



Technical Information

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- 2. Selection of Bearings**

- 3. Load Capacity and Life of Bearings**

- 4. Boundary Dimensions and Bearing Numbers of Bearings**

- 5. Accuracy of Bearings**

- 6. Internal Clearance of Bearings**

- 7. Materials of Bearings**

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- 9. Trouble-shooting Bearing Problem**



1. Types and Features of Bearings

1.1 Classification and Types

1.2 Designs and Feature

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1.2.5 Cylindrical Roller Bearings

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1. Types and Features of bearings

1.1 Classification and Types of Rolling Contact Bearings

In general, rolling contact bearings may be classified as radial or thrust bearings according to bearing design or they may be classified as ball or roller bearings according to the type of rolling element.

Radial bearings are mainly designed for supporting a load perpendicular to a shaft axis, whereas thrust bearings accept loads parallel to the shaft axis.

Using the BALL and ROLLER classification ROLLER bearings may be further divided according to the shape of the roller into the sub-classes; Cylindrical roller, Tapered roller, Spherical roller, or Needle roller bearings. BALL bearings can be further divided according to the number of rows into either single-row or double-row (for Thrust Ball bearings, single-direction and double-direction.) BALL Bearing may be still further sub-divided into smaller segments according to the relationship between the bearing rings and rolling elements; the shape of bearing rings; and use of accessories.

Bearings are also classified by specific application, such as Clutch-release ball bearings for automotive applications.

Table 1.1 indicates the principal types of radial and thrust bearings and a summary of their design. Table 1.2 summarizes the designs and features of rolling contact bearings.

Table 1.1 Classification and Types of Rolling Contact Bearings

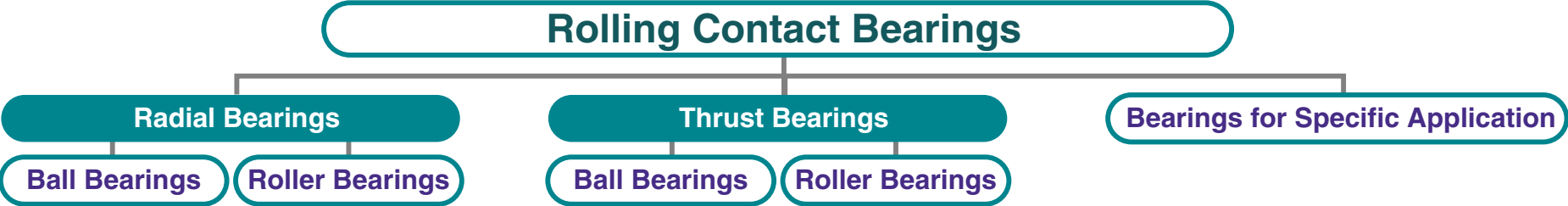


Table 1.2 Types and Features of Rolling Contact Bearings



Table 1.1 Classification and Types of Rolling Contact Bearings
Radial Bearings > Ball Bearings

1/2


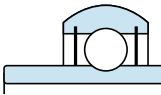





| Bearing Types | | | Cross Sections | Bearing Series Symbols | | |
|---------------------------|------------|--|---|------------------------|----------------|------------------------------|
| | | | | JIS | | Others |
| Deep Groove Ball Bearings | Single row | Without filling slot (JIS B 1521) |  | 67 68 69 | 60 62 63 | 00B60 RLS RMS 16000 |
| | | Without filling slot [for unit ;JIS B 1558] |  | UC UWE UNE | UM UK | U B KH |
| | | With filling slot |  | - | | |
| | Double row | Without filling slot |  | - | | |
| | | With filling slot |  | - | | 42 43 |
| Counter-Bored Bearings | Single row | Non-Separable |  | - | | |
| | | Separable (JIS B 1538) |  | E EN | | BM |



Table 1.1 Classification and Types of Rolling Contact Bearings
Radial Bearings > Ball Bearings





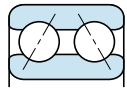
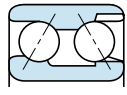
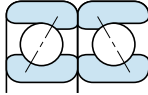

| Bearing Types | | | Cross Sections | Bearing Series Symbols | |
|-------------------------------|-----------------|---|---|------------------------|----------|
| | | | | JIS | Others |
| Angular Contact Ball Bearings | Single row | Non-Separable (JIS B 1522) |  | 79 70 | 72 73 |
| | | Separable |  | - | |
| | Double row | Without filling slot |  | - | 52 53 |
| | | With filling slot |  | - | 32 33 |
| | Duplex mounting | DB mounting DF mounting DT mounting |  | - | |
| Self-Aligning Ball Bearings | Double row | Outer ring raceway : spherical |  | 12 13 | 22 23 |

Table 1.1 Classification and Types of Rolling Contact Bearings
Radial Bearings > Roller Bearings

1/2


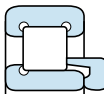





| Bearing Types | | | | | Cross Sections | Bearing Series Symbols | |
|-----------------------------|------------|------------------------------------|-------------------|---|--|----------------------------------|--------|
| | | | | | | JIS | Others |
| Cylindrical Roller Bearings | Single row | Inner ring with a rib | Without loose rib | Outer ring with ribs on both sides [JIS B 1533] |  | NJ2 NJ23 NJ22 NJ4 NJ3 | |
| | | | With loose rib | |  | NH2 NH23 NH22 NH4 NH3 | |
| | | Inner ring without rib | | |  | NU10 NU3 NU2 NU23 NU22 NU4 | |
| | | Inner ring with ribs on both sides | | Outer ring with a rib [JIS B 1533] |  | NF2 NF3 NF4 | |
| | | | | Outer ring without rib |  | N2 N3 N4 | N10 |
| | Double row | Inner ring with ribs on both sides | | Outer ring without rib |  | NN30 | |
| | | Inner ring without rib | | Outer ring with ribs on both sides |  | NNU49 | |



Table 1.1 Classification and Types of Rolling Contact Bearings
Radial Bearings > Roller Bearings



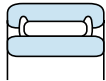
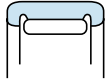
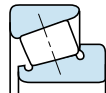
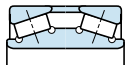
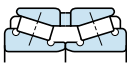
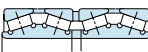


| Bearing Types | | | | Cross Sections | Bearing Series Symbols | | | |
|---------------------------|------------|--------------------------------|------------------------------------|---|---|--------------------|-------------------|------------|
| | | | | | JIS | | Others | |
| Needle Roller Bearings | Single row | Inner ring without rib | Outer ring with ribs on both sides |  | NA48 NA49 | | | |
| | | Without inner ring | |  | RNA48 RNA49 | | | |
| Tapered Roller Bearings | Single row | Separable (JIS B 1534) | |  | 320 302 322 | 303 303D 323 | 329 331 313 | 330 332 |
| | Double row | Separable (Inward) | |  | - | | KBD | |
| | | Separable (Outward) | |  | - | | KBE KDE | |
| | | Four row | Separable | |  | - | | |
| Spherical Roller Bearings | Single row | Outer ring raceway : spherical | |  | - | | | |
| | Double row | Outer ring raceway : spherical | |  | 239 230 240 | 231 241 222 | 232 213 223 | |

Table 1.1 Classification and Types of Rolling Contact Bearings
Thrust Bearings > Ball Bearings

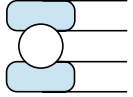
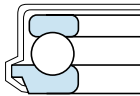
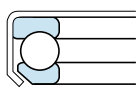
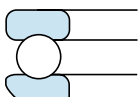

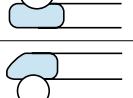
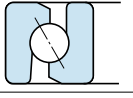
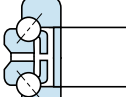
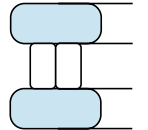
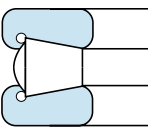
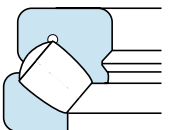
| Bearing Types | | | Cross Sections | Bearing Series Symbols | |
|--------------------------------------|------------------|-----------------------------|---|------------------------|---|
| | | | | JIS | Others |
| Thrust Ball Bearings | Single direction | Flat back face (JIS B 1532) |  | 511 513 512 514 | 29 39 9 0 |
| | | Flat back face |  | - | TMN |
| | | Flat back face |  | - | TG |
| | | Spherical back face |  | - | 532(U) 7(U) 533(U) 37(U) 534(U) OOT6(U) |
| | Double direction | Flat back face (JIS B 1532) |  | 522 523 524 | 19 |
| | | Spherical back face |  | - | 542(U) 543(U) 544(U) |
| Thrust Angular Contact Ball Bearings | Single direction | Non-Separable (DB, DF, DT) |  | - | TAB |
| | Double direction | Separable |  | - | TAD |

Table 1.1 Classification and Types of Rolling Contact Bearings
Thrust Bearings > Roller Bearings

| Bearing Types | | | Cross Sections | Bearing Series Symbols | |
|------------------------------------|------------------|--------------------------------|---|------------------------|--------|
| | | | | JIS | Others |
| Thrust Cylindrical Roller Bearings | Single direction | Flat back face |  | - | TMP |
| Thrust Tapered Roller Bearings | | Flat back face |  | - | |
| Spherical Roller Thrust Bearings | Single direction | Outer ring raceway : spherical |  | 292 293 294 | |

**Table 1.1 Classification and Types of Rolling Contact Bearings
Bearings for Specific Application**

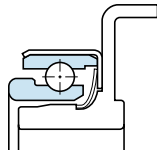
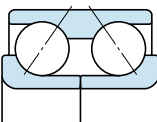
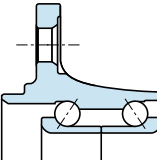
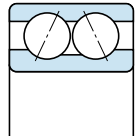
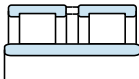
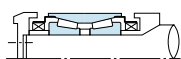
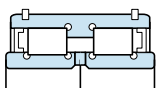


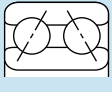
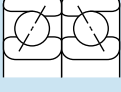


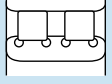
| Bearing Types | | Cross Sections | Bearing Series Symbols | |
|-------------------------------------|--|---|------------------------|---------------------|
| | | | JIS | Others |
| Automotive Bearings | Self-Aligning Clutch-Release Ball Bearings |  | - | SCRN |
| | Ball Bearings for Wheel (1st type) |  | - | BVV |
| | Ball Bearings for Wheel (2nd type) |  | - | F BVV |
| | Ball Bearings for Air Conditioner Clutch |  | - | BG |
| Journal Bearings for Rolling Stocks | |  | - | FCD JC AP |
| | |  | - | JT |
| Sheave Bearings | |  | - | E50 RB48 RC48 |

Table 1.2 Classification and Types of Rolling Contact Bearings

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| Features Bearing Type | | Load carrying capacity | High speed rotation | Accuracy | Low noise • Low torque | Permissible aligning of inner ring • outer ring | Rigidity | Aligning action | Separable inner ring • outer ring | Applicable to "fix side" | Applicable to "free side" only | Inner ring with tapered bore |
|---|--|------------------------|---------------------|----------|------------------------|---|----------|-----------------|-----------------------------------|--------------------------|--------------------------------|------------------------------|
| Deep Groove Ball Bearings |  | ↑ ← → | ● ● ● ● | ● ● ● | ● ● ● | ● ● | ● | | | ○ | □ | ○ |
| Angular Contact Ball Bearings |  | ↑ ← | ● ● ● ● | ● ● ● | ● ● ● | ● | ● | | | | | |
| Double Row Angular Contact Ball Bearings |  | ↑ ← → | ● ● ● | ● | ● | ● | ● | | | ○ | □ | |
| Duplex Mounting Angular Contact Ball Bearings |  | ↑ ← → | ● ● ● | ● ● ● | ● ● | ● | ● ● | | | ○ | □ | |
| Self-Aligning Ball Bearing |  | ↑ ← → | ● ● | ● | ● | ● ● ● | ● | ○ | | | □ | ○ |
| Cylindrical Roller Bearings |  | ↑ | ● ● ● | ● ● ● | ● ● | ● | ● ● | | ○ | | ○ | ○ |
| Double Row Cylindrical Roller Bearings |  | ↑ | ● ● ● | ● ● ● | ● ● | ● | ● ● ● | | ○ | | ○ | ○ |

Remarks

- (1) ↑ and ← → show radial load and axial load respectively ← and ← → mean single direction and double directions respectively.
- (2) Mark "●" shows possibility for getting the characteristics. More number of "●" means much easier than less number.
"X" mean "not applicable".
- (3) "○" means "applicable". "□" means "can be applicable", but shaft thermal expansion must be absorbed.
- (4) Thrust Ball/Roller Bearings can sustain axial loads ONLY.
- (5) This table is for reference only. Bearings should be selected for specific applications.



Table 1.2 Classification and Types of Rolling Contact Bearings



| Bearing Type | Features | Load carrying capacity | High speed rotation | Accuracy | Low noise • Low torque | Permissible aligning of inner ring • outer ring | Rigidity | Aligning action | Separable inner ring • outer ring | Applicable to "fix side" | Applicable to "free side" only | Inner ring with tapered bore |
|---|----------|------------------------|---------------------|----------|------------------------|---|----------|-----------------|-----------------------------------|--------------------------|--------------------------------|------------------------------|
| | | | | | | | | | | | | |
| Tapered Roller Bearings | | ↑ ← | ● ● | ● ● ● | ● | ● | ● ● | | ○ | | | |
| Double-row Multi-row Tapered Roller Bearings | | ↑ ← → | ● ● | ● | ● | ● | ● ● ● ● | | ○ | ○ | □ | |
| Spherical Roller Bearings | | ↑ ← → | ● ● | ● | ● | ● ● ● | ● ● ● | ○ | | ○ | □ | ○ |
| Cylindrical Roller Bearings With One Rib Inner Ring | | ↑ → | ● ● ● | ● ● | ● ● | ● | ● ● | | ○ | | | |
| Cylindrical Roller Bearings With L-shaped Thrust Collar | | ↑ ← → | ● ● ● | ● ● | ● ● | ● | ● ● | | ○ | ○ | | |
| Needle Roller Bearings | | ↑ | ● ● | ● | ● | ● | ● ● | | ○ | | ○ | |







Remarks

- (1) ↑ and ← → show radial load and axial load respectively ← and ← → mean single direction and double directions respectively.
- (2) Mark "●" shows possibility for getting the characteristics. More number of "●" means much easier than less number. "X" mean "not applicable".
- (3) "○" means "applicable". "□" means "can be applicable", but shaft thermal expansion must be absorbed.
- (4) Thrust Ball/Roller Bearings can sustain axial loads ONLY.
- (5) This table is for reference only. Bearings should be selected for specific applications.



Table 1.2 Classification and Types of Rolling Contact Bearings



| Bearing Type \ Features | Load carrying capacity | High speed rotation | Accuracy | Low noise - Low torque | Permissible aligning of inner ring • outer ring | Rigidity | Aligning action | Separable inner ring - outer ring | Applicable to "fix side" | Applicable to "free side" only | Inner ring with tapered bore |
|---|------------------------|---------------------|----------|------------------------|---|----------|-----------------|-----------------------------------|--------------------------|--------------------------------|------------------------------|
| Single Direction Thrust Ball Bearings With Flat Back Face  | ← | ● | ● | ●● | × | ● | | ○ | | | |
| Single Direction Thrust Ball Bearings With Spherical Flat Back Face  | ← | ● | ● | ●● | ●●● | ● | ○ | ○ | | | |
| Double-row Thrust Angular Contact Ball Bearings  | ← → | ●●● | ●●● | ●● | × | ●● | | ○ | | | |
| Thrust Cylindrical Roller Bearings  | ← | ● | ● | ● | × | ●●● | | ○ | | | |
| Thrust Tapered Roller Bearings  | ← | ● | ● | ● | × | ●●● | | ○ | | | |
| Spherical Roller Thrust Bearings  | ← ↑ | ● | ● | ● | ●●● | ●●● | ○ | ○ | | | |

Remarks

- (1) ↑ and ← → show radial load and axial load respectively ← and ← → mean single direction and double directions respectively.
- (2) Mark "●" shows possibility for getting the characteristics. More number of "●" means much easier than less number. "X" mean "not applicable".
- (3) "○" means "applicable". "□" means "can be applicable", but shaft thermal expansion must be absorbed.
- (4) Thrust Ball/Roller Bearings can sustain axial loads ONLY.
- (5) This table is for reference only. Bearings should be selected for specific applications.

1.2 Rolling Contact Bearing Designs and Features

Rolling Contact Bearings usually consist of an inner ring, outer ring, and rolling elements (balls or rollers), and a cage which positions the rolling elements at fixed intervals between the ring raceways. (See Figure 1).

Standard materials for inner and outer rings, and for the rolling elements, are high carbon chromium bearing steel or case hardening steel. The steel is heat-treated to an appropriate hardness to attain optimum resistance to rolling fatigue. Bearing surfaces are ground to a very high accuracy using special machine tools.

While each of the various types of rolling contact bearings has special features, the following features are common to most rolling contact bearing types:

- Rolling contact bearings have relatively low starting resistance. There is little difference between the starting and running resistance of rolling contact bearings.
- Dimensions and accuracy are standardized. Ready-made products of high quality are easy to obtain.
- Compared to “sliding” bearings, rolling contact bearings are less prone to wear and help to maintain the accuracy of the machine in which they are used.
- Rolling contact bearings consume small amounts of lubricant and are far less costly to maintain than sliding-type bearings.
- While not common to all rolling contact bearings, many types can sustain both axial and radial loads.

To get optimum performance from a selected bearing, it is necessary to understand the design and features of the various bearing types and to then select bearings optimal to individual machine performance.

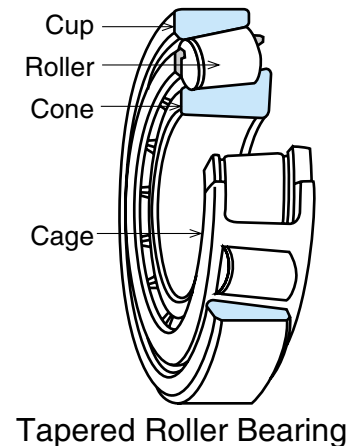
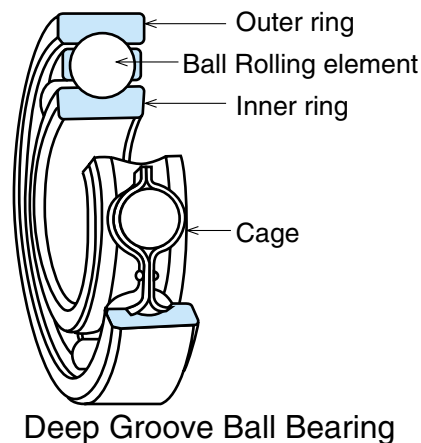


Fig 1. Rolling Contact Bearing Designs

1.2.1 Deep Groove Ball Bearings

Deep Groove ball bearings are the most popular of all the ball bearing types because they are available in a wide variety of seal, shield and snap-ring arrangements.

The bearing ring grooves are circular arcs made slightly larger than the radius of the ball. The balls make point contact with the raceways (elliptical contact when loaded). The inner ring shoulders are of equal height (as the outer ring shoulders).

Deep Groove ball bearings can sustain radial, axial, or composite loads and because of simple design, this bearing type can be produced to provide both high-running accuracy and high-speed operation.

Deep Groove ball bearings having an outside diameter less than 9 mm are known as Miniature ball bearings.

Deep Groove ball bearings having an outside diameter ≥ 9 mm and a bore diameter < 10 mm are known as Extra-small ball bearings.

Standard ball retainers (cages) are made from pressed steel. Machined cages are used in bearing operating at very high speed or for large diameter bearings.

Deep groove ball bearings with seals or shields are standardized. They contain proper amount of grease in advance.



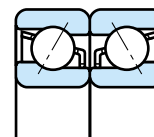
1.2.2 Single-row Angular Contact Ball Bearings

The raceways of both the inner and outer rings of this bearing type are made with a set contact angle. These bearings are non-separable. Since the balls are inserted utilizing counter-bore construction, a larger number of balls can be installed than in the case of Deep-groove ball bearings.

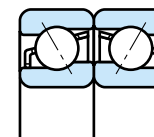
Standard cage materials may be pressed steel, high-strength brass, or synthetic resin. Cage material is dependent on the bearing series and or service condition.

Single-row Angular Contact ball bearings can sustain radial, axial or composite loads, however, any axial load must be in one direction.

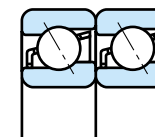
This bearing type is generally used in pairs to handle the induced load resulting from the internal axial force generated by the applied radial load. When mounting two single bearings in adjacent positions, NACHI provides these combination parts (pairs) with preadjusted clearance. Paired combination bearings are matched sets. Combination or paired bearings can be arranged BACK-TO-BACK (DB), FACE-TO-FACE (DF), or in TANDEM (DT). DB or DF sets can sustain bidirectional axial loads.



DB
(Back-to-back)



DF
(Face-to-face)



DT
(Tandem)

1.2.3 Double-row Angular Contact Ball Bearings

The construction of this type ball bearing is similar to the adjacent, BACK-TO-BACK mounting of two Single-row Angular Contact ball bearings. Because fewer balls can be inserted per row compared to Single-row Angular Contact ball bearings, a Double-row Angular Contact ball bearing will have less load capacity than an equivalent size/series BACK-TO-BACK set of two Single-row Angular Contact ball bearings.

This bearing type can sustain radial, moment and bi-directional axial loads.

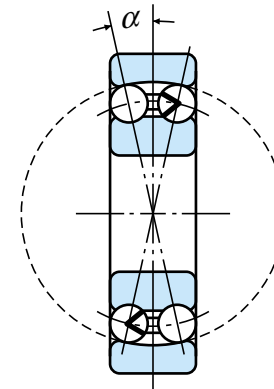


1.2.4 Self-aligning Ball Bearings

This type is constructed with the inner ring and ball assembly contained within an outer ring which has a spherical raceway. Due to the construction, this bearing type will tolerate a small angular misalignment from deflection or mounting error.

Self-aligning Ball bearings are suitable for long shafts where accurate positioning of housing bores is difficult. This type is often used in conjunction with pillow blocks. Cages are made from pressed steel or polyamide resin.

This bearing should only be used in light axial load applications due to the small axial support of the rolling elements by the outer ring raceway.



1.2.5 Cylindrical Roller Bearings

Construction of this roller bearing type is the simplest of all radial roller bearings. This bearing type is often used in high-speed applications.

Because the inner ring, outer ring, and rollers are in line contact, this bearing type has a large radial load capacity. Various Cylindrical roller bearing configurations are:

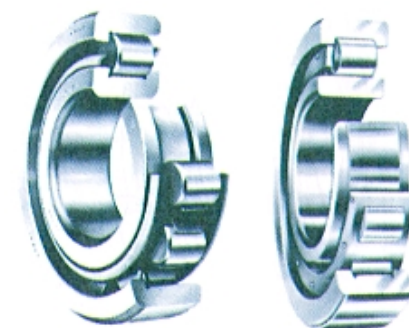
- N,NJ,NF,NU,RNU : integral ribs (flanges)
- NH,NP,NUP,NUH : integral and loose ribs
- NN,NNU : double-row bearings

[Continue→]

(See the Cylindrical roller bearing dimensional data section for description of configuration design).

Configurations having integral flanges or loose ribs on both the inner and outer rings can sustain a small amount of axial load. Since this bearing type supports axial loads as sliding action between the end of the rollers and flange faces, axial loading is limited.

Double-row Cylindrical roller bearings are used for high-speed, high-accuracy applications such as; main spindle support for lathes, milling machines, and machining centers. Radial clearance of tapered-bore bearings can be adjusted during mounting of the bearing(s) onto the mating journal. Standard cages are pressed steel or polyamide resin. Machined cages of high-strength brass are used for bearings of large dimension or for high-speed applications.



1.2.6 Tapered Roller Bearings

The inner and outer ring raceways and rollers of this type of bearing are made with a taper so that the planes of the surfaces of the raceways and roller axis meet at a point. The rollers are guided by the cone (inner ring) back-face rib.

A single-row Tapered roller bearing can support a combined radial and axial load. If either a radial load or bi-directional axial load is to be carried, a pair of bearings must be used in a “face-to-face” or “back-to-back” position.

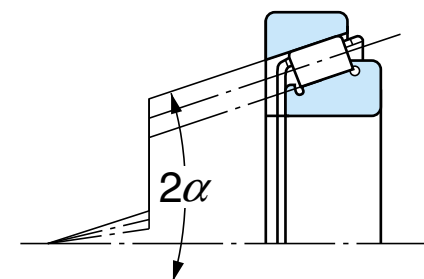
Tapered roller bearings are separable into the components: outer ring, inner ring and roller assembly. The non-separable inner ring and roller assembly is called the “cone”, and the outer ring is called the “cup”. Internal clearance is established during mounting by the axial positioning of the cone relative to the cup.

This bearing type can be used in a preload situation to obtain higher rigidity and better running accuracy of the shaft.

Double-row and four-row Tapered roller bearings are designed to carry radial, and bi-directional axial loads. Four-row Tapered roller bearings are used for the roll necks of rolling machines and for other applications where heavy or impact loads are present.

Multi-row Tapered roller bearings have the serial number and the combination symbol stamped on the faces of the rings for clearance adjustment and must be assembled according to this number and symbol.

Pressed steel cages are used for small bore bearings and machined, high-strength brass or mild-steel cages are used for bearings with larger bores. Heavy-duty pin-type cages are used for some large-bore bearings.



1.2.7 Spherical Roller Bearings

NACHI double-row Spherical roller bearings are available in bore sizes from 25 mm to over 1000 mm.

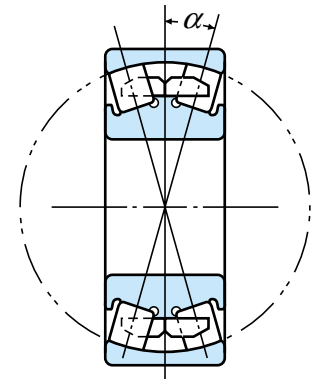
The raceways in the outer ring of this type bearing are designed with a spherical surface whose center coincides with the bearing center.

NACHI Spherical roller bearings are of an improved design having a modified line contact between the raceways and rollers. This construction enables very high radial and impact-load capacity.

This bearing type can carry a moderately-high level of bi-directional axial load and is self-aligning. This type is used extensively for large machines where shaft deflection or mounting error may occur.

Spherical roller bearings are used for paper mill equipment, rolling machines, rolling stock, shaker screens and general industrial machinery. The mounting and dismounting of Spherical roller bearings is facilitated through the use of tapered-bore bearings in conjunction with tapered journals, or adapters or withdrawal sleeves. Internal clearance can also be precisely set using a tapered-bore bearing.

Pressed steel cages are used for small-bore bearings and machined, high-strength brass or mild-steel cages are used for bearings with larger bores.



1.2.8 Thrust Ball Bearings

Thrust ball bearings can handle axial loads only. Bearing rings mounted on the shaft are called shaft washers, and those mounted in the bearing housing are called housing washers. Both washers contain grooves for the balls.

Thrust Ball bearings are of two types: single type which can support axial loads in only one direction and double type that can support bi-directional loads. The central washer of double type thrust ball bearing is located in an axial direction by a shaft shoulder and sleeve.

Thrust Ball bearings are not suitable for high-speed rotation since lubricant is expelled by centrifugal force. When used on a horizontal shaft, a minimum axial load must be applied.

Pressed steel plate, polyamide resin, machined high-strength brass or mild steel are used for cages.

Care must be taken in handling to prevent damage to the separable rings and ball assembly.



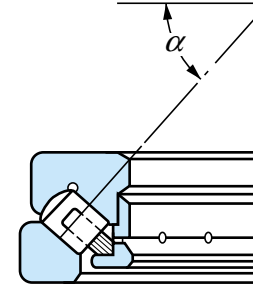
1.2.9 Spherical Roller Thrust Bearings

The raceway of housing washer of this bearing type is spherical with the center of the radius located on the bearing axis. The design provides self-alignment capability to the bearing. The contact angle (see sketch below) is approximately 45° enabling the bearing to support axial load and a small to moderate amount of radial load.

NACHI Spherical Roller Thrust bearings can sustain high loads at low-to-moderate speeds.

Because of the large load capacity and self-aligning characteristics, this bearing type is often used for injection molding machines, crane hooks and other large machines.

Cages are made from machined, high-strength brass or pressed steel.





2. Selection of Bearings

Introduction

2.1 Bearing Type Selection Considerations

2.1.1 Load

2.1.2 Rotating Speed

2.1.3 Noise and Torque

2.1.4 Alignment

2.1.5 Rigidity

2.1.6 Mounting, Dismounting

2.1.7 Axial Location; Bearing Arrangement

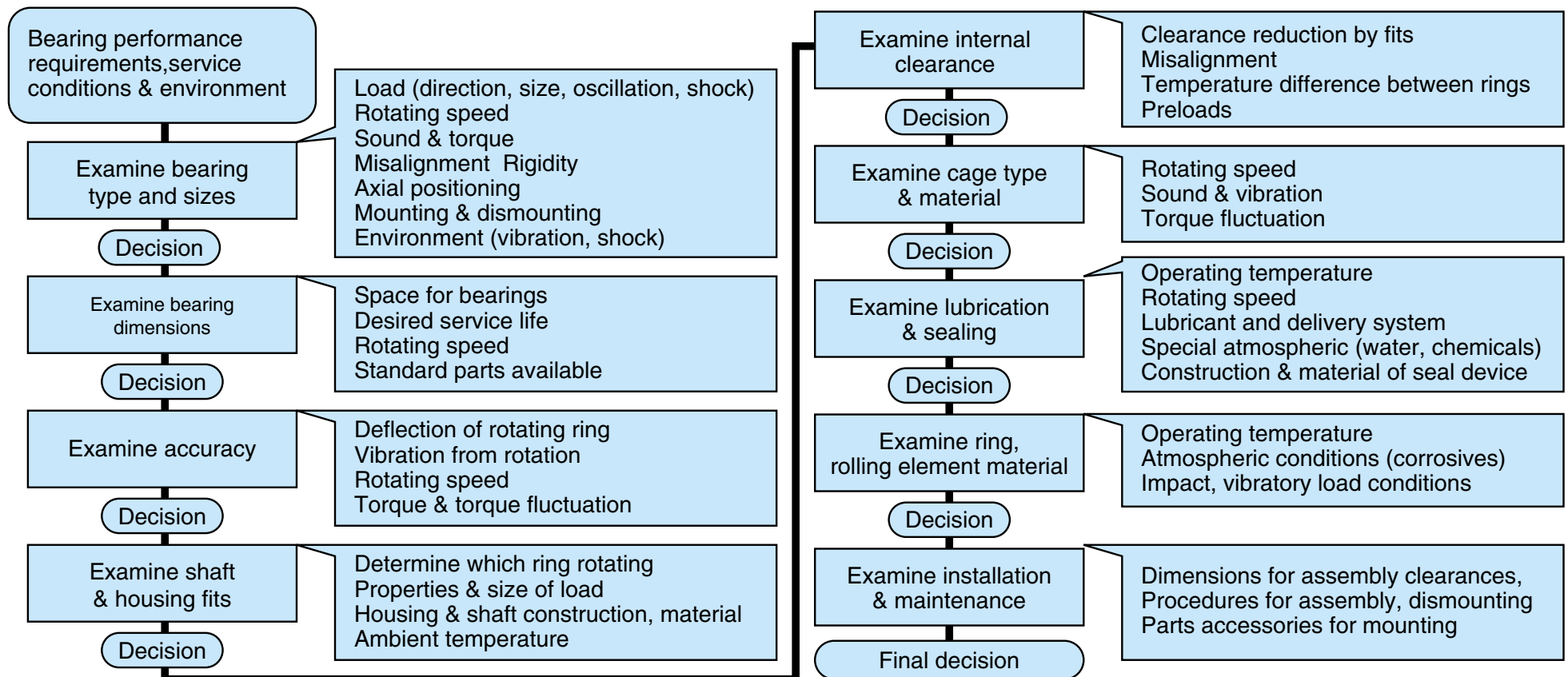
2.1.8 Bearing Environment

2. Selection of Rolling Contact Bearings

Rolling contact bearings are important, often critical, components of machinery. To meet the demands of a large variety of applications, rolling contact bearings are manufactured in a wide variety of types, sizes, and configurations. While machine performance and service life depend on which bearings are selected, it is often difficult to select the optimal bearing from among the many available variations.

While there is no "best" procedure for selecting the optimal bearing, Figure 2.1 provides an example of a procedure based on the establishment of priorities for the required bearing characteristics.

Fig. 2.1 Bearing Selection Procedure



2.1 Bearing Type Selection Considerations

2.1.1 Load

Bearing types are selected according to the types of load (radial, axial, moment) and the magnitude of these loads on the bearing. Table 2.1 outlines the types of load and applicable bearing types. In bearings of identical dimensional series, a roller bearing will have a greater load rating capacity than a ball bearing.

Table 2.1 Applicable Bearings vs Load Type

| Load type Bearing type | Radial | | | | | | |
|---------------------------------------|--------|---|---|---|---|---|---|
| | Axial | | | | | | |
| | Moment | | | | | | |
| Ball bearings: Single-row Deep Groove | | ○ | △ | ○ | ○ | △ | ○ |
| Single-row Angular Contact | | | ○ | ○ | | | |
| Paired Angular Contact | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Double-row Angular Contact | ○ | △ | ○ | ○ | △ | ○ | |
| Roller bearings: Cylindrical | ○ | | △ | | | | |
| Single-row Tapered | | ○ | ○ | | | | |
| Paired Tapered | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Multi-row Tapered | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Spherical radial | ○ | | △ | | | | |
| Spherical thrust | | ○ | | | | △ | |

Remarks:○ Bearing type can meet the load type.
△ Bearing can meet the load type conditionally. (Contact NACHI for more information.)

