347
620	450	450	487	5	5	7 350	17 800	8	470	588	4	4	430
620	450	450	487	Spec.	3	8 100	19 700	8	466	594	3	2.5	433
620	450	450	490	4	4	7 450	19 000	5	466	591	3	3	430
630	450	450	500	4	4	6 950	17 500	5	476	601	3	3	440
620	400	400	506	4	4	5 500	14 700	1	486	591	3	3	347
620	400	400	502	4	4	6 400	16 600	8	486	591	3	3	358
620	460	460	502	4	4	7 100	19 100	8M	486	591	3	3	412
650	470	470	509	6	3	8 400	20 900	8	496	624	5	2.5	514
650	470	470	509	4	3	8 600	21 200	8	486	624	3	2.5	501
670	500	500	522	6	6	8 900	22 700	7	496	631	5	5	596
660	470	470	519	4	4	8 450	20 800	8	496	631	3	3	505
680	420	420	528	Spec.	3	8 350	19 000	8	508	653	3.5	2.5	490
680	500	500	532	4	3	9 400	23 500	8	506	653	3	2.5	586
680	500	500	534	5	5	9 000	23 100	7	510	646	4	4	610
680	500	500	534	5	5	9 000	23 100	8	510	646	4	4	610
700	400	400	538	6	6	7 650	17 400	9	517	660	5	5	538
670	450	450	540	Spec.	4	7 750	20 000	8	529	640	3.5	3	446
670	450	450	540	5	5	8 300	22 300	SP	531	637	4	4	464
680	420	405	550	5	5	6 700	17 600	8	531	646	4	4	451

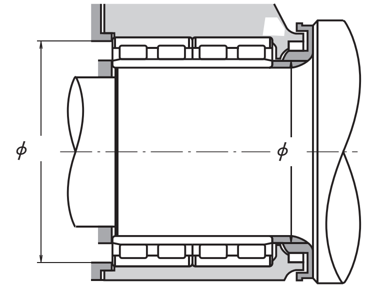
Notes

INDUSTRY SOLUTIONS

INDUSTRY SOLUTIONS

Bore Diameter

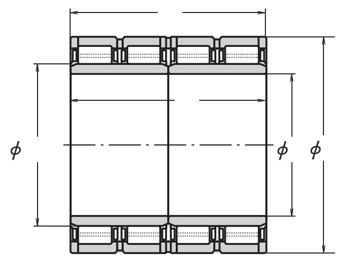


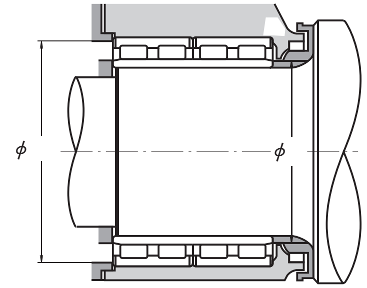


690	510	510	550	5	5	8 850	23 900	8M	531	656	4	4	480
690	510	510	552	5	5	9 000	24 600	7	531	656	4	4	580
700	515	515	554	5	5	9 100	23 800	7	531	666	4	4	622
710	480	480	558	5	5	8 500	21 200	8	531	676	4	4	632
720	530	530	560	6	6	9 950	25 300	8	537	680	5	5	782
720	530	530	568	6	6	10 100	25 900	8M	537	680	5	5	722
670	320	320	554	5	5	4 950	12 700	1	541	637	4	4	298
680	500	500	560	5	5	8 950	25 700	8	541	646	4	4	514
735	535	535	574.5	5	5	10 400	26 300	9	551	700	4	4	750
735	535	535	574.5	5	5	10 800	27 500	8M	551	700	4	4	733
780	570	570	601	6	6	11 800	29 200	8M	568	738	5	5	960
780	570	570	595	6	6	11 800	29 200	8	568	738	5	5	960
762.03	558.8	558.8	600	5	5	10 800	28 800	9	568	727	4	4	849
762.03	558.8	558.8	598	Spec.	4	11 600	30 000	SP	568	731	5.8	3	849
740	510	510	602	5	5	9 150	25 700	8M	582	705	4	4	648
740	510	510	600	Spec.	2	10 100	27 600	8	580	716	3.5	2	632
800	600	600	620	6	6	12 400	31 500	8	598	758	5	5	1 020
820	600	600	625	Spec.	6	14 100	34 000	8	595	778	4.5	5	1 100
815	594	594	628	6	6	13 200	32 000	8	608	773	5	5	1 010
815	594	594	628	6	6	13 700	33 500	8	608	773	5	5	960
812.97	594	594	636	6	5	13 200	34 500	8	610	777	5	4	947
820	575	575	660	Spec.	3	12 900	35 500	SP	629	790	5.5	2.5	931
850	600	600	664	5	5	14 600	37 500	8M	633	813	4	4	1 110
870	640	640	682	7.5	4	15 700	40 000	8M	645	836	6	3	1 320
870	640	640	672	7.5	4	15 700	40 000	8	645	836	6	3	1 320
870	640	640	669	5	5	15 700	40 000	8M	633	833	4	4	1 310
850	570	570	670	6	5	12 600	33 000	8	649	813	5	4	1 040
870	660	660	680	6	6	15 400	41 500	8	649	827	5	5	1 330

Notes

Bore Diameter

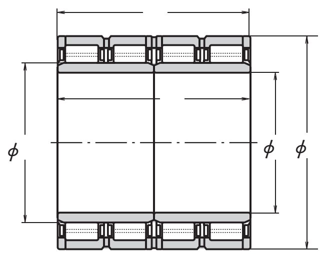


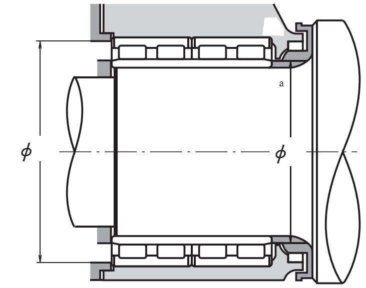


Boundary Dimensions (mm)						Basic Load Ratings (kN)		Bearing Numbers	Fig-ure([1])	Abutment and Fillet Dimensions (mm)				Mass (kg)
				min.	min.							max.	max.	approx.
922	600	600	702	6	5	15 600	37 000		8	668	883	5	4	1 390
901.87	674	674	705	7.5	4	16 200	43 500		9	680	868	6	3	1 440
901.87	674	674	705	5	4	17 000	44 500		8M	668	868	4	3	1 410
870	610	610	697	6	3	14 200	40 000		8M	680	839	5	2.5	1 100
880	600	600	700	6	6	14 200	38 000		8	680	836	5	5	1 110
900	650	650	710	Spec.	5	16 000	42 000		8	688	862	4.5	4	1 280
920	670	670	723	7.5	7.5	16 200	44 000		8	696	870	6	6	1 470
920	690	690	723	7.5	7.5	16 600	45 000		8	696	870	6	6	1 520
930	660	660	728	6	6	17 000	44 000		8	700	885	5	5	1 440
980	640	640	760	Spec.	4	17 500	43 500		8	727	944	6	3	1 630
960	670	670	760	7.5	7.5	17 400	47 000		8	737	909	6	6	1 520
980	715	715	767.5	7.5	7.5	17 900	48 000		9	737	929	6	6	1 790
980	750	750	766	7.5	7.5	19 200	53 000		9M	737	929	6	6	1 880
980	750	750	766	7.5	7.5	19 200	53 000		8	737	929	6	6	1 880
980	750	750	766	7.5	7.5	19 200	53 000		8M	737	929	6	6	1 860
930	620	620	763	6	6	12 900	38 000		8	741	885	5	5	1 200
930	620	620	763	6	6	14 800	43 000		8	741	885	5	5	1 180
980	700	700	774	6	6	18 000	48 500		8	741	934	5	5	1 680
980	700	700	774	6	6	17 800	49 000		7	741	934	5	5	1 720
1000	715	715	787.5	7.5	7.5	18 700	50 500		8	757	948	6	6	1 840
1000	700	700	796	6	6	18 200	51 000		8	767	954	5	5	1 670
1000	700	700	790	Spec.	4	19 000	51 500		8	763	964	4.5	3	1 700
1000	700	700	796	6	6	17 700	49 500		7	767	954	5	5	1 670
960	620	620	790	6	3	15 000	44 500		8	772	928	5	2.5	1 250
1030	750	750	809	6	6	20 700	56 500		8	772	983	5	5	2 050
1000	670	670	813	6	6	16 800	49 500		8	792	954	5	5	1 520
1000	670	670	813	Spec.	3	17 500	50 000		8	798	967	6	2.5	1 490

Notes ([1]) Refer to pages D142 and D143.
The letter "M" indicates bearing for oil mist lubrication.