2.1.2 Rotating Speed



Limiting speed of bearings is determined by bearing type, bearing dimensions, accuracy of work, construction of cages, load, lubricating system, and seal type and design. The bearing dimension tables show the rotating speed limits of standard rolling contact bearings as a criterion of bearing type selection. Bearings used at high rotating speeds should generally have high accuracy. In applications over the limiting speed, please consult NACHI for assistance.

2.1.3 Noise and Torque

All NACHI rolling contact bearings are designed and manufactured to operate with low noise and torque levels. Of the many types of ball and roller bearings, single-row deep-groove ball bearings will tend to operate with the lowest noise and torque levels.

2.1.4 Alignment

If the accuracy of alignment of the shaft and bearing housing is poor or the shaft is deflected due to load, the inner and outer rings of the bearings will be misaligned. Non-self-aligning rolling contact bearings are capable of tolerating only that amount of misalignment which can be handled by the assembled internal clearance. If inclination is expected to occur between the inner and outer rings, the choice of bearings should be from types such as thrust ball bearings with self-aligning washer, Self-aligning ball bearings, or Spherical roller bearings. The permissible angle of inclination of bearings differs by bearing type, internal clearance, and load conditions. Table 2.2 outlines the permissible angles of mis-alignment by bearing type. Internal bearing damage can occur if misalignment in the bearing is greater than the permissible angle. Please contact NACHI for assistance.

Table 2.2 Permissible Misalignment of Bearing Types

| Bearing type | Permissible angle of misalignment |
|--|-----------------------------------|
| Single-row deep groove ball bearings | 1/300 |
| Single-row angular contact ball bearings | 1/1000 |
| Cylindrical roller bearings | 1/1000 |
| Tapered roller bearings | 1/800 |
| Thrust ball bearings | 1/2000 |



2.1.5 Rigidity



When rolling contact bearings are loaded, the contact section between the bearing rings and rolling elements will elastically deform. The magnitude of this elastic deformation will differ depending on load, bearing type, and bearing dimensions.

If bearings of identical dimension series are compared, roller bearings will have a much higher level of rigidity than ball bearings, and if bearings of identical type are compared, bearings of larger dimensions will have higher rigidity than those of smaller dimensions. (Pre-loading combinations of units of two or more bearings will increase rigidity.)

2.1.6 Mounting, Dismounting

Rolling contact bearings can be divided into bearing types classed as separable or non-separable. Mounting and dismounting is facilitated if a separable bearing type is used.

Use of tapered-bore bearings and sleeves or hydraulic assist also makes bearing mounting and dismounting easier.

There is a possibility that noise and shortening of life occur due to poor mounting of bearings. When bearings are mounted, the following items should be noticed.

- Keep the bearings clean
- Rust prevention
- Protect bearings from external damage

2.1.7 Axial Location; Bearing Arrangement

Generally the shaft is supported by two units (or the equivalent to two units) of bearings. Generally, one of the bearings acts to hold (or fix) the axial position of the assembly and the other bearing acts to allow linear expansion.

The fixed side bearings must be firmly seated against both housing and shaft.

Table 2.3 shows representative examples of actual bearing arrangements according to service conditions.

Table 2.3 Examples of Bearing Arrangements

2.1.8 Bearing Environment

If there is a comparatively large source of vibration near the bearing mount, or if the bearing is to handle impact loading, the use of Spherical roller bearings or Spherical roller thrust bearings is recommended.

Standard bearings will be not suitable to be operated under severe condition (load, rotating speed, operating temperature, lubrication amount, vibrating environment).

Table 2.3 Examples of Bearing Arrangements

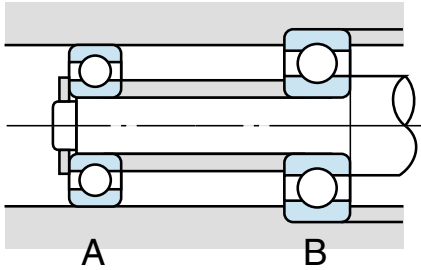
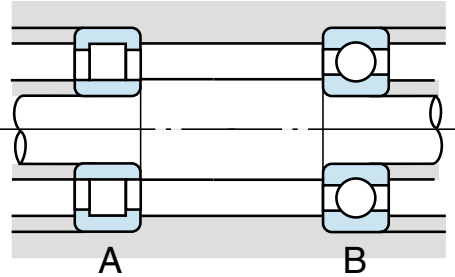
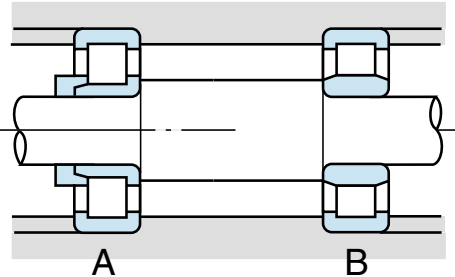
| No. | Mounting examples | Applicable bearings | | Application & design considerations |
|-----|--|---|---|---|
| | | A | B | |
| ① |  | Deep Groove Ball | Deep Groove Ball | <p>Popular mounting. Ball bearings can support light-to-moderate axial loads.</p> <p>Spherical roller bearings are good for heavy radial loads and light axial loads.</p> <p>One of the bearing outer ring must be free to move axially to handle thermal expansion.</p> |
| | | Spherical Roller | Spherical Roller | |
| ② |  | Cylindrical Roller; N, NU configuration | Deep Groove Ball | <p>Popular mounting. Axial expansion of shaft taken by inner ring of Cylindrical roller bearing.</p> <p>Use a Cylindrical roller bearing for the heavy load position.</p> <p>The Deep groove ball bearing carries the axial load.</p> <p>Not recommended for handling angular misalignment.</p> |
| ③ |  | Cylindrical Roller; NH configuration | Cylindrical Roller; N, NU configuration | <p>Easy mounting arrangement where interference fit is required for both inner and outer rings.</p> <p>Not recommended for handling angular misalignment.</p> <p>Thermal expansion taken internally.</p> <p>Suitable for light axial load applications.</p> |



Table 2.3 Examples of Bearing Arrangements



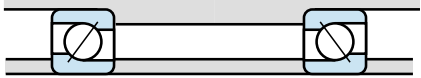
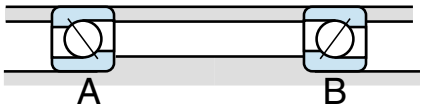
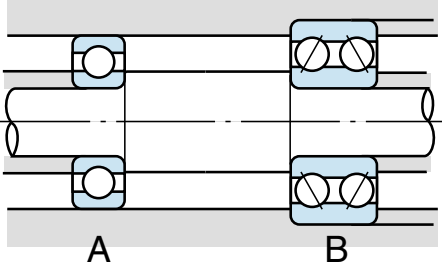
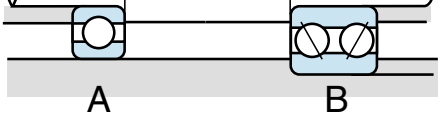
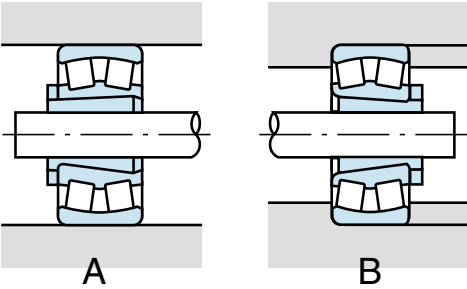
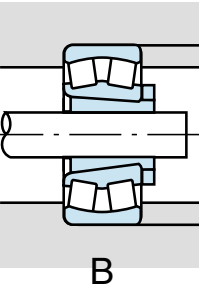
| No. | Mounting examples | Applicable bearings | | Application & design considerations |
|-----|--|---|---------------------------------|---|
| | | A | B | |
| ④ |  | Deep Groove Ball | Deep Groove Ball | <p>Preloading allows good rigidity.</p> <p>Care must be taken in design of preload amount.</p> <p>Angular contact ball bearings are better than Deep groove ball bearings for moderate axial loads and preload.</p> |
| |  | Angular Contact Ball | Angular Contact Ball | |
| ⑤ |  | Deep Groove Ball | Double-Row Angular Contact Ball | <p>Good for moderate, bidirectional axial loads.</p> <p>When using Deep groove ball bearings in position <A>, and double-row bearings in position , the outer ring of one of the parts must be free to move axially for thermal expansion. If an N, or NU configuration bearing is used in position <A>, thermal expansion can be taken internally and a much greater radial load can be taken on side <A>.</p> |
| |  | Cylindrical Roller; N, NU configuration | Double-Row Angular Contact Ball | |
| ⑥ |  | Self-Aligning Ball | Self-Aligning Ball | <p>Good for small angular misalignment.</p> <p>Use with adapter for long shafts which eliminates costly, shaft-weakening shaft shoulders and threading.</p> <p>Outer ring of one bearing must be free to move to compensate for thermal expansion or mounting error.</p> <p>Axial load capacity is light for ball bearing and moderate for Spherical roller bearing.</p> <p>Check with NACHI if F_a/F_r ratio is greater than 0.6 for Spherical roller bearings.</p> |
| |  | Spherical Roller | Spherical Roller | |



Table 2.3 Examples of Bearing Arrangements



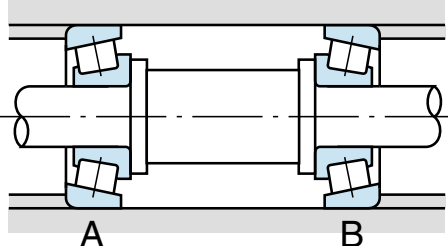
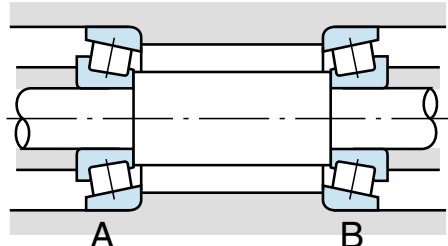
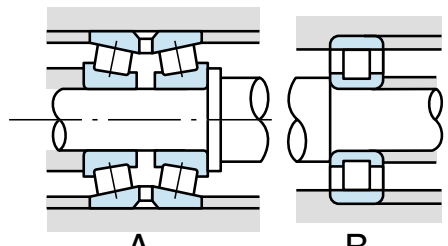
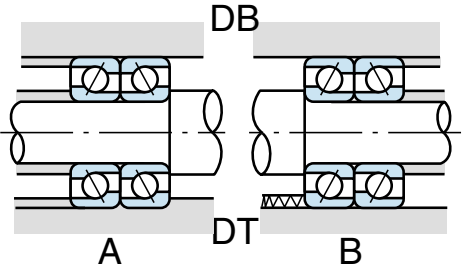
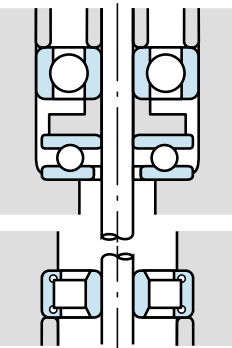
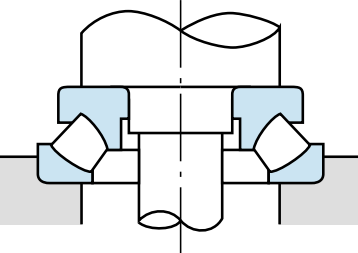
| No. | Mounting examples | Applicable bearings | | Application & design considerations |
|-----|--|----------------------|---|---|
| | | A | B | |
| ⑦ |  | Tapered Roller | Tapered Roller | General application, direct mounting ("face-to-face"). Good for heavy axial loads. Clearance easily adjustable. Assembly is convenient where one or both inner ring are interference-fit to shaft. |
| ⑧ |  | Tapered Roller | Tapered Roller | Indirect mounting ("back-to-back"). Good shaft rigidity. Good for moment loading. Good for large axial and radial loads. Use care in establishing preload or clearance. |
| | | Angular Contact Ball | Angular Contact Ball | |
| ⑨ |  | Tapered Roller | Cylindrical Roller; N, NU configuration | Good for heavy loads and radial and axial rigidity. Clearance on side <A> easy to adjust. Thermal expansion can be taken by Cylindrical roller bearing. Alignment must be accurate. |



Table 2.3 Examples of Bearing Arrangements



| No. | Mounting examples | Applicable bearings | | Application & design considerations |
|-----|--|----------------------------------|-----------------------------|---|
| | | A | B | |
| ⑩ |  | Paired Angular Contact Ball | Paired Angular Contact Ball | <p>Good for very accurate rotation and light loads.</p> <p>Two bearings are used in pairs with preload.</p> <p>Good shaft rigidity.</p> <p>Alignment must be accurate.</p> <p>Mounting example above the shaft center line is DB ("back-to-back") mount; below line is DT ("tandem") mount.</p> |
| ⑪ |  | Deep Groove Ball & Thrust Ball | Cylindrical Roller | <p>Thrust bearing should be close to radial bearing to reduce shaft deflection.</p> <p>When using Thrust ball bearing on a horizontal shaft, it is important to keep a load on the thrust bearing at all times.</p> <p>If there is shaft deflection at the thrust bearing location, use of a Thrust ball bearing with aligning washer arrangement is recommended.</p> |
| | | Cylindrical Roller & Thrust Ball | Cylindrical Roller | |
| ⑫ |  | Spherical Roller Thrust | Various Radial Types | <p>Spherical roller thrust bearings are applicable if radial load is 55% or less than that of axial load.</p> <p>Suitable for heavy axial load.</p> <p>Good where there is shaft deflection and housing accuracy error.</p> <p>Axial load must be continuous.</p> <p>Used in conjunction with radial bearings at low-to-moderate speed.</p> |



3. Load Capacity and Life of Bearings

3.1 Basic Dynamic Load Rating and Rating Life

3.2 Basic Rating Life Calculation Guide

3.3 Rating Life and Operating Temperature

3.4 Calculation of Bearings Load

3.5 Dynamic Equivalent Load

3.6 Basic Static Load Rating and Static Equivalent Load

3.7 Axial Load Capacity of Cylindrical Roller Bearings

3. Load Capacity and Life of Rolling Contact Bearings

3.1 Basic Dynamic Load Rating and Rating Life

Although requirements of rolling contact bearings vary somewhat with the individual application the principal requirements are:

- High load capabilities
- Smooth and quiet rotation
- High rigidity
- Low friction
- High accuracy
- Reliability

The reliability or durability requirement sets the time frame over which all other requirements are to be maintained. The reliability requirement (life in the broad sense) includes grease and acoustic life, as well as fatigue life. Reliability is reduced by various types of damage and degradation.

Improper handling, mounting, lubrication, and fits are the major causes of problems leading to lower-than-calculated bearing life. Regardless of how well they are maintained or mounted or handled, dynamic bearings will eventually fail from rolling fatigue generated by the repetitive stress of bearing load.

The service life of a bearing can be examined from two perspectives: 1) If, from inspection, a trace of fatigue becomes noticeable, the bearing should be deemed not suitable for further use; or 2) length of bearing life in hours or revolutions can be predefined as a limit beyond which the bearing is automatically replaced.

Since calculated fatigue life will vary with the size and type of bearings used under identical load conditions, great care must be taken in the analysis of the load conditions and the final choice of bearings to satisfy the application requirements.

Fatigue lives of individual bearing are dispersed. When a group of identical bearings operate under the same conditions, the statistical phenomenon of dispersion will appear. Use of average life is not an adequate criterion for selecting rolling contact bearings. Instead, it is more appropriate to consider a limit (hours or numbers of revolutions) which a large percentage of the operating bearings can attain.

Accordingly, the rating life and basic dynamic load rating C_r or C_a are defined using the following definition:

- Basic rating life is defined as the total number of revolutions (or total operating hours at some given constant speed) that 90% of a group of identical bearings operated individually under equal conditions can complete without suffering material damage from rolling fatigue.
- Basic dynamic load rating (C_r or C_a) is defined as a bearing load of constant direction and size that ends the bearing life after a million revolutions.



[Continue→]

Constant-direction radial or thrust loads (for radial and thrust bearings, respectively) are used as the basis of the ratings. The rating life of bearings is calculated by formulas (3.1) and (3.2):



$$L = \left(\frac{C}{P}\right)^p \quad \bullet \bullet \bullet \bullet \bullet (3.1)$$

$$L_h = \left(\frac{C}{P}\right)^p \cdot \frac{10^6}{60 n} \quad \bullet \bullet \bullet \bullet \bullet (3.2)$$

The relationship of f_h , the bearing life factor and f_n , the speed factor, is outlined in Table 3.1. Formula (3.3) may be used to determine the basic dynamic load rating, C , of bearings given the bearing equivalent load, P , and the operating speed, n , in revolutions-per-minute. The lives of automobile wheel bearings may be defined in kilometers using the formula (3.4). [Table 3.2](#) shows values for the life factor, f_h , by application and machine type. If a bearing is used with vibrating or impact loads or low speed including no rotation, additional study with basic static load rating is required.

$$C = \frac{P}{f_n} \cdot \left(\frac{L_h}{500}\right)^{1/p} \quad \bullet \bullet \bullet \bullet \bullet (3.3)$$

$$L_s = \frac{\pi \cdot D}{1000} \cdot L \quad \bullet \bullet \bullet \bullet \bullet (3.4)$$

- Where:
- L : Basic rating life (10^6 rev.)
 - L_h : Basic rating life in hours
 - C : Basic dynamic load rating (N). (C_r for radial bearings and C_a for thrust bearings)
 - P : Bearing load (dynamic equivalent load) (N) P_r for radial, and, P_a for thrust bearings
 - p : 3 for ball, $10/3$ for roller bearings
 - n : Rotating speed (rpm)

Table 3.1 Bearing Basic Rating Life; Life and Speed Factors

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

- Where:
- L_s : Kilometer traveled (10^6 km)
 - D : Outside diameter of wheel (m)
 - L : Life in revolutions

[Table 3.2 Life Factors \(\$f_h\$ \)](#)



Table 3.2 Life Factors (fh)

| Application conditions | Application example | Life Factor (fh) |
|----------------------------------|--|------------------|
| Infrequent use | Hinges | to 1.5 |
| Short period or Intermittent use | Hand tools Agricultural equipment Household apparatus Casting plant cranes | 2 ~ 3 |
| Intermittent, critical use | Power plant auxiliary machines Assembly line conveyers General crane applications Motors for home air conditioning | 3 ~ 4 |
| 8 hour per day, intermittent | General gearing applications General industrial motors | 3 ~ 5 |
| 8 hour per day, continuous | Cranes in continuous use Air blowers Mechanical power transmission General industrial machinery Industrial wood-working machines | 4 ~ 5 |
| 24 hour per day, continuous | Compressors Mine hoists Marine propeller shafts Rolling machine tables | 5 ~ 8 |
| 24 hour per, critical | Paper manufacturing Power plants Water supply equipment Mine water pumps, air blowers | 6-up |

3.2 Basic Rating Life Calculation Guide

- Determine the bearing life normal to the application by using [Table 3.2](#) to define the life factor, f_h .
- Use rating life charts (nomograms) to calculate life. The nomogram for ball bearings is shown in [Fig. 3.4](#). The nomogram for roller bearings is shown in [Fig. 3.5](#). These nomograms are based on formulas (3.1) and (3.2).
- Where operating temperatures are to be in excess of 150°C, a correction factor must be applied to the bearing basic dynamic load rating. (See Item 3.3.1).
- If the bearings are to operate with vibration or impact loading, or where a bearing mounting or manufacturing error exists, the actual load may be greater than the calculated load. In this case, the calculated load must be multiplied by a safety coefficient to obtain an approximation of the actual load. For safety coefficients in actual application, refer to the machine and drive factors. (See Item 3.4.1 and 3.4.2)
- Bearings do not always operate under a constant load. When the bearing operates with a fluctuation load, the load must be converted to a constant size reflecting the effect of the fluctuating load. Conversion may be done using weighted average mean loading (See Item 3.4.4).
- By definition, bearing load P_r (net radial load) or P_a (net axial load) is a load with constant direction and size. When a composite load of radial and axial loads occurs on a radial bearing, these loads must be converted to a radial load reflecting the effect of the composite load. This effective load is called the DYNAMIC EQUIVALENT LOAD. (See Item 3.5).
- When calculating bearing load using the loads on a position on the shaft, it is necessary to calculate center distance between the load application point of the bearings. Many bearing types have load center points at the center line of the width as shown in Fig. 3.1. Single-row Angular Contact ball bearings and single-row Tapered roller bearings, have load center points off-center to the center line of the bearing width (See Fig. 3.2 and 3.3 respectively). Refer to the dimension tables for the value of the off-set.
- The axial load limit for Cylindrical roller bearings is a function of the lubrication conditions and speed of rotation. This limit differs from a rating load as determined by fatigue life. (See Item 3.7).

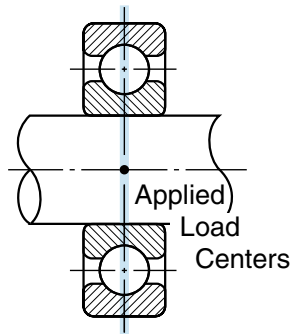


Fig 3.1

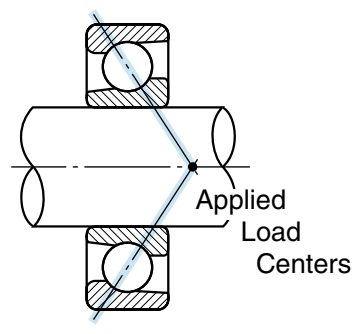


Fig 3.2

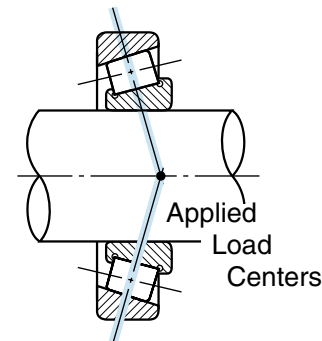


Fig 3.3

[Continue→]

Calculation example : 1

Suppose that an application has selection parameters as follows :

Bore : 50 mm or smaller

Outside diameter : 100 mm or smaller

Width : 20 mm or smaller

Radial load (Fr) : 4000 N (Newtons)

Rotating speed (n) : 1800rpm

Life factor (fh) : 2 or greater

Bearing type : Single-row deep groove ball bearing

From Table 3.1 the speed factor, fn is obtained as follows:

$$f_n = \left(\frac{10^6}{500 \times 60 \times 1800} \right)^{1/3} = 0.265$$

From Table 3.1,

$$C_r = \frac{f_h \cdot P}{f_n} = \frac{2 \times 4000}{0.265} = 30188\text{N}$$

Bearings having the required basic dynamic load rating are selected from the bearing dimension table(s). Of the two sizes meeting the load and diameter constraints, only bearing 6209 will satisfy the width constraint. Given the above parameters, bearing part 6209 would be the selection.

| Bearing No. | Bore Dia. (mm) | Outside Dia. (mm) | Width (mm) | Basic Dynamic Load Rating (N) |
|-------------|----------------|-------------------|------------|-------------------------------|
| 6209 | 45 | 85 | 19 | 32500 |
| 6307 | 35 | 80 | 21 | 33500 |

Ball Bearing

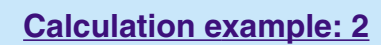


Fig 3.5
Roller Bearing
Reliability Nomogram

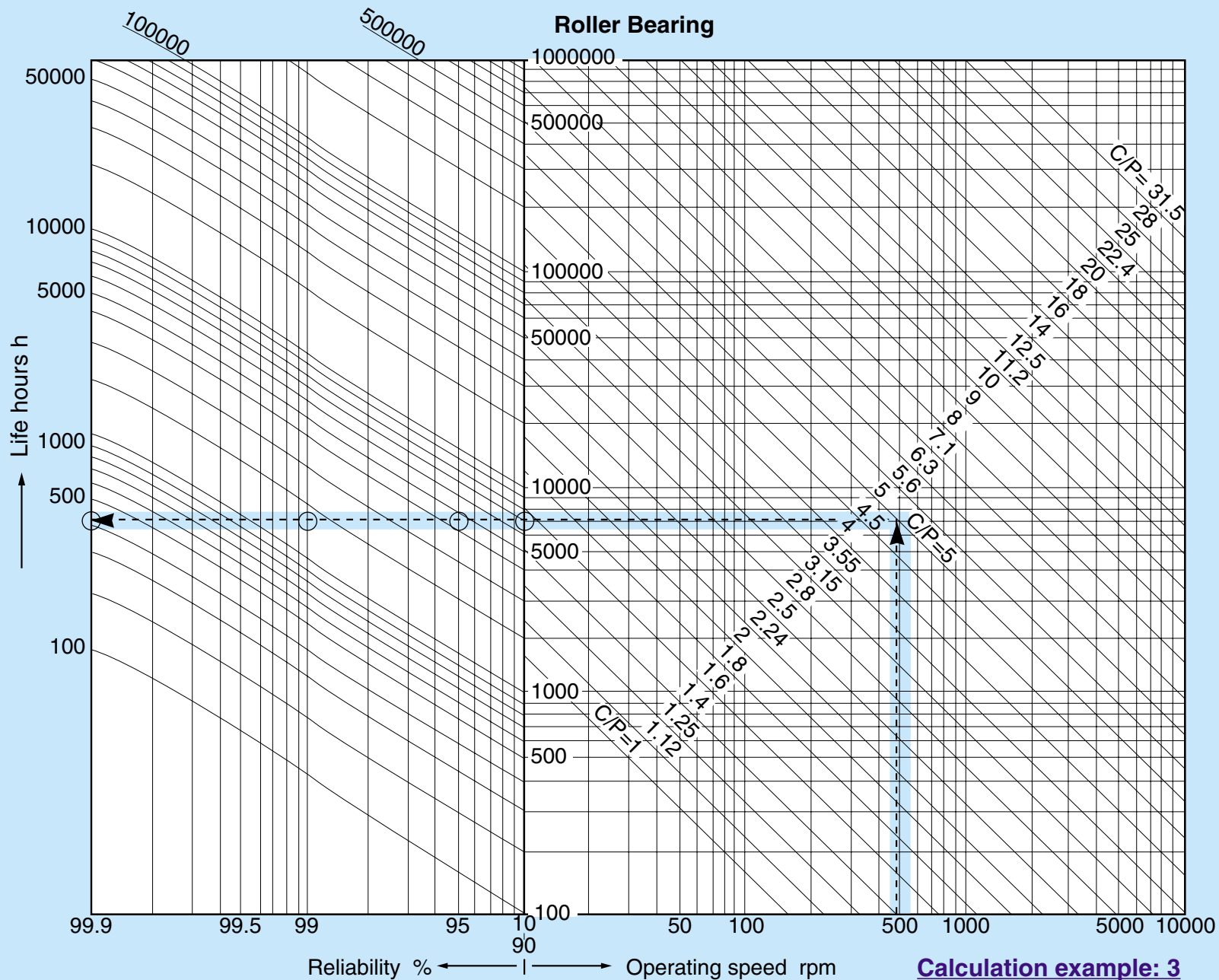


Fig 3.4 Ball Bearing Reliability Nomogram

Calculation example: 2

Bearing Number 6012 is loaded with an dynamic equivalent radial load $P_r = 2950\text{N}$.

Object is to obtain the life at various levels of reliability when the bearing is rotated at $n = 800\text{ rpm}$.

The basic dynamic load rating C_r is taken from the dimension table.

$$C_r = 29400\text{N}$$

$$C_r/P_r = 10$$

(*) For reliabilities, see Item 3. 3. 2.

By tracing the dotted lines, rating lives are obtained as follows:

| Reliability (*) | Life hours |
|-------------------|------------|
| 90% | 20000 |
| 95% | 15000 |
| 99% | 4500 |
| 99.9% | 1200 |

Fig 3.5 Roller Bearing Reliability Nomogram

Calculation example: 3

Bearing Number 22222EX is loaded with dynamic equivalent radial load $P_r = 98000\text{N}$.

Object is to obtain the life at various levels of reliability when the bearing is rotated at $n = 500\text{ rpm}$.

The basic dynamic load rating C_r is taken from the dimension table.

$$C_r = 490000\text{N}$$

$$C_r/P_r = 5$$

By tracing the dotted lines, rating lives are obtained as follows:

| Reliability (*) | Life hours |
|-------------------|------------|
| 90% | 7000 |
| 95% | 4400 |
| 99% | 1500 |
| 99.9% | 400 |

(*) For reliabilities, see Item 3. 3. 2.

3.3 Rating Life and Operating Temperature



3.3.1 Temperature-Related Decrease in Basic Dynamic Load Rating

Bearing ring diameters grow slightly with an increase in temperature. If the operating temperature does not exceed about 120°C , the bearing rings will return to their original dimensions at normal temperature. If the operating temperature exceeds this level (approximately 120°C), the bearing rings and rolling elements can undergo small, permanent changes in size. To prevent these permanent changes in size, special heat-stabilization treatment can be used (see Table 3.3).

Table 3.3 Heat - Stabilization Treatment

| Max. Operating temperature | Heat stabilization treatment symbol |
|----------------------------|-------------------------------------|
| ~ 150°C | S26 |
| ~ 200°C | S28 |

The S26 heat-treated bearings will resist dimensional change through a maximum temperature of 150°C. Bearings with the S26 heat-treated steel will suffer decreases to their rating life and will have dimensional changes if they are used at temperatures in excess of 150°C.

The S28 heat-treated bearings will resist dimensional change and have a temperature factor of 0.90 through a maximum temperature of 200°C.

Bearings with the S28 heat-treated steel will suffer further decreases to their rating life and will have dimensional changes if they are used at temperatures in excess of 200°C.

Operation at temperatures exceed the limit of the heat-stabilization should be avoided to prevent bad effects of these dimensional changes.



If bearings are operated at temperatures exceeding the limit of the heat-stabilization, hardness of the bearing steel will be reduced. In calculating the life of such bearings, the basic dynamic load rating must be multiplied by the temperature factor as shown in Table 3.4. The temperature factor for standard bearings operating at a temperature under 120°C is 1 and these bearings will show no dimensional change. Standard bearings run at an operating temperature exceeding 120°C, will experience dimensional changes and are subject to the basic dynamic load rating decreases as shown in Table 3.4.

Table 3.4 Temperature Factor

| | | | |
|---------------------|---------|-------|-------|
| Bearing Temperature | ~ 150°C | 175°C | 200°C |
| Temperature Factor | 1 | 0.95 | 0.90 |

3.3.2 Life Calculation Factors

Rating Life Formula, $L=(C/P)^p$ (3.1), is used when applying rolling contact bearings for normal use.

To provide for utilization of lubrication theory, and advances in bearing material and bearing manufacturing technology, the ISO and JIS have adopted the following life calculation formula.

$$L_{na} = a_1 \cdot a_2 \cdot a_3 \cdot \left(\frac{C}{P}\right)^p \dots\dots\dots (3.5)$$

where:

- L_{na} : Adjusted rating life (10⁶ rev.)
- a_1 : Reliability factor
- a_2 : Material factor
- a_3 : Application conditions factor

Formula (3.5) is applicable only when all bearing loads are considered and operating conditions are clearly defined.

Generally, reliability of 90% is used, and material and operating conditions may be considered as $a_1, a_2, a_3=1$, coinciding with formula (3.1).

1) Reliability Factor, a_1

Reliability Factor, a_1 , becomes 1 if 90% of a group of identical bearings operated individually under the same conditions can complete the calculated life without exhibiting material damage from rolling fatigue. Reliability is then set as 90 %, and for reliability over 90%; a_1 takes a value from Table 3.5.

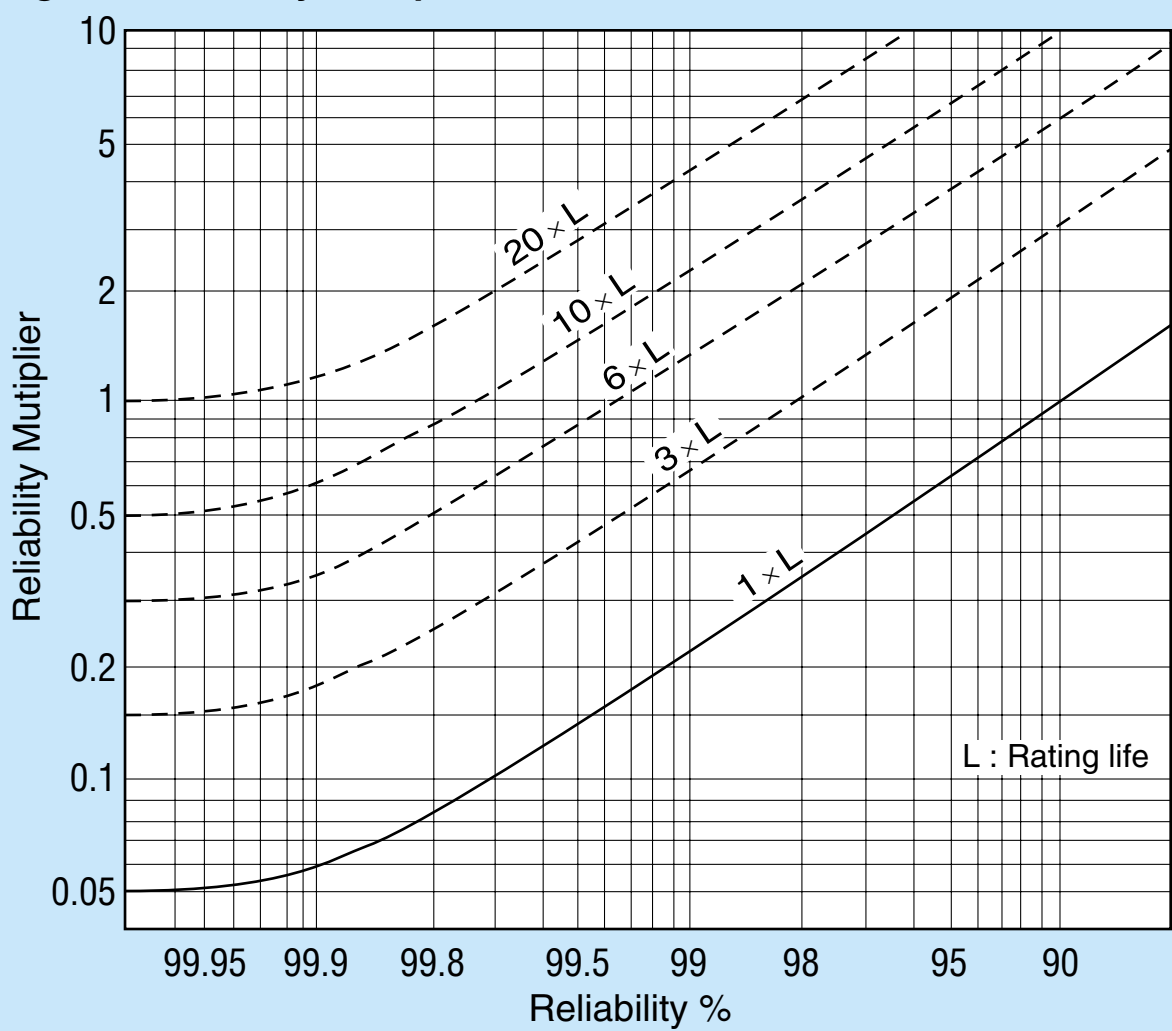
As observed from [Table 3.5](#), the calculated bearing life decreases in proportion to a higher level of bearing reliabilities.

[Fig. 3.6](#) shows the improved reliabilities when bearings having rating lives of 3, 6, 10 and 20 times are used in comparison with the 90% reliability (life-multiplying factor being 1) of a bearing having a given rating life.

Table 3.5 Reliability Factor a_1

| Reliability % | 99 | 98 | 97 | 96 | 95 | 90 |
|---------------|------|------|------|------|------|----|
| a_1 factor | 0.21 | 0.33 | 0.44 | 0.53 | 0.62 | 1 |

Fig 3.6 Reliability Multiplier



Calculation example: 4

Bearing Number 6209 is used to support a radial load of 3160N. Object is to define the life and select a bearing which will have a reliability of 99.4%.

The life corresponding to the reliability of 90% is obtained as follows by reading the basic dynamic load rating, $C_r=32500\text{N}$ from the dimension table and using formula (3.1):

$$\left(\frac{32500}{3160}\right)^3 \times 10^6 = 1088 \times 10^6 \text{ rev.}$$

Reading Fig. 3.6, it can be seen that a bearing having a life -multiplying factor of 6 is required to attain 99.4% reliability. Applying this multiplier to the basic dynamic load rating, C_r as obtained from formula (3.1), will calculate as:

$$\left(\frac{C_r}{3160}\right)^3 \times 10^6 = 6 \times 1088 \times 10^6 \text{ rev.}$$

From the above equation, obtain;

$$\begin{aligned} C_r &= (6)^{1/3} \times 32500 = 1.817 \times 32500 \\ &= 59000\text{N} \end{aligned}$$

The bearing meeting this basic dynamic load rating (in the same diameter series) is bearing number 6214.



[Continue→]

2) Material factor, a_2

Material factor, a_2 , is the adjustment factor applied as an increase to rating life for type and quality of material, special manufacturing process and/or special design.

The basic dynamic load rating, C_r (or C_a), listed in the bearing dimension tables reflects both the use of vacuum-degassed, high-carbon chrome bearing steel for all NACHI rolling contact bearings as well as improvements in manufacturing technology. The a_2 -factor has a base value of 1 for NACHI standard parts.

Unless specialty steels are utilized, a_2 is defined as 1 when calculating the life using the formula (3.5).

3) Application condition factor, a_3

The application condition factor, a_3 , is used to consider bearing load conditions, lubricating conditions, and temperature conditions.

Factor a_3 is set as 1 if the rolling elements and raceway surfaces are separated (good lubricating condition). When lubricating conditions are poor (as in the following cases), a_3 is less than 1:

- When the operating speed is $< d_m \cdot n$ of 10,000. (Where $d_m \cdot n$ = rolling element pitch diameter in millimeters times the speed in revolutions-per-minute).
- When lubricant will tend to deteriorate rapidly.

At present, it is difficult to quantify the application condition factor because of the many variables involved.

Because factors a_2 and a_3 have interactive effects on each other, these two factors are treated as one value (a_2) (a_3). When lubrication and application conditions are good, the value (a_2) (a_3) can be set as equal to 1.

In case of poor lubrication such as when lubricant viscosity is considerably low, please consult NACHI.



3.4 Calculation of Bearing Load



Generally, the load that is applied to the bearings is composed of loads generated by machine operation, drive components, and dead weight of the shaft and components mounted to and on the shaft. These loads can be precisely calculated. The above loads are usually accompanied by vibration and impact. With the exception of very special cases, it is impractical to calculate and add the specific effects of vibration and impact loading on each component in a machine. To facilitate the calculation and analysis of loading in a machine system, loading factors (based on empirical experience) have been developed as multipliers to the driving and static loads.

$$F = f_s \cdot F_c \quad \dots\dots\dots (3.6)$$

where:

F : Bearing load (N)

f_s : Machine factor ([Table 3.6](#))

F_c : Calculated load (N)

When a load fluctuates in size, an average load must be calculated which reflects the effects of the fluctuating load.

When a composite load of radial and axial load occurs on a radial bearing, the loads must be converted to an effective radial load by use of the dynamic equivalent load formula for the specific bearing type. This value, P , is used in the basic rating life formula (3.1).



Table 3.6 Machine Factors, (f_s)

| Type of Machine | f_s |
|---|-----------|
| Smooth running machinery (no impact) ; motors, conveyors, turbo compressor, paper manufacturing machinery | 1 ~ 1.2 |
| Machine with low impact; reciprocating pumps, internal combustion engine, hoists, cranes | 1.2 ~ 1.5 |
| Machines with high impact; shears, crushers, rolling mill equipment | 1.5 ~ 3.0 |

Table 3.7 Belt Drive Factors, (f_1)

| Type of drive | f_1 |
|---|------------|
| Flat leather belt (with tension pulley) | 1.75 ~ 2.5 |
| Flat leather belt (without tension pulley) Silk Rubber Balata | 2.25 ~ 3.5 |
| V-belt | 1.5 ~ 2 |
| Steel strip belt | 4 ~ 6 |
| Cotton belt / Hemp belt | 2 ~ 6 |

Notes : 1. For low speed, use top value

Table 3.8 Gear Precisiion Factors, (f_z)

| Type of gear | f_z |
|---|-----------|
| Precision (Pitch and form errors $\leq 0.02\text{mm}$) | 1 ~ 1.1 |
| Normal (Pitch and form errors $0.02 \sim 0.1\text{mm}$) | 1.1 ~ 1.3 |

3.4.1 Belt Drives

Transferring of power through belt drives requires on initial belt tension. Radial load, K, that occurs from this tension can be calculated as follows:

$$M = 955000 \cdot \frac{H}{n} \quad \dots\dots\dots (3.7)$$

$$K_t = \frac{M}{r} \quad \dots\dots\dots (3.8)$$

where:

M : Rotating moment of pulley (N • cm)

K_t : Effective transfer power of belt (N)
(tension side minus slack side)

H : Transfer power (kW)

n : Rotating speed of pulley (rpm)

r : Radius of pulley (cm)

Load that works on the shaft through the pulley is calculated by multiplying the effective transfer power, K_t, by the belt drive factors, f₁, from Table 3.7.

Generally,

$$K = f_1 \cdot K_t \quad \dots\dots\dots (3.9)$$

where:

K : Radial load (N) applied to the pulley transferred by the belt

f₁ : Belt drive factor ([Table 3.7](#))

3.4.2 Gear Drives

Shaft load from gear drives are calculated using the transfer power and type of gear.

Helical, bevel and worm gears transmit radial loads and create an axial load component, while spur gears transmit only radial loads.

Gear load formulas described below refer to spur gears.

$$M = 955000 \cdot \frac{H}{n} \quad \dots\dots\dots (3.10)$$

$$K_t = \frac{M}{r} \quad \dots\dots\dots (3.11)$$

$$K_s = K_t \cdot \tan \alpha \quad \dots\dots\dots (3.12)$$

$$K_g = \sqrt{K_t^2 + K_s^2} = K_t \cdot \sec \alpha \quad \dots\dots (3.13)$$

where:

M : Rotating gear moment (N • cm)

K_t : Tangential component of force (N)

K_s : Radial component of force (N)

K_g : Total gear load (N)

H : Transfer power (kW)

n : Rotating speed (rpm)

r : Drive gear pitch radius (cm)

α : Pressure angle of gear (°)

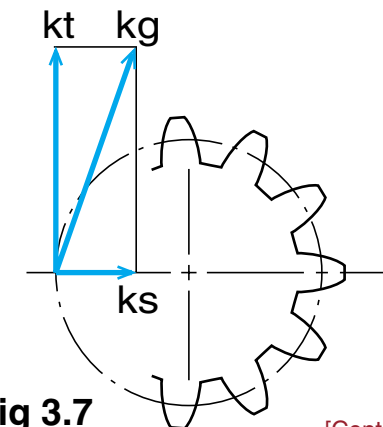


Fig 3.7

[Continue→]

K_g , the total theoretical gear load, must be multiplied by both the gear precision factor and the machine factor (the latter of which takes into account impact and other forces dependent on machinery type).

$$K = f_z \cdot f_s \cdot K_g \quad \dots\dots\dots (3.14)$$

where:

K : Gear load transmitted to shaft (N)

f_z : Gear precision factor ([Table 3.8](#))

f_s : Machine factor ([Table 3.6](#))

3.4.3 Load Distribution to Bearings

Load applied to a point on the shaft is distributed to the bearings supporting the shaft.

Reference Fig. 3.8,

$$F_{rI} = \frac{\ell + m}{\ell} K + \frac{x}{x + y} W \quad \dots\dots\dots (3.15)$$

$$F_{rII} = \frac{m}{\ell} K - \frac{y}{x + y} W \quad \dots\dots\dots (3.16)$$

where:

F_{rI} : Load working on bearing I (N)

F_{rII} : Load working on bearing II (N)

K : Gear load transmitted to shaft (N)

W : Shaft Weight (N)

ℓ, m, x, y : Relative positions of the points of applied force

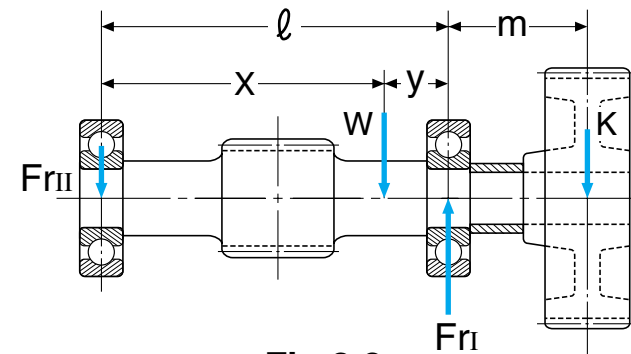


Fig 3.8

3.4.4 Averaging Fluctuating Loads

A large load will have an emphasized effect on bearing life even if it is applied only for a very short duration of the total life-span of the bearing.

When the size of bearing load fluctuates with a defined cycle, bearing life may be calculated by deriving an average load simulating the affects of the fluctuating load.

(1) Step Type Load Fluctuation

$$F_m = \sqrt[p]{\frac{F_1^p n_1 + F_2^p n_2 + \dots + F_n^p n_n}{n_1 + n_2 + \dots + n_n}} \quad \dots\dots\dots (3.17)$$

where:

F_m : Average of fluctuating load (N)

n_1 : Total number of revolutions at load F_1 (rev.)

n_2 : Total number of revolutions at load F_2 (rev.)

n_n : Total number of revolutions at load F_n (rev.)

p : 3 for ball; 10/3 for roller bearings

In formula (3.17), if rotating speed is constant, and $(n_1 + n_2 + \dots + n_n)$ is referenced as applied time, then n_1 , n_2 and n_n , can be replaced by time periods t_1 , t_2 , t_n respectively, in the formula.

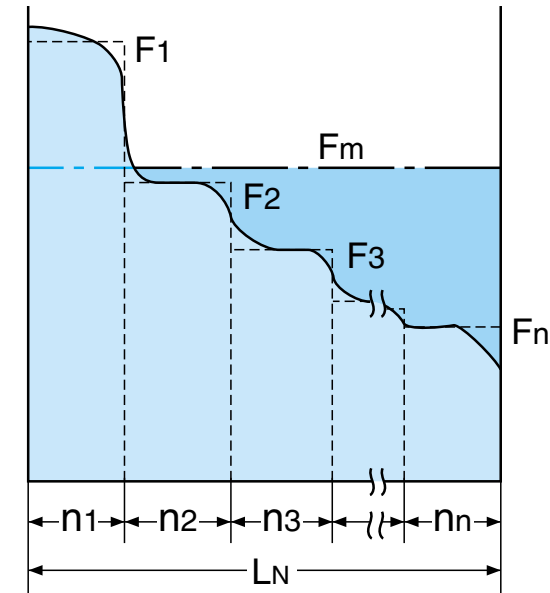


Fig 3.9

(2) Linear Load Fluctuation

When the load fluctuates almost linearly (see Fig. 3.10), the following formula is used to obtain the average load.

$$F_m \cong \frac{1}{3} F_{\min} + \frac{2}{3} F_{\max} \quad \dots\dots\dots (3.18)$$

where:

F_m : Average load (N)

F_{\min} : Minimum load (N)

F_{\max} : Maximum load (N)

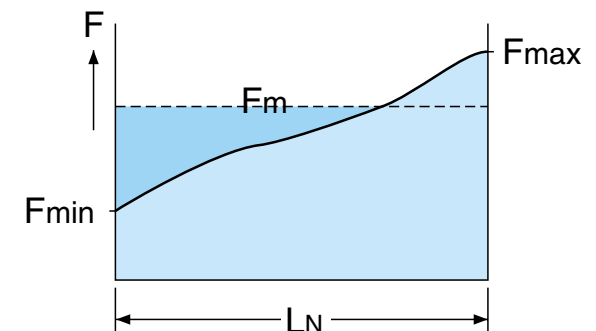


Fig 3.10

[Continue→]

(3) Dynamic plus static load fluctuation

Where load F_1 of a constant size and direction, is combined with a constantly revolving load F_2 caused by an unbalanced load on the bearing (see Fig. 3.11), the average load is calculated using formula 3.19.

$$F_m \cong A F_1 + F_2 \quad \bullet \bullet \bullet \bullet \bullet (3.19)$$

Value of A is taken from Fig. 3.12.

Calculation example: 5

A Single-row Deep-groove ball bearing is loaded with the fluctuating radial loads shown below.

Object: to obtain an average radial load on the bearing.

$F_1=100\text{N}$: 800 rpm for 6 sec

$F_2= 50\text{N}$: 1800 rpm for 20 sec

$F_3=200\text{N}$: 3600 rpm for 12 sec

Numbers of revolution for the individual loads F_1 , F_2 and F_3 are derived for the formula as follows.

$$n_1 = \frac{6}{60} \times 800 = 80 \text{ rev.} \quad n_2 = \frac{20}{60} \times 1800 = 600 \text{ rev.} \quad n_3 = \frac{12}{60} \times 3600 = 720 \text{ rev.}$$

Therefore,

$$n = n_1 + n_2 + n_3 = 1400 \text{ rev.}$$

From formula (3.17),

$$F_m =$$

$$\sqrt[3]{\frac{100^3 \times 80 + 50^3 \times 600 + 200^3 \times 720}{1400}}$$

$$= 162 \text{ N}$$

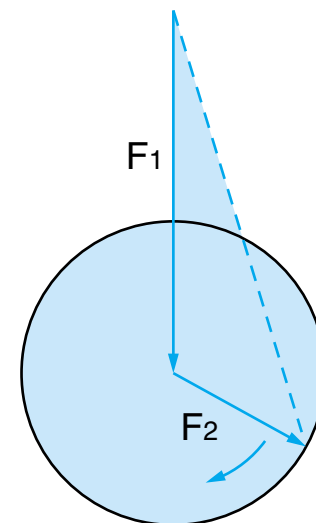


Fig 3.11

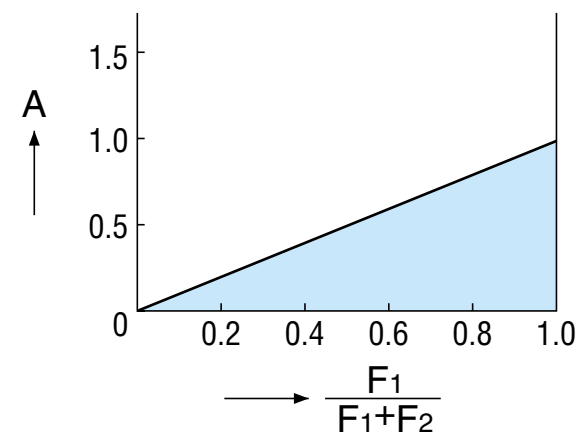


Fig 3.12

3.5 Dynamic Equivalent Load



Dynamic equivalent load refers to a load having constant direction and size such that theoretical calculations of bearing life using this load will simulate actual bearing life. This load is called dynamic equivalent radial load when calculated for radial bearings and dynamic equivalent axial load when calculated for thrust bearings.

In formula (3.1) expressing the relation between the bearing load and bearing life, bearing load, P , is either radial or axial load. Since radial and axial loads often occur simultaneously, the radial and axial loads must be converted to composite load within the dynamic equivalent load formula.

3.5.1 Dynamic Equivalent Radial Load

Dynamic equivalent radial load for radial bearings is calculated using the formula:

$$Pr = XFr + YFa \quad \dots\dots\dots (3.20)$$

where:

- Pr : Dynamic equivalent radial load (N)
- Fr : Radial load (N)
- Fa : Axial load (N)
- X : Radial load factor
(from dimensional tables)
- Y : Axial load factor
(from dimensional tables)

In the above formula, if the axial load to radial load ratio, Fa/Fr , is less than or equal to e (a value determined by the bearing size and load as shown in the dimension tables), X , Y , and Pr will be as follows:

$$\begin{aligned} X &= 1 \\ Y &= 0 \\ Pr &= Fr \end{aligned}$$

3.5.2 Dynamic Equivalent Axial Load

While most thrust bearings are incapable of supporting any radial load, Spherical roller thrust bearings will support some radial load. For Spherical roller thrust bearings, the dynamic equivalent axial load is derived using the formula:

$$Pa = Fa + 1.2Fr \quad \dots\dots\dots (3.21)$$

where:

- Pa : Dynamic equivalent axial load (N)
- Fa : Axial load (N)
- Fr : Radial load (N)
- Fr / Fa must be ≤ 0.55



3.5.3 Dynamic Equivalent Load for Oscillating Loads

The dynamic equivalent load of radial bearings sustaining oscillating movements is derived using the formula:

$$Pr = \left(\frac{\Psi}{90^\circ} \right)^{\frac{1}{p}} (XFr + YFa) \quad \dots\dots\dots (3.22)$$

where:

Pr : Dynamic equivalent load (N)
 Ψ : Angle of oscillation
 (Ψ must be ≥ 90°/Z)
 p : 3 for ball, 10/3 for roller bearings
 Fr : Radial load (N)
 Fa : Axial load (N)

X : Radial load factor
 (from dimensional tables)
 Y : Axial load factor
 (from dimensional tables)
 Z : Number of rolling elements in row

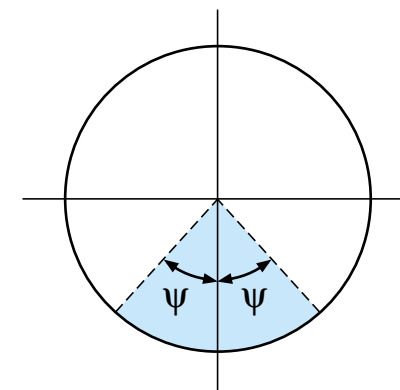


Fig 3.13

If the value of $\Psi < 90^\circ/Z$, the above formula may not accurately predict bearing life since localized wear may be generated in the raceways. (Oil lubrication may be tried to prevent the wear (false brinelling) associated with low-amplitude operation in this type application).

3.5.4 Angular Contact Ball; Tapered Roller Bearing Loads

For single-row Angular Contact ball and single-row Tapered roller bearings, the load center dimensions from the bearing tables must be used when determining the relative load positions. The load-center positions of these bearings are off-set from the midpoint of the width of these bearings as shown in Fig 3.14 and 3.15).

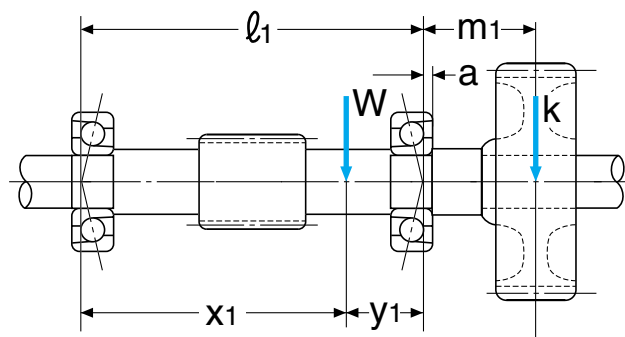


Fig 3.14

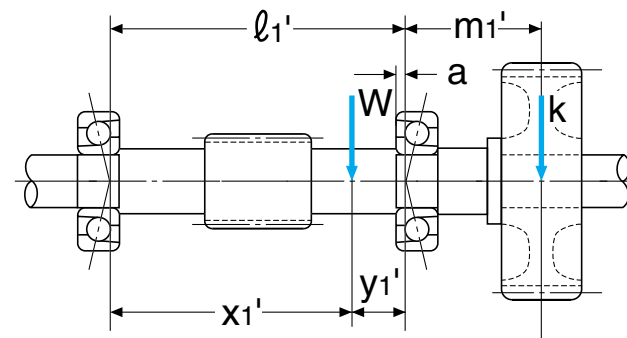


Fig 3.15

[Continue→]

The off-set dimension for Angular Contact ball and Tapered roller bearings is shown as the value "a" in the dimensional tables to indicate the load-center position. If moment loading is to be considered in a bearing system, location of load-center is of particular importance.

Where ℓ_1 , m_1 , x_1 or ℓ'_1 , m'_1 , x'_1 , and y'_1 are applied to formulas (3.15) and (3.16) as effective intervals instead of r , m , x , and y previously used in formulas (3.15) and (3.16). If the radial load is applied to two units of Tapered roller bearings used in pairs and induced axial load will be produced. The magnitude of this induced axial force $F_{a'}$ is calculated using the formula:

$$F_{a'} = \frac{F_r}{2Y_1} \quad \bullet \bullet \bullet \bullet \bullet (3.23)$$

where:

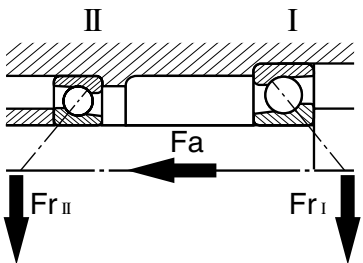
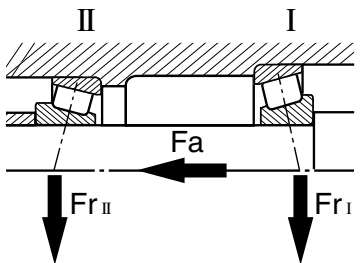
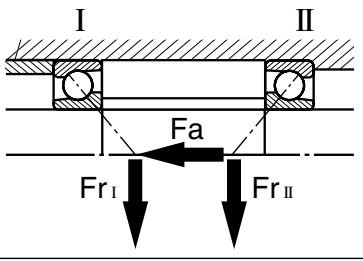
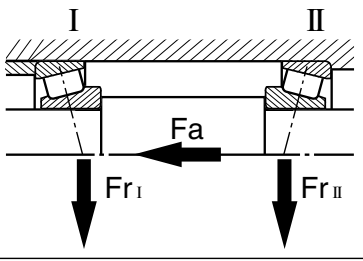
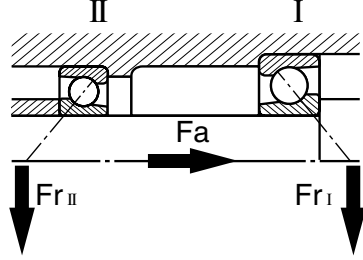
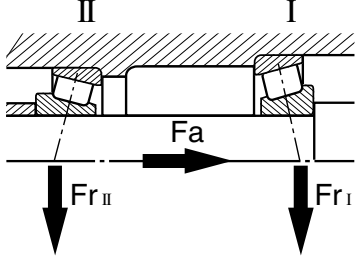
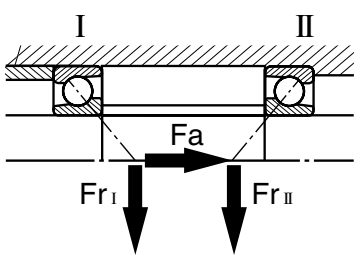
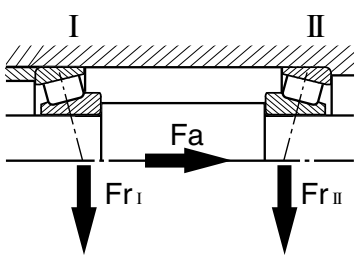
- Y_1 : Axial load factor
(from dimension tables)
- $F_{a'}$: External axial load (N)
- F_r : Radial load (N)

Axial and equivalent radial load on bearing calculated using formulas in Tables 3.9.

Table 3.9 Axial and Equivalent Load of Angular Contact Ball and Tapered Roller Bearings

- F_{r1}, F_{r2} : Radial load applied to bearings1and2(N)
- F_a : External axial load (N) direction shown by Table 3.9
- F_{a1}, F_{a2} : Axial load on bearings1and2(N)
- P_{r1}, P_{r2} : Dynamic equivalent radial load on bearings1and2(N)
- X_1, X_2 : Radial Load Factor for bearings1and2from dimension tables
- Y_1, Y_2 : Axial Load Factor for bearings1and2from dimension tables
(Use Y_1 for Tapered roller bearings)

Table 3.9 Axial and Equivalent Load of Angular Contact Ball and Tapered Roller Bearings

| Bearing arrangement | Load conditions | Axial load | Dynamic equivalent radial load |
|---|--|---|--|
|   | $Fa \geq 0.5 \left(\frac{Fr_I}{Y_I} - \frac{Fr_{II}}{Y_{II}} \right)$ | $Fa_I = Fa_{II} + Fa$ $Fa_{II} = 0.5 \frac{Fr_{II}}{Y_{II}}$ | $Pr_I = X_I Fr_I + Y_I (Fa_{II} + Fa)$ $Pr_{II} = Fr_{II}$ |
|   | $Fa < 0.5 \left(\frac{Fr_I}{Y_I} - \frac{Fr_{II}}{Y_{II}} \right)$ | $Fa_I = 0.5 \frac{Fr_I}{Y_I}$ $Fa_{II} = Fa_I - Fa$ | $Pr_I = Fr_I$ $Pr_{II} = X_{II} Fr_{II} + Y_{II} (Fa_I - Fa)$ |
|   | $Fa \geq 0.5 \left(\frac{Fr_{II}}{Y_{II}} - \frac{Fr_I}{Y_I} \right)$ | $Fa_I = 0.5 \frac{Fr_I}{Y_I}$ $Fa_{II} = Fa_I + Fa$ | $Pr_I = Fr_I$ $Pr_{II} = X_{II} Fr_{II} + Y_{II} (Fa_I + Fa)$ |
|   | $Fa < 0.5 \left(\frac{Fr_{II}}{Y_{II}} - \frac{Fr_I}{Y_I} \right)$ | $Fa_I = Fa_{II} - Fa$ $Fa_{II} = 0.5 \frac{Fr_{II}}{Y_{II}}$ | $Pr_I = X_I Fr_I + Y_I (Fa_{II} - Fa)$ $Pr_{II} = Fr_{II}$ |

Notes : 1. Equalities apply when the bearing clearance and preload are 0.

2. Radial load applied in reverse direction to the arrows above will be also treated as positive values.

3.6 Basic Static Load Rating and Static Equivalent Load



3.6.1 Basic Static Load Rating

Load applied to stationary bearings can create permanent indentations in the load surfaces. While some level of deformation can be tolerated, a level of deformation will be reached where noise and vibration during operation of the bearing, will make the bearing unusable.

The term "Basic static load rating" refers to the maximum contact stress value of the static load where the rolling element and raceways contact. The ratings are:

- Self-aligning ball bearing ••• 4600MPa
- Other ball bearings ••• 4200MPa
- Roller bearings ••• 4000 MPa

With these contact stresses, the sum of deformations (ball/roller and raceway) is approximately 1/10000 of the diameter of the rolling element.

Basic static load ratings are shown in the dimension tables for each bearing number. The symbol C_{or} is for radial bearings and the symbol C_{oa} is for thrust bearings.

3.6.2 Static Equivalent Load

Static equivalent load is the static load that reflects the actual load conditions to the contact section of the rolling elements and raceway receiving the maximum stress. For radial bearings, radial load of a constant direction and size is called the static equivalent radial load, and for thrust bearings, axial load of a constant direction and size is called the static equivalent axial load.

1) Static equivalent radial load

To calculate the static equivalent radial load of a radial bearing supporting simultaneous radial and axial loads, the larger of the values obtained from formulas (3.24) and (3.25) are to be used

$$P_{or} = X_o F_r + Y_o F_a \quad \bullet \bullet \bullet \bullet \bullet (3.24)$$

$$P_{or} = F_r \quad \bullet \bullet \bullet \bullet \bullet (3.25)$$

where:

P_{or} : Static equivalent radial load (N)

F_r : Radial load (N)

F_a : Axial load (N)

X_o & Y_o : Static radial and axial load factors from dimension tables



[Continue→]

2) Static equivalent axial load

Static equivalent axial load for Spherical Thrust bearings is calculated using formula (3.26)

$$P_{oa}=F_a+2.7F_r \quad \bullet \bullet \bullet \bullet \bullet (3.26)$$

where:

P_{oa} : Static equivalent axial load (N)

F_a : Axial load (N)

F_r : Radial load (N)

F_r/F_a must be ≤ 0.55

3.6.3 Safety Factor

The basic static load rating is considered as the limiting load for general applications. In terms of a safety factor, this means that, by definition, a safety factor, S_o , is set as a base of 1. An application may require a larger or allow a smaller safety factor. Table 3.10 provides a guide for selection of the safety factor, S_o , to be used with formula (3.27) for calculation of the maximum (weighted) static equivalent load.

$$C_o=S_o \cdot P_{omax} \quad \bullet \bullet \bullet \bullet \bullet (3.27)$$

where:

C_o : Basic static load rating (N)
(C_o for radial; C_{oa} for thrust bearings)

S_o : Safety factor
(select from Table 3.10)

P_{omax} : Static equivalent load (N)

Table 3.10 Static Safety Factor (S_o)

| Application condition | So | |
|--|---------------|-----------------|
| | Ball Bearings | Roller Bearings |
| High rotating accuracy is needed | 2 | 3 |
| Vibration and/or impact present | 1.5 | 2 |
| Normal operating conditions | 1 | 1.5 |
| Small amount of permanent deformation is tolerable | 0.7 | 1 |

Note : $S_o > 4$ for spherical roller thrust bearings

3.7 Axial Load Capacity of Cylindrical Roller Bearings



Cylindrical roller bearings are generally used for supporting radial loads only. Bearings having flanges or loose ribs on both the inner and outer rings (such as on configurations NJ, NF, and NUP), however, are capable of supporting some amount of axial load. Since any axial loading on a cylindrical roller bearing is supported by a "sliding" action between the roller ends and flanges, allowable axial load is based on the limiting values of heat, seizure, and wear caused by this "sliding" contact. Permissible axial loading (no consideration of bearing life as a radial bearing) on Cylindrical roller bearings is calculated using the following formula.

$$F_a = (pv) \frac{\lambda}{n}$$
..... Allowable axial load (N)

pv : Application factor from Table 3.11.1
λ : Bearing type factor from Table 3.11.2
n : Rotating speed (rpm)

However, there is another limits shown by the following formula because Fa exceeding the limits cause abnormal roller movement

Allowable axial load ≤ K1 · Fr

| Bearing series | K1 |
|-----------------------------------|-----|
| 1000, 200, 200E 300, 300E, 400 | 0.2 |
| 2200, 2200E, 2300, 2300E | 0.4 |

When cylindrical roller bearings are applied axial load, additional considerations are required as follows;

- Apply sufficient radial load to overcome axial load
- Supply sufficient lubricant between roller ends and flanges
- Use lubricant which has good film strength (pressure resistant) properties
- Practice good bearing mounting accuracy (see section 8.3)
- Allow sufficient running-in
- Minimize radial bearing clearance

Table 3.11.1 Application Factor (pv)

| Operating conditions (Load and lubrication) | (pv) |
|--|-------------|
| Intermittent axial load, Good heat conduction and Good cooling or Very large amount of lubricant | 5400 ~ 6900 |
| Intermittent axial load, Good heat conduction and Large amount of lubricant | 2600 ~ 3200 |
| Oil lubrication, Good heat conduction or Good cooling | 1900 ~ 2200 |
| Continuous axial load and Oil lubrication or Intermittent axial load and Grease lubrication | 1300 ~ 1600 |
| Continuous axial load and Grease lubrication | 690 ~ 780 |

Table 3.11.2 Bearing Type Factor λ

| Diameter Series | λ |
|-----------------|-----|
| 0 | 19d |
| 2 | 32d |
| 3 | 45d |
| 4 | 60d |

d=Bearing bore (mm)



4. Boundary Dimensions and Bearing Numbers of Bearings

4.1 Boundary Dimensions

4.2 Radial Bearings(Except Tapered Roller Bearings)

Table 4.2.1

- Diameter series 7
- Diameter series 8
- Diameter series 9
- Diameter series 0

Table 4.2.2

- Diameter series 1
- Diameter series 2
- Diameter series 3
- Diameter series 4

4.3 Boundary Dimensions of Tapered Roller Bearings

Table 4.3.1

- Diameter series 9
- Diameter series 1

Table 4.3.2

- Diameter series 0
- Diameter series 2
- Diameter series 3

4.4 Boundary Dimensions of Thrust Bearings with Flat Back Face

Table 4.4.1

- Diameter series 0
- Diameter series 1

Table 4.4.2

- Diameter series 2

Table 4.4.3

- Diameter series 3

Table 4.4.4

- Diameter series 4
- Diameter series 5

4.5 Dimensions of Snap Ring Grooves and Snap Rings

- Table 4.5.1 Dimensions of Snap Ring Grooves for Bearing Dimension Series 18 and 19
- Table 4.5.2 Snap Ring Dimensions for Bearing Dimension Series 18 and 19
- Table 4.5.3 Dimensions of Snap Ring Grooves for Bearing Diameter Series 0, 2, 3 and 4
- Table 4.5.4 Snap Ring Dimensions for Bearing Diameter Series 0, 2, 3 and 4

4.6 NACHI Bearing Numbers

4. Boundary Dimensions and Bearing Numbers of Rolling Contact Bearings

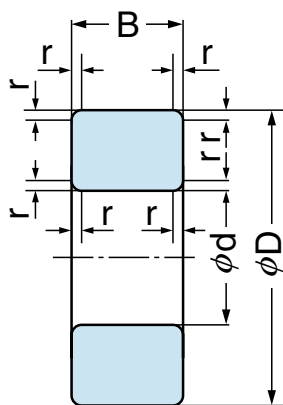
4.1 Boundary Dimensions of Rolling Contact Bearings

Boundary dimensions have been established in a standard plan for metric rolling contact bearings to facilitate the selection process, improve availability, and to limit the necessity for use of high cost, non-standard parts. Boundary dimensions standards include the bore diameter (d), outside diameter (D), width (B), assembly width (T) or height (H), and the chamfer dimension (r) of bearings. Boundary dimensions are standardized by the International Organization for Standardization (ISO 15) and also Japanese Industrial Standard (JIS B 1512). NACHI has adopted the ISO boundary dimension standards. [Figures 4.6](#) and [4.7](#) show the relationship of the dimensions for radial and thrust rolling contact bearings (except for Tapered roller bearings).