Bore Diameter



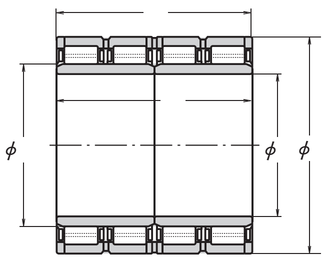


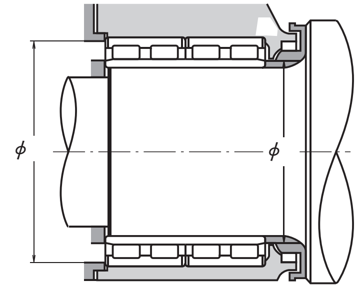
( )

1 070	750	750	837	7.5	7.5	21 700	58 500	8	803	1 017	6	6	2 230
1 030	750	750	834	7.5	7.5	18 200	53 500	9	808	978	6	6	1 880
1 030	750	750	828	7.5	7.5	20 800	60 000	8M	808	978	6	6	1 850
1 080	805	790	845	6	6	22 200	61 000	9M	802	1 032	5	5	2 430
1 079.602	787.4	787.4	846	Spec.	7.5	23 900	65 500	8	807	1 026	5.5	6	2 390
1 079.602	787.4	787.4	845	7.5	7.5	22 200	61 000	9	810	1 026	6	6	2 390
1 075	770	770	847	7.5	7.5	23 100	63 500	8M	819	1 022	6	6	2 220
1 070	780	780	853	6	6	22 800	64 500	8	823	1 023	5	5	2 140
1 080	700	700	878	6	3	19 100	56 000	8	843	1 045	5	2.5	1 920
1 080	700	700	878	6	3	19 600	58 000	8	843	1 045	5	2.5	1 910
1 080	750	750	880	6	6	19 200	56 500	8	843	1 032	5	5	2 050
1 080	750	750	880	6	6	18 700	56 500	9	843	1 032	5	5	2 050
1 100	745	720	892	6	3	19 700	58 500	SP	863	1 065	5	2.5	2 000
1 100	745	720	892	6	6	20 100	59 000	8M	863	1 052	5	5	1 990
1 130	650	650	891	Spec.	6	20 300	53 000	8	867	1 081	5.5	5	2 000
1 130	800	800	903	7.5	7.5	22 900	66 500	8M	870	1 076	6	6	2 510
1 130	825	800	903	7.5	7.5	22 900	66 500	SP	870	1 076	6	6	2 530
1 160	840	840	911	7.5	7.5	25 600	72 000	8	870	1 105	6	6	2 900
1 160	840	840	920	2	7.5	24 900	71 000	8M	866	1 105	2	6	2 790
1 150	840	840	928	7.5	4	23 300	68 500	8	900	1 111	6	3	2 610
1 150	840	840	928	7.5	8	25 600	77 500	8	900	1 093	6	6.5	2 600
1 180	650	650	945	7.5	7.5	19 600	53 000	9	900	1 125	6	6	2 260
1 180	850	850	940	7.5	7.5	24 600	72 000	8M	900	1 125	6	6	2 850
1 180	875	850	940	7.5	7.5	24 600	72 000	8M	900	1 125	6	6	2 880

Notes

Bore Diameter

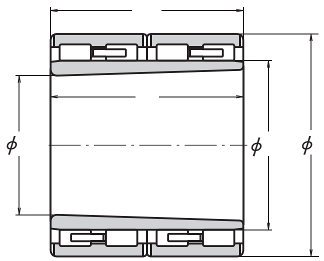


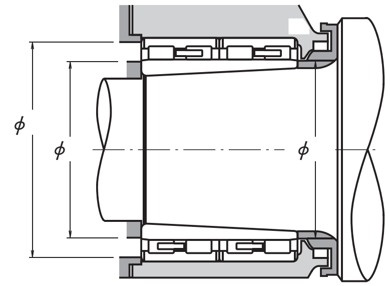


						( )				( )			
1 130	670	670	934	6	6	18 400	56 500	9	904	1 081	5	5	1 780
1 160	735	710	940	7.5	4	20 400	60 000	9	910	1 121	6	3	2 200
1 180	750	750	945.3	Spec.	7.5	23 800	67 000	8	915	1 125	6	6	2 480
1 145	705	685	940	9.5	6	20 500	61 000	8	929	1 096	8	5	1 970
1 230	850	850	970	7.5	7.5	29 100	81 000	8	931	1 174	6	6	3 240
1 220	810	800	981	7.5	6	25 900	74 500	8	951	1 170	6	5	2 790
1 220	840	840	989	7.5	4	26 800	80 000	8	951	1 179	6	3	2 950
1 230	895	870	985	7.7	7.5	25 800	76 000	8M	951	1 174	6	6	3 200
1 280	930	930	1 000	7.5	7.5	32 000	89 500	8	951	1 223	6	6	3 990
1 280	930	930	1 000	7.5	7.5	33 000	93 000	8	951	1 223	6	6	4 010
1 280	865	865	1 015	7.5	7.5	28 000	80 000	8M	972	1 223	6	6	3 510
1 330	950	950	1 053	Spec.	9	33 500	97 000	8	1 008	1 266	7.5	7.5	4 240
1 360	1 000	1 000	1 075	9.5	5	37 500	108 000	8	1 010	1 313	8	4	4 910
1 580	1 150	1 150	1 255	9.5	9.5	43 500	134 500	8	1 184	1 509	8	8	7 400
1 602	850	850	1 350	7.5	7.5	32 000	103 000	SP	1 329	1 538	6	6	4 130
1 655	890	880	1 391	7.5	7.5	34 000	110 500	SP	1 359	1 590	6	6	4 710
1 745	1 010	1 000	1 466	11.4	7.5	42 500	134 000	SP	1 423	1 678	9.5	6	6 240

Notes

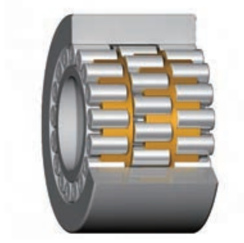
Bore Diameter





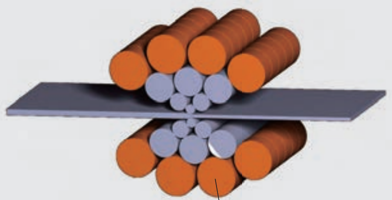
							( )						( )				
	180	115	115	136	1	1	490	840		10	118	128	171	1	1	10
	230	168	168	180	1	1	1 040	2 170		11	160	174	220	1	1	23.5
	260	175	168	212	1.1	2	1 140	2 600		10	190	205	245	1	2	25.1
	260	175	168	212	1.1	2	1 140	2 600		10	191	206	245	1	2	25
	260	168	168	209	1	2	1 140	2 600		10	191	205	245	1	2	24.2
	360	268	268	278	1.5	1.5	2 770	6 000		11	249	272	344	1.5	1.5	92.9
	400	285	285	312	2	2	3 200	7 500		11	281	305	383	2	2	118
	550	400	400	434	5	5	5 450	13 300		12	385	419	519	4	4	328
	550	400	400	431.9	3	2.5	5 450	13 300		12	378	412	527	2.5	2	328
	650	488	488	494.5	3	4	8 900	21 100		SP	434	476	621	2.5	3	603
	740	540	540	580	5	5	10 100	26 800		13	516	561	705	4	4	823
	960	680	680	745.8	7.5	7.5	18 100	47 000		13	679	737	909	6	6	1 720