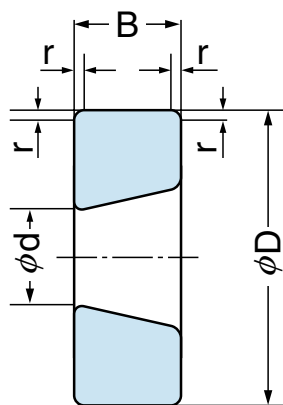
Table 4.1 Boundary Dimensions Terminology

| Series | Definition | Remarks |
|------------------------|---|---|
| Diameter series | The diameter series is a series of standard outside diameters with standard bore diameters. Several series of outside diameters are set in stages to the same bearing bore diameter. Diameter series are labeled by single digit numbers 7, 8, 9, 0, 1, 2, 3, and 4. | Diameter series is in ascending order by diameter size with number 7 the smallest and 4 the largest. |
| Width or Height series | Width or height series is a series of standard widths or heights with the same bore diameter within the same diameter series of bearings. These width or height series are labeled with single digit numbers. Width series 8, 0, 1, 2, 3, 4, 5, and 6 for radial bearings and height series 7, 9, 1, and 2 are for thrust bearings. | Each radial bearing diameter series has width series with numbers 8, 0, 1, 2, 3, 4, 5 and 6. Number 8 is the minimum width to the same bore and outside diameter. Number 6 is the maximum width |
| Dimension series | Dimension series = width or height series number + Diameter series. Dimension series are labeled with a two digit number by combining numbers for the width or height series to the numbers for the diameter series. The two digit number has the width or height series in the lead position. | Each thrust bearing diameter series has width series with number 7, 9, 1 and 2. Number 7 is the minimum width to the same bore and outside diameter. Number 2 is the maximum width |





Cylindrical Bore



Tapered bore ($\frac{1}{12}$ or $\frac{1}{30}$ taper)

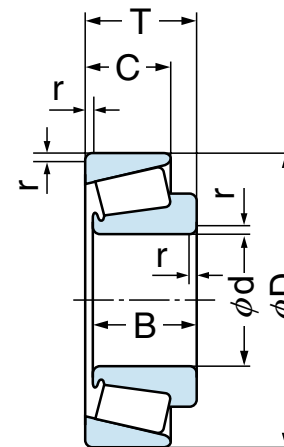


Fig 4.1 Radial Bearings (except Tapered Roller Bearings)

Fig 4.2 Tapered Roller Bearings

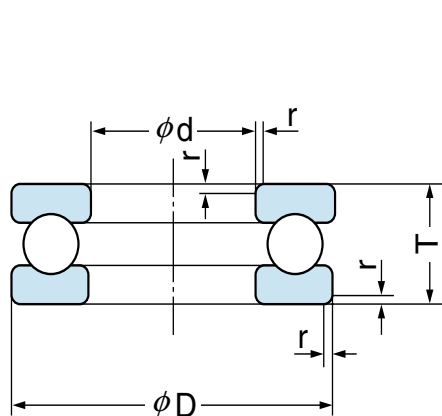


Fig 4.3 Single-direction Thrust Ball Bearings

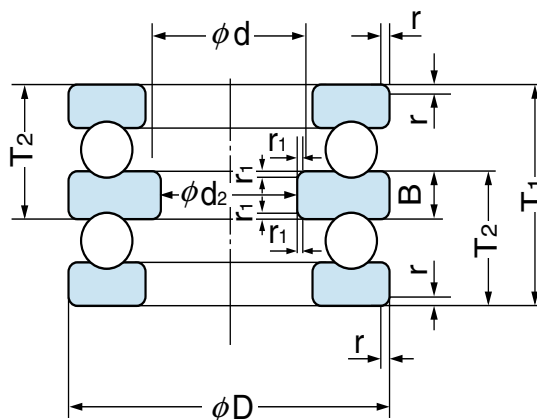


Fig 4.4 Double-direction Thrust Ball Bearings

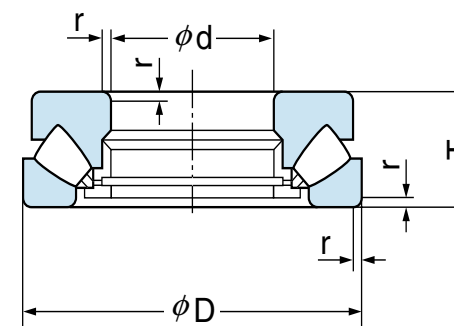


Fig 4.5 Spherical Roller Thrust Bearings

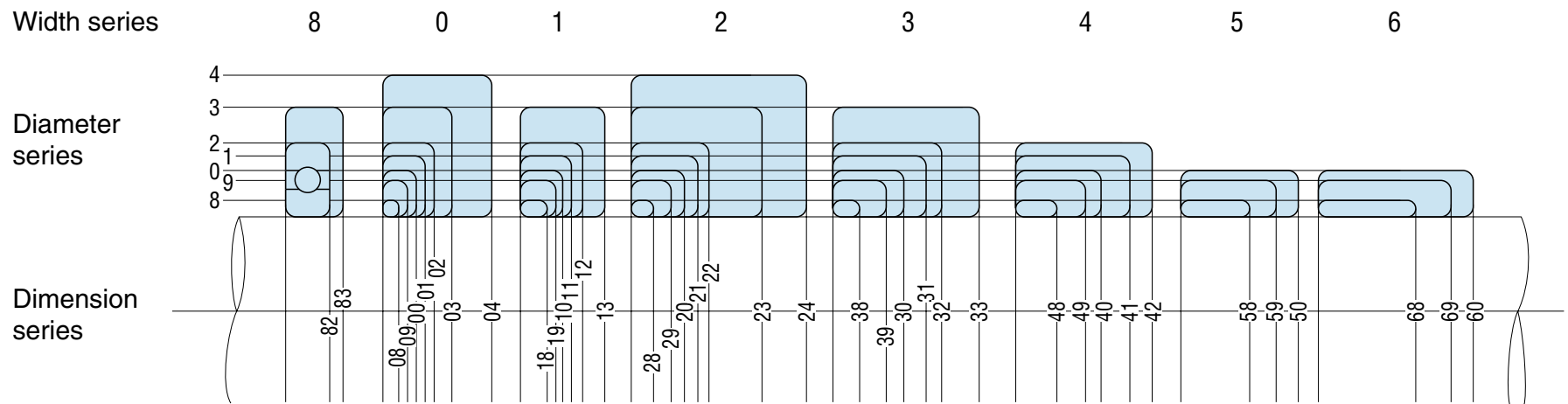


Fig 4.6 Graphical Representation of the Dimension series of Radial Bearings (except Tapered Roller Bearings)

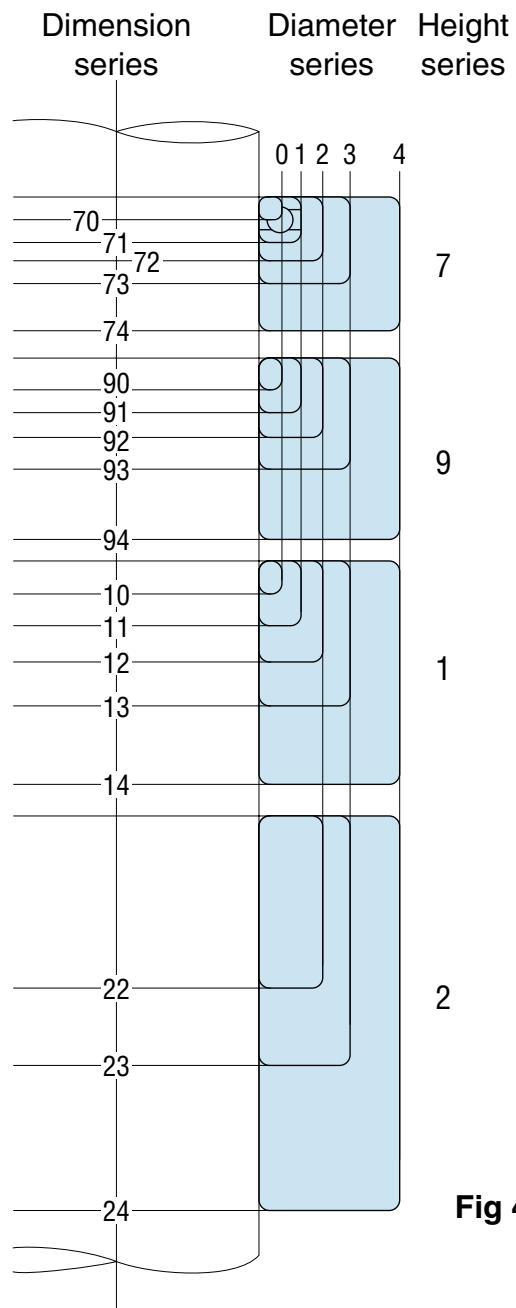


Fig 4.7 Graphical Indication of Dimension Series of Thrust Bearings

Unit : mm

Remarks: 1. r_{min} is the smallest chamfer dimension.
2. The chamfer dimensions given in this table do not necessarily apply to:

| | |
|--|--|
| (1) the groove side of bearing rings with snap ring groove | (3) the front face side of angular contact bearing |
| (2) the flangeless side of thin cylindrical roller bearing rings | (4) inner rings of bearings with tapered bore |

Table 4.2.1 Boundary Dimensions of Diameter Series 7, 8

(2/8)

Unit : mm

| | | | | | | | | | | | | | | | | | |
|----------------------------------|----------------------------|-------------------|----|-----|-------------------|------------------|----------------------------|-------------------|----|----|----|----|-------------------|------------------|---------------|--|--|
| Single row, radial ball bearings | | 67 | | | | | | 68 | | | | | | | | | |
| Double row, radial ball bearings | | | | | | | | | | | | | | | | | |
| Cylindrical roller bearings | | | | | | | | | | | | | | | | | |
| Spherical roller bearings | | | | | | | | | | | | | | | | | |
| Bearing bore diameter Nominal | Bearing outside diameter D | Diameter series 7 | | | | | Bearing outside diameter D | Diameter series 8 | | | | | | | | | |
| | | Width series | | | Chamfer dimension | Width series | | | | | | | Chamfer dimension | | | | |
| | | 1 | 2 | 3 | | 0 | | 1 | 2 | 3 | 4 | 5 | | 6 | | | |
| | | Dimension series | | | | Dimension series | | | | | | | | | | | |
| | | 17 | 27 | 37 | 17 1 37 | 08 | | 18 | 28 | 38 | 48 | 58 | 68 | 08 | 18 1 68 | | |
| Bore No. d | | Width B | | | r _{min} | | Width B | | | | | | | r _{min} | | | |
| 00 10 | 15 | 3 | — | 4.5 | 0.1 | 19 | — | 5 | 6 | 7 | 9 | — | — | — | 0.3 | | |
| 01 12 | 18 | 4 | — | 5 | 0.2 | 21 | — | 5 | 6 | 7 | 9 | — | — | — | 0.3 | | |
| 02 15 | 21 | 4 | — | 5 | 0.2 | 24 | — | 5 | 6 | 7 | 9 | — | — | — | 0.3 | | |
| 03 17 | 23 | 4 | — | 5 | 0.2 | 26 | — | 5 | 6 | 7 | 9 | — | — | — | 0.3 | | |
| 04 20 | 27 | 4 | — | 5 | 0.2 | 32 | 4 | 7 | 8 | 10 | 12 | 16 | 22 | 0.3 | 0.3 | | |
| /22 22 | — | — | — | — | — | 34 | 4 | 7 | — | 10 | — | 16 | 22 | 0.3 | 0.3 | | |
| 05 25 | 32 | 4 | — | 5 | 0.2 | 37 | 4 | 7 | 8 | 10 | 12 | 16 | 22 | 0.3 | 0.3 | | |
| /28 28 | — | — | — | — | — | 40 | 4 | 7 | — | 10 | — | 16 | 22 | 0.3 | 0.3 | | |
| 06 30 | 37 | 4 | — | 5 | 0.2 | 42 | 4 | 7 | 8 | 10 | 12 | 16 | 22 | 0.3 | 0.3 | | |
| /32 32 | — | — | — | — | — | 44 | 4 | 7 | — | 10 | — | 16 | 22 | 0.3 | 0.3 | | |
| 07 35 | — | — | — | — | — | 47 | 4 | 7 | 8 | 10 | 12 | 16 | 22 | 0.3 | 0.3 | | |
| 08 40 | — | — | — | — | — | 52 | 4 | 7 | 8 | 10 | 12 | 16 | 22 | 0.3 | 0.3 | | |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. The chamfer dimensions given in this table do not necessarily apply to:

- (1) the groove side of bearing rings with snap ring groove
 (2) the flangeless side of thin cylindrical roller bearing rings

- (3) the front face side of angular contact bearing
 (4) inner rings of bearings with tapered bore

Table 4.2.1 Boundary Dimensions of Diameter Series 7, 8

(3/8)

Unit : mm

| | | | | | | | | | | | | | | | | |
|----------------------------------|----------------------------|------------------|----|----|-------------------|----------------------------|------------------|----|----|----|----|----|-------------------|-----|----------|--|
| Single row, radial ball bearings | | 67 | | | | | | 68 | | | | | | | | |
| Double row, radial ball bearings | | | | | | | | | | | | | | | | |
| Cylindrical roller bearings | | | | | | | | | | | | | | | | |
| Spherical roller bearings | | | | | | | | | | | | | | | | |
| Bearing bore diameter Nominal | Diameter series 7 | | | | | Diameter series 8 | | | | | | | | | | |
| | Bearing outside diameter D | Width series | | | Chamfer dimension | Bearing outside diameter D | Width series | | | | | | Chamfer dimension | | | |
| | | 1 | 2 | 3 | | | 0 | 1 | 2 | 3 | 4 | 5 | | 6 | | |
| | | Dimension series | | | | | Dimension series | | | | | | | | | |
| | | 17 | 27 | 37 | 17 37 | | 08 | 18 | 28 | 38 | 48 | 58 | 68 | 08 | 18 68 | |
| Bore No. d | | Width B | | | r _{min} | | Width B | | | | | | r _{min} | | | |
| 09 45 | — | — | — | — | — | 58 | 4 | 7 | 8 | 10 | 13 | 18 | 23 | 0.3 | 0.3 | |
| 10 50 | — | — | — | — | — | 65 | 5 | 7 | 10 | 12 | 15 | 20 | 27 | 0.3 | 0.3 | |
| 11 55 | — | — | — | — | — | 72 | 7 | 9 | 11 | 13 | 17 | 23 | 30 | 0.3 | 0.3 | |
| 12 60 | — | — | — | — | — | 78 | 7 | 10 | 12 | 14 | 18 | 24 | 32 | 0.3 | 0.3 | |
| 13 65 | — | — | — | — | — | 85 | 7 | 10 | 13 | 15 | 20 | 27 | 36 | 0.3 | 0.6 | |
| 14 70 | — | — | — | — | — | 90 | 8 | 10 | 13 | 15 | 20 | 27 | 36 | 0.3 | 0.6 | |
| 15 75 | — | — | — | — | — | 95 | 8 | 10 | 13 | 15 | 20 | 27 | 36 | 0.3 | 0.6 | |
| 16 80 | — | — | — | — | — | 100 | 8 | 10 | 13 | 15 | 20 | 27 | 36 | 0.3 | 0.6 | |
| 17 85 | — | — | — | — | — | 110 | 9 | 13 | 16 | 19 | 25 | 34 | 45 | 0.3 | 1 | |
| 18 90 | — | — | — | — | — | 115 | 9 | 13 | 16 | 19 | 25 | 34 | 45 | 0.3 | 1 | |
| 19 95 | — | — | — | — | — | 120 | 9 | 13 | 16 | 19 | 25 | 34 | 45 | 0.3 | 1 | |
| 20 100 | — | — | — | — | — | 125 | 9 | 13 | 16 | 19 | 25 | 34 | 45 | 0.3 | 1 | |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. The chamfer dimensions given in this table do not necessarily apply to:

- (1) the groove side of bearing rings with snap ring groove
- (2) the flangeless side of thin cylindrical roller bearing rings

- (3) the front face side of angular contact bearing
- (4) inner rings of bearings with tapered bore

Table 4.2.1 Boundary Dimensions of Diameter Series 7, 8

(4/8)

Unit : mm

| | | | | | | | | | | | | | | | | | | |
|----------------------------------|----------------------------|------------------|----|----|-------------------|----------------------------|------------------|----|----|----|----|----|-------------------|-----|-----|----|----------|--|
| Single row, radial ball bearings | | 67 | | | | | | 68 | | | | | | | | | | |
| Double row, radial ball bearings | | | | | | | | | | | | | | | | | | |
| Cylindrical roller bearings | | | | | | | | | | | | | | | | | | |
| Spherical roller bearings | | | | | | | | | | | | | | | | | | |
| Bearing bore diameter Nominal | Diameter series 7 | | | | | Diameter series 8 | | | | | | | | | | | | |
| | Bearing outside diameter D | Width series | | | Chamfer dimension | Bearing outside diameter D | Width series | | | | | | Chamfer dimension | | | | | |
| | | 1 | 2 | 3 | | | 0 | 1 | 2 | 3 | 4 | 5 | | 6 | | | | |
| | | Dimension series | | | | | Dimension series | | | | | | | | | | | |
| | | 17 | 27 | 37 | | | 17 37 | 08 | 18 | 28 | 38 | 48 | | 58 | 68 | 08 | 18 68 | |
| Bore No. d | | Width B | | | r _{min} | | Width B | | | | | | r _{min} | | | | | |
| 21 105 | — | — | — | — | — | 130 | 9 | 13 | 16 | 19 | 25 | 34 | 45 | 0.3 | 1 | | | |
| 22 110 | — | — | — | — | — | 140 | 10 | 16 | 19 | 23 | 30 | 40 | 54 | 0.6 | 1 | | | |
| 24 120 | — | — | — | — | — | 150 | 10 | 16 | 19 | 23 | 30 | 40 | 54 | 0.6 | 1 | | | |
| 26 130 | — | — | — | — | — | 165 | 11 | 18 | 22 | 26 | 35 | 46 | 63 | 0.6 | 1.1 | | | |
| 28 140 | — | — | — | — | — | 175 | 11 | 18 | 22 | 26 | 35 | 46 | 63 | 0.6 | 1.1 | | | |
| 30 150 | — | — | — | — | — | 190 | 13 | 20 | 24 | 30 | 40 | 54 | 71 | 0.6 | 1.1 | | | |
| 32 160 | — | — | — | — | — | 200 | 13 | 20 | 24 | 30 | 40 | 54 | 71 | 0.6 | 1.1 | | | |
| 34 170 | — | — | — | — | — | 215 | 14 | 22 | 27 | 34 | 45 | 60 | 80 | 0.6 | 1.1 | | | |
| 36 180 | — | — | — | — | — | 225 | 14 | 22 | 27 | 34 | 45 | 60 | 80 | 0.6 | 1.1 | | | |
| 38 190 | — | — | — | — | — | 240 | 16 | 24 | 30 | 37 | 50 | 67 | 90 | 1 | 1.5 | | | |
| 40 200 | — | — | — | — | — | 250 | 16 | 24 | 30 | 37 | 50 | 67 | 90 | 1 | 1.5 | | | |
| 44 220 | — | — | — | — | — | 270 | 16 | 24 | 30 | 37 | 50 | 67 | 90 | 1 | 1.5 | | | |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. The chamfer dimensions given in this table do not necessarily apply to:

- (1) the groove side of bearing rings with snap ring groove
 (2) the flangeless side of thin cylindrical roller bearing rings

- (3) the front face side of angular contact bearing
 (4) inner rings of bearings with tapered bore

Table 4.2.1 Boundary Dimensions of Diameter Series 7, 8

(5/8)

Unit : mm

| | | | | | | | | | | | | | | | | |
|----------------------------------|-------------------------------|------------------|----|------------------|----------------------|-------------------------------|------------------|----|----|----|------------------|-----|----------------------|-----|-----|----|
| Single row, radial ball bearings | | 67 | | | | | | 68 | | | | | | | | |
| Double row, radial ball bearings | | | | | | | | | | | | | | | | |
| Cylindrical roller bearings | | | | | | | | | | | | | | | | |
| Spherical roller bearings | | | | | | | | | | | | | | | | |
| Bearing bore diameter Nominal | Diameter series 7 | | | | | Diameter series 8 | | | | | | | | | | |
| | Bearing outside diameter D | Width series | | | Chamfer dimension | Bearing outside diameter D | Width series | | | | | | Chamfer dimension | | | |
| | | 1 | 2 | 3 | | | 0 | 1 | 2 | 3 | 4 | 5 | | 6 | | |
| | | Dimension series | | | | | Dimension series | | | | | | | | | |
| | | 17 | 27 | 37 | | | 17 27 37 | 08 | 18 | 28 | 38 | 48 | | 58 | 68 | 08 |
| Bore No. d | Width B | | | r _{min} | Width B | | | | | | r _{min} | | | | | |
| 48 240 52 260 56 280 | — | — | — | — | — | 300 | 19 | 28 | 36 | 45 | 60 | 80 | 109 | 1 | 2 | |
| 60 300 64 320 68 340 | — | — | — | — | — | 380 | 25 | 38 | 48 | 60 | 80 | 109 | 145 | 1.5 | 2.1 | |
| 72 360 76 380 80 400 | — | — | — | — | — | 440 | 25 | 38 | 48 | 60 | 80 | 109 | 145 | 1.5 | 2.1 | |
| 84 420 88 440 92 460 | — | — | — | — | — | 520 | 31 | 46 | 60 | 75 | 100 | 136 | 180 | 2 | 2.1 | |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. The chamfer dimensions given in this table do not necessarily apply to:

- (1) the groove side of bearing rings with snap ring groove
 (2) the flangeless side of thin cylindrical roller bearing rings

- (3) the front face side of angular contact bearing
 (4) inner rings of bearings with tapered bore

Table 4.2.1 Boundary Dimensions of Diameter Series 7, 8

(6/8)

Unit : mm

| | | | | | | | | | | | | | | | | |
|----------------------------------|----------------------------|-------------------|-------------|-------------|----------------------------|---------------------|-------------------|----------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------|----|
| Single row, radial ball bearings | | 67 | | | | | | 68 | | | | | | | | |
| Double row, radial ball bearings | | | | | | | | | | | | | | | | |
| Cylindrical roller bearings | | | | | | | | | | | | | | | | |
| Spherical roller bearings | | | | | | | | | | | | | | | | |
| Bearing bore diameter Nominal | Bearing outside diameter D | Diameter series 7 | | | | Chamfer dimension | Diameter series 8 | | | | | | | | | |
| | | Width series | | | Bearing outside diameter D | | Width series | | | | | | Chamfer dimension | | | |
| | | 1 | 2 | 3 | | | 0 | 1 | 2 | 3 | 4 | 5 | | 6 | | |
| | | Dimension series | | | | | Dimension series | | | | | | | | | |
| | | 17 | 27 | 37 | | | 17 1 37 | 08 | 18 | 28 | 38 | 48 | | 58 | 68 | 08 |
| Bore No. d | | Width B | | | r _{min} | | Width B | | | | | | r _{min} | | | |
| 96 480 /500 500 /530 530 | — — — | — — — | — — — | — — — | — — — | 600 620 650 | 37 37 37 | 56 56 56 | 72 72 72 | 90 90 90 | 118 118 118 | 160 160 160 | 218 218 218 | 2.1 2.1 2.1 | 3 3 3 | |
| /560 560 /600 600 /630 630 | — — — | — — — | — — — | — — — | — — — | 680 730 780 | 37 42 48 | 56 60 69 | 72 78 88 | 90 98 112 | 118 128 150 | 160 175 200 | 218 236 272 | 2.1 3 3 | 3 3 4 | |
| /670 670 /710 710 /750 750 | — — — | — — — | — — — | — — — | — — — | 820 870 920 | 48 50 54 | 69 74 78 | 88 95 100 | 112 118 128 | 150 160 170 | 200 218 230 | 272 290 308 | 3 4 4 | 4 4 5 | |
| /800 800 /850 850 /900 900 | — — — | — — — | — — — | — — — | — — — | 980 1030 1090 | 57 57 60 | 82 82 85 | 106 106 112 | 136 136 140 | 180 180 190 | 243 243 258 | 325 325 345 | 4 4 5 | 5 5 5 | |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. The chamfer dimensions given in this table do not necessarily apply to:

- (1) the groove side of bearing rings with snap ring groove
 (2) the flangeless side of thin cylindrical roller bearing rings

- (3) the front face side of angular contact bearing
 (4) inner rings of bearings with tapered bore

Table 4.2.1 Boundary Dimensions of Diameter Series 7, 8

(7/8)

Unit : mm

| | | | | | | | | | | | | | | | | |
|----------------------------------|----------------------------|------------------|----|----|-------------------|----------------------------|------------------|-----|-----|-----|-----|-----|-----|-------------------|---------------|--|
| Single row, radial ball bearings | | 67 | | | | | | 68 | | | | | | | | |
| Double row, radial ball bearings | | | | | | | | | | | | | | | | |
| Cylindrical roller bearings | | | | | | | | | | | | | | | | |
| Spherical roller bearings | | | | | | | | | | | | | | | | |
| Bearing bore diameter Nominal | Diameter series 7 | | | | | Diameter series 8 | | | | | | | | | | |
| | Bearing outside diameter D | Width series | | | Chamfer dimension | Bearing outside diameter D | Width series | | | | | | | Chamfer dimension | | |
| | | 1 | 2 | 3 | | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | | | |
| | | Dimension series | | | | | Dimension series | | | | | | | | | |
| | | 17 | 27 | 37 | 17 ↕ 37 | | 08 | 18 | 28 | 38 | 48 | 58 | 68 | 08 | 18 ↕ 68 | |
| | | Width B | | | r _{min} | | Width B | | | | | | | r _{min} | | |
| /950 950 | — | — | — | — | — | 1150 | 63 | 90 | 118 | 150 | 200 | 272 | 355 | 5 | 5 | |
| /1000 1000 | — | — | — | — | — | 1220 | 71 | 100 | 128 | 165 | 218 | 300 | 400 | 5 | 6 | |
| /1060 1060 | — | — | — | — | — | 1280 | 71 | 100 | 128 | 165 | 218 | 300 | 400 | 5 | 6 | |
| /1120 1120 | — | — | — | — | — | 1360 | 78 | 106 | 140 | 180 | 243 | 325 | 438 | 5 | 6 | |
| /1180 1180 | — | — | — | — | — | 1420 | 78 | 106 | 140 | 180 | 243 | 325 | 438 | 5 | 6 | |
| /1250 1250 | — | — | — | — | — | 1500 | 80 | 112 | 145 | 185 | 250 | 335 | 450 | 6 | 6 | |
| /1320 1320 | — | — | — | — | — | 1600 | 88 | 122 | 165 | 206 | 280 | 375 | 500 | 6 | 6 | |
| /1400 1400 | — | — | — | — | — | 1700 | 95 | 132 | 175 | 224 | 300 | 400 | 545 | 6 | 7.5 | |
| /1500 1500 | — | — | — | — | — | 1820 | — | 140 | 185 | 243 | 315 | — | — | — | 7.5 | |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. The chamfer dimensions given in this table do not necessarily apply to:

- (1) the groove side of bearing rings with snap ring groove
- (2) the flangeless side of thin cylindrical roller bearing rings
- (3) the front face side of angular contact bearing
- (4) inner rings of bearings with tapered bore

Table 4.2.1 Boundary Dimensions of Diameter Series 7, 8

(8/8)

Unit : mm



| | | | | | | | | | | | | | | | | |
|----------------------------------|-------------------------------|------------------|----|------------------|----------------------|-------------------------------|------------------|-----|-----|-----|-----|------------------|----------------------|----|-----|----------------|
| Single row, radial ball bearings | | 67 | | | | | | 68 | | | | | | | | |
| Double row, radial ball bearings | | | | | | | | | | | | | | | | |
| Cylindrical roller bearings | | | | | | | | | | | | | | | | |
| Spherical roller bearings | | | | | | | | | | | | | | | | |
| Bearing bore diameter Nominal | Diameter series 7 | | | | | Diameter series 8 | | | | | | | | | | |
| | Bearing outside diameter D | Width series | | | Chamfer dimension | Bearing outside diameter D | Width series | | | | | | Chamfer dimension | | | |
| | | 1 | 2 | 3 | | | 0 | 1 | 2 | 3 | 4 | 5 | | 6 | | |
| | | Dimension series | | | | | Dimension series | | | | | | | | | |
| | | 17 | 27 | 37 | | | 17 27 37 | 08 | 18 | 28 | 38 | 48 | 58 | 68 | 08 | 18 27 68 |
| Bore No. d | | Width B | | r _{min} | | Width B | | | | | | r _{min} | | | | |
| /1600 1600 | — | — | — | — | — | 1950 | — | 155 | 200 | 265 | 345 | — | — | — | 7.5 | |
| /1700 1700 | — | — | — | — | — | 2060 | — | 160 | 206 | 272 | 355 | — | — | — | 7.5 | |
| /1800 1800 | — | — | — | — | — | 2180 | — | 165 | 218 | 290 | 375 | — | — | — | 9.5 | |
| /1900 1900 | — | — | — | — | — | 2300 | — | 175 | 230 | 300 | 400 | — | — | — | 9.5 | |
| /2000 2000 | — | — | — | — | — | 2430 | — | 190 | 250 | 325 | 425 | — | — | — | 9.5 | |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. The chamfer dimensions given in this table do not necessarily apply to:

- (1) the groove side of bearing rings with snap ring groove
- (2) the flangeless side of thin cylindrical roller bearing rings

- (3) the front face side of angular contact bearing
- (4) inner rings of bearings with tapered bore

Table 4.2.1 Boundary Dimensions of Diameter Series 9, 0

(1/8)

Unit : mm

| | | | | | | | | | | | | | | | | | | | | | | | | | | |
|----------------------------------|-------------------------------|------------------|-------------|-----------------|-------------|-----------------|----------------|------------------|----------------------|----------------------|--------------------|-------------------------------|-------------------|------------------|--------------|----------------|---------------|------------------|---------------|----------------------|-------------|-------------|----------------------|--|--|--|
| Single row, radial ball bearings | | | 69 79 | | | | | | | | | | | 160 | 60 70 | | | | | | | | | | | |
| Double row, radial ball bearings | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cylindrical roller bearings | | | | | | NN49 | | | | | | | | | N10 | | NN30 | | | | | | | | | |
| Spherical roller bearings | | | | | 239 | | | | | | | | | | | | 230 | 240 | | | | | | | | |
| Bearing bore diameter Nominal | Diameter series 9 | | | | | | | | | | | | Diameter series 0 | | | | | | | | | | | | | |
| | Bearing outside diameter D | Width series | | | | | | | Chamfer dimension | | | Bearing outside diameter D | Width series | | | | | | | Chamfer dimension | | | | | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | | | | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | | | | | | | |
| | | Dimension series | | | | | | | | | | | | Dimension series | | | | | | | | | | | | |
| | | 09 | 19 | 29 | 39 | 49 | 59 | 69 | 09 | 19 39 | 49 69 | | 00 | 10 | 20 | 30 | 40 | 50 | 60 | 00 | 10 60 | | | | | |
| Bore No. d | Width B | | | | | | | r _{min} | | | Width B | | | | | | | r _{min} | | | | | | | | |
| /0.6 1 /1.5 | 0.6 1 1.5 | — 4 5 | — — — | — 1.6 2 | — — — | — 2.3 2.6 | — — — | — — — | — — — | — 0.1 0.15 | — — — | — 6 | — — — | — — 2.5 | — — — | — — 3 | — — — | — — — | — — — | — — — | — — — | — — — | — — 0.15 | | | |
| 2 /2.5 3 | 2 2.5 3 | 6 7 8 | — — — | 2.3 2.5 3 | — — — | 3 3.5 4 | — — — | — — — | — — — | 0.15 0.15 0.15 | — — — | 7 8 9 | — — — | 2.8 2.8 3 | — — — | 3.5 4 5 | — — — | — — — | — — — | — — — | — — — | — — — | 0.15 0.15 0.15 | | | |
| 4 5 6 | 4 5 6 | 11 13 15 | — — — | 4 4 5 | — — — | 5 6 7 | — 10 10 | — — — | — — — | 0.15 0.2 0.2 | — 0.15 0.15 | 12 14 17 | — — — | 4 5 6 | — — — | 6 7 9 | — — — | — — — | — — — | — — — | — — — | — — — | 0.2 0.2 0.3 | | | |
| 7 8 9 | 7 8 9 | 17 19 20 | — — — | 5 6 6 | — — — | 7 9 9 | 10 11 11 | — — — | — — — | 0.3 0.3 0.3 | 0.15 0.2 0.3 | 19 22 24 | — — — | 6 7 7 | 8 9 10 | 10 11 12 | — 14 15 | — 19 20 | — 25 27 | — — — | — — — | — — — | 0.3 0.3 0.3 | | | |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. The chamfer dimensions given in this table do not necessarily apply to:

- (1) the groove side of bearing rings with snap ring groove
 (2) the flangeless side of thin cylindrical roller bearing rings

- (3) the front face side of angular contact bearing
 (4) inner rings of bearings with tapered bore



Table 4.2.1 Boundary Dimensions of Diameter Series 9, 0

(2/8)

Unit : mm



| | | | | | | | | | | | | | | | | | | | | | | | | |
|----------------------------------|-------------------------------|------------------|----------|-----|-----|------|----|----|-----|----------------------|----------|----|-------------------------------|------------------|----------|----|------|-----|----|-----|----------|----------------------|--|--|
| Single row, radial ball bearings | | | 69 79 | | | | | | | | | | | 160 | 60 70 | | | | | | | | | |
| Double row, radial ball bearings | | | | | | | | | | | | | | | | | | | | | | | | |
| Cylindrical roller bearings | | | | | | NN49 | | | | | | | | | N10 | | NN30 | | | | | | | |
| Spherical roller bearings | | | | | 239 | | | | | | | | | | | | 230 | 240 | | | | | | |
| Bearing bore diameter Nominal | Diameter series 9 | | | | | | | | | | | | Diameter series 0 | | | | | | | | | | | |
| | Bearing outside diameter D | Width series | | | | | | | | Chamfer dimension | | | Bearing outside diameter D | Width series | | | | | | | | Chamfer dimension | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 0 | | | | | 1 | 2 | 3 | 4 | 5 | 6 | | | | | |
| | | Dimension series | | | | | | | | | | | | Dimension series | | | | | | | | | | |
| | | 09 | 19 | 29 | 39 | 49 | 59 | 69 | 09 | 19 39 | 49 69 | 00 | | 10 | 20 | 30 | 40 | 50 | 60 | 00 | 10 60 | | | |
| Bore No. d | | Width B | | | | | | | | r _{min} | | | | Width B | | | | | | | | r _{min} | | |
| 00 10 | 22 | — | 6 | 8 | 10 | 13 | 16 | 22 | — | 0.3 | 0.3 | 26 | — | 8 | 10 | 12 | 16 | 21 | 29 | — | 0.3 | | | |
| 01 12 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | | | |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. The chamfer dimensions given in this table do not necessarily apply to:

- (1) the groove side of bearing rings with snap ring groove
 (2) the flangeless side of thin cylindrical roller bearing rings

- (3) the front face side of angular contact bearing
 (4) inner rings of bearings with tapered bore



Table 4.2.1 Boundary Dimensions of Diameter Series 9, 0

(3/8)

Unit : mm



| | | | | | | | | | | | | | | | | | | | | | | | | |
|----------------------------------|-------------------------------|------------------|----------|----|-----|------|----|----|----------------------|----------|----------|-------------------------------|-------------------|------------------|----------|----|------|-----|----|----------------------|----------|--|--|--|
| Single row, radial ball bearings | | | 69 79 | | | | | | | | | | | 160 | 60 70 | | | | | | | | | |
| Double row, radial ball bearings | | | | | | | | | | | | | | | | | | | | | | | | |
| Cylindrical roller bearings | | | | | | NN49 | | | | | | | | | N10 | | NN30 | | | | | | | |
| Spherical roller bearings | | | | | 239 | | | | | | | | | | | | 230 | 240 | | | | | | |
| Bearing bore diameter Nominal | Diameter series 9 | | | | | | | | | | | | Diameter series 0 | | | | | | | | | | | |
| | Bearing outside diameter D | Width series | | | | | | | Chamfer dimension | | | Bearing outside diameter D | Width series | | | | | | | Chamfer dimension | | | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | | | | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | | | | | |
| | | Dimension series | | | | | | | | | | | | Dimension series | | | | | | | | | | |
| | | 09 | 19 | 29 | 39 | 49 | 59 | 69 | 09 | 19 39 | 49 69 | | 00 | 10 | 20 | 30 | 40 | 50 | 60 | 00 | 10 60 | | | |
| | | Width B | | | | | | | r _{min} | | | | Width B | | | | | | | r _{min} | | | | |
| 09 45 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | | | |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. The chamfer dimensions given in this table do not necessarily apply to:

- (1) the groove side of bearing rings with snap ring groove
 (2) the flangeless side of thin cylindrical roller bearing rings

- (3) the front face side of angular contact bearing
 (4) inner rings of bearings with tapered bore



Table 4.2.1 Boundary Dimensions of Diameter Series 9, 0

(4/8)

Unit : mm



| | | | | | | | | | | | | | | | | | | | | | | | | | |
|----------------------------------|-------------------------------|------------------|----------|----|-----|------|-----|-----|-----|----------------------|----------|-----|-------------------|-------------------------------|------------------|----------|-----|------|-----|-----|----------|--|----------------------|--|--|
| Single row, radial ball bearings | | | 69 79 | | | | | | | | | | | | 160 | 60 70 | | | | | | | | | |
| Double row, radial ball bearings | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cylindrical roller bearings | | | | | | NN49 | | | | | | | | | | N10 | | NN30 | | | | | | | |
| Spherical roller bearings | | | | | 239 | | | | | | | | | | | | | 230 | 240 | | | | | | |
| Bearing bore diameter Nominal | Diameter series 9 | | | | | | | | | | | | Diameter series 0 | | | | | | | | | | | | |
| | Bearing outside diameter D | Width series | | | | | | | | Chamfer dimension | | | | Bearing outside diameter D | Width series | | | | | | | | Chamfer dimension | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 0 | | | | | | 1 | 2 | 3 | 4 | 5 | 6 | | | | | |
| | | Dimension series | | | | | | | | | | | | | Dimension series | | | | | | | | | | |
| | | 09 | 19 | 29 | 39 | 49 | 59 | 69 | 09 | 19 39 | 49 69 | 00 | 10 | | 20 | 30 | 40 | 50 | 60 | 00 | 10 60 | | | | |
| Bore No. d | | Width B | | | | | | | | r _{min} | | | | | Width B | | | | | | | | r _{min} | | |
| 21 105 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | | | | |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. The chamfer dimensions given in this table do not necessarily apply to:

- (1) the groove side of bearing rings with snap ring groove
 (2) the flangeless side of thin cylindrical roller bearing rings

- (3) the front face side of angular contact bearing
 (4) inner rings of bearings with tapered bore



Table 4.2.1 Boundary Dimensions of Diameter Series 9, 0

| | | | | | | | | | | | | | | | | | | | | | | | | |
|----------------------------------|----------------------------|------------------|----------|---------|-----|-------------|----|----|------------------|-------------------|----------|---------|----------------------------|------------------|----------|----|------|-----|----|------------------|----------|-------------------|--|--|
| Single row, radial ball bearings | | | 69 79 | | | | | | | | | | | 160 | 60 70 | | | | | | | | | |
| Double row, radial ball bearings | | | | | | | | | | | | | | | | | | | | | | | | |
| Cylindrical roller bearings | | | | | | NN49 | | | | | | | | | N10 | | NN30 | | | | | | | |
| Spherical roller bearings | | | | | 239 | | | | | | | | | | | | 230 | 240 | | | | | | |
| Bearing bore diameter Nominal | Diameter series 9 | | | | | | | | | | | | Diameter series 0 | | | | | | | | | | | |
| | Bearing outside diameter D | Width series | | | | | | | | Chamfer dimension | | | Bearing outside diameter D | Width series | | | | | | | | Chamfer dimension | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 0 | | | | | 1 | 2 | 3 | 4 | 5 | 6 | | | | | |
| | | Dimension series | | | | | | | | | | | | Dimension series | | | | | | | | | | |
| | | 09 | 19 | 29 | 39 | 49 | 59 | 69 | 09 | 19 39 | 49 69 | 00 | | 10 | 20 | 30 | 40 | 50 | 60 | 00 | 10 60 | | | |
| Bore No. d | Width B | | | | | | | | r _{min} | | | Width B | | | | | | | | r _{min} | | | | |
| 48 240 52 260 56 280 | 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 | | | | | | | | | | |
| | 360 | 31 46 | 60 75 | 100 136 | 180 | 2 2.1 2.1 | | | 400 | 44 65 | 82 104 | 140 190 | 250 | 3 4 | | | | | | | | | | |
| | 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 64 320 68 340 | 420 | 37 56 | 72 90 | 118 160 | 218 | 2.1 3 3 | | | 460 | 50 74 | 95 118 | 160 218 | 290 | 4 4 | | | | | | | | | | |
| | 440 | 37 56 | 72 90 | 118 160 | 218 | 2.1 3 3 | | | 480 | 50 74 | 95 121 | 160 218 | 290 | 4 4 | | | | | | | | | | |
| | 460 | 37 56 | 72 90 | 118 160 | 218 | 2.1 3 3 | | | 520 | 57 82 | 106 133 | 180 243 | 325 | 4 5 | | | | | | | | | | |
| 72 360 76 380 80 400 | 480 | 37 56 | 72 90 | 118 160 | 218 | 2.1 3 3 | | | 540 | 57 82 | 106 134 | 180 243 | 325 | 4 5 | | | | | | | | | | |
| | 520 | 44 65 | 82 106 | 140 190 | 250 | 3 4 4 | | | 560 | 57 82 | 106 135 | 180 243 | 325 | 4 5 | | | | | | | | | | |
| | 540 | 44 65 | 82 106 | 140 190 | 250 | 3 4 4 | | | 600 | 63 90 | 118 148 | 200 272 | 355 | 5 5 | | | | | | | | | | |
| 84 420 88 440 92 460 | 560 | 44 65 | 82 106 | 140 190 | 250 | 3 4 4 | | | 620 | 63 90 | 118 150 | 200 272 | 355 | 5 5 | | | | | | | | | | |
| | 600 | 50 74 | 95 118 | 160 218 | 290 | 4 4 4 | | | 650 | 67 94 | 122 157 | 212 280 | 375 | 5 6 | | | | | | | | | | |
| | 620 | 50 74 | 95 118 | 160 218 | 290 | 4 4 4 | | | 680 | 71 100 | 128 163 | 218 300 | 400 | 5 6 | | | | | | | | | | |

Remarks: 1. r_{min} is the smallest chamfer dimension.
2. The chamfer dimensions given in this table do not necessarily apply to:
(1) the groove side of bearing rings with snap ring groove
(2) the flangeless side of thin cylindrical roller bearing rings
(3) the front face side of angular contact bearing
(4) inner rings of bearings with tapered bore

Table 4.2.1 Boundary Dimensions of Diameter Series 9, 0

(6/8)

Unit : mm



| | | | | | | | | | | | | | | | | | | | | | | | | | | |
|----------------------------------|-------------------------------|----------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------|----------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------|------------------|----------|----|------|----------------------|----|----|----------|---|--|--|--|--|
| Single row, radial ball bearings | | | 69 79 | | | | | | | | | | | 160 | 60 70 | | | | | | | | | | | |
| Double row, radial ball bearings | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cylindrical roller bearings | | | | | | NN49 | | | | | | | | | N10 | | NN30 | | | | | | | | | |
| Spherical roller bearings | | | | | 239 | | | | | | | | | | | | 230 | 240 | | | | | | | | |
| Bearing bore diameter Nominal | Diameter series 9 | | | | | | | | | | | | Diameter series 0 | | | | | | | | | | | | | |
| | Bearing outside diameter D | Width series | | | | | | Chamfer dimension | | | Bearing outside diameter D | Width series | | | | | | Chamfer dimension | | | | | | | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | | | | | 6 | 0 | 1 | 2 | 3 | 4 | | | | 5 | 6 | | | | |
| | | Dimension series | | | | | | | | | | | | Dimension series | | | | | | | | | | | | |
| | | 09 | 19 | 29 | 39 | 49 | 59 | 69 | 09 | 19 39 | | 49 69 | 00 | 10 | 20 | 30 | 40 | 50 | 60 | 00 | 10 60 | | | | | |
| Bore No. d | | Width B | | | | | | r _{min} | | | | Width B | | | | | | r _{min} | | | | | | | | |
| 96 480 /500 500 /530 530 | 650 670 710 | 54 78 54 78 57 82 | 100 128 100 128 106 136 | 170 230 170 230 180 243 | 308 308 308 308 325 325 | 4 5 5 4 5 5 4 5 5 | 700 720 780 | 71 100 71 100 80 112 | 128 165 128 167 145 185 | 218 300 218 300 250 335 | 400 400 400 400 450 450 | 5 6 5 6 6 6 | | | | | | | | | | | | | | |
| /560 560 /600 600 /630 630 | 750 800 850 | 60 85 63 90 71 100 | 112 140 118 150 128 165 | 190 258 200 272 218 300 | 345 355 355 438 400 400 | 5 5 5 5 5 5 5 6 6 | 820 870 920 | 82 115 85 118 92 128 | 150 195 155 200 170 212 | 258 355 272 365 290 388 | 462 488 488 515 515 515 | 6 6 6 6 6 7.5 | | | | | | | | | | | | | | |
| /670 670 /710 710 /750 750 | 900 950 1000 | 73 103 78 106 80 112 | 136 170 140 180 145 185 | 230 308 243 325 250 335 | 412 438 438 450 450 450 | 5 6 6 5 6 6 6 6 6 | 980 1030 1090 | 100 136 103 140 109 150 | 180 230 185 236 195 250 | 308 425 315 438 335 462 | 560 580 580 615 615 615 | 6 7.5 6 7.5 7.5 7.5 | | | | | | | | | | | | | | |
| /800 800 /850 850 /900 900 | 1060 1120 1180 | 82 115 85 118 88 122 | 150 195 155 200 165 206 | 258 355 272 365 280 375 | 462 488 488 500 500 500 | 6 6 6 6 6 6 6 6 6 | 1150 1220 1280 | 112 155 118 165 122 170 | 200 258 212 272 218 280 | 345 475 365 500 375 515 | 630 670 670 690 690 690 | 7.5 7.5 7.5 7.5 7.5 7.5 | | | | | | | | | | | | | | |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. The chamfer dimensions given in this table do not necessarily apply to:


- (1) the groove side of bearing rings with snap ring groove
 (2) the flangeless side of thin cylindrical roller bearing rings

- (3) the front face side of angular contact bearing
 (4) inner rings of bearings with tapered bore



Table 4.2.1 Boundary Dimensions of Diameter Series 9, 0

(7/8)

Unit : mm 

| | | | | | | | | | | | | | | | | | | | | | | | |
|----------------------------------|----------------------------|------------------|----------|-----|-----|------|-----|-----|-------------------|----------|----------|----------------------------|------------------|----------|-----|------|-----|-----|-----|-------------------|----------|--|--|
| Single row, radial ball bearings | | | 69 79 | | | | | | | | | | 160 | 60 70 | | | | | | | | | |
| Double row, radial ball bearings | | | | | | | | | | | | | | | | | | | | | | | |
| Cylindrical roller bearings | | | | | | NN49 | | | | | | | | N10 | | NN30 | | | | | | | |
| Spherical roller bearings | | | | | 239 | | | | | | | | | | | 230 | 240 | | | | | | |
| Bearing bore diameter Nominal | Diameter series 9 | | | | | | | | | | | Diameter series 0 | | | | | | | | | | | |
| | Bearing outside diameter D | Width series | | | | | | | Chamfer dimension | | | Bearing outside diameter D | Width series | | | | | | | Chamfer dimension | | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | | | | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | | | | |
| | | Dimension series | | | | | | | | | | | Dimension series | | | | | | | | | | |
| | | 09 | 19 | 29 | 39 | 49 | 59 | 69 | 09 | 19 39 | 49 69 | | 00 | 10 | 20 | 30 | 40 | 50 | 60 | 00 | 10 60 | | |
| Bore No. d | | Width B | | | | | | | r _{min} | | | | Width B | | | | | | | r _{min} | | | |
| /950 950 | 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 | 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 | 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 | 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 | 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 | 1630 | 122 | 170 | 218 | 280 | 375 | 515 | 690 | 7.5 | 7.5 | 7.5 | 1750 | — | 218 | 290 | 375 | 500 | — | — | — 9.5 | | | |
| /1320 1320 | 1720 | 128 | 175 | 230 | 300 | 400 | 545 | 710 | 7.5 | 7.5 | 7.5 | 1850 | — | 230 | 300 | 400 | 530 | — | — | — 12 | | | |
| /1400 1400 | 1820 | — | 185 | 243 | 315 | 425 | — | — | — | 9.5 | 9.5 | 1950 | — | 243 | 315 | 412 | 545 | — | — | — 12 | | | |
| /1500 1500 | 1950 | — | 195 | 258 | 335 | 450 | — | — | — | 9.5 | 9.5 | 2120 | — | 272 | 355 | 462 | 615 | — | — | — 12 | | | |

Remarks: 1. r_{min} is the smallest chamfer dimension.
2. The chamfer dimensions given in this table do not necessarily apply to:
(1) the groove side of bearing rings with snap ring groove
(2) the flangeless side of thin cylindrical roller bearing rings
(3) the front face side of angular contact bearing
(4) inner rings of bearings with tapered bore

Table 4.2.1 Boundary Dimensions of Diameter Series 9, 0

| | | | | | | | | | | | | | | | | | | | | | | |
|----------------------------------|-------------------------------|------------------|----------|-----|-----|------|----|----|----------------------|----------|-------------------------------|-------------------|-----|----------|-----|------|-----|----|----------------------|----|----------|--|
| Single row, radial ball bearings | | | 69 79 | | | | | | | | | | 160 | 60 70 | | | | | | | | |
| Double row, radial ball bearings | | | | | | | | | | | | | | | | | | | | | | |
| Cylindrical roller bearings | | | | | | NN49 | | | | | | | | N10 | | NN30 | | | | | | |
| Spherical roller bearings | | | | | 239 | | | | | | | | | | | 230 | 240 | | | | | |
| Bearing bore diameter Nominal | Diameter series 9 | | | | | | | | | | | Diameter series 0 | | | | | | | | | | |
| | Bearing outside diameter D | Width series | | | | | | | Chamfer dimension | | Bearing outside diameter D | Width series | | | | | | | Chamfer dimension | | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | | | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | | | | |
| | | Dimension series | | | | | | | | | | Dimension series | | | | | | | | | | |
| | | 09 | 19 | 29 | 39 | 49 | 59 | 69 | 09 | 19 39 | | 49 69 | 00 | 10 | 20 | 30 | 40 | 50 | 60 | 00 | 10 60 | |
| Bore No. d | | Width B | | | | | | | r _{min} | | | Width B | | | | | | | r _{min} | | | |
| /1600 1600 | 2060 | – | 200 | 265 | 345 | 462 | – | – | – | 9.5 | 9.5 | 2240 | – | 280 | 365 | 475 | 630 | – | – | – | 12 | |
| /1700 1700 | 2180 | – | 212 | 280 | 355 | 475 | – | – | – | 9.5 | 9.5 | 2360 | – | 290 | 375 | 500 | 650 | – | – | – | 15 | |
| /1800 1800 | 2300 | – | 218 | 290 | 375 | 500 | – | – | – | 12 | 12 | 2500 | – | 308 | 400 | 530 | 690 | – | – | – | 15 | |
| /1900 1900 | 2430 | – | 230 | 308 | 400 | 530 | – | – | – | 12 | 12 | – | – | – | – | – | – | – | – | – | – | |
| /2000 2000 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |

Remarks: 1. r_{min} is the smallest chamfer dimension.
2. The chamfer dimensions given in this table do not necessarily apply to:
(1) the groove side of bearing rings with snap ring groove
(2) the flangeless side of thin cylindrical roller bearing rings
(3) the front face side of angular contact bearing
(4) inner rings of bearings with tapered bore

Table 4.2.2 Boundary Dimensions of Diameter Series 1, 2

(1/8)

Unit : mm

| | | | | | | | | | | | | | | | | | | |
|----------------------------------|-------------------------------|------------------|----|----|-----|-----|----------------------|----------|-------------------------------|------------------|---------------|-------------|-------------|-------------|----------------|----------------------|---------------------|-------------------|
| Single row, radial ball bearings | | | | | | | | | | | 62 72 | | | | | | | |
| Double row, radial ball bearings | | | | | | | | | | | 12 | | | 32 52 | | | | |
| Cylindrical roller bearings | | | | | | | | | | | N2 | | N22 | | | | | |
| Spherical roller bearings | | | | | 231 | 241 | | | | | | | 222 | 232 | | | | |
| Bearing bore diameter Nominal | Diameter series 1 | | | | | | | | Diameter series 2 | | | | | | | | | |
| | Bearing outside diameter D | Width series | | | | | Chamfer dimension | | Bearing outside diameter D | Width series | | | | | | Chamfer dimension | | |
| | | 0 | 1 | 2 | 3 | 4 | | | | 8 | 0 | 1 | 2 | 3 | 4 | | | |
| | | Dimension series | | | | | | | | Dimension series | | | | | | | | |
| | | 01 | 11 | 21 | 31 | 41 | 01 | 11 41 | | 82 | 02 | 12 | 22 | 32 | 42 | 82 | 02 42 | |
| Bore No. d | | Width B | | | | | r _{min} | | | Width B | | | | | | r _{min} | | |
| 1/0.6 1 1/1.5 | 0.6 1 1.5 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | |
| 2 2/2.5 3 | 2 2.5 3 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | |
| 4 5 6 | 4 5 6 | — | — | — | — | — | — | — | — | 13 16 19 | 3 3.5 4 | 5 5 6 | — — — | — — — | 7 8 10 | — — — | 0.15 0.15 0.2 | 0.2 0.3 0.3 |
| 7 8 9 | 7 8 9 | — | — | — | — | — | — | — | — | 22 24 26 | 5 5 6 | 7 8 8 | — — — | — — — | 11 12 13 | — — — | 0.3 0.3 0.3 | 0.3 0.3 0.3 |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. The chamfer dimensions given in this table do not necessarily apply to:

- (1) the groove side of bearing rings with snap ring groove
 (2) the flangeless side of thin cylindrical roller bearing rings

- (3) the front face side of angular contact bearing
 (4) inner rings of bearings with tapered bore



Table 4.2.2 Boundary Dimensions of Diameter Series 1, 2

(2/8)

Unit : mm

| | | | | | | | | | | | | | | | | | |
|----------------------------------|----------------------------|------------------|----|----|-----|------------------|-------------------|----------------------------|-------------------|----|----|----|-----|------|-------------------|-----|----------|
| Single row, radial ball bearings | | | | | | | | | | | 62 | | | | | | |
| Double row, radial ball bearings | | | | | | | | | | | 12 | | | 32 | | | |
| Cylindrical roller bearings | | | | | | | | | | | N2 | | N22 | | | | |
| Spherical roller bearings | | | | | 231 | 241 | | | | | | | 222 | 232 | | | |
| Bearing bore diameter Nominal | Diameter series 1 | | | | | | | | Diameter series 2 | | | | | | | | |
| | Bearing outside diameter D | Width series | | | | | Chamfer dimension | Bearing outside diameter D | Width series | | | | | | Chamfer dimension | | |
| | | 0 | 1 | 2 | 3 | 4 | | | 8 | 0 | 1 | 2 | 3 | 4 | | | |
| | | Dimension series | | | | | | | Dimension series | | | | | | | | |
| | | 01 | 11 | 21 | 31 | 41 | 01 | | 11 41 | 82 | 02 | 12 | 22 | 32 | 42 | 82 | 02 42 |
| Bore No. d | | Width B | | | | r _{min} | | | Width B | | | | | | r _{min} | | |
| 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 |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. The chamfer dimensions given in this table do not necessarily apply to:

- (1) the groove side of bearing rings with snap ring groove
 (2) the flangeless side of thin cylindrical roller bearing rings

- (3) the front face side of angular contact bearing
 (4) inner rings of bearings with tapered bore

Table 4.2.2 Boundary Dimensions of Diameter Series 1, 2

(3/8)

Unit : mm



| | | | | | | | | | | | | | | | | | | |
|----------------------------------|----------------------------|-------------------|----|----|-----|-----|-------------------|--------------|---------------|-------------------|----|----|-----|-------------------|------------------|----|-----|---------------|
| Single row, radial ball bearings | | | | | | | | | | | 62 | 72 | | | | | | |
| Double row, radial ball bearings | | | | | | | | | | | 12 | | | 32 | 52 | | | |
| Cylindrical roller bearings | | | | | | | | | | | N2 | | N22 | | | | | |
| Spherical roller bearings | | | | | 231 | 241 | | | | | | | | 222 | 232 | | | |
| Bearing bore diameter Nominal | Bearing outside diameter D | Diameter series 1 | | | | | | | | Diameter series 2 | | | | | | | | |
| | | Width series | | | | | Chamfer dimension | Width series | | | | | | Chamfer dimension | | | | |
| | | 0 | 1 | 2 | 3 | 4 | | 8 | 0 | 1 | 2 | 3 | 4 | | | | | |
| | | Dimension series | | | | | | | | Dimension series | | | | | | | | |
| | Bore No. d | | 01 | 11 | 21 | 31 | 41 | 01 | 11 1 41 | | 82 | 02 | 12 | 22 | 32 | 42 | 82 | 02 1 42 |
| | | Width B | | | | | r _{min} | | | Width B | | | | | r _{min} | | | |
| 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 | 150 | — | — | — | — | 60 | — | 2 | — | 160 | 22 | 30 | — | 40 | 52.4 | 69 | 1.1 | 2 |
| 19 95 | 160 | — | — | — | — | 65 | — | 2 | — | 170 | 24 | 32 | — | 43 | 55.6 | 75 | 1.1 | 2.1 |
| 20 100 | 165 | 21 | 30 | 39 | 52 | 65 | 1.1 | 2 | — | 180 | 25 | 34 | — | 46 | 60.3 | 80 | 1.5 | 2.1 |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. The chamfer dimensions given in this table do not necessarily apply to:

- (1) the groove side of bearing rings with snap ring groove
- (2) the flangeless side of thin cylindrical roller bearing rings

- (3) the front face side of angular contact bearing
- (4) inner rings of bearings with tapered bore



Table 4.2.2 Boundary Dimensions of Diameter Series 1, 2

(4/8)

Unit : mm

| | | | | | | | | | | | | | | | | | | |
|----------------------------------|-------------------------------|------------------|----|----|-----|------------------|----------------------|---------------|-------------------------------|------------------|----|----|-----|------|------------------|----------------------|---------------|--|
| Single row, radial ball bearings | | | | | | | | | | | 62 | 72 | | | | | | |
| Double row, radial ball bearings | | | | | | | | | | | 12 | | | 32 | 52 | | | |
| Cylindrical roller bearings | | | | | | | | | | | N2 | | N22 | | | | | |
| Spherical roller bearings | | | | | 231 | 241 | | | | | | | | 222 | 232 | | | |
| Bearing bore diameter Nominal | Diameter series 1 | | | | | | | | Diameter series 2 | | | | | | | | | |
| | Bearing outside diameter D | Width series | | | | | Chamfer dimension | | Bearing outside diameter D | Width series | | | | | | Chamfer dimension | | |
| | | 0 | 1 | 2 | 3 | 4 | | | | 8 | 0 | 1 | 2 | 3 | 4 | | | |
| | | Dimension series | | | | | | | | Dimension series | | | | | | | | |
| | | 01 | 11 | 21 | 31 | 41 | 01 | 11 2 41 | | 82 | 02 | 12 | 22 | 32 | 42 | 82 | 02 2 42 | |
| Bore No. d | | Width B | | | | r _{min} | | | Width B | | | | | | r _{min} | | | |
| 21 105 | 175 | 22 | 33 | 42 | 56 | 69 | 1.1 | 2 | 190 | 27 | 36 | — | 50 | 65.1 | 85 | 1.5 | 2.1 | |
| 22 110 | 180 | 22 | 33 | 42 | 56 | 69 | 1.1 | 2 | 200 | 28 | 38 | — | 53 | 69.8 | 90 | 1.5 | 2.1 | |
| 24 120 | 200 | 25 | 38 | 48 | 62 | 80 | 1.5 | 2 | 215 | — | 40 | 42 | 58 | 76 | 95 | — | 2.1 | |
| 26 130 | 210 | 25 | 38 | 48 | 64 | 80 | 1.5 | 2 | 230 | — | 40 | 46 | 64 | 80 | 100 | — | 3 | |
| 28 140 | 225 | 27 | 40 | 50 | 68 | 85 | 1.5 | 2.1 | 250 | — | 42 | 50 | 68 | 88 | 109 | — | 3 | |
| 30 150 | 250 | 31 | 46 | 60 | 80 | 100 | 2 | 2.1 | 270 | — | 45 | 54 | 73 | 96 | 118 | — | 3 | |
| 32 160 | 270 | 34 | 51 | 66 | 86 | 109 | 2 | 2.1 | 290 | — | 48 | 58 | 80 | 104 | 128 | — | 3 | |
| 34 170 | 280 | 34 | 51 | 66 | 88 | 109 | 2 | 2.1 | 310 | — | 52 | 62 | 86 | 110 | 140 | — | 4 | |
| 36 180 | 300 | 37 | 56 | 72 | 96 | 118 | 2.1 | 3 | 320 | — | 52 | 62 | 86 | 112 | 140 | — | 4 | |
| 38 190 | 320 | 42 | 60 | 78 | 104 | 128 | 3 | 3 | 340 | — | 55 | 65 | 92 | 120 | 150 | — | 4 | |
| 40 200 | 340 | 44 | 65 | 82 | 112 | 140 | 3 | 3 | 360 | — | 58 | 70 | 98 | 128 | 160 | — | 4 | |
| 44 220 | 370 | 48 | 69 | 88 | 120 | 150 | 3 | 4 | 400 | — | 65 | 78 | 108 | 144 | 180 | — | 4 | |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. The chamfer dimensions given in this table do not necessarily apply to:

- (1) the groove side of bearing rings with snap ring groove
 (2) the flangeless side of thin cylindrical roller bearing rings

- (3) the front face side of angular contact bearing
 (4) inner rings of bearings with tapered bore

Table 4.2.2 Boundary Dimensions of Diameter Series 1, 2

(5/8)