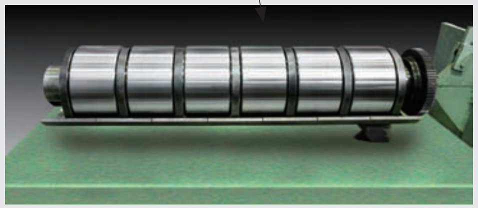
Notes

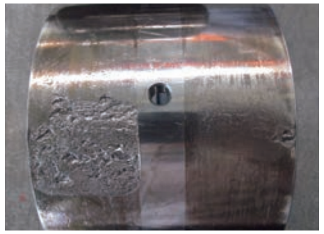


(1)

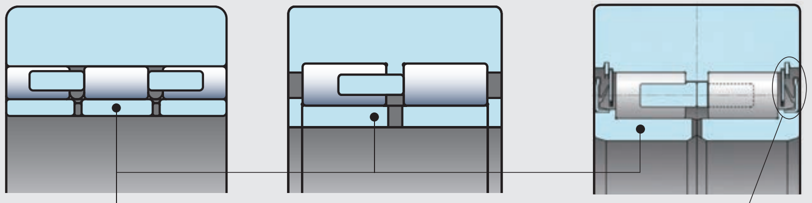
Benefits ❶ ❷ ❸

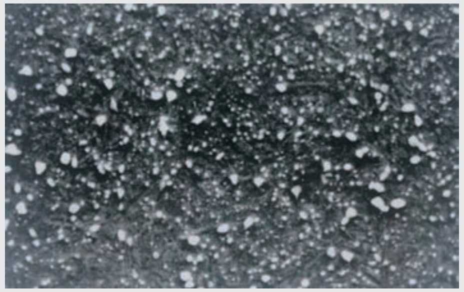






(Sealed Type)

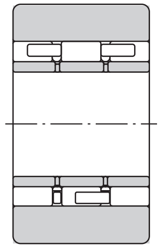




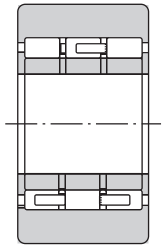
Note (1): Photo courtesy of Nippon Steel & Sumikin Stainless Steel Corporation.

Backing Bearings for Multi-Roll Rolling Cluster Mills

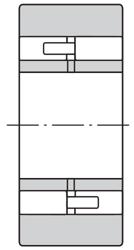
Figures of Typical Backing Bearings for Multi-Roll Rolling Mills



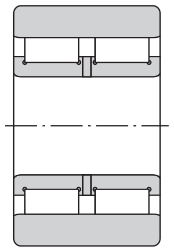
3PL
Figure 1



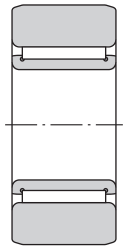
3U
Figure 2



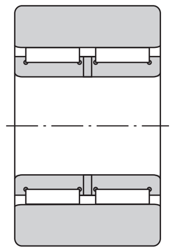
2PL
Figure 3



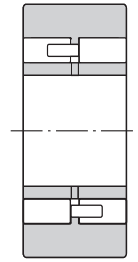
2L
Figure 4



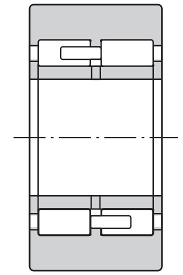
S
Figure 5



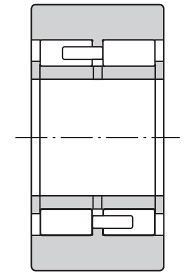
2S
Figure 6



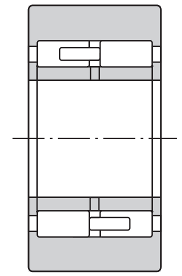
2U
Figure 7



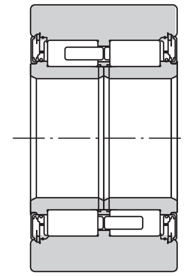
2U
Figure 8



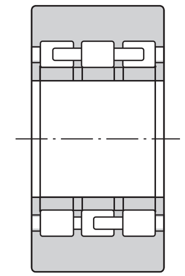
2U
Figure 9



2U
Figure 10

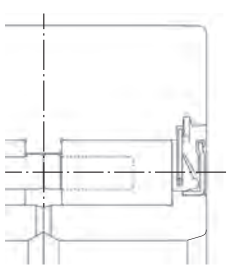


2U(Sealed Types)
Figure 11

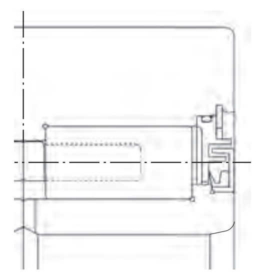


3U
Figure 12

(Example) Figure11 of Sealed 2U type bearings



2U180-7

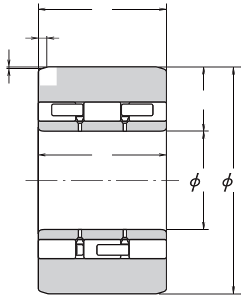


2U130-36, 2U130-16B

INDUSTRY SOLUTIONS

Backing Bearings for Multi-Roll Rolling Cluster Mills

Bore Diameter



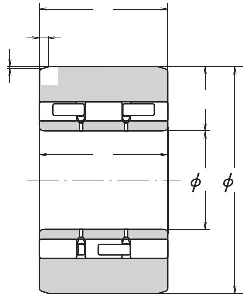
Boundary Dimensions (mm)					Basic Load Ratings (kN)		Permissible Radial Load Pu (kN) approx.	Bearing Numbers	Figure( )	Outer Ring Edge Bevel (mm)		Radial Thickness When Delivered (mm)		Mass (kg) approx.
			min.			( )								
76.2	46.23	45.85	1	0.8	94.5	174	91.8		6	—	—	22.2	0 to +0.010	1.3
120	80	80	1.5	1.5	257	385	147		9	6.5	0.042	34.976	±0.010	5.2
120	85	85	1	1.5	305	435	113		9	6.5	0.042	34.984	±0.010	5.3
120	26	26	1.6	1.6	74.5	142	90.2		5	—	—	32.5	-0.025 to -0.010	1.7
120	52.2	52	1.6	1.6	159	375	185		5	7	0.041	32.485	-0.010 to +0.005	3.4
120	52.2	52	1	1	186	298	115		4	5	0.036	32.5	0 to +0.010	3.2
160	95	95	1.1	1.5	400	590	290		9	6.5	0.042	49.984	±0.010	11.5
155	90	90	1.5	1	355	530	247		10	6	0.036	46.484	±0.010	9.9
155	110	110	1.5	1	405	620	297		2	6	0.036	46.484	±0.010	12.1
160	90	90	1.1	1	410	745	303		1	6	0.035	45	-0.048 to -0.018	10.7
220	95	95	1.1	2	590	880	347		8	6	0.105	64.982	±0.010	20.8
220.02	96	94	1.5	1.5	520	730	333		8	8	0.047	65	-0.010 to 0	20.5
220	120	119	1	3	685	1 020	411		8	21	0.086	65	-0.015 to 0	26.0
220	122	119	1	3	685	1 020	410		8SP	21	0.086	65	-0.015 to 0	27.0
220	120	120	1	2	675	1 260	494		2	6	0.105	64.98	0 to +0.010	27.2
220	130	130	1	2	680	1 090	499		2SP	6	0.105	64.982	±0.010	28.7
230	100	100	2.5	2	645	990	322		10SP	12	0.07	69.98	±0.010	24.4
225	80	80	2	1.5	535	925	366		3	7.6	0.045	62.47	0 to +0.010	18.4
225	120	119	2	3	550	1 000	586		8	12	0.07	62.5	±0.010	27.2
225	120	120	2	2	715	1 350	542		1	8	0.093	62.47	0 to +0.010	27.5
260	130	130	2	2	950	1 580	617		10SP	12	0.07	79.97	±0.010	41.5
280	165	165	2.5	2	1 120	1 880	818		2	12	0.072	84.965	±0.010	60.2
260	140	140	1.1	2	940	1 660	613		2	12	0.209	72.47	±0.010	42.1
280	165	165	2.5	2	1 190	2 060	802		9	12	0.072	79.965	±0.010	58.0
300	160	160	2	2	1 180	1 960	847		2SP	12	0.07	89.966	±0.010	66.7
350	165	165	2.5	2	1 370	2 220	1 140		9	12	0.072	114.965	±0.010	98.5

Notes ( )Cr and Cor of basic load ratings is not the limiting load. Cor is for reference.
( )Refer to pages D168 and D169.
The letter "SP" indicate a special design.

Remarks Outer rings are used for back-up roll , it must be use less than permissible radial Load(Pu)
Bearings marked are special material design.
Bearing number of "STF" is adopted Super-TF™ material.
Please consult with NSK for selection and usage of bearings.

Backing Bearings for Multi-Roll Rolling Cluster Mills

Bore Diameter



Boundary Dimensions (mm)					Basic Load Ratings (kN)		Permissible Radial Load Pu (kN)	Bearing Numbers	Figure( )	Outer Ring Edge Bevel (mm)		Radial Thickness When Delivered (mm)		Mass (kg)
			min.			( )	approx.							approx.
300	132	129	2	4	1 040	1 580	590		8SP	28.2	0.082	85	-0.015 to 0	52.3
300.02	150	149	2	4	1 100	1 850	732		9SP	25	0.145	85.01	-0.015 to 0	60.9
300	160	159.5	2	1.1	1 470	2 670	799		1	9	0.209	84.95	0 to +0.010	66.6
300	172.64	172.64	2	4	1 580	2 930	862		1	10	0.131	84.95	0 to +0.010	71.8
300	172.64	172.64	2	4	1 580	2 930	862		1SP	10	0.131	84.95	0 to +0.010	72
300.02	172.64	172.64	2	3	1 580	2 930	862		1	25.4	0.148	84.965	-0.010 to 0	72.1
300	172.64	172.64	2	4	1 580	2 930	862		1	25	0.087	84.95	0 to +0.010	72
300	172.644	172.644	2	4	1 370	2 440	854		9	12.7	0.2	84.955	±0.010	69.1
300	172.644	172.644	3	4	1 240	2 150	808		11	25	0.15	84.955	±0.010	68.8
300	172.64	170	2	2	1 240	2 150	800		11	30	0.05	84.95	0 to +0.030	71.2
300	172.64	171.6	2	4	1 320	2 300	866		12	10	0.131	84.95	0 to +0.010	69.4
350	175	175	2.5	2	1 450	2 410	1 230		9	12	0.10	109.965	±0.010	102
406.4	224	220.66	3	3.3	1 950	3 550	1 460		11	15.9	0.093	113.205	-0.015 to 0	168
406.43	224.25	220	3	4	2 250	4 250	1 570		11	60	0.175	113.181	±0.015	161
406.42	171.04	171.04	2.1	4	2 060	3 800	1 220		1	25	0.145	113.155	-0.010 to 0	129
406.42	171.04	171.04	2.1	4	2 060	3 800	1 220		1	25	0.145	113.155	±0.005	129
406.42	171.04	171.04	0.6	1	1 900	3 300	1 150		9	25	0.145	113.16	-0.010 to 0	125
406.42	171.04	170	2	3	1 650	2 850	1 220		8	25	0.145	113.2	-0.015 to 0	124
406.42	171.04	170	2	3	1 650	2 850	1 220		8	36.5	0.212	113.2	-0.015 to 0	124
406.42	171.04	171.04	3	4	1 560	2 660	1 150		8	25	0.25	113.155	±0.010	123
406.42	176	170	2	3	1 650	2 850	1 220		8	25	0.145	113.2	-0.015 to 0	128
406.4	217	217	2.1	1.5	2 550	5 000	1 560		1	10	0.058	113.16	-0.012 to 0	164
406.4	224	220	2.1	1.5	2 050	3 750	1 580		12	10	0.058	113.16	-0.012 to 0	162
406.4	224	220	2.1	1.5	2 050	3 750	1 580		12	10	0.058	113.205	-0.015 to 0	162
406.42	224	224	2.1	1.5	2 610	5 150	1 610		1	10	0.058	113.155	-0.012 to 0	169
406.42	224	224	0.6	1	2 360	4 400	1 510		9	25	0.145	113.16	-0.010 to 0	164

Notes ( ) Cr and Cor of basic load ratings is not the limiting load. Cor is for reference.
( ) Refer to pages D168 and D169.
The letter "SP" indicate a special design.

Remarks Outer rings are used for back-up roll , it must be use less than permissible radial Load(Pu)
Bearings marked are special material design.
Bearing number of "STF" is adopted Super-TF™ material.
Please consult with NSK for selection and usage of bearings.

APPENDICES

Appendix Table 1 Conversion Table from SI (International Units) System

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

Prefixes Used In SI System

Multiples	Prefix	Symbols	Multiples	Prefix	Symbols
18	Exa	E	–1	Deci	d
15	Peta	P	–2	Centi	c
12	Tera	T	–3	Milli	m
9	Giga	G	–6	Micro	µ
6	Mega	M	–9	Nano	n
3	Kilo	k	–12	Pico	p
2	Hecto	h	–15	Femto	f
	Deca	da	–18	Ato	a

Conversion Factors from SI Units

Parameter	SI Units: Names of Units	SI Units: Symbols	Units other than SI: Name of Units	Units other than SI: Symbols	Conversion Factors from SI Units
Angle	Radian	rad	Degree Minute Second		π π π
Length	Meter	m	Micron Angstrom	µ Å	6 10
Area	Square meter	m^2	Are Hectare	a ha	–2 –4
Volume	Cubic meter	m^3	Liter Deciliter	l, L dl, dL	3 4
Time	Second	s	Minute Hour Day	min h d	
Frequency	Hertz	Hz	Cycle	s^{-1}	
Speed of Rotation	Revolution per second	s^{-1}	Revolution per miunte	rpm	
Speed	Meter per second	m/s	Kilometer per hour Knot	km/h kn	
Acceleration	Meter per second per second	m/s^2	Gal g	Gal G	2
Mass	Kilogram	kg	Ton	t	–3
Force	Newton	N	Kilogram-force Ton-force Dyne	kgf tf dyn	× 3 5
Torque or Moment	Newton · meter	N · m	Kilogram-force meter	kgf · m	
Stress	Pascal	Pa N/m^2	Kilogram-force per square centimeter Kilogram-force per square millimeter	kgf/cm^2 kgf/mm^2	× 4 × 6

Conversion Factors from SI Units (Continued)

Parameter	SI Units: Names of Units	SI Units: Symbols	Units other than SI: Names of Units	Units other than SI: Units	Conversion Factors from SI 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	/ /(× 3) /(× 5) /(× 5) –5 /(× 5)
Energy	Joule (Newton · meter)	J (N · m)	Erg Calorie (International) Kilogram-force meter Kilowatt hour French horse power hour	erg cal_{IT} kgf · m kW · h PS · h	7 / / /(× 6) ≈ × –7
Work	Watt (Joule per second)	W (J/s)	Kilogram-force meter per second Kilocalorie per hour French horse power	kgf · m/s kcal/h PS	/ / ≈
Viscosity, Viscosity Index	Pascal second	Pa · s	Poise	P	
Kinematic Viscosity, Kinematic Viscosity Index	Square meter per second	m^2/s	Stokes Centistokes	St cSt	4 6
Temperature	Kelvin, Degree celsius	K, °C	Degree	°C	(See note (1))
Electric Current, Magnetomotive Force	Ampere	A	Ampere	A	
Voltage, Electromotive Force	Volt	V	(Watts per ampere)	(W/A)	
Magnetic Field Strength	Ampere per meter	A/m	Oersted	Oe	π 3
Magnetic Flux Density	Tesla	T	Gauss Gamma	Gs γ	4 9
Electrical Resistance	Ohm	Ω	(Volts per ampere)	(V/A)	

Note (1) The conversion from TK into θ°C is $\theta = T - 273.15$ but for a temperature difference, it is $T = \theta$. However, T and θ represent temperature differences measured using the Kelvin and Celsius scales respectively.