Unit : mm



| | | | | | | | | | | | | | | | | | | |
|----------------------------------|-------------------------------|------------------|-----|-----|-----|-----|----------------------|----------|-------------------------------|------------------|-----|-----|-----|-----|----------------------|----|----------|--|
| Single row, radial ball bearings | | | | | | | | | | | 62 | | | | | | | |
| Double row, radial ball bearings | | | | | | | | | | | 12 | | | 32 | | | | |
| Cylindrical roller bearings | | | | | | | | | | | N2 | | N22 | | | | | |
| Spherical roller bearings | | | | | 231 | 241 | | | | | | | 222 | 232 | | | | |
| Bearing bore diameter Nominal | Diameter series 1 | | | | | | | | Diameter series 2 | | | | | | | | | |
| | Bearing outside diameter D | Width series | | | | | Chamfer dimension | | Bearing outside diameter D | Width series | | | | | Chamfer dimension | | | |
| | | 0 | 1 | 2 | 3 | 4 | | | | 8 | 0 | 1 | 2 | 3 | | | 4 | |
| | | Dimension series | | | | | | | | Dimension series | | | | | | | | |
| | | 01 | 11 | 21 | 31 | 41 | 01 | 11 41 | | 82 | 02 | 12 | 22 | 32 | 42 | 82 | 02 42 | |
| Bore No. d | | Width B | | | | | r _{min} | | | Width B | | | | | r _{min} | | | |
| 48 240 | 400 | 50 | 74 | 95 | 128 | 160 | 4 | 4 | 440 | — | 72 | 85 | 120 | 160 | 200 | — | 4 | |
| 52 260 | 440 | 57 | 82 | 106 | 144 | 180 | 4 | 4 | 480 | — | 80 | 90 | 130 | 174 | 218 | — | 5 | |
| 56 280 | 460 | 57 | 82 | 106 | 146 | 180 | 4 | 5 | 500 | — | 80 | 90 | 130 | 176 | 218 | — | 5 | |
| 60 300 | 500 | 63 | 90 | 118 | 160 | 200 | 5 | 5 | 540 | — | 85 | 98 | 140 | 192 | 243 | — | 5 | |
| 64 320 | 540 | 71 | 100 | 128 | 176 | 218 | 5 | 5 | 580 | — | 92 | 105 | 150 | 208 | 258 | — | 5 | |
| 68 340 | 580 | 78 | 106 | 140 | 190 | 243 | 5 | 5 | 620 | — | 92 | 118 | 165 | 224 | 280 | — | 6 | |
| 72 360 | 600 | 78 | 106 | 140 | 192 | 243 | 5 | 5 | 650 | — | 95 | 122 | 170 | 232 | 290 | — | 6 | |
| 76 380 | 620 | 78 | 106 | 140 | 194 | 243 | 5 | 5 | 680 | — | 95 | 132 | 175 | 240 | 300 | — | 6 | |
| 80 400 | 650 | 80 | 112 | 145 | 200 | 250 | 6 | 6 | 720 | — | 103 | 140 | 185 | 256 | 315 | — | 6 | |
| 84 420 | 700 | 88 | 122 | 165 | 224 | 280 | 6 | 6 | 760 | — | 109 | 150 | 195 | 272 | 335 | — | 7.5 | |
| 88 440 | 720 | 88 | 122 | 165 | 226 | 280 | 6 | 6 | 790 | — | 112 | 155 | 200 | 280 | 345 | — | 7.5 | |
| 92 460 | 760 | 95 | 132 | 175 | 240 | 300 | 6 | 7.5 | 830 | — | 118 | 165 | 212 | 296 | 365 | — | 7.5 | |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. The chamfer dimensions given in this table do not necessarily apply to:

- (1) the groove side of bearing rings with snap ring groove
- (2) the flangeless side of thin cylindrical roller bearing rings

- (3) the front face side of angular contact bearing
- (4) inner rings of bearings with tapered bore



Table 4.2.2 Boundary Dimensions of Diameter Series 1, 2

(6/8)

Unit : mm

| | | | | | | | | | | | | | | | | | | |
|----------------------------------|----------------------------|---|-------------------------------|----|----------------------|---|-------------------------|--------------|----|-------------------|----|----|-----|-------------------|------------------|----------|--|--|
| Single row, radial ball bearings | | | | | | | | | | | 62 | 72 | | | | | | |
| Double row, radial ball bearings | | | | | | | | | | | 12 | | | 32 | 52 | | | |
| Cylindrical roller bearings | | | | | | | | | | | N2 | | N22 | | | | | |
| Spherical roller bearings | | | | | 231 | 241 | | | | | | | 222 | 232 | | | | |
| Bearing bore diameter Nominal | Bearing outside diameter D | Diameter series 1 | | | | | | | | Diameter series 2 | | | | | | | | |
| | | Width series | | | | | Chamfer dimension | Width series | | | | | | Chamfer dimension | | | | |
| | | 0 | 1 | 2 | 3 | 4 | | 8 | 0 | 1 | 2 | 3 | 4 | | | | | |
| | | Dimension series | | | | | | | | Dimension series | | | | | | | | |
| | | 01 | 11 | 21 | 31 | 41 | 01 | 11 41 | 82 | 02 | 12 | 22 | 32 | 42 | 82 | 02 42 | | |
| Bore No. d | | Width B | | | | | r _{min} | | | Width B | | | | | r _{min} | | | |
| 96 480 /500 500 /530 530 | 790 830 870 | 100 136 180 248 308 106 145 190 264 325 109 150 195 272 335 | 6 7.5 7.5 7.5 7.5 7.5 | | 870 920 980 | — 125 170 224 310 388 — 136 185 243 336 412 — 145 200 258 355 450 | — 7.5 — 7.5 — 9.5 | | | | | | | | | | | |
| /560 560 /600 600 /630 630 | 920 980 1030 | 115 160 206 280 355 122 170 218 300 375 128 175 230 315 400 | 7.5 7.5 7.5 7.5 7.5 7.5 | | 1030 1090 1150 | — 150 206 272 365 475 — 155 212 280 388 488 — 165 230 300 412 515 | — 9.5 — 9.5 — 12 | | | | | | | | | | | |
| /670 670 /710 710 /750 750 | 1090 1150 1220 | 136 185 243 336 412 140 195 250 345 438 150 206 272 365 475 | 7.5 7.5 9.5 9.5 9.5 9.5 | | 1220 1280 1360 | — 175 243 315 438 545 — 180 250 325 450 560 — 195 265 345 475 615 | — 12 — 12 — 15 | | | | | | | | | | | |
| /800 800 /850 850 /900 900 | 1280 1360 1420 | 155 212 272 375 475 165 224 290 400 500 165 230 300 412 515 | 9.5 9.5 12 12 12 12 | | 1420 1500 1580 | — 200 272 355 488 615 — 206 280 375 515 650 — 218 300 388 515 670 | — 15 — 15 — 15 | | | | | | | | | | | |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. The chamfer dimensions given in this table do not necessarily apply to:

- (1) the groove side of bearing rings with snap ring groove
 (2) the flangeless side of thin cylindrical roller bearing rings

- (3) the front face side of angular contact bearing
 (4) inner rings of bearings with tapered bore

Table 4.2.2 Boundary Dimensions of Diameter Series 1, 2

(7/8)

Unit : mm

| | | | | | | | | | | | | | | | | | | |
|----------------------------------|-------------------------------|------------------|-----|-----|-----|-----|----------------------|-------------------------------|------------------|-------------------|-----|-----|-----|----------------------|-----|----|----------|--|
| Single row, radial ball bearings | | | | | | | | | | | 62 | 72 | | | | | | |
| Double row, radial ball bearings | | | | | | | | | | | 12 | | | | 32 | 52 | | |
| Cylindrical roller bearings | | | | | | | | | | | N2 | | N22 | | | | | |
| Spherical roller bearings | | | | | 231 | 241 | | | | | | | | 222 | 232 | | | |
| Bearing bore diameter Nominal | Diameter series 1 | | | | | | | | | Diameter series 2 | | | | | | | | |
| | Bearing outside diameter D | Width series | | | | | Chamfer dimension | Bearing outside diameter D | Width series | | | | | Chamfer dimension | | | | |
| | | 0 | 1 | 2 | 3 | 4 | | | 8 | 0 | 1 | 2 | 3 | | 4 | | | |
| | | Dimension series | | | | | | | Dimension series | | | | | | | | | |
| | | 01 | 11 | 21 | 31 | 41 | 01 | | 11 41 | 82 | 02 | 12 | 22 | 32 | 42 | 82 | 02 42 | |
| | | Width B | | | | | r _{min} | | Width B | | | | | r _{min} | | | | |
| /950 950 | 1500 | 175 | 243 | 315 | 438 | 545 | 12 | 12 | 1660 | — | 230 | 315 | 412 | 530 | 710 | — | 15 | |
| /1000 1000 | 1580 | 185 | 258 | 335 | 462 | 580 | 12 | 12 | 1750 | — | 243 | 330 | 425 | 560 | 750 | — | 15 | |
| /1060 1060 | 1660 | 190 | 265 | 345 | 475 | 600 | 12 | 15 | — | — | — | — | — | — | — | — | — | |
| /1120 1120 | 1750 | — | 280 | 365 | 475 | 630 | — | 15 | — | — | — | — | — | — | — | — | — | |
| /1180 1180 | 1850 | — | 290 | 388 | 500 | 670 | — | 15 | — | — | — | — | — | — | — | — | — | |
| /1250 1250 | 1950 | — | 308 | 400 | 530 | 710 | — | 15 | — | — | — | — | — | — | — | — | — | |
| /1320 1320 | 2060 | — | 325 | 425 | 560 | 750 | — | 15 | — | — | — | — | — | — | — | — | — | |
| /1400 1400 | 2180 | — | 345 | 450 | 580 | 775 | — | 19 | — | — | — | — | — | — | — | — | — | |
| /1500 1500 | 2300 | — | 355 | 462 | 600 | 800 | — | 19 | — | — | — | — | — | — | — | — | — | |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. The chamfer dimensions given in this table do not necessarily apply to:

- (1) the groove side of bearing rings with snap ring groove
- (2) the flangeless side of thin cylindrical roller bearing rings

- (3) the front face side of angular contact bearing
- (4) inner rings of bearings with tapered bore

| | | | | | | | | | | | | | | | | | |
|----------------------------------|----------------------------|------------------|----|----|-----|------------------|-------------------|------------------|----------------------------|--------------|----|------------------|-----|-----|-------------------|----|----------|
| Single row, radial ball bearings | | | | | | | | | | | 62 | 72 | | | | | |
| Double row, radial ball bearings | | | | | | | | | | | 12 | | | 32 | 52 | | |
| Cylindrical roller bearings | | | | | | | | | | | N2 | | N22 | | | | |
| Spherical roller bearings | | | | | 231 | 241 | | | | | | | 222 | 232 | | | |
| Bearing bore diameter Nominal | Diameter series 1 | | | | | | | | Diameter series 2 | | | | | | | | |
| | Bearing outside diameter D | Width series | | | | | Chamfer dimension | | Bearing outside diameter D | Width series | | | | | Chamfer dimension | | |
| | | 0 | 1 | 2 | 3 | 4 | | | | 8 | 0 | 1 | 2 | 3 | | | 4 |
| | | Dimension series | | | | | | Dimension series | | | | | | | | | |
| | | 01 | 11 | 21 | 31 | 41 | 01 | 11 41 | | 82 | 02 | 12 | 22 | 32 | 42 | 82 | 02 42 |
| | | Width B | | | | r _{min} | | Width B | | | | r _{min} | | | | | |
| /1600 1600 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| /1700 1700 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| /1800 1800 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| /1900 1900 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| /2000 2000 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. The chamfer dimensions given in this table do not necessarily apply to:

(1) the groove side of bearing rings with snap ring groove

(2) the flangeless side of thin cylindrical roller bearing rings

(3) the front face side of angular contact bearing

(4) inner rings of bearings with tapered bore

Table 4.2.2 Boundary Dimensions of Diameter Series 3, 4

(1/8)

Unit : mm

| | | | | | | | | | | | | | |
|----------------------------------|----------------------------|------------------|----------|----|----|-----|-------------------|----------------------------|--------------|-------------------|-------------------|------------------|---|
| Single row, radial ball bearings | | | 63 73 | | | | | | | | | | |
| Double row, radial ball bearings | | | 13 | | | | 33 53 | | | | | | |
| Cylindrical roller bearings | | | N3 | | | N23 | | | | | N4 | | |
| Spherical roller bearings | | | 213 | | | 223 | | | | | | | |
| | Diameter series 3 | | | | | | | | | Diameter series 4 | | | |
| Bearing bore diameter Nominal | Bearing outside diameter D | Width series | | | | | Chamfer dimension | Bearing outside diameter D | Width series | | Chamfer dimension | | |
| | | 8 | 0 | 1 | 2 | 3 | | | 0 | 2 | | | |
| | | Dimension series | | | | | Dimension series | | | | | | |
| | | 83 | 03 | 13 | 23 | 33 | 83 | | 03 33 | 04 | 24 | 04 24 | |
| Bore No. d | | Width B | | | | | r _{min} | | | Width B | | r _{min} | |
| /0.6 0.6 | | — | — | — | — | — | — | — | — | — | — | — | — |
| 1 1 | | — | — | — | — | — | — | — | — | — | — | — | — |
| /1.5 1.5 | | — | — | — | — | — | — | — | — | — | — | — | — |
| 2 2 | | — | — | — | — | — | — | — | — | — | — | — | — |
| /2.5 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 | 30 | 10 | 14 | 0.6 | |
| 9 9 | 30 | — | 10 | — | 14 | 16 | — | 0.6 | 32 | 11 | 15 | 0.6 | |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. The chamfer dimensions given in this table do not necessarily apply to:

- (1) the groove side of bearing rings with snap ring groove
 (2) the flangeless side of thin cylindrical roller bearing rings

- (3) the front face side of angular contact bearing
 (4) inner rings of bearings with tapered bore



Table 4.2.2 Boundary Dimensions of Diameter Series 3, 4

(2/8)

Unit : mm

| | | | | | | | | | | | | | |
|----------------------------------|----------------------------|------------------|----------|----|----|------|------------------|-------------------|----------------------------|-------------------|----|-------------------|--|
| Single row, radial ball bearings | | | 63 73 | | | | | | | | | | |
| Double row, radial ball bearings | | | 13 | | | | 33 53 | | | | | | |
| Cylindrical roller bearings | | | N3 | | | N23 | | | | | N4 | | |
| Spherical roller bearings | | | 213 | | | 223 | | | | | | | |
| | Diameter series 3 | | | | | | | | | Diameter series 4 | | | |
| Bearing bore diameter Nominal | Bearing outside diameter D | Width series | | | | | | Chamfer dimension | Bearing outside diameter D | Width series | | Chamfer dimension | |
| | | 8 | 0 | 1 | 2 | 3 | 0 | | | 2 | | | |
| | | Dimension series | | | | | | Dimension series | | | | | |
| | | 83 | 03 | 13 | 23 | 33 | 83 | 03 33 | | 04 | 24 | 04 24 | |
| Bore No. d | | Width B | | | | | r _{min} | | | Width B | | r _{min} | |
| 00 10 | 35 | 9 | 11 | — | 17 | 19 | 0.3 | 0.6 | 37 | 12 | 16 | 0.6 | |
| 01 12 | 37 | 9 | 12 | — | 17 | 19 | 0.3 | 1 | 42 | 13 | 19 | 1 | |
| 02 15 | 42 | 9 | 13 | — | 17 | 19 | 0.3 | 1 | 52 | 15 | 24 | 1.1 | |
| 03 17 | 47 | 10 | 14 | — | 19 | 22.2 | 0.6 | 1 | 62 | 17 | 29 | 1.1 | |
| 04 20 | 52 | 10 | 15 | — | 21 | 22.2 | 0.6 | 1.1 | 72 | 19 | 33 | 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 | 80 | 21 | 36 | 1.5 | |
| /28 28 | 68 | 13 | 18 | — | 24 | 30 | 0.6 | 1.1 | — | — | — | — | |
| 06 30 | 72 | 13 | 19 | — | 27 | 30.2 | 0.6 | 1.1 | 90 | 23 | 40 | 1.5 | |
| /32 32 | 75 | 14 | 20 | — | 28 | 32 | 0.6 | 1.1 | — | — | — | — | |
| 07 35 | 80 | 14 | 21 | — | 31 | 34.9 | 0.6 | 1.5 | 100 | 25 | 43 | 1.5 | |
| 08 40 | 90 | 16 | 23 | — | 33 | 36.5 | 1 | 1.5 | 110 | 27 | 46 | 2 | |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. The chamfer dimensions given in this table do not necessarily apply to:

- (1) the groove side of bearing rings with snap ring groove
- (2) the flangeless side of thin cylindrical roller bearing rings

- (3) the front face side of angular contact bearing
- (4) inner rings of bearings with tapered bore

Table 4.2.2 Boundary Dimensions of Diameter Series 3, 4

(3/8)

Unit : mm

| | | | | | | | | | | | | | |
|----------------------------------|----------------------------|------------------|----------|----|-----|------|-------------------|----------------------------|--------------|-------------------|-------------------|------------------|--|
| Single row, radial ball bearings | | | 63 73 | | | | | | | | | | |
| Double row, radial ball bearings | | | 13 | | | | 33 53 | | | | | | |
| Cylindrical roller bearings | | | N3 | | N23 | | | | | | N4 | | |
| Spherical roller bearings | | | 213 | | 223 | | | | | | | | |
| | Diameter series 3 | | | | | | | | | Diameter series 4 | | | |
| Bearing bore diameter Nominal | Bearing outside diameter D | Width series | | | | | Chamfer dimension | Bearing outside diameter D | Width series | | Chamfer dimension | | |
| | | 8 | 0 | 1 | 2 | 3 | | | 0 | 2 | | | |
| | | Dimension series | | | | | Dimension series | | | | | | |
| | | 83 | 03 | 13 | 23 | 33 | 83 | | 03 33 | 04 24 | | | |
| Bore No. d | | Width B | | | | | r _{min} | | | Width B | | r _{min} | |
| 09 45 | 100 | 17 | 25 | — | 36 | 39.7 | 1 | 1.5 | 120 | 29 | 50 | 2 | |
| 10 50 | 110 | 19 | 27 | — | 40 | 44.4 | 1 | 2 | 130 | 31 | 53 | 2.1 | |
| 11 55 | 120 | 21 | 29 | — | 43 | 49.2 | 1.1 | 2 | 140 | 33 | 57 | 2.1 | |
| 12 60 | 130 | 22 | 31 | — | 46 | 54 | 1.1 | 2.1 | 150 | 35 | 60 | 2.1 | |
| 13 65 | 140 | 24 | 33 | — | 48 | 58.7 | 1.1 | 2.1 | 160 | 37 | 64 | 2.1 | |
| 14 70 | 150 | 25 | 35 | — | 51 | 63.5 | 1.5 | 2.1 | 180 | 42 | 74 | 3 | |
| 15 75 | 160 | 27 | 37 | — | 55 | 68.3 | 1.5 | 2.1 | 190 | 45 | 77 | 3 | |
| 16 80 | 170 | 28 | 39 | — | 58 | 68.3 | 1.5 | 2.1 | 200 | 48 | 80 | 3 | |
| 17 85 | 180 | 30 | 41 | — | 60 | 73 | 2 | 3 | 210 | 52 | 86 | 4 | |
| 18 90 | 190 | 30 | 43 | — | 64 | 73 | 2 | 3 | 225 | 54 | 90 | 4 | |
| 19 95 | 200 | 33 | 45 | — | 67 | 77.8 | 2 | 3 | 240 | 55 | 95 | 4 | |
| 20 100 | 215 | 36 | 47 | 51 | 73 | 82.6 | 2.1 | 3 | 250 | 58 | 98 | 4 | |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. The chamfer dimensions given in this table do not necessarily apply to:

(1) the groove side of bearing rings with snap ring groove

(3) the front face side of angular contact bearing

(2) the flangeless side of thin cylindrical roller bearing rings

(4) inner rings of bearings with tapered bore

Table 4.2.2 Boundary Dimensions of Diameter Series 3, 4

(4/8)

Unit : mm

| | | | | | | | | | | | | | |
|----------------------------------|----------------------------|------------------|----------|-----|-----|----------|-------------------|----------------------------|-------------------|---------|-------------------|------------------|--|
| Single row, radial ball bearings | | | 63 73 | | | | | | | | | | |
| Double row, radial ball bearings | | | 13 | | | 33 53 | | | | | | | |
| Cylindrical roller bearings | | | N3 | | N23 | | | | | | N4 | | |
| Spherical roller bearings | | | 213 | | 223 | | | | | | | | |
| | Diameter series 3 | | | | | | | | Diameter series 4 | | | | |
| Bearing bore diameter Nominal | Bearing outside diameter D | Width series | | | | | Chamfer dimension | Bearing outside diameter D | Width series | | Chamfer dimension | | |
| | | 8 | 0 | 1 | 2 | 3 | | | 0 | 2 | | | |
| | | Dimension series | | | | | Dimension series | | | | | | |
| | | 83 | 03 | 13 | 23 | 33 | 83 | | 03 33 | 04 | 24 | 04 24 | |
| Bore No. d | | Width B | | | | | r _{min} | | | Width B | | r _{min} | |
| 21 105 | 225 | 37 | 49 | 53 | 77 | 87.3 | 2.1 | 3 | 260 | 60 | 100 | 4 | |
| 22 110 | 240 | 42 | 50 | 57 | 80 | 92.1 | 3 | 3 | 280 | 65 | 108 | 4 | |
| 24 120 | 260 | 44 | 55 | 62 | 86 | 106 | 3 | 3 | 310 | 72 | 118 | 5 | |
| 26 130 | 280 | 48 | 58 | 66 | 93 | 112 | 3 | 4 | 340 | 78 | 128 | 5 | |
| 28 140 | 300 | 50 | 62 | 70 | 102 | 118 | 4 | 4 | 360 | 82 | 132 | 5 | |
| 30 150 | 320 | — | 65 | 75 | 108 | 128 | — | 4 | 380 | 85 | 138 | 5 | |
| 32 160 | 340 | — | 68 | 79 | 114 | 136 | — | 4 | 400 | 88 | 142 | 5 | |
| 34 170 | 360 | — | 72 | 84 | 120 | 140 | — | 4 | 420 | 92 | 145 | 5 | |
| 36 180 | 380 | — | 75 | 88 | 126 | 150 | — | 4 | 440 | 95 | 150 | 6 | |
| 38 190 | 400 | — | 78 | 92 | 132 | 155 | — | 5 | 460 | 98 | 155 | 6 | |
| 40 200 | 420 | — | 80 | 97 | 138 | 165 | — | 5 | 480 | 102 | 160 | 6 | |
| 44 220 | 460 | — | 88 | 106 | 145 | 180 | — | 5 | 540 | 115 | 180 | 6 | |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. The chamfer dimensions given in this table do not necessarily apply to:

- (1) the groove side of bearing rings with snap ring groove
 (2) the flangeless side of thin cylindrical roller bearing rings

- (3) the front face side of angular contact bearing
 (4) inner rings of bearings with tapered bore

Table 4.2.2 Boundary Dimensions of Diameter Series 3, 4

(5/8)

Unit : mm

| | | | | | | | | | | | | |
|----------------------------------|----------------------------|------------------|----------|-----|-----|----------|-------------------|----------------------------|-------------------|------------------|-------------------|------------------|
| Single row, radial ball bearings | | | 63 73 | | | | | | | | | |
| Double row, radial ball bearings | | | 13 | | | 33 53 | | | | | | |
| Cylindrical roller bearings | | | N3 | | N23 | | | | | N4 | | |
| Spherical roller bearings | | | 213 | | 223 | | | | | | | |
| | Diameter series 3 | | | | | | | | Diameter series 4 | | | |
| Bearing bore diameter Nominal | Bearing outside diameter D | Width series | | | | | Chamfer dimension | Bearing outside diameter D | Width series | | Chamfer dimension | |
| | | 8 | 0 | 1 | 2 | 3 | | | 0 | 2 | | |
| | | Dimension series | | | | | 83 | | 03 33 | Dimension series | | 04 24 |
| | | 83 | 03 | 13 | 23 | 33 | | | | 04 | 24 | |
| Bore No. d | | Width B | | | | | r _{min} | | | Width B | | r _{min} |
| 48 240 | 500 | — | 95 | 114 | 155 | 195 | — | 5 | 580 | 122 | 190 | 6 |
| 52 260 | 540 | — | 102 | 123 | 165 | 206 | — | 6 | 620 | 132 | 206 | 7.5 |
| 56 280 | 580 | — | 108 | 132 | 175 | 224 | — | 6 | 670 | 140 | 224 | 7.5 |
| 60 300 | 620 | — | 109 | 140 | 185 | 236 | — | 7.5 | 710 | 150 | 236 | 7.5 |
| 64 320 | 670 | — | 112 | 155 | 200 | 258 | — | 7.5 | 750 | 155 | 250 | 9.5 |
| 68 340 | 710 | — | 118 | 165 | 212 | 272 | — | 7.5 | 800 | 165 | 265 | 9.5 |
| 72 360 | 750 | — | 125 | 170 | 224 | 290 | — | 7.5 | 850 | 180 | 280 | 9.5 |
| 76 380 | 780 | — | 128 | 175 | 230 | 300 | — | 7.5 | 900 | 190 | 300 | 9.5 |
| 80 400 | 820 | — | 136 | 185 | 243 | 308 | — | 7.5 | 950 | 200 | 315 | 12 |
| 84 420 | 850 | — | 136 | 190 | 250 | 315 | — | 9.5 | 980 | 206 | 325 | 12 |
| 88 440 | 900 | — | 145 | 200 | 265 | 345 | — | 9.5 | 1030 | 212 | 335 | 12 |
| 92 460 | 950 | — | 155 | 212 | 280 | 365 | — | 9.5 | 1060 | 218 | 345 | 12 |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. The chamfer dimensions given in this table do not necessarily apply to:

- (1) the groove side of bearing rings with snap ring groove
 (2) the flangeless side of thin cylindrical roller bearing rings

- (3) the front face side of angular contact bearing
 (4) inner rings of bearings with tapered bore

Table 4.2.2 Boundary Dimensions of Diameter Series 3, 4

(6/8)

Unit : mm

| | | | | | | | | | | | | |
|----------------------------------|----------------------------|------------------|----------|-----|-----|----------|-------------------|-----------------|----------------------------|-------------------|-------------------|-------------------|
| Single row, radial ball bearings | | | 63 73 | | | | | | | | | |
| Double row, radial ball bearings | | | 13 | | | 33 53 | | | | | | |
| Cylindrical roller bearings | | | N3 | | N23 | | | | | N4 | | |
| Spherical roller bearings | | | 213 | | 223 | | | | | | | |
| | Diameter series 3 | | | | | | | | Diameter series 4 | | | |
| Bearing bore diameter Nominal | Bearing outside diameter D | Width series | | | | | Chamfer dimension | | Bearing outside diameter D | Width series | | Chamfer dimension |
| | | 8 | 0 | 1 | 2 | 3 | | | | 0 | 2 | |
| | | Dimension series | | | | | | | | Dimension series | | |
| | | 83 | 03 | 13 | 23 | 33 | 83 | 03 33 | | 04 | 24 | 04 24 |
| Bore No. d | | Width B | | | | | r _{min} | | | Width B | | r _{min} |
| 96 480 /500 500 /530 530 | 980 1030 1090 | — | 160 | 218 | 290 | 375 | — | 9.5 12 12 | 1120 1150 1220 | 230 236 250 | 365 375 400 | 15 15 15 |
| /560 560 /600 600 /630 630 | 1150 1220 1280 | — | 190 | 258 | 335 | 438 | — | 12 15 15 | 1280 1360 1420 | 258 272 280 | 412 438 450 | 15 15 15 |
| /670 670 /710 710 /750 750 | 1360 1420 1500 | — | 218 | 300 | 400 | 515 | — | 15 15 15 | 1500 — — | 290 — — | 475 — — | 15 — — |
| /800 800 /850 850 /900 900 | 1600 1700 1780 | — | 258 | 355 | 462 | 600 | — | 15 19 19 | — — — | — — — | — — — | — — — |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. The chamfer dimensions given in this table do not necessarily apply to:

- (1) the groove side of bearing rings with snap ring groove
 (2) the flangeless side of thin cylindrical roller bearing rings

- (3) the front face side of angular contact bearing
 (4) inner rings of bearings with tapered bore

Table 4.2.2 Boundary Dimensions of Diameter Series 3, 4

(7/8)

Unit : mm

| | | | | | | | | | | | | | |
|--|----------------------------|------------------|-----------------|-----------------|-----------------|-----------------|-------------------|---------------|----------------------------|------------------|-------------|-------------------|--|
| Single row, radial ball bearings | | | 63 73 | | | | | | | | | | |
| Double row, radial ball bearings | | | 13 | | | 33 53 | | | | | | | |
| Cylindrical roller bearings | | | N3 | | N23 | | | | | N4 | | | |
| Spherical roller bearings | | | 213 | | 223 | | | | | | | | |
| | Diameter series 3 | | | | | | | | Diameter series 4 | | | | |
| Bearing bore diameter Nominal | Bearing outside diameter D | Width series | | | | | Chamfer dimension | | Bearing outside diameter D | Width series | | Chamfer dimension | |
| | | 8 | 0 | 1 | 2 | 3 | | | | 0 | 2 | | |
| | | Dimension series | | | | | | | | Dimension series | | | |
| | | 83 | 03 | 13 | 23 | 33 | 83 | 03 33 | | 04 | 24 | 04 24 | |
| Bore No. d | | Width B | | | | | r _{min} | | | Width B | | r _{min} | |
| /950 950 /1000 1000 /1060 1060 | 1850 1950 — | — — — | 290 300 — | 400 412 — | 515 545 — | 670 710 — | — — — | 19 19 — | — — — | — — — | — — — | | |
| /1120 1120 /1180 1180 /1250 1250 | — — — | — — — | — — — | — — — | — — — | — — — | — — — | — — — | — — — | — — — | — — — | | |
| /1320 1320 /1400 1400 /1500 1500 | — — — | — — — | — — — | — — — | — — — | — — — | — — — | — — — | — — — | — — — | — — — | | |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. The chamfer dimensions given in this table do not necessarily apply to:

- | | |
|--|--|
| (1) the groove side of bearing rings with snap ring groove | (3) the front face side of angular contact bearing |
| (2) the flangeless side of thin cylindrical roller bearing rings | (4) inner rings of bearings with tapered bore |

Table 4.2.2 Boundary Dimensions of Diameter Series 3, 4

(8/8)

Unit : mm



| | | | | | | | | | | | | |
|----------------------------------|----------------------------|------------------|----------|----|-----|----|-------------------|----------------------------|-------------------|----------|-------------------|------------------|
| Single row, radial ball bearings | | | 63 73 | | | | | | | | | |
| Double row, radial ball bearings | | | 13 | | | | 33 53 | | | | | |
| Cylindrical roller bearings | | | N3 | | N23 | | | | | N4 | | |
| Spherical roller bearings | | | 213 | | 223 | | | | | | | |
| | Diameter series 3 | | | | | | | | Diameter series 4 | | | |
| Bearing bore diameter Nominal | Bearing outside diameter D | Width series | | | | | Chamfer dimension | Bearing outside diameter D | Width series | | Chamfer dimension | |
| | | 8 | 0 | 1 | 2 | 3 | | | 0 | 2 | | |
| | | Dimension series | | | | | Dimension series | | | | | |
| | | 83 | 03 | 13 | 23 | 33 | 83 | | 03 23 | 04 24 | | |
| Bore No. d | | Width B | | | | | r _{min} | | | Width B | | r _{min} |
| /1600 1600 | — | — | — | — | — | — | — | — | — | — | — | — |
| /1700 1700 | — | — | — | — | — | — | — | — | — | — | — | — |
| /1800 1800 | — | — | — | — | — | — | — | — | — | — | — | — |
| /1900 1900 | — | — | — | — | — | — | — | — | — | — | — | — |
| /2000 2000 | — | — | — | — | — | — | — | — | — | — | — | — |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. The chamfer dimensions given in this table do not necessarily apply to:

- (1) the groove side of bearing rings with snap ring groove
- (2) the flangeless side of thin cylindrical roller bearing rings

- (3) the front face side of angular contact bearing
- (4) inner rings of bearings with tapered bore

Table 4.3.1 Boundary Dimensions of Tapered Roller Bearings (1/3)

Unit : mm

| Tapered roller bearing | | | 329 | | | | | | 320 | | | | 330 | | | | | 331 | | | | | |
|----------------------------------|----|-------------------|----------------|------|----|--------------------------------|--------------------------------|-------------------|----------------|------|----|----------------|-----|----|--------------------------------|--------------------------------|------------------|----------------|------|----|--------------------------------|--------------------------------|--|
| Bearing bore diameter Nominal | | Diameter series 9 | | | | | | Diameter series 0 | | | | | | | | Diameter series 1 | | | | | | | |
| | | Outside diameter | Width series 2 | | | Chamfer dimension | | Outside diameter | Width series 2 | | | Width series 3 | | | Chamfer dimension | | Outside diameter | Width series 3 | | | Chamfer dimension | | |
| Bore No. | d | D | B | C | T | r _{min} Inner ring | r _{min} Outer ring | D | B | C | T | B | C | T | r _{min} Inner ring | r _{min} Outer ring | D | B | C | T | r _{min} Inner ring | r _{min} Outer ring | |
| 02 | 15 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | |
| 03 | 17 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | |
| 04 | 20 | 37 | 12 | 9 | 12 | 0.3 | 0.3 | 42 | 15 | 12 | 15 | — | — | — | 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 | 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 | 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 | 14 | 11.5 | 14 | 0.6 | 0.6 | 62 | 18 | 14 | 18 | 21 | 17 | 21 | 1 | 1 | — | — | — | — | — | — | |
| 08 | 40 | 62 | 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 | 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 | 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 | 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 | 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 | 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 | |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. Dimensions B, C, T of 32000 and 32200 series bearings without prefix E and suffix J listed on the pages from D84 to D87 are differ from the above dimensions.

Note: (1) To be applied to 30300D series.