Remarks The names and symbols in ( ) are equivalent to those directly above them or on their left.
Example of conversion N= kgf

Appendix Table 2 N-kgf Force Conversion Table

[Method of using this table] For example, to convert 10N into kgf, read the figure in the right kgf column adjacent to the 10 in the center column in the 1st block. This means that 10N is 1.0197kgf. To convert 10kgf into N, read the figure in the left N column of the same row, which indicates that the answer is 98.066N.

N kgf
kgf N

N		kgf	N		kgf	N		kgf
	1			34			67	
	2			35			68	
	3			36			69	
	4			37			70	
	5			38			71	
	6			39			72	
	7			40			73	
	8			41			74	
	9			42			75	
	10			43			76	
	11			44			77	
	12			45			78	
	13			46			79	
	14			47			80	
	15			48			81	
	16			49			82	
	17			50			83	
	18			51			84	
	19			52			85	
	20			53			86	
	21			54			87	
	22			55			88	
	23			56			89	
	24			57			90	
	25			58			91	
	26			59			92	
	27			60			93	
	28			61			94	
	29			62			95	
	30			63			96	
	31			64			97	
	32			65			98	
	33			66			99	

Appendix Table 3 kg-lb Mass Conversion Table

[Method of using this table] For example, to convert 10kg into lb, read the figure in the right lb column adjacent to the 10 in the center column in the 1st block. This means that 10kg is 22.046lb. To convert 10lb into kg, read the figure in the left kg column of the same row, which indicates that the answer is 4.536kg.

kg lb
lb kg

kg		lb	kg		lb	kg		lb
	1			34			67	
	2			35			68	
	3			36			69	
	4			37			70	
	5			38			71	
	6			39			72	
	7			40			73	
	8			41			74	
	9			42			75	
	10			43			76	
	11			44			77	
	12			45			78	
	13			46			79	
	14			47			80	
	15			48			81	
	16			49			82	
	17			50			83	
	18			51			84	
	19			52			85	
	20			53			86	
	21			54			87	
	22			55			88	
	23			56			89	
	24			57			90	
	25			58			91	
	26			59			92	
	27			60			93	
	28			61			94	
	29			62			95	
	30			63			96	
	31			64			97	
	32			65			98	
	33			66			99	

Appendix Table 4 °C-°F Temperature Conversion Table

[Method of using this table] For example, to convert 38°C into °F, read the figure in the right °F column adjacent to the 38 in the center column in the 2nd block. This means that 38°C is 100.4°F. To convert 38°F into °C, read the figure in the left °C column of the same row, which indicates that the answer is 3.3°C.

C — F

F —C

°C		°F	°C		°F	°C		°F	°C		°F
	100			32			71			110	
	80			33			72			115	
	60			34			73			120	
	40			35			74			125	
	30			36			75			130	
	20			37			76			135	
	10			38			77			140	
	0			39			78			150	
	1			40			79			160	
	2			41			80			170	
	3			42			81			180	
	4			43			82			190	
	5			44			83			200	
	6			45			84			210	
	7			46			85			220	
	8			47			86			230	
	9			48			87			240	
	10			49			88			250	
	11			50			89			300	
	12			51			90			350	
	13			52			91			400	
	14			53			92			450	
	15			54			93			500	
	16			55			94			550	
	17			56			95			600	
	18			57			96			650	
	19			58			97			700	
	20			59			98			750	
	21			60			99			800	
	22			61			100			850	
	23			62			101			900	
	24			63			102			950	
	25			64			103			1000	
	26			65			104			1100	
	27			66			105			1200	
	28			67			106			1300	
	29			68			107			1400	
	30			69			108			1500	
	31			70			109			1600	

Appendix Table 5 Viscosity Conversion Table

Kinematic Viscosity mm^2/s	Saybolt Universal SUS (sec)		No.1 Type Redwood R (sec)		Engler E (degree)	Kinematic Viscosity mm^2/s	Saybolt Universal SUS (sec)		No.1 Type Redwood R (sec)		Engler E (degree)
	100°F	210°F	50°C	100°C			100°F	210°F	50°C	100°C	
2						35					
3						36					
4						37					
5						38					
6						39					
7						40					
8						41					
9						42					
10						43					
11						44					
12						45					
13						46					
14						47					
15						48					
16						49					
17						50					
18						55					
19						60					
20						65					
21						70					
22						75					
23						80					
24						85					
25						90					
26						95					
27						100					
28						120					
29						140					
30						160					
31						180					
32						200					
33						250					
34						300					

Remark $mm^2/s=$ cSt

Appendix Table 6 inch - mm Conversion Table

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
1/16	0.062500	1.588	26.988	52.388	77.788	103.188	128.588	153.988	179.388	204.788	230.188	255.588
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
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
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
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
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
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
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
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
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
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
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
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
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
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

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
1/4	0.2500	285.750	311.150	336.550	361.950	387.350	412.750	438.150	463.550	488.950	514.350
1/2	0.5000	292.100	317.500	342.900	368.300	393.700	419.100	444.500	469.900	495.300	520.700
3/4	0.7500	298.450	323.850	349.250	374.650	400.050	425.450	450.850	476.250	501.650	527.050

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
1/4	0.2500	539.750	565.150	590.550	615.950	641.350	666.750	692.150	717.550	742.950	768.350
1/2	0.5000	546.100	571.500	596.900	622.300	647.700	673.100	698.500	723.900	749.300	774.700
3/4	0.7500	552.450	577.850	603.250	628.650	654.050	679.450	704.850	730.250	755.650	781.050

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
1/4	0.2500	793.750	819.150	844.550	869.950	895.350	920.750	946.150	971.550	996.950	1022.350
1/2	0.5000	800.100	825.500	850.900	876.300	901.700	927.100	952.500	977.900	1003.300	1028.700
3/4	0.7500	806.450	831.850	857.250	882.650	908.050	933.450	958.850	984.250	1009.650	1035.050

Appendix Table 7 Hardness Conversion Table (Reference)

Rockwell C Scale Hardness (1 471N) {150kgf}	Vickers Hardness	Brinell Hardness Standard Ball	Brinell Hardness Tungsten Carbide Ball	Rockwell Hardness A Scale Load 588.4N {60kgf} Brale Indenter	Rockwell Hardness B Scale Load 980.7N {100kgf} 1.588 mm (1/16in) Ball	Shore Hardness
68		—	—		—	
67		—	—		—	
66		—	—		—	
65		—			—	
64		—			—	
63		—			—	
62		—			—	
61		—			—	
60		—			—	
59		—			—	
58		—			—	
57		—			—	
56		—			—	
55		—			—	
54		—			—	
53		—			—	
52					—	
51					—	
50					—	
49					—	
48					—	
47					—	
46					—	
45					—	
44					—	
43					—	
42					—	
41					—	
40					—	
39					—	
38					—	
37					—	
36						
35						
34						
33						
32						
31						
30						
29						
28						
27						
26						
25						
24						
23						
22						
21						
20						
18				—		
16				—		
14				—		
12				—		
10				—		
8				—		
6				—		
4				—		
2				—		
0				—		

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)		×					
Martensitic Stainless Steel SUS 440C		×					
Mild Steel (C=0.12 to 0.20%)		×					
Hard Steel (C=0.3 to 0.5%)		×					
Austenitic Stainless Steel SUS 304		×					
Cast Iron — Gray Iron FC200		×			More than		
Cast Iron — Spheroidal graphite Iron FCD400		×	Less than		More than		More than
Aluminum		×					
Zinc		×					
Copper		×					
Brass (Annealed) (Machined)		×					

Remark The hardness of hardened bearing steel and martensitic stainless steel is usually expressed using the Rockwell C Scale, but for comparison, it is converted into Brinell hardness.

Appendix Table 9 Tolerances for Shaft Diameters

Units :

Diameter Classification (mm) over	Diameter Classification (mm) incl.	Single Plane Mean B.D. Deviation (Normal) Δ_{dmp}	d6	e6	f6	g5	g6	h5	h6	h7	h8	h9	h10	js5	js6	j5	j6	j7	k5	k6	k7	m5	m6	n6	p6	r6	r7	Diameter Classification (mm) over	Diameter Classification (mm) incl.
														±	±														
														±	±														
														±	±														
														±	±														
														±	±														
														±	±														
														±	±														
														±	±														
														±	±														
														±	±		±	±											
														±	±		±												
														±	±		±												
															±														
															±														
															±														
															±														
															±														
															±														

Appendix Table 10 Tolerances for Housing Bore Diameters

Units :

Diameter Classification (mm) over	Diameter Classification (mm) incl.	Single Plane Mean O.D. Deviation (Normal) Dmp	E6	F6	F7	G6	G7	H6	H7	H8	J6	J7	JS6	JS7
													±	±
													±	±
													±	±
													±	±
													±	±
													±	±
													±	±
													±	±
													±	±
													±	±
													±	±
													±	±
													±	±
													±	±
													±	±
													±	±
													±	±

K5	K6	K7	M5	M6	M7	N5	N6	N7	P6	P7	Diameter Classification (mm) over	Diameter Classification (mm) incl.

Appendix Table 11 Values of Standard Tolerance Grades IT

Basic Size (mm)		Standard Grades										
		IT1	IT2	IT3	IT4	IT5	IT6	IT7	IT8	IT9	IT10	IT11
over	incl.	Tolerances (m)										

Standard Grades							Basic Size (mm)	
IT12	IT13	IT14	IT15	IT16	IT17	IT18		
Tolerances (mm)							over	incl.

Remarks
1. Standard tolerance grades IT14 to IT18 shall not be used for basic sizes less than or equal to 1 mm.
2. Values for standard tolerance grades IT1 to IT5 for basic sizes over 500 mm are included for experimental use.

Appedix Table 12 Speed Factor f_n

Ball Bearings f_n $n^{-1/3}$
Roller Bearings f_n $n^{-3/10}$

Speed n (min^{-1})	Speed Factor f_n		Speed n (min^{-1})	Speed Factor f_n		Speed n (min^{-1})	Speed Factor f_n	
	Ball Bearings	Roller Bearings		Ball Bearings	Roller Bearings		Ball Bearings	Roller Bearings
33.3	1.00	1.00						

Appendix Table 13 Fatigue Life Factor f_h and Fatigue Life L-L_h

Ball Bearings L C/P^3 L_h f_h^3
Roller Bearings L $C/P^{10/3}$ L_h $f_h^{10/3}$

C/P or f_h	Ball Bearing Life		Roller Bearing Life		C/P or f_h	Ball Bearing Life		Roller Bearing Life	
	L rev	L_h h	L rev	L_h h		L rev	L_h h	L rev	L_h h
1.00	1.00	500	1.00	500					

Appendix Table14 Index of Inch Design Tapered Roller Bearings

Bearing No.	Nominal Dimension (mm) *d* (Bore Dia.) *D* (Outside Dia.)	Pages
332	*D*	
336	*d*	
342	*d*	
342 S	*d*	
344	*d*	
344 A	*d*	
346	*d*	
354 A	*D*	
359 S	*d*	
362 A	*D*	
366	*d*	
368	*d*	
368 A	*d*	
369 A	*d*	
372	*D*	
374	*D*	
376	*d*	
377	*d*	
382	*D*	
382 A	*D*	
382 S	*D*	
385	*d*	
387	*d*	
387 A	*d*	
388 A	*d*	
390 A	*d*	
394 A	*D*	
395	*d*	
395 A	*d*	
395 S	*d*	
397	*d*	
399 A	*d*	
414	*D*	
418	*d*	
432	*D*	
432 A	*D*	
436	*d*	
438	*d*	
453 A	*D*	
453 X	*D*	
460	*d*	
462	*d*	
469	*d*	
472	*D*	
472 A	*D*	
478	*d*	
480	*d*	
484	*d*	
492 A	*D*	
493	*D*	
495	*d*	
495 A	*d*	
495 AX	*d*	
496	*d*	

Bearing No.	Nominal Dimension (mm) *d* (Bore Dia.) *D* (Outside Dia.)	Pages
497	*d*	
498	*d*	
522	*D*	
528	*d*	
529	*d*	
529 X	*d*	
532 X	*D*	
539	*d*	
552 A	*D*	
553 X	*D*	
555 S	*d*	
557 S	*d*	
558	*d*	
559	*d*	
560	*d*	
560 S	*d*	
563	*D*	
563 X	*D*	
565	*d*	
566	*d*	
567	*d*	
567 A	*d*	
567 S	*d*	
568	*d*	
569	*d*	
570	*d*	
572	*D*	
572 X	*D*	
575	*d*	
580	*d*	
581	*d*	
582	*d*	
590 A	*d*	
592	*D*	
592 A	*D*	
593	*d*	
594	*d*	
596	*d*	
597	*d*	
598	*d*	
598 A	*d*	
614 X	*D*	
622 X	*d*	
632	*D*	
633	*D*	
637	*d*	
639	*d*	
643	*d*	
644	*d*	
645	*d*	
652	*D*	
653	*D*	
653 X	*D*	
655	*d*	

Bearing No.	Nominal Dimension (mm) *d* (Bore Dia.) *D* (Outside Dia.)	Pages
657	*d*	
658	*d*	
659	*d*	
661	*d*	
663	*d*	
664	*d*	
665	*d*	
665 A	*d*	
672	*D*	
677	*d*	
681	*d*	
683	*d*	
685	*d*	
687	*d*	
742	*D*	
743	*D*	
745 A	*d*	
749	*d*	
749 A	*d*	
749 S	*d*	
750	*d*	
752	*D*	
753	*D*	
757	*d*	
758	*d*	
759	*d*	
760	*d*	
766	*d*	
772	*D*	
776	*d*	
779	*d*	
780	*d*	
782	*d*	
787	*d*	
792	*D*	
795	*d*	
797	*d*	
799	*d*	
799 A	*d*	
832	*D*	
837	*d*	
842	*d*	
843	*d*	
850	*d*	
854	*D*	
855	*d*	
857	*d*	
861	*d*	
864	*d*	
866	*d*	
932	*D*	
938	*d*	
1220	*D*	
1280	*d*	

Bearing No.	Nominal Dimension (mm) *d* (Bore Dia.) *D* (Outside Dia.)	Pages
1328	*D*	
1329	*D*	
1380	*d*	
1620	*D*	
1680	*d*	
1729	*D*	
1755	*d*	
1779	*d*	
1922	*D*	
1988	*d*	
1997 X	*d*	
A2047	*d*	
A2126	*D*	
2523	*D*	
2558	*d*	
2559	*d*	
2580	*d*	
2582	*d*	
2585	*d*	
2631	*D*	
2690	*d*	
2720	*D*	
2729	*D*	
2735 X	*D*	
2788	*d*	
2789	*d*	
2820	*D*	
2877	*d*	
2924	*D*	
2984	*d*	
3120	*D*	
3188	*d*	
3197	*d*	
3320	*D*	
3386	*d*	
3420	*D*	
3478	*d*	
3479	*d*	
3490	*d*	
3525	*D*	
3576	*d*	
3578	*d*	
3720	*D*	
3730	*D*	
3775	*d*	
3780	*d*	
3782	*d*	
3820	*D*	
3877	*d*	
3920	*D*	
3926	*D*	
3981	*d*	
3982	*d*	
3984	*d*	