Table 4.3.1 Boundary Dimensions of Tapered Roller Bearings (2/3)

Unit : mm

| Tapered roller bearing | | | 329 | | | | | | 320 | | | | | 330 | | | | | | 331 | | | | | | |
|----------------------------------|-----|-------------------|----------------|----|----|--------------------------------|------------|------------------|-------------------|----|----|----------------|------|-----|--------------------------------|------------|------------------|----------------|-------------------|-----|--------------------------------|------------|--|--|--|--|
| Bearing bore diameter Nominal | | Diameter series 9 | | | | | | | Diameter series 0 | | | | | | | | | | Diameter series 1 | | | | | | | |
| | | Outside diameter | Width series 2 | | | Chamfer dimension | | Outside diameter | Width series 2 | | | Width series 3 | | | Chamfer dimension | | Outside diameter | Width series 3 | | | Chamfer dimension | | | | | |
| Bore No. | d | D | B | C | T | r _{min} Inner ring | Outer ring | D | B | C | T | B | C | T | r _{min} Inner ring | Outer ring | D | B | C | T | r _{min} Inner ring | Outer ring | | | | |
| 14 | 70 | 100 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 32 | 25 | 32 | 2 | 1.5 | 200 | 45 | 34 | 45 | 55 | 43 | 55 | 2.5 | 2 | — | — | — | — | — | — | | | | |
| 28 | 140 | 190 | 32 | 25 | 32 | 2 | 1.5 | 210 | 45 | 34 | 45 | 56 | 44 | 56 | 2.5 | 2 | — | — | — | — | — | — | | | | |
| 30 | 150 | 210 | 38 | 30 | 38 | 2.5 | 2 | 225 | 48 | 36 | 48 | 59 | 46 | 59 | 3 | 2.5 | — | — | — | — | — | — | | | | |
| 32 | 160 | 220 | 38 | 30 | 38 | 2.5 | 2 | 240 | 51 | 38 | 51 | — | — | — | 3 | 2.5 | — | — | — | — | — | — | | | | |
| 34 | 170 | 230 | 38 | 30 | 38 | 2.5 | 2 | 260 | 57 | 43 | 57 | — | — | — | 3 | 2.5 | — | — | — | — | — | — | | | | |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. Dimensions B, C, T of 32000 and 32200 series bearings without prefix E and suffix J listed on the pages from D84 to D87 are differ from the above dimensions.

Note: (1) To be applied to 30300D series.

Table 4.3.1 Boundary Dimensions of Tapered Roller Bearings (3/3)

Unit : mm



| Tapered roller bearing | | | 329 | | | | | | 320 | | | | | 330 | | | | | | 331 | | | | | | |
|----------------------------------|-----|-------------------|----------------|----|------|--------------------------------|--------------------------------|------------------|-------------------|----|-----|----------------|---|-----|--------------------------------|--------------------------------|-------------------|----------------|---|-----|--------------------------------|--------------------------------|--|--|--|--|
| Bearing bore diameter Nominal | | Diameter series 9 | | | | | | | Diameter series 0 | | | | | | | | Diameter series 1 | | | | | | | | | |
| | | Outside diameter | Width series 2 | | | Chamfer dimension | | Outside diameter | Width series 2 | | | Width series 3 | | | Chamfer dimension | | Outside diameter | Width series 3 | | | Chamfer dimension | | | | | |
| Bore No. | d | D | B | C | T | r _{min} Inner ring | r _{min} Outer ring | D | B | C | T | B | C | T | r _{min} Inner ring | r _{min} Outer ring | D | B | C | T | r _{min} Inner ring | r _{min} Outer ring | | | | |
| 36 | 180 | 250 | 45 | 34 | 45 | 2.5 | 2 | 280 | 64 | 48 | 64 | — | — | — | 3 | 2.5 | — | — | — | — | — | — | | | | |
| 38 | 190 | 260 | 45 | 34 | 45 | 2.5 | 2 | 290 | 64 | 48 | 64 | — | — | — | 3 | 2.5 | — | — | — | — | — | — | | | | |
| 40 | 200 | 280 | 51 | 39 | 51 | 3 | 2.5 | 310 | 70 | 53 | 70 | — | — | — | 3 | 2.5 | — | — | — | — | — | — | | | | |
| 44 | 220 | 300 | 51 | 39 | 51 | 3 | 2.5 | 340 | 76 | 57 | 76 | — | — | — | 4 | 3 | — | — | — | — | — | — | | | | |
| 48 | 240 | 320 | 51 | 39 | 51 | 3 | 2.5 | 360 | 76 | 57 | 76 | — | — | — | 4 | 3 | — | — | — | — | — | — | | | | |
| 52 | 260 | 360 | 63.5 | 48 | 63.5 | 3 | 2.5 | 400 | 87 | 65 | 87 | — | — | — | 5 | 4 | — | — | — | — | — | — | | | | |
| 56 | 280 | 380 | 63.5 | 48 | 63.5 | 3 | 2.5 | 420 | 87 | 65 | 87 | — | — | — | 5 | 4 | — | — | — | — | — | — | | | | |
| 60 | 300 | 420 | 76 | 57 | 76 | 4 | 3 | 460 | 100 | 74 | 100 | — | — | — | 5 | 4 | — | — | — | — | — | — | | | | |
| 64 | 320 | 440 | 76 | 57 | 76 | 4 | 3 | 480 | 100 | 74 | 100 | — | — | — | 5 | 4 | — | — | — | — | — | — | | | | |
| 68 | 340 | 460 | 76 | 57 | 76 | 4 | 3 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | | | | |
| 72 | 360 | 480 | 76 | 57 | 76 | 4 | 3 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | | | | |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. Dimensions B, C, T of 32000 and 32200 series bearings without prefix E and suffix J listed on the pages from D84 to D87 are differ from the above dimensions.

Note: (1) To be applied to 30300D series.

Table 4.3.2 Boundary Dimensions of Tapered Roller Bearings (1/3)

Unit : mm

| Tapered roller bearing | | | 302 | | | | 322 | | | | 332 | | | | | | 303 | | | | 303D | | | | 313 | | | | 323 | | | | |
|----------------------------------|----|-------------------|----------------|----|-------|------|----------------|-------|----|------|----------------|--------------------------------|--------------------------------|-------------------|-------------------|------------------|------------------|-------|---|---|----------------|----|----|-------|----------------|-----|---|--------------------------------|--------------------------------|--|--|--|--|
| Bearing bore diameter Nominal | | Diameter series 2 | | | | | | | | | | | | Diameter series 3 | | | | | | | | | | | | | | | | | | | |
| | | Outside diameter | Width series 0 | | | | Width series 2 | | | | Width series 3 | | | | Chamfer dimension | Outside diameter | Width series 0 | | | | Width series 1 | | | | Width series 2 | | | | Chamfer dimension | | | | |
| Bore No. | d | D | B | C | T | B | C | T | B | C | T | r _{min} Inner ring | r _{min} Outer ring | D | B | C | C ⁽¹⁾ | T | B | C | T | B | C | T | B | C | T | r _{min} Inner ring | r _{min} Outer ring | | | | |
| 02 | 15 | — | — | — | — | — | — | — | — | — | — | — | — | 42 | 13 | 11 | — | 14.25 | — | — | — | — | — | — | — | — | — | 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 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | | | | |
| 05 | 25 | 52 | 15 | 13 | 16.25 | 18 | 16 | 19.25 | 22 | 18 | 22 | 1 | 1 | 62 | 17 | 15 | 13 | 18.25 | — | — | — | 24 | 20 | 25.25 | 1.5 | 1.5 | — | — | — | | | | |
| /28 | 28 | 58 | — | — | — | 19 | 16 | 20.25 | 24 | 19 | 24 | 1 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | | | | |
| 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 | 26.5 | 17 | 22 | 26 | 20.5 | 26 | 1 | 1 | 75 | — | — | — | — | — | — | — | 28 | 23 | 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 | — | — | — | | | | |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. Dimensions B, C, T of 32000 and 32200 series bearings without prefix E and suffix J listed on the pages from D84 to D87 are differ from the above dimensions.

Note: (1) To be applied to 30300D series.

Table 4.3.2 Boundary Dimensions of Tapered Roller Bearings (2/3)

Unit : mm

| Tapered roller bearing | | | 302 | | | | 322 | | | | 332 | | | | | | 303 | | | | 303D | | | | 313 | | | | 323 | | | | | | | |
|----------------------------------|-----|-------------------|----------------|----|-------|----|----------------|-------|----|----------------|-----|--------------------------------|--------------------------------|-------------------|------------------|----------------|------------------|-------|----|----------------|------|----|----------------|------|-----|-------------------|---|--------------------------------|--------------------------------|--|--|--|--|--|--|--|
| Bearing bore diameter Nominal | | Diameter series 2 | | | | | | | | | | | | Diameter series 3 | | | | | | | | | | | | | | | | | | | | | | |
| | | Outside diameter | Width series 0 | | | | Width series 2 | | | Width series 3 | | | Chamfer dimension | | Outside diameter | Width series 0 | | | | Width series 1 | | | Width series 2 | | | Chamfer dimension | | | | | | | | | | |
| Bore No. | d | D | B | C | T | B | C | T | B | C | T | r _{min} Inner ring | r _{min} Outer ring | D | B | C | C ⁽¹⁾ | T | B | C | T | B | C | T | B | C | T | r _{min} Inner ring | r _{min} Outer ring | | | | | | | |
| 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 | — | — | — | 5 | 4 | | | | | | | | | | |
| 28 | 140 | 250 | 42 | 36 | 45.75 | 68 | 58 | 71.75 | — | — | — | 4 | 3 | 300 | 62 | 53 | — | 67.75 | 70 | 47 | 77 | — | — | — | 5 | 4 | | | | | | | | | | |
| 30 | 150 | 270 | 45 | 38 | 49 | 73 | 60 | 77 | — | — | — | 4 | 3 | 320 | 65 | 55 | — | 72 | 75 | 50 | 82 | — | — | — | 5 | 4 | | | | | | | | | | |
| 32 | 160 | 290 | 48 | 40 | 52 | 80 | 67 | 84 | — | — | — | 4 | 3 | 340 | 68 | 58 | — | 75 | — | — | — | — | — | — | 5 | 4 | | | | | | | | | | |
| 34 | 170 | 310 | 52 | 43 | 57 | 86 | 71 | 91 | — | — | — | 5 | 4 | 360 | 72 | 62 | — | 80 | — | — | — | — | — | — | 5 | 4 | | | | | | | | | | |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. Dimensions B, C, T of 32000 and 32200 series bearings without prefix E and suffix J listed on the pages from D84 to D87 are differ from the above dimensions.

Note: (1) To be applied to 30300D series.

Table 4.3.2 Boundary Dimensions of Tapered Roller Bearings (3/3)

Unit : mm

| | | | | | | | | | | | | | | | | | | | | | | | | | | |
|----------------------------------|-------------------|----------------|----|----|----|----------------|----|-----|----------------|-----|---|--------------------------------|--------------------------------|-------------------|----------------|---|------------------|---|----------------|---|---|----------------|---|---|--------------------------------|--------------------------------|
| Tapered roller bearing | | 302 | | | | 322 | | | | 332 | | | | | 303 | | 303D | | 313 | | | 323 | | | | |
| Bearing bore diameter Nominal | Diameter series 2 | | | | | | | | | | | | | Diameter series 3 | | | | | | | | | | | | |
| | Outside diameter | Width series 0 | | | | Width series 2 | | | Width series 3 | | | Chamfer dimension | | Outside diameter | Width series 0 | | | | Width series 1 | | | Width series 2 | | | Chamfer dimension | |
| Bore No. | d | D | B | C | T | B | C | T | B | C | T | r _{min} Inner ring | r _{min} Outer ring | D | B | C | C ⁽¹⁾ | T | B | C | T | B | C | T | r _{min} Inner ring | r _{min} Outer ring |
| 36 | 180 | 320 | 52 | 43 | 57 | 86 | 71 | 91 | — | — | — | 5 | 4 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 38 | 190 | 340 | 55 | 46 | 60 | 92 | 75 | 97 | — | — | — | 5 | 4 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 40 | 200 | 360 | 58 | 48 | 64 | 98 | 82 | 104 | — | — | — | 5 | 4 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 44 | 220 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 48 | 240 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 52 | 260 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 56 | 280 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 60 | 300 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 64 | 320 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 68 | 340 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 72 | 360 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |

Remarks: 1. rmin is the smallest chamfer dimension.
2. Dimensions B, C, T of 32000 and 32200 series bearings without prefix E and suffix J listed on the pages from D84 to D87 are differ from the above dimensions.

Note: (1) To be applied to 30300D series.

Table 4.4.1 Boundary Dimensions of Thrust Bearings with Flat Back Face

(1/4)

Unit : mm

| | | | | | | | | | | | |
|---|----------------|---------------------------------------|------------------|-------------|----------------|---|---------------------------------------|------------------|-------------|----------------|---|
| Single direction thrust ball bearings | | | | | | | | | 511 | | |
| Double direction thrust ball bearings | | | | | | | | | | | |
| Spherical roller thrust bearings | | | | | | | | | | | |
| Bearing bore diameter Nominal Bore No. d | | Diameter series 0 | | | | | Diameter series 1 | | | | |
| | | Bearing outside diameter Nominal D | Dimension series | | | Chamfer dimension r _{min} | Bearing outside diameter Nominal D | Dimension series | | | Chamfer dimension r _{min} |
| | | | 70 | 90 | 10 | | | 71 | 91 | 11 | |
| | | | Height Nominal T | | | | | Height Nominal T | | | |
| 4 6 8 | 4 6 8 | 12 16 18 | 4 5 5 | — — — | 6 7 7 | 0.3 0.3 0.3 | — — — | — — — | — — — | — — — | |
| 00 01 02 | 10 12 15 | 20 22 26 | 5 5 5 | — — — | 7 7 7 | 0.3 0.3 0.3 | 24 26 28 | 6 6 6 | — — — | 9 9 9 | 0.3 0.3 0.3 |
| 03 04 05 | 17 20 25 | 28 32 37 | 5 6 6 | — — — | 7 8 8 | 0.3 0.3 0.3 | 30 35 42 | 6 7 8 | — — — | 9 10 11 | 0.3 0.3 0.6 |
| 06 07 08 | 30 35 40 | 42 47 52 | 6 6 6 | — — — | 8 8 9 | 0.3 0.3 0.3 | 47 52 60 | 8 8 9 | — — — | 11 12 13 | 0.6 0.6 0.6 |
| 09 10 11 | 45 50 55 | 60 65 70 | 7 7 7 | — — — | 10 10 10 | 0.3 0.3 0.3 | 65 70 78 | 9 9 10 | — — — | 14 14 16 | 0.6 0.6 0.6 |
| 12 13 14 | 60 65 70 | 75 80 85 | 7 7 7 | — — — | 10 10 10 | 0.3 0.3 0.3 | 85 90 95 | 11 11 11 | — — — | 17 18 18 | 1 1 1 |
| 15 16 17 | 75 80 85 | 90 95 100 | 7 7 7 | — — — | 10 10 10 | 0.3 0.3 0.3 | 100 105 110 | 11 11 11 | — — — | 19 19 19 | 1 1 1 |

Remarks: r_{min} is the smallest chamfer dimension.

Table 4.4.1 Boundary Dimensions of Thrust Bearings with Flat Back Face

(2/4)

Unit : mm

| | | | | | | | | | | |
|---|---------------------------------------|------------------|----------------|----------------|---|---------------------------------------|------------------|----------------|----------------|---|
| Single direction thrust ball bearings | | | | | | | | | 511 | |
| Double direction thrust ball bearings | | | | | | | | | | |
| Spherical roller thrust bearings | | | | | | | | | | |
| Bearing bore diameter Nominal Bore No. d | Diameter series 0 | | | | | Diameter series 1 | | | | |
| | Bearing outside diameter Nominal D | Dimension series | | | Chamfer dimension r _{min} | Bearing outside diameter Nominal D | Dimension series | | | Chamfer dimension r _{min} |
| | | 70 | 90 | 10 | | | 71 | 91 | 11 | |
| | | Height Nominal T | | | | | Height Nominal T | | | |
| 18 90 20 100 22 110 | 105 120 130 | 7 9 9 | — — — | 10 14 14 | 0.3 0.6 0.6 | 120 135 145 | 14 16 16 | — 21 21 | 22 25 25 | 1 1 1 |
| 24 120 26 130 28 140 | 140 150 160 | 9 9 9 | — — — | 14 14 14 | 0.6 0.6 0.6 | 155 170 180 | 16 18 18 | 21 24 24 | 25 30 31 | 1 1 1 |
| 30 150 32 160 34 170 | 170 180 190 | 9 9 9 | — — — | 14 14 14 | 0.6 0.6 0.6 | 190 200 215 | 18 18 20 | 24 24 27 | 31 31 34 | 1 1 1.1 |
| 36 180 38 190 40 200 | 200 215 225 | 9 11 11 | — — — | 14 17 17 | 0.6 1 1 | 225 240 250 | 20 23 23 | 27 30 30 | 34 37 37 | 1.1 1.1 1.1 |
| 44 220 48 240 52 260 | 250 270 290 | 14 14 14 | — — — | 22 22 22 | 1 1 1 | 270 300 320 | 23 27 27 | 30 36 36 | 37 45 45 | 1.1 1.5 1.5 |
| 56 280 60 300 64 320 | 310 340 360 | 14 18 18 | — 24 24 | 22 30 30 | 1 1 1 | 350 380 400 | 32 36 36 | 42 48 48 | 53 62 63 | 1.5 2 2 |
| 68 340 72 360 76 380 | 380 400 420 | 18 18 18 | 24 24 24 | 30 30 30 | 1 1 1 | 420 440 460 | 36 36 36 | 48 48 48 | 64 65 65 | 2 2 2 |

Remarks: r_{min} is the smallest chamfer dimension.

Table 4.4.1 Boundary Dimensions of Thrust Bearings with Flat Back Face

(3/4)

Unit : mm

| | | | | | | | | | | | |
|---|---------------------------------------|------------------|----|----|---|---------------------------------------|------------------|-----|-----|---|--|
| Single direction thrust ball bearings | | | | | | | | | | 511 | |
| Double direction thrust ball bearings | | | | | | | | | | | |
| Spherical roller thrust bearings | | | | | | | | | | | |
| Bearing bore diameter Nominal Bore No. d | Diameter series 0 | | | | | Diameter series 1 | | | | | |
| | Bearing outside diameter Nominal D | Dimension series | | | Chamfer dimension r _{min} | Bearing outside diameter Nominal D | Dimension series | | | Chamfer dimension r _{min} | |
| | | 70 | 90 | 10 | | | 71 | 91 | 11 | | |
| | | Height Nominal T | | | | | Height Nominal T | | | | |
| 80 400 | 440 | 18 | 24 | 30 | 1 | 480 | 36 | 48 | 65 | 2 | |
| 84 420 | 460 | 18 | 24 | 30 | 1 | 500 | 36 | 48 | 65 | 2 | |
| 88 440 | 480 | 18 | 24 | 30 | 1 | 540 | 45 | 60 | 80 | 2.1 | |
| 92 460 | 500 | 18 | 24 | 30 | 1 | 560 | 45 | 60 | 80 | 2.1 | |
| 96 480 | 520 | 18 | 24 | 30 | 1 | 580 | 45 | 60 | 80 | 2.1 | |
| /500 500 | 540 | 18 | 24 | 30 | 1 | 600 | 45 | 60 | 80 | 2.1 | |
| /530 530 | 580 | 23 | 30 | 38 | 1.1 | 640 | 50 | 67 | 85 | 3 | |
| /560 560 | 610 | 23 | 30 | 38 | 1.1 | 670 | 50 | 67 | 85 | 3 | |
| /600 600 | 650 | 23 | 30 | 38 | 1.1 | 710 | 50 | 67 | 85 | 3 | |
| /630 630 | 680 | 23 | 30 | 38 | 1.1 | 750 | 54 | 73 | 95 | 3 | |
| /670 670 | 730 | 27 | 36 | 45 | 1.5 | 800 | 58 | 78 | 105 | 4 | |
| /710 710 | 780 | 32 | 42 | 53 | 1.5 | 850 | 63 | 85 | 112 | 4 | |
| /750 750 | 820 | 32 | 42 | 53 | 1.5 | 900 | 67 | 90 | 120 | 4 | |
| /800 800 | 870 | 32 | 42 | 53 | 1.5 | 950 | 67 | 90 | 120 | 4 | |
| /850 850 | 920 | 32 | 42 | 53 | 1.5 | 1000 | 67 | 90 | 120 | 4 | |
| /900 900 | 980 | 36 | 48 | 63 | 2 | 1060 | 73 | 95 | 130 | 5 | |
| /950 950 | 1030 | 36 | 48 | 63 | 2 | 1120 | 78 | 103 | 135 | 5 | |
| /1000 1000 | 1090 | 41 | 54 | 70 | 2.1 | 1180 | 82 | 109 | 140 | 5 | |
| /1060 1060 | 1150 | 41 | 54 | 70 | 2.1 | 1250 | 85 | 115 | 150 | 5 | |
| /1120 1120 | 1220 | 45 | 60 | 80 | 2.1 | 1320 | 90 | 122 | 160 | 5 | |
| /1180 1180 | 1280 | 45 | 60 | 80 | 2.1 | 1400 | 100 | 132 | 175 | 6 | |

Remarks: r_{min} is the smallest chamfer dimension.

Table 4.4.1 Boundary Dimensions of Thrust Bearings with Flat Back Face (4/4) Unit : mm



| | | | | | | | | | | | |
|---------------------------------------|---------------------------------------|------------------|----|----|-------------------|---------------------------------------|------------------|----|----|-------------------|-----|
| Single direction thrust ball bearings | | | | | | | | | | 511 | |
| Double direction thrust ball bearings | | | | | | | | | | | |
| Spherical roller thrust bearings | | | | | | | | | | | |
| Bearing bore diameter Nominal | Diameter series 0 | | | | | Diameter series 1 | | | | | |
| | Bearing outside diameter Nominal D | Dimension series | | | Chamfer dimension | Bearing outside diameter Nominal D | Dimension series | | | Chamfer dimension | |
| | | 70 | 90 | 10 | | | 71 | 91 | 11 | | |
| | | Height Nominal T | | | | | Height Nominal T | | | | |
| Bore No. | d | | | | r _{min} | | | | | | |
| /1250 | 1250 | 1360 | 50 | 67 | 85 | 3 | 1460 | — | — | 175 | 6 |
| /1320 | 1320 | 1440 | — | — | 95 | 3 | 1540 | — | — | 175 | 6 |
| /1400 | 1400 | 1520 | — | — | 95 | 3 | 1630 | — | — | 180 | 6 |
| /1500 | 1500 | 1630 | — | — | 105 | 4 | 1750 | — | — | 195 | 6 |
| /1600 | 1600 | 1730 | — | — | 105 | 4 | 1850 | — | — | 195 | 6 |
| /1700 | 1700 | 1840 | — | — | 112 | 4 | 1970 | — | — | 212 | 7.5 |
| /1800 | 1800 | 1950 | — | — | 120 | 4 | 2080 | — | — | 220 | 7.5 |
| /1900 | 1900 | 2060 | — | — | 130 | 5 | 2180 | — | — | 220 | 7.5 |
| /2000 | 2000 | 2160 | — | — | 130 | 5 | 2300 | — | — | 236 | 7.5 |
| /2120 | 2120 | 2300 | — | — | 140 | 5 | 2430 | — | — | 243 | 7.5 |
| /2240 | 2240 | 2430 | — | — | 150 | 5 | 2570 | — | — | 258 | 9.5 |
| /2360 | 2360 | 2550 | — | — | 150 | 5 | 2700 | — | — | 265 | 9.5 |
| /2500 | 2500 | 2700 | — | — | 160 | 5 | 2850 | — | — | 272 | 9.5 |

Remarks: r_{min} is the smallest chamfer dimension.

Table 4.4.2 Boundary Dimensions of Thrust Bearings with Flat Back Face

(1/4)

Unit : mm

| | | | | | | | | | | |
|---|----|---------------------------------------|------------------|-----|-----|---------------------|---------------|----|-------------------|-------------------|
| Single direction thrust ball bearings | | | | | 512 | | | | | |
| Double direction thrust ball bearings | | | | | | 522 | | | | |
| Spherical roller thrust bearings | | | | 292 | | | | | | |
| Bearing bore diameter Nominal Bore No. d | | Diameter series 2 | | | | | | | | |
| | | Bearing outside diameter Nominal D | Dimension series | | | | | | Chamfer dimension | |
| | | | 72 | 92 | 12 | 22 | 22 | | r _{min} | r _{1min} |
| | | | Height Nominal T | | | | Center washer | | | |
| | | | | | | Bore d ₂ | Height a | | | |
| 4 | 4 | 16 | 6 | — | 8 | — | — | — | 0.3 | — |
| 6 | 6 | 20 | 6 | — | 9 | — | — | — | 0.3 | — |
| 8 | 8 | 22 | 6 | — | 9 | — | — | — | 0.3 | — |
| 00 | 10 | 26 | 7 | — | 11 | — | — | — | 0.6 | — |
| 01 | 12 | 28 | 7 | — | 11 | — | — | — | 0.6 | — |
| 02 | 15 | 32 | 8 | — | 12 | 22 | 10 | 5 | 0.6 | 0.3 |
| 03 | 17 | 35 | 8 | — | 12 | — | — | — | 0.6 | — |
| 04 | 20 | 40 | 9 | — | 14 | 26 | 15 | 6 | 0.6 | 0.3 |
| 05 | 25 | 47 | 10 | — | 15 | 28 | 20 | 7 | 0.6 | 0.3 |
| 06 | 30 | 52 | 10 | — | 16 | 29 | 25 | 7 | 0.6 | 0.3 |
| 07 | 35 | 62 | 12 | — | 18 | 34 | 30 | 8 | 1 | 0.3 |
| 08 | 40 | 68 | 13 | — | 19 | 36 | 30 | 9 | 1 | 0.6 |
| 09 | 45 | 73 | 13 | — | 20 | 37 | 35 | 9 | 1 | 0.6 |
| 10 | 50 | 78 | 13 | — | 22 | 39 | 40 | 9 | 1 | 0.6 |
| 11 | 55 | 90 | 16 | 21 | 25 | 45 | 45 | 10 | 1 | 0.6 |
| 12 | 60 | 95 | 16 | 21 | 26 | 46 | 50 | 10 | 1 | 0.6 |
| 13 | 65 | 100 | 16 | 21 | 27 | 47 | 55 | 10 | 1 | 0.6 |
| 14 | 70 | 105 | 16 | 21 | 27 | 47 | 55 | 10 | 1 | 1 |
| 15 | 75 | 110 | 16 | 21 | 27 | 47 | 60 | 10 | 1 | 1 |
| 16 | 80 | 115 | 16 | 21 | 28 | 48 | 65 | 10 | 1 | 1 |
| 17 | 85 | 125 | 18 | 24 | 31 | 55 | 70 | 12 | 1 | 1 |

Remarks: r_{min} is the smallest chamfer dimension.

Table 4.4.2 Boundary Dimensions of Thrust Bearings with Flat Back Face (2/4)

Unit : mm

| | | | | | | | | | | |
|---|-----|---------------------------------------|------------------|-----|-----|-----|---|----|-------------------|-------------------|
| Single direction thrust ball bearings | | | | | 512 | | | | | |
| Double direction thrust ball bearings | | | | | | 522 | | | | |
| Spherical roller thrust bearings | | | | 292 | | | | | | |
| Bearing bore diameter Nominal Bore No. d | | Diameter series 2 | | | | | | | | |
| | | Bearing outside diameter Nominal D | Dimension series | | | | | | Chamfer dimension | |
| | | | 72 | 92 | 12 | 22 | 22 | | r _{min} | r _{1min} |
| | | | Height Nominal T | | | | Center washer Bore d ₂ Height a | | | |
| 18 | 90 | 135 | 20 | 27 | 35 | 62 | 75 | 14 | 1.1 | 1 |
| 20 | 100 | 150 | 23 | 30 | 38 | 67 | 85 | 15 | 1.1 | 1 |
| 22 | 110 | 160 | 23 | 30 | 38 | 67 | 95 | 15 | 1.1 | 1 |
| 24 | 120 | 170 | 23 | 30 | 39 | 68 | 100 | 15 | 1.1 | 1.1 |
| 26 | 130 | 190 | 27 | 36 | 45 | 80 | 110 | 18 | 1.5 | 1.1 |
| 28 | 140 | 200 | 27 | 36 | 46 | 81 | 120 | 18 | 1.5 | 1.1 |
| 30 | 150 | 215 | 29 | 39 | 50 | 89 | 130 | 20 | 1.5 | 1.1 |
| 32 | 160 | 225 | 29 | 39 | 51 | 90 | 140 | 20 | 1.5 | 1.1 |
| 34 | 170 | 240 | 32 | 42 | 55 | 97 | 150 | 21 | 1.5 | 1.1 |
| 36 | 180 | 250 | 32 | 42 | 56 | 98 | 150 | 21 | 1.5 | 2 |
| 38 | 190 | 270 | 36 | 48 | 62 | 109 | 160 | 24 | 2 | 2 |
| 40 | 200 | 280 | 36 | 48 | 62 | 109 | 170 | 24 | 2 | 2 |
| 44 | 220 | 300 | 36 | 48 | 63 | 110 | 190 | 24 | 2 | 2 |
| 48 | 240 | 340 | 45 | 60 | 78 | — | — | — | 2.1 | — |
| 52 | 260 | 360 | 45 | 60 | 79 | — | — | — | 2.1 | — |
| 56 | 280 | 380 | 45 | 60 | 80 | — | — | — | 2.1 | — |
| 60 | 300 | 420 | 54 | 73 | 95 | — | — | — | 3 | — |
| 64 | 320 | 440 | 54 | 73 | 95 | — | — | — | 3 | — |
| 68 | 340 | 460 | 54 | 73 | 96 | — | — | — | 3 | — |
| 72 | 360 | 500 | 63 | 85 | 110 | — | — | — | 4 | — |
| 76 | 380 | 520 | 63 | 85 | 112 | — | — | — | 4 | — |

Remarks: r_{min} is the smallest chamfer dimension.

Table 4.4.1 Boundary Dimensions of Thrust Bearings with Flat Back Face

(3/4)

Unit : mm

| | | | | | | | | | | |
|---|------|---------------------------------------|------------------------------|-----|-----|-----|---------------|---|-------------------|-------------------|
| Single direction thrust ball bearings | | | | | 512 | | | | | |
| Double direction thrust ball bearings | | | | | | 522 | | | | |
| Spherical roller thrust bearings | | | | 292 | | | | | | |
| Bearing bore diameter Nominal Bore No. d | | Diameter series 2 | | | | | | | | |
| | | Bearing outside diameter Nominal D | Dimension series | | | | | | Chamfer dimension | |
| | | | 72 | 92 | 12 | 22 | 22 | | r _{min} | r _{1min} |
| | | | Height Nominal T | | | | Center washer | | | |
| | | | Bore d ₂ Height a | | | | | | | |
| 80 | 400 | 540 | 63 | 85 | 112 | — | — | — | 4 | — |
| 84 | 420 | 580 | 73 | 95 | 130 | — | — | — | 5 | — |
| 88 | 440 | 600 | 73 | 95 | 130 | — | — | — | 5 | — |
| 92 | 460 | 620 | 73 | 95 | 130 | — | — | — | 5 | — |
| 96 | 480 | 650 | 78 | 103 | 135 | — | — | — | 5 | — |
| /500 | 500 | 670 | 78 | 103 | 135 | — | — | — | 5 | — |
| /530 | 530 | 710 | 82 | 109 | 140 | — | — | — | 5 | — |
| /560 | 560 | 750 | 85 | 115 | 150 | — | — | — | 5 | — |
| /600 | 600 | 800 | 90 | 122 | 160 | — | — | — | 5 | — |
| /630 | 630 | 850 | 100 | 132 | 175 | — | — | — | 6 | — |
| /670 | 670 | 900 | 103 | 140 | 180 | — | — | — | 6 | — |
| /710 | 710 | 950 | 109 | 145 | 190 | — | — | — | 6 | — |
| /750 | 750 | 1000 | 112 | 150 | 195 | — | — | — | 6 | — |
| /800 | 800 | 1060 | 118 | 155 | 205 | — | — | — | 7.5 | — |
| /850 | 850 | 1120 | 122 | 160 | 212 | — | — | — | 7.5 | — |
| /900 | 900 | 1180 | 125 | 170 | 220 | — | — | — | 7.5 | — |
| /950 | 950 | 1250 | 136 | 180 | 236 | — | — | — | 7.5 | — |
| /1000 | 1000 | 1320 | 145 | 190 | 250 | — | — | — | 9.5 | — |
| /1060 | 1060 | 1400 | 155 | 206 | 265 | — | — | — | 9.5 | — |
| /1120 | 1120 | 1460 | — | 206 | — | — | — | — | 9.5 | — |
| /1180 | 1180 | 1520 | — | 206 | — | — | — | — | 9.5 | — |

Remarks: r_{min} is the smallest chamfer dimension.

Table 4.4.2 Boundary Dimensions of Thrust Bearings with Flat Back Face

(4/4)

Unit : mm



| | | | | | | | | |
|---|---------------------------------------|------------------|-----|-----|---|----|-------------------|-------------------|
| Single direction thrust ball bearings | | | | 512 | | | | |
| Double direction thrust ball bearings | | | | | 522 | | | |
| Spherical roller thrust bearings | | | 292 | | | | | |
| Bearing bore diameter Nominal Bore No. d | Diameter series 2 | | | | | | | |
| | Bearing outside diameter Nominal D | Dimension series | | | | | Chamfer dimension | |
| | | 72 | 92 | 12 | 22 | 22 | r _{min} | r _{1min} |
| | | Height Nominal T | | | Center washer Bore d ₂ Height a | | | |
| /1250 1250 | 1610 | — | 216 | — | — | — | 9.5 | — |
| /1320 1320 | 1700 | — | 228 | — | — | — | 9.5 | — |
| /1400 1400 | 1760 | — | 234 | — | — | — | 12 | — |
| /1500 1500 | 1920 | — | 252 | — | — | — | 12 | — |
| /1600 1600 | 2040 | — | 264 | — | — | — | 15 | — |
| /1700 1700 | 2160 | — | 276 | — | — | — | 15 | — |
| /1800 1800 | 2280 | — | 280 | — | — | — | 15 | — |
| /1900 1900 | | — | — | — | — | — | — | — |
| /2000 2000 | | — | — | — | — | — | — | — |
| /2120 2120 | — | — | — | — | — | — | — | — |
| /2240 2240 | — | — | — | — | — | — | — | — |
| /2360 2360 | — | — | — | — | — | — | — | — |
| /2500 2500 | — | — | — | — | — | — | — | — |

Remarks: r_{min} is the smallest chamfer dimension.