Bearing No.	Nominal Dimension (mm) d (Bore Dia.) D (Outside Dia.)	Pages
3994	*d*	
A4050	*d*	
A4059	*d*	
A4138	*D*	
4335	*D*	
4388	*d*	
4535	*D*	
4595	*d*	
A5069	*d*	
A5144	*D*	
5335	*D*	
5356	*d*	
5535	*D*	
5566	*d*	
5582	*d*	
5584	*d*	
5735	*D*	
5760	*d*	
5795	*d*	
A6062	*d*	
A6067	*d*	
A6075	*d*	
A6157	*D*	
6220	*D*	
6279	*d*	
6280	*d*	
6320	*D*	
6376	*d*	
6379	*d*	
6420	*D*	
6454	*d*	
6455	*d*	
6460	*d*	
6461	*d*	
6535	*D*	
6536	*D*	
6559	*d*	
6575	*d*	
6576	*d*	
6580	*d*	
9121	*D*	
9180	*d*	
9185	*d*	
9220	*D*	
9285	*d*	
9320	*D*	
9321	*D*	
9378	*d*	
9380	*d*	
9385	*d*	
02420	*D*	
02473	*d*	
02474	*d*	
02475	*d*	

Bearing No.	Nominal Dimension (mm) d (Bore Dia.) D (Outside Dia.)	Pages
02820	*D*	
02872	*d*	
02878	*d*	
03062	*d*	
03162	*D*	
05062	*d*	
05068	*d*	
05075	*d*	
05079	*d*	
05175	*D*	
05185	*D*	
07079	*d*	
07087	*d*	
07097	*d*	
07098	*d*	
07100	*d*	
07100SA	*d*	
07196	*D*	
07204	*D*	
07205	*D*	
08118	*d*	
08125	*d*	
08231	*D*	
09062	*d*	
09067	*d*	
09074	*d*	
09078	*d*	
09081	*d*	
09194	*D*	
09195	*D*	
09196	*D*	
11162	*d*	
11300	*D*	
11520	*D*	
11590	*d*	
LM11710	*D*	
LM11749	*d*	
LM11910	*D*	
LM11949	*d*	
12168	*d*	
12303	*D*	
12520	*D*	
12580	*d*	
M12610	*D*	
M12648	*d*	
M12649	*d*	
LM12710	*D*	
LM12711	*D*	
LM12749	*d*	
13175	*d*	
13181	*d*	
13318	*D*	
13620	*D*	
13621	*D*	

Bearing No.	Nominal Dimension (mm) d (Bore Dia.) D (Outside Dia.)	Pages
13685	*d*	
13687	*d*	
13830	*D*	
13889	*d*	
14123 A	*d*	
14125 A	*d*	
14130	*d*	
14131	*d*	
14137 A	*d*	
14138 A	*d*	
14139	*d*	
14274	*D*	
14276	*D*	
14283	*D*	
15100	*d*	
15101	*d*	
15106	*d*	
15112	*d*	
15113	*d*	
15116	*d*	
15117	*d*	
15118	*d*	
15119	*d*	
15120	*d*	
15123	*d*	
15125	*d*	
15126	*d*	
15245	*D*	
15250	*D*	
15250 X	*D*	
15520	*D*	
15523	*D*	
15578	*d*	
15580	*d*	
16150	*d*	
16284	*D*	
16929	*D*	
16986	*d*	
17098	*d*	
17118	*d*	
17244	*D*	
17520	*D*	
17580	*d*	
17831	*D*	
17887	*d*	
18200	*d*	
18337	*D*	
18520	*D*	
18590	*d*	
18620	*D*	
18690	*d*	
18720	*D*	
18790	*d*	
19138	*d*	

Bearing No.	Nominal Dimension (mm) d (Bore Dia.) D (Outside Dia.)	Pages
19150	*d*	
19268	*D*	
21075	*d*	
21212	*D*	
L21511	*D*	
L21549	*d*	
22168	*d*	
22325	*D*	
23100	*d*	
23256	*D*	
23621	*D*	
23691	*d*	
24720	*D*	
24721	*D*	
24780	*d*	
25520	*D*	
25521	*D*	
25523	*D*	
25577	*d*	
25578	*d*	
25580	*d*	
25584	*d*	
25590	*d*	
25820	*D*	
25821	*D*	
25877	*d*	
25878	*d*	
25880	*d*	
26118	*d*	
26131	*d*	
26283	*D*	
26820	*D*	
26822	*D*	
26823	*D*	
26882	*d*	
26884	*d*	
27620	*D*	
27687	*d*	
27689	*d*	
27690	*d*	
27820	*D*	
27880	*d*	
28138	*d*	
28315	*D*	
28521	*D*	
28580	*d*	
28584	*d*	
28622	*D*	
28680	*d*	
28920	*D*	
28921	*D*	
28985	*d*	
29520	*D*	
29586	*d*	

Bearing No.	Nominal Dimension (mm) *d* (Bore Dia.) *D* (Outside Dia.)	Pages
29620	*D*	
29630	*D*	
29675	*d*	
29685	*d*	
LM29710	*D*	
LM29711	*D*	
LM29748	*d*	
LM29749	*d*	
31520	*D*	
31594	*d*	
33262	*d*	
33275	*d*	
33281	*d*	
33287	*d*	
JHM33410	*D*	
JHM33449	*d*	
33462	*D*	
33821	*D*	
33889	*d*	
34300	*d*	
34306	*d*	
34478	*D*	
36620	*D*	
36690	*d*	
36920	*D*	
36990	*d*	
37425	*d*	
37625	*D*	
M38510	*D*	
M38511	*D*	
M38547	*d*	
M38549	*d*	
39236	*d*	
39250	*d*	
39412	*D*	
39520	*D*	
39521	*D*	
39585	*d*	
39590	*d*	
41100	*d*	
41125	*d*	
41126	*d*	
41286	*D*	
42350	*d*	
42362	*d*	
42368	*d*	
42375	*d*	
42376	*d*	
42381	*d*	
42584	*D*	
42587	*D*	
42620	*D*	
42687	*d*	
42688	*d*	

Bearing No.	Nominal Dimension (mm) *d* (Bore Dia.) *D* (Outside Dia.)	Pages
42690	*d*	
43118	*d*	
43131	*d*	
43300	*D*	
43312	*D*	
44143	*d*	
44150	*d*	
44157	*d*	
44162	*d*	
44348	*D*	
L44610	*D*	
L44640	*d*	
L44643	*d*	
L44649	*d*	
45220	*D*	
45221	*D*	
45289	*d*	
L45410	*D*	
L45449	*d*	
46143	*d*	
46162	*d*	
46176	*d*	
46368	*D*	
46720	*D*	
46780	*d*	
47420	*D*	
47487	*d*	
47490	*d*	
47620	*D*	
47680	*d*	
47685	*d*	
47686	*d*	
47687	*d*	
47820	*D*	
47890	*d*	
47896	*d*	
48120	*D*	
48190	*d*	
48220	*D*	
48282	*d*	
48286	*d*	
48290	*d*	
48320	*D*	
48385	*d*	
48393	*d*	
LM48510	*D*	
LM48511	*D*	
LM48548	*d*	
48620	*D*	
48685	*d*	
49175	*d*	
49176	*d*	
49368	*D*	
49520	*D*	

Bearing No.	Nominal Dimension (mm) *d* (Bore Dia.) *D* (Outside Dia.)	Pages
49585	*d*	
52387	*d*	
52393	*d*	
52400	*d*	
52618	*D*	
52637	*D*	
53150	*d*	
53162	*d*	
53176	*d*	
53177	*d*	
53178	*d*	
53375	*D*	
53387	*D*	
55175	*d*	
55187	*d*	
55200	*d*	
55200C	*d*	
55206	*d*	
55437	*D*	
55443	*D*	
56418	*d*	
56425	*d*	
56650	*D*	
59200	*d*	
59429	*D*	
64433	*d*	
64450	*d*	
64700	*D*	
65200	*d*	
65212	*d*	
65237	*d*	
65320	*D*	
65385	*d*	
65500	*D*	
66187	*d*	
66462	*D*	
66520	*D*	
66584	*d*	
66585	*d*	
66587	*d*	
LM67010	*D*	
LM67043	*d*	
LM67048	*d*	
67320	*D*	
67322	*D*	
67388	*d*	
67389	*d*	
67390	*d*	
67720	*D*	
67780	*d*	
67787	*d*	
67790	*d*	
67820	*D*	
67885	*d*	

Bearing No.	Nominal Dimension (mm) *d* (Bore Dia.) *D* (Outside Dia.)	Pages
67920	*D*	
67983	*d*	
67985	*d*	
L68110	*D*	
L68111	*D*	
L68149	*d*	
68450	*d*	
68462	*d*	
68709	*D*	
68712	*D*	
JL69310	*D*	
JL69349	*d*	
71412	*d*	
71425	*d*	
71437	*d*	
71450	*d*	
71453	*d*	
71750	*D*	
72187	*d*	
72200	*d*	
72200C	*d*	
72212	*d*	
72212C	*d*	
72218	*d*	
72218C	*d*	
72225C	*d*	
72487	*D*	
LM72810	*D*	
LM72849	*d*	
74500	*d*	
74525	*d*	
74537	*d*	
74550	*d*	
74850	*D*	
74856	*D*	
77375	*d*	
77675	*D*	
78225	*d*	
78250	*d*	
LM78310	*D*	
LM78310A	*D*	
LM78349	*d*	
78537	*D*	
78551	*D*	
78571	*D*	
HM81610	*D*	
HM81649	*d*	
M84210	*D*	
M84249	*d*	
M84510	*D*	
M84548	*d*	
M86610	*D*	
M86643	*d*	
M86647	*d*	

Bearing No.	Nominal Dimension (mm) *d* (Bore Dia.) *D* (Outside Dia.)	Pages
M86648A	*d*	
M86649	*d*	
M88010	*D*	
M88043	*d*	
M88046	*d*	
M88048	*d*	
HM88510	*D*	
HM88542	*d*	
HM88547	*d*	
HM88610	*D*	
HM88630	*d*	
HM88638	*d*	
HM88648	*d*	
HM88649	*d*	
HM89410	*D*	
HM89411	*D*	
HM89443	*d*	
HM89444	*d*	
HM89446	*d*	
HM89446A	*d*	
HM89449	*d*	
99100	*D*	
99550	*d*	
99575	*d*	
99587	*d*	
99600	*d*	
LM102910	*D*	
LM102949	*d*	
JLM104910	*D*	
LM104911	*D*	
LM104911A	*D*	
LM104912	*D*	
LM104947A	*d*	
JLM104948	*d*	
LM104949	*d*	
M201011	*D*	
M201047	*d*	
JM205110	*D*	
JM205149	*d*	
JM207010	*D*	
JM207049	*d*	
JH211710	*D*	
JH211749	*d*	
HM212010	*D*	
HM212011	*D*	
HM212044	*d*	
HM212046	*d*	
HM212047	*d*	
HM212049	*d*	
JH217210	*D*	
JH217249	*d*	
HM218210	*D*	
HM218248	*d*	
HH221410	*D*	

Bearing No.	Nominal Dimension (mm) *d* (Bore Dia.) *D* (Outside Dia.)	Pages
HH221432	*d*	
HH221434	*d*	
HH221440	*d*	
HH221442	*d*	
HH221447	*d*	
HH221449	*d*	
HH224310	*D*	
HH224335	*d*	
HH224340	*d*	
HH224346	*d*	
M224710	*D*	
M224748	*d*	
LL225710	*D*	
LL225749	*d*	
HM231110	*D*	
HM231140	*d*	
M236810	*D*	
M236849	*d*	
LM300811	*D*	
LM300849	*d*	
L305610	*D*	
L305649	*d*	
JH307710	*D*	
JH307749	*d*	
JHM318410	*D*	
JHM318448	*d*	
L327210	*D*	
L327249	*d*	
LM328410	*D*	
LM328448	*d*	
H414210	*D*	
H414245	*d*	
H414249	*d*	
JH415610	*D*	
JH415647	*d*	
LM501310	*D*	
LM501314	*D*	
LM501349	*d*	
LM503310	*D*	
LM503349	*d*	
HH506310	*D*	
HH506348	*d*	
JLM506810	*D*	
JLM506849	*d*	
JLM508710	*D*	
JLM508748	*d*	
JM511910	*D*	
JM511946	*d*	
JM515610	*D*	
JM515649	*d*	
HM516410	*D*	
HM516448	*d*	
JHM516810	*D*	
JHM516849	*d*	

Bearing No.	Nominal Dimension (mm) *d* (Bore Dia.) *D* (Outside Dia.)	Pages
HM518410	*D*	
HM518445	*d*	
LM522510	*D*	
LM522546	*d*	
LM522548	*d*	
LM522549	*d*	
JHM522610	*D*	
JHM522649	*d*	
JHM534110	*D*	
JHM534149	*d*	
LM603011	*D*	
LM603012	*D*	
LM603049	*d*	
L610510	*D*	
L610549	*d*	
JM612910	*D*	
JM612949	*d*	
LM613410	*D*	
LM613449	*d*	
HM617010	*D*	
HM617049	*d*	
L623110	*D*	
L623149	*d*	
JLM710910	*D*	
JLM710949	*d*	
JLM714110	*D*	
JLM714149	*d*	
JM714210	*D*	
JM714249	*d*	
H715311	*D*	
H715334	*d*	
H715340	*d*	
H715341	*d*	
H715343	*d*	
H715345	*d*	
JM716610	*D*	
JM716648	*d*	
JM716649	*d*	
JM718110	*D*	
JM718149	*d*	
JM719113	*D*	
JM719149	*d*	
JM720210	*D*	
JHM720210	*D*	
JM720249	*d*	
JHM720249	*d*	
JL724314	*D*	
JL724348	*d*	
JL725316	*D*	
JL725346	*d*	
JM734410	*D*	
JM734449	*d*	
JM738210	*D*	
JM738249	*d*	

Bearing No.	Nominal Dimension (mm) *d* (Bore Dia.) *D* (Outside Dia.)	Pages
HM801310	*D*	
HM801346	*d*	
M802011	*D*	
M802048	*d*	
HM803110	*D*	
HM803145	*d*	
HM803146	*d*	
HM803149	*d*	
M804010	*D*	
M804049	*d*	
HM804810	*D*	
HM804840	*d*	
HM804843	*d*	
HM804846	*d*	
HM804848	*d*	
HM804849	*d*	
HM807010	*D*	
HM807011	*D*	
JHM807012	*D*	
HM807040	*d*	
HM807044	*d*	
JHM807045	*d*	
HM807046	*d*	
JLM813010	*D*	
JLM813049	*d*	
JLM820012	*D*	
JLM820048	*d*	
JM822010	*D*	
JM822049	*d*	
JHM840410	*D*	
JHM840449	*d*	
HM903210	*D*	
HM903247	*d*	
HM903249	*d*	
HM911210	*D*	
HM911242	*d*	
H913810	*D*	
H913842	*d*	
H913849	*d*	