Table 4.4.3 Boundary Dimensions of Thrust Bearings with Flat Back Face (1/4)

Unit : mm

| | | | | | | | | | | |
|---------------------------------------|----|---------------------------------------|------------------|-----|-----|---|----|----|-------------------|-------------------|
| Single direction thrust ball bearings | | | | | 513 | | | | | |
| Double direction thrust ball bearings | | | | | | 523 | | | | |
| Spherical roller thrust bearings | | | | 293 | | | | | | |
| Bearing bore diameter Nominal | | Diameter series 3 | | | | | | | | |
| | | Bearing outside diameter Nominal D | Dimension series | | | | | | Chamfer dimension | |
| | | | 73 | 93 | 13 | 23 | 23 | | r _{min} | r _{1min} |
| Bore No. | d | Height Nominal T | | | | Center washer Bore d ₂ Height a | | | | |
| 4 | 4 | 20 | 7 | — | 11 | — | — | — | 0.6 | — |
| 6 | 6 | 24 | 8 | — | 12 | — | — | — | 0.6 | — |
| 8 | 8 | 26 | 8 | — | 12 | — | — | — | 0.6 | — |
| 00 | 10 | 30 | 9 | — | 14 | — | — | — | 0.6 | — |
| 01 | 12 | 32 | 9 | — | 14 | — | — | — | 0.6 | — |
| 02 | 15 | 37 | 10 | — | 15 | — | — | — | 0.6 | — |
| 03 | 17 | 40 | 10 | — | 16 | — | — | — | 0.6 | — |
| 04 | 20 | 47 | 12 | — | 18 | — | — | — | 1 | — |
| 05 | 25 | 52 | 12 | — | 18 | 34 | 20 | 8 | 1 | 0.3 |
| 06 | 30 | 60 | 14 | — | 21 | 38 | 25 | 9 | 1 | 0.3 |
| 07 | 35 | 68 | 15 | — | 24 | 44 | 30 | 10 | 1 | 0.3 |
| 08 | 40 | 78 | 17 | 22 | 26 | 49 | 30 | 12 | 1 | 0.6 |
| 09 | 45 | 85 | 18 | 24 | 28 | 52 | 35 | 12 | 1 | 0.6 |
| 10 | 50 | 95 | 20 | 27 | 31 | 58 | 40 | 14 | 1.1 | 0.6 |
| 11 | 55 | 105 | 23 | 30 | 35 | 64 | 45 | 15 | 1.1 | 0.6 |
| 12 | 60 | 110 | 23 | 30 | 35 | 64 | 50 | 15 | 1.1 | 0.6 |
| 13 | 65 | 115 | 23 | 30 | 36 | 65 | 55 | 15 | 1.1 | 0.6 |
| 14 | 70 | 125 | 25 | 34 | 40 | 72 | 55 | 16 | 1.1 | 1 |
| 15 | 75 | 135 | 27 | 36 | 44 | 79 | 60 | 18 | 1.5 | 1 |
| 16 | 80 | 140 | 27 | 36 | 44 | 79 | 65 | 18 | 1.5 | 1 |
| 17 | 85 | 150 | 29 | 39 | 49 | 87 | 70 | 19 | 1.5 | 1 |

Remarks: r_{min} is the smallest chamfer dimension.

Table 4.4.3 Boundary Dimensions of Thrust Bearings with Flat Back Face (2/4)

Unit : mm

| | | | | | | | | | | |
|---------------------------------------|-----|---------------------------------------|------------------|-----|-----|---|-----|----|-------------------|-------------------|
| Single direction thrust ball bearings | | | | | 513 | | | | | |
| Double direction thrust ball bearings | | | | | | 523 | | | | |
| Spherical roller thrust bearings | | | | 293 | | | | | | |
| Bearing bore diameter Nominal | | Diameter series 3 | | | | | | | | |
| | | Bearing outside diameter Nominal D | Dimension series | | | | | | Chamfer dimension | |
| | | | 73 | 93 | 13 | 23 | 23 | | r _{min} | r _{1min} |
| Bore No. | d | Height Nominal T | | | | Center washer Bore d ₂ Height a | | | | |
| 18 | 90 | 155 | 29 | 39 | 50 | 88 | 75 | 19 | 1.5 | 1 |
| 20 | 100 | 170 | 32 | 42 | 55 | 97 | 85 | 21 | 1.5 | 1 |
| 22 | 110 | 190 | 36 | 48 | 63 | 110 | 95 | 24 | 2 | 1 |
| 24 | 120 | 210 | 41 | 54 | 70 | 123 | 100 | 27 | 2.1 | 1.1 |
| 26 | 130 | 225 | 42 | 58 | 75 | 130 | 110 | 30 | 2.1 | 1.1 |
| 28 | 140 | 240 | 45 | 60 | 80 | 140 | 120 | 31 | 2.1 | 1.1 |
| 30 | 150 | 250 | 45 | 60 | 80 | 140 | 130 | 31 | 2.1 | 1.1 |
| 32 | 160 | 270 | 50 | 67 | 87 | 153 | 140 | 33 | 3 | 1.1 |
| 34 | 170 | 280 | 50 | 67 | 87 | 153 | 150 | 33 | 3 | 1.1 |
| 36 | 180 | 300 | 54 | 73 | 95 | 165 | 150 | 37 | 3 | 2 |
| 38 | 190 | 320 | 58 | 78 | 105 | 183 | 160 | 40 | 4 | 2 |
| 40 | 200 | 340 | 63 | 85 | 110 | 192 | 170 | 42 | 4 | 2 |
| 44 | 220 | 360 | 63 | 85 | 112 | — | — | — | 4 | — |
| 48 | 240 | 380 | 63 | 85 | 112 | — | — | — | 4 | — |
| 52 | 260 | 420 | 73 | 95 | 130 | — | — | — | 5 | — |
| 56 | 280 | 440 | 73 | 95 | 130 | — | — | — | 5 | — |
| 60 | 300 | 480 | 82 | 109 | 140 | — | — | — | 5 | — |
| 64 | 320 | 500 | 82 | 109 | 140 | — | — | — | 5 | — |
| 68 | 340 | 540 | 90 | 122 | 160 | — | — | — | 5 | — |
| 72 | 360 | 560 | 90 | 122 | 160 | — | — | — | 5 | — |
| 76 | 380 | 600 | 100 | 132 | 175 | — | — | — | 6 | — |

Remarks: r_{min} is the smallest chamfer dimension.

Table 4.4.3 Boundary Dimensions of Thrust Bearings with Flat Back Face (3/4)

Unit : mm

| | | | | | | | | | | |
|---------------------------------------|------|---------------------------------------|------------------|-----|-----|---|----|---|-------------------|-------------------|
| Single direction thrust ball bearings | | | | | 513 | | | | | |
| Double direction thrust ball bearings | | | | | | 523 | | | | |
| Spherical roller thrust bearings | | | | 293 | | | | | | |
| Bearing bore diameter Nominal | | Diameter series 3 | | | | | | | | |
| | | Bearing outside diameter Nominal D | Dimension series | | | | | | Chamfer dimension | |
| | | | 73 | 93 | 13 | 23 | 23 | | r _{min} | r _{1min} |
| Bore No. | d | Height Nominal T | | | | Center washer Bore d ₂ Height a | | | | |
| 80 | 400 | 620 | 100 | 132 | 175 | — | — | — | 6 | — |
| 84 | 420 | 650 | 103 | 140 | 180 | — | — | — | 6 | — |
| 88 | 440 | 680 | 109 | 145 | 190 | — | — | — | 6 | — |
| 92 | 460 | 710 | 112 | 150 | 195 | — | — | — | 6 | — |
| 96 | 480 | 730 | 112 | 150 | 195 | — | — | — | 6 | — |
| /500 | 500 | 750 | 112 | 150 | 195 | — | — | — | 6 | — |
| /530 | 530 | 800 | 122 | 160 | 212 | — | — | — | 7.5 | — |
| /560 | 560 | 850 | 132 | 175 | 224 | — | — | — | 7.5 | — |
| /600 | 600 | 900 | 136 | 180 | 236 | — | — | — | 7.5 | — |
| /630 | 630 | 950 | 145 | 190 | 250 | — | — | — | 9.5 | — |
| /670 | 670 | 1000 | 150 | 200 | 258 | — | — | — | 9.5 | — |
| /710 | 710 | 1060 | 160 | 212 | 272 | — | — | — | 9.5 | — |
| /750 | 750 | 1120 | 165 | 224 | 290 | — | — | — | 9.5 | — |
| /800 | 800 | 1180 | 170 | 230 | 300 | — | — | — | 9.5 | — |
| /850 | 850 | 1250 | 180 | 243 | 315 | — | — | — | 12 | — |
| /900 | 900 | 1320 | 190 | 250 | 335 | — | — | — | 12 | — |
| /950 | 950 | 1400 | 200 | 272 | 355 | — | — | — | 12 | — |
| /1000 | 1000 | 1460 | — | 276 | — | — | — | — | 12 | — |
| /1060 | 1060 | 1540 | — | 288 | — | — | — | — | 15 | — |
| /1120 | 1120 | 1630 | — | 306 | — | — | — | — | 15 | — |
| /1180 | 1180 | 1710 | — | 318 | — | — | — | — | 15 | — |

Remarks: r_{min} is the smallest chamfer dimension.

Table 4.4.3 Boundary Dimensions of Thrust Bearings with Flat Back Face (4/4)

Unit : mm



| | | | | | | | | | | |
|---------------------------------------|------|---------------------------------------|------------------|-----|-----|---|----|---|-------------------|-------------------|
| Single direction thrust ball bearings | | | | | 513 | | | | | |
| Double direction thrust ball bearings | | | | | | 523 | | | | |
| Spherical roller thrust bearings | | | | 293 | | | | | | |
| Bearing bore diameter Nominal | | Diameter series 3 | | | | | | | | |
| | | Bearing outside diameter Nominal D | Dimension series | | | | | | Chamfer dimension | |
| | | | 73 | 93 | 13 | 23 | 23 | | r _{min} | r _{1min} |
| Bore No. | d | Height Nominal T | | | | Center washer Bore d ₂ Height a | | | | |
| /1250 | 1250 | 1800 | — | 330 | — | — | — | — | 15 | — |
| /1320 | 1320 | 1900 | — | 348 | — | — | — | — | 19 | — |
| /1400 | 1400 | 2000 | — | 360 | — | — | — | — | 19 | — |
| /1500 | 1500 | 2140 | — | 384 | — | — | — | — | 19 | — |
| /1600 | 1600 | 2270 | — | 402 | — | — | — | — | 19 | — |
| /1700 | 1700 | — | — | — | — | — | — | — | — | — |
| /1800 | 1800 | — | — | — | — | — | — | — | — | — |
| /1900 | 1900 | — | — | — | — | — | — | — | — | — |
| /2000 | 2000 | — | — | — | — | — | — | — | — | — |
| /2120 | 2120 | — | — | — | — | — | — | — | — | — |
| /2240 | 2240 | — | — | — | — | — | — | — | — | — |
| /2360 | 2360 | — | — | — | — | — | — | — | — | — |
| /2500 | 2500 | — | — | — | — | — | — | — | — | — |

Remarks: r_{min} is the smallest chamfer dimension.

Table 4.4.4 Boundary Dimensions of Thrust Bearings with Flat Back Face (1/4)

Unit : mm

| | | | | | | | | | | | | | |
|---------------------------------------|----|---------------------------------------|------------------|-----|-----|---|----|----|-------------------|-------------------|---------------------------------------|------------------|-------------------|
| Single direction thrust ball bearings | | | | | 514 | | | | | | | | |
| Double direction thrust ball bearings | | | | | | 524 | | | | | | | |
| Spherical roller thrust bearings | | | | 294 | | | | | | | | | |
| Bearing bore diameter Nominal | | Diameter series 4 | | | | | | | | Diameter series 5 | | | |
| | | Bearing outside diameter Nominal D | Dimension series | | | | | | Chamfer dimension | | Bearing outside diameter Nominal D | Dimension series | Chamfer dimension |
| | | | 74 | 94 | 14 | 24 | 24 | | r _{min} | r _{1min} | | 95 | r _{min} |
| Bore No. | d | Height Nominal T | | | | Center washer Bore d ₂ Height a | | | | | | Height Nominal T | |
| 4 | 4 | — | — | — | — | — | — | — | — | — | — | — | — |
| 6 | 6 | — | — | — | — | — | — | — | — | — | — | — | — |
| 8 | 8 | — | — | — | — | — | — | — | — | — | — | — | — |
| 00 | 10 | — | — | — | — | — | — | — | — | — | — | — | — |
| 01 | 12 | — | — | — | — | — | — | — | — | — | — | — | — |
| 02 | 15 | — | — | — | — | — | — | — | — | — | — | — | — |
| 03 | 17 | — | — | — | — | — | — | — | — | — | 52 | 21 | 1 |
| 04 | 20 | — | — | — | — | — | — | — | — | — | 60 | 24 | 1 |
| 05 | 25 | 60 | 16 | 21 | 24 | 45 | 15 | 11 | 1 | 0.6 | 73 | 29 | 1.1 |
| 06 | 30 | 70 | 18 | 24 | 28 | 52 | 20 | 12 | 1 | 0.6 | 85 | 34 | 1.1 |
| 07 | 35 | 80 | 20 | 27 | 32 | 59 | 25 | 14 | 1.1 | 0.6 | 100 | 39 | 1.1 |
| 08 | 40 | 90 | 23 | 30 | 36 | 65 | 30 | 15 | 1.1 | 0.6 | 110 | 42 | 1.5 |
| 09 | 45 | 100 | 25 | 34 | 39 | 72 | 35 | 17 | 1.1 | 0.6 | 120 | 45 | 2 |
| 10 | 50 | 110 | 27 | 36 | 43 | 78 | 40 | 18 | 1.5 | 0.6 | 135 | 51 | 2 |
| 11 | 55 | 120 | 29 | 39 | 48 | 87 | 45 | 20 | 1.5 | 0.6 | 150 | 58 | 2.1 |
| 12 | 60 | 130 | 32 | 42 | 51 | 93 | 50 | 21 | 1.5 | 0.6 | 160 | 60 | 2.1 |
| 13 | 65 | 140 | 34 | 45 | 56 | 101 | 50 | 23 | 2 | 1 | 170 | 63 | 2.1 |
| 14 | 70 | 150 | 36 | 48 | 60 | 107 | 55 | 24 | 2 | 1 | 180 | 67 | 3 |
| 15 | 75 | 160 | 38 | 51 | 65 | 115 | 60 | 26 | 2 | 1 | 190 | 69 | 3 |
| 16 | 80 | 170 | 41 | 54 | 68 | 120 | 65 | 27 | 2.1 | 1 | 200 | 73 | 3 |
| 17 | 85 | 180 | 42 | 58 | 72 | 128 | 65 | 29 | 2.1 | 1.1 | 215 | 78 | 4 |

Remarks: r_{min} is the smallest chamfer dimension.

Table 4.4.4 Boundary Dimensions of Thrust Bearings with Flat Back Face (2/4)

Unit : mm

| | | | | | | | | | | | | | |
|---------------------------------------|-----|---------------------------------------|------------------|-----|-----|-----|---|----|-------------------|-------------------|---------------------------------------|------------------|-------------------|
| Single direction thrust ball bearings | | | | | 514 | | | | | | | | |
| Double direction thrust ball bearings | | | | | | 524 | | | | | | | |
| Spherical roller thrust bearings | | | | 294 | | | | | | | | | |
| Bearing bore diameter Nominal | | Diameter series 4 | | | | | | | | Diameter series 5 | | | |
| | | Bearing outside diameter Nominal D | Dimension series | | | | | | Chamfer dimension | | Bearing outside diameter Nominal D | Dimension series | Chamfer dimension |
| | | | 74 | 94 | 14 | 24 | 24 | | r _{min} | r _{1min} | | 95 | r _{min} |
| | | | Height Nominal T | | | | Center washer Bore d ₂ Height a | | | | | Height Nominal T | |
| Bore No. | d | | | | | | | | | | | | |
| 18 | 90 | 190 | 45 | 60 | 77 | 135 | 70 | 30 | 2.1 | 1.1 | 225 | 82 | 4 |
| 20 | 100 | 210 | 50 | 67 | 85 | 150 | 80 | 33 | 3 | 1.1 | 250 | 90 | 4 |
| 22 | 110 | 230 | 54 | 73 | 95 | 166 | 90 | 37 | 3 | 1.1 | 270 | 95 | 5 |
| 24 | 120 | 250 | 58 | 78 | 102 | 177 | 95 | 40 | 4 | 1.5 | 300 | 109 | 5 |
| 26 | 130 | 270 | 63 | 85 | 110 | 192 | 100 | 42 | 4 | 2 | 320 | 115 | 5 |
| 28 | 140 | 280 | 63 | 85 | 112 | 196 | 110 | 44 | 4 | 2 | 340 | 122 | 5 |
| 30 | 150 | 300 | 67 | 90 | 120 | 209 | 120 | 46 | 4 | 2 | 360 | 125 | 6 |
| 32 | 160 | 320 | 73 | 95 | 130 | 226 | 130 | 50 | 5 | 2 | 380 | 132 | 6 |
| 34 | 170 | 340 | 78 | 103 | 135 | 236 | 135 | 50 | 5 | 2.1 | 400 | 140 | 6 |
| 36 | 180 | 360 | 82 | 109 | 140 | 245 | 140 | 52 | 5 | 3 | 420 | 145 | 6 |
| 38 | 190 | 380 | 85 | 115 | 150 | — | — | — | 5 | — | 440 | 150 | 6 |
| 40 | 200 | 400 | 90 | 122 | 155 | — | — | — | 5 | — | 460 | 155 | 7.5 |
| 44 | 220 | 420 | 90 | 122 | 160 | — | — | — | 6 | — | 500 | 170 | 7.5 |
| 48 | 240 | 440 | 90 | 122 | 160 | — | — | — | 6 | — | 540 | 180 | 7.5 |
| 52 | 260 | 480 | 100 | 132 | 175 | — | — | — | 6 | — | 580 | 190 | 9.5 |
| 56 | 280 | 520 | 109 | 145 | 190 | — | — | — | 6 | — | 620 | 206 | 9.5 |
| 60 | 300 | 540 | 109 | 145 | 190 | — | — | — | 6 | — | 670 | 224 | 9.5 |
| 64 | 320 | 580 | 118 | 155 | 205 | — | — | — | 7.5 | — | 710 | 236 | 9.5 |
| 68 | 340 | 620 | 125 | 170 | 220 | — | — | — | 7.5 | — | 750 | 243 | 12 |
| 72 | 360 | 640 | 125 | 170 | 220 | — | — | — | 7.5 | — | 780 | 250 | 12 |
| 76 | 380 | 670 | 132 | 175 | 224 | — | — | — | 7.5 | — | 820 | 265 | 12 |

Remarks: r_{min} is the smallest chamfer dimension.

Table 4.4.4 Boundary Dimensions of Thrust Bearings with Flat Back Face (3/4)

Unit : mm

| | | | | | | | | | | | | | |
|---------------------------------------|---------------------------------------|------------------|-----|-----|-----|---|------------------|-------------------|------------------|---------------------------------------|------------------|-------------------|--|
| Single direction thrust ball bearings | | | | 514 | | | | | | | | | |
| Double direction thrust ball bearings | | | | | 524 | | | | | | | | |
| Spherical roller thrust bearings | | | 294 | | | | | | | | | | |
| Bearing bore diameter Nominal | Diameter series 4 | | | | | | | | | Diameter series 5 | | | |
| | Bearing outside diameter Nominal D | Dimension series | | | | | | Chamfer dimension | | Bearing outside diameter Nominal D | Dimension series | Chamfer dimension | |
| | | 74 | 94 | 14 | 24 | 24 | r _{min} | r _{1min} | 95 | | r _{min} | | |
| | | Height Nominal T | | | | Center washer Bore d ₂ Height a | | | Height Nominal T | | | | |
| Bore No. d | | | | | | | | | | | | | |
| 80 400 | 710 | 140 | 185 | 243 | — | — | — | 7.5 | — | 850 | 272 | 12 | |
| 84 420 | 730 | 140 | 185 | 243 | — | — | — | 7.5 | — | 900 | 290 | 15 | |
| 88 440 | 780 | 155 | 206 | 265 | — | — | — | 9.5 | — | 950 | 308 | 15 | |
| 92 460 | 800 | 155 | 206 | 265 | — | — | — | 9.5 | — | 980 | 315 | 15 | |
| 96 480 | 850 | 165 | 224 | 290 | — | — | — | 9.5 | — | 1000 | 315 | 15 | |
| /500 500 | 870 | 165 | 224 | 290 | — | — | — | 9.5 | — | 1060 | 335 | 15 | |
| /530 530 | 920 | 175 | 236 | 308 | — | — | — | 9.5 | — | 1090 | 335 | 15 | |
| /560 560 | 980 | 190 | 250 | 335 | — | — | — | 12 | — | 1150 | 355 | 15 | |
| /600 600 | 1030 | 195 | 258 | 335 | — | — | — | 12 | — | 1220 | 375 | 15 | |
| /630 630 | 1090 | 206 | 280 | 365 | — | — | — | 12 | — | 1280 | 388 | 15 | |
| /670 670 | 1150 | 218 | 290 | 375 | — | — | — | 15 | — | 1320 | 388 | 15 | |
| /710 710 | 1220 | 230 | 308 | 400 | — | — | — | 15 | — | 1400 | 412 | 15 | |
| /750 750 | 1280 | 236 | 315 | 412 | — | — | — | 15 | — | — | — | — | |
| /800 800 | 1360 | 250 | 335 | 438 | — | — | — | 15 | — | — | — | — | |
| /850 850 | 1440 | — | 354 | — | — | — | — | 15 | — | — | — | — | |
| /900 900 | 1520 | — | 372 | — | — | — | — | 15 | — | — | — | — | |
| /950 950 | 1600 | — | 390 | — | — | — | — | 15 | — | — | — | — | |
| /1000 1000 | 1670 | — | 402 | — | — | — | — | 15 | — | — | — | — | |
| /1060 1060 | 1770 | — | 426 | — | — | — | — | 15 | — | — | — | — | |
| /1120 1120 | 1860 | — | 444 | — | — | — | — | 15 | — | — | — | — | |
| /1180 1180 | 1950 | — | 462 | — | — | — | — | 19 | — | — | — | — | |

Remarks: r_{min} is the smallest chamfer dimension.

Table 4.4.4 Boundary Dimensions of Thrust Bearings with Flat Back Face (4/4)

Unit : mm



| | | | | | | | | | | | | |
|---------------------------------------|---------------------------------------|------------------|-----|-----|-----|---|---|-------------------|-------------------|---------------------------------------|------------------|-------------------|
| Single direction thrust ball bearings | | | | 514 | | | | | | | | |
| Double direction thrust ball bearings | | | | | 524 | | | | | | | |
| Spherical roller thrust bearings | | | 294 | | | | | | | | | |
| Bearing bore diameter Nominal | Diameter series 4 | | | | | | | | Diameter series 5 | | | |
| | Bearing outside diameter Nominal D | Dimension series | | | | | | Chamfer dimension | | Bearing outside diameter Nominal D | Dimension series | Chamfer dimension |
| | | 74 | 94 | 14 | 24 | 24 | | r _{min} | r _{1min} | | 95 | r _{min} |
| | | Height Nominal T | | | | Center washer Bore d ₂ Height a | | | | | Height Nominal T | |
| Bore No. d | | | | | | | | | | | | |
| /1250 1250 | 2050 | — | 480 | — | — | — | — | 19 | — | — | — | — |
| /1320 1320 | 2160 | — | 505 | — | — | — | — | 19 | — | — | — | — |
| /1400 1400 | 2280 | — | 530 | — | — | — | — | 19 | — | — | — | — |
| /1500 1500 | — | — | — | — | — | — | — | — | — | — | — | — |
| /1600 1600 | — | — | — | — | — | — | — | — | — | — | — | — |
| /1700 1700 | — | — | — | — | — | — | — | — | — | — | — | — |
| /1800 1800 | — | — | — | — | — | — | — | — | — | — | — | — |
| /1900 1900 | — | — | — | — | — | — | — | — | — | — | — | — |
| /2000 2000 | — | — | — | — | — | — | — | — | — | — | — | — |
| /2120 2120 | — | — | — | — | — | — | — | — | — | — | — | — |
| /2240 2240 | — | — | — | — | — | — | — | — | — | — | — | — |
| /2360 2360 | — | — | — | — | — | — | — | — | — | — | — | — |
| /2500 2500 | — | — | — | — | — | — | — | — | — | — | — | — |

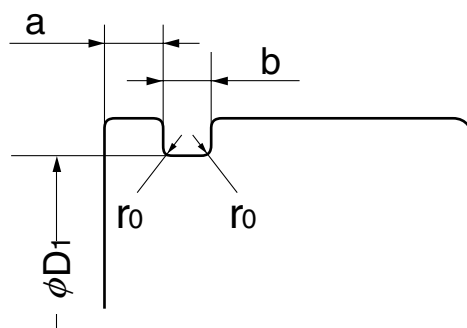
 Remarks: r_{min} is the smallest chamfer dimension.

Table 4.5.1 Dimensions of Snap Ring Grooves for Bearing Dimension Series 18 and 19

(1/3)

Unit: mm

| Bearing outside diameter Nominal D | Snap ring groove diameter D ₁ | | Snap ring groove location a | | | | Snap ring groove width b | | Fillet radius at snap ring groove bottom r ₀ | Applicable snap ring |
|--|--|------|-----------------------------|------|---------------------|------|--------------------------------|------|---|-------------------------|
| | | | Dimension series 18 | | Dimension series 19 | | | | | |
| | Max | Min | Max | Min | Max | Min | Max | Min | Max | |
| 22 | 20.8 | 20.5 | — | — | 1.05 | 0.9 | 1.05 | 0.8 | 0.2 | NR1022 |
| 24 | 22.8 | 22.5 | — | — | 1.05 | 0.9 | 1.05 | 0.8 | 0.2 | NR1024 |
| 28 | 26.7 | 26.4 | — | — | 1.3 | 1.15 | 1.2 | 0.95 | 0.25 | NR1028 |
| 30 | 28.7 | 28.4 | — | — | 1.3 | 1.15 | 1.2 | 0.95 | 0.25 | NR1030 |
| 32 | 30.7 | 30.4 | 1.3 | 1.15 | — | — | 1.2 | 0.95 | 0.25 | NR1032 |
| 34 | 32.7 | 32.4 | 1.3 | 1.15 | — | — | 1.2 | 0.95 | 0.25 | NR1034 |
| 37 | 35.7 | 35.4 | 1.3 | 1.15 | 1.7 | 1.55 | 1.2 | 0.95 | 0.25 | NR1037 |
| 39 | 37.7 | 37.4 | — | — | 1.7 | 1.55 | 1.2 | 0.95 | 0.25 | NR1039 |
| 40 | 38.7 | 38.4 | 1.3 | 1.15 | — | — | 1.2 | 0.95 | 0.25 | NR1040 |
| 42 | 40.7 | 40.4 | 1.3 | 1.15 | 1.7 | 1.55 | 1.2 | 0.95 | 0.25 | NR1042 |
| 44 | 42.7 | 42.4 | 1.3 | 1.15 | — | — | 1.2 | 0.95 | 0.25 | NR1044 |
| 45 | 43.7 | 43.4 | — | — | 1.7 | 1.55 | 1.2 | 0.95 | 0.25 | NR1045 |
| 47 | 45.7 | 45.4 | 1.3 | 1.15 | 1.7 | 1.55 | 1.2 | 0.95 | 0.25 | NR1047 |
| 52 | 50.7 | 50.4 | 1.3 | 1.15 | 1.7 | 1.55 | 1.2 | 0.95 | 0.25 | NR1052 |
| 55 | 53.7 | 53.4 | — | — | 1.7 | 1.55 | 1.2 | 0.95 | 0.25 | NR1055 |



Remarks:

Chamfer at groove side of outer ring clears a fillet radius of:
 0.3 mm in dimension series 18 up to and including D = 78 mm and
 in dimension series 19 up to and including D = 47 mm;
 0.5 mm in dimension series 18 over D = 78 mm and
 in dimension series 19 over D = 47 mm

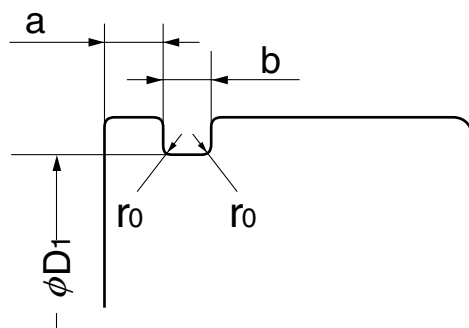


Table 4.5.1 Dimensions of Snap Ring Grooves for Bearing Dimension Series 18 and 19

(2/3)

Unit: mm ▲

| Bearing outside diameter Nominal D | Snap ring groove diameter D ₁ | | Snap ring groove location a | | | | Snap ring groove width b | | Fillet radius at snap ring groove bottom r ₀ | Applicable snap ring |
|--|--|-------|-----------------------------|------|---------------------|------|--------------------------------|------|---|-------------------------|
| | | | Dimension series 18 | | Dimension series 19 | | | | | |
| | Max | Min | Max | Min | Max | Min | Max | Min | Max | |
| 58 | 56.7 | 56.4 | 1.3 | 1.15 | — | — | 1.2 | 0.95 | 0.25 | NR1058 |
| 62 | 60.7 | 60.3 | — | — | 1.7 | 1.55 | 1.2 | 0.95 | 0.25 | NR1062 |
| 65 | 63.7 | 63.3 | 1.3 | 1.15 | — | — | 1.2 | 0.95 | 0.25 | NR1065 |
| 68 | 66.7 | 66.3 | — | — | 1.7 | 1.55 | 1.2 | 0.95 | 0.25 | NR1068 |
| 72 | 70.7 | 70.3 | 1.7 | 1.55 | 1.7 | 1.55 | 1.2 | 0.95 | 0.25 | NR1072 |
| 78 | 76.2 | 75.8 | 1.7 | 1.55 | — | — | 1.6 | 1.3 | 0.4 | NR1078 |
| 80 | 77.9 | 77.5 | — | — | 2.1 | 1.9 | 1.6 | 1.3 | 0.4 | NR1080 |
| 85 | 82.9 | 82.5 | 1.7 | 1.55 | 2.1 | 1.9 | 1.6 | 1.3 | 0.4 | NR1085 |
| 90 | 87.9 | 87.5 | 1.7 | 1.55 | 2.1 | 1.9 | 1.6 | 1.3 | 0.4 | NR1090 |
| 95 | 92.9 | 92.5 | 1.7 | 1.55 | — | — | 1.6 | 1.3 | 0.4 | NR1095 |
| 100 | 97.9 | 97.5 | 1.7 | 1.55 | 2.5 | 2.3 | 1.6 | 1.3 | 0.4 | NR1100 |
| 105 | 102.6 | 102.1 | — | — | 2.5 | 2.3 | 1.6 | 1.3 | 0.4 | NR1105 |



Remarks:

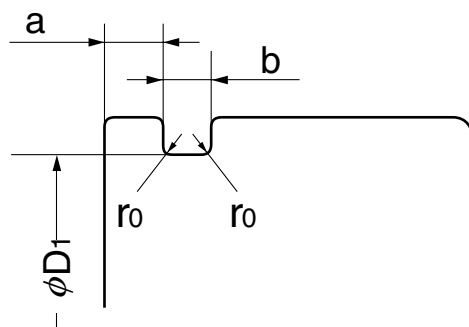
Chamfer at groove side of outer ring clears a fillet radius of:
 0.3 mm in dimension series 18 up to and including D = 78 mm and
 in dimension series 19 up to and including D = 47 mm;
 0.5 mm in dimension series 18 over D = 78 mm and
 in dimension series 19 over D = 47 mm

Table 4.5.1 Dimensions of Snap Ring Grooves for Bearing Dimension Series 18 and 19

(3/3)

Unit: mm ▲

| Bearing outside diameter Nominal D | Snap ring groove diameter D ₁ | | Snap ring groove location a | | | | Snap ring groove width b | | Fillet radius at snap ring groove bottom r ₀ | Applicable snap ring |
|--|--|-------|-----------------------------|-----|---------------------|-----|--------------------------------|-----|---|-------------------------|
| | | | Dimension series 18 | | Dimension series 19 | | | | | |
| | Max | Min | Max | Min | Max | Min | Max | Min | Max | |
| 110 | 107.6 | 107.1 | 2.1 | 1.9 | 2.5 | 2.3 | 1.6 | 1.3 | 0.4 | NR1110 |
| 115 | 112.6 | 112.1 | 2.1 | 1.9 | — | — | 1.6 | 1.3 | 0.4 | NR1115 |
| 120 | 117.6 | 117.1 | 2.1 | 1.9 | 3.3 | 3.1 | 1.6 | 1.3 | 0.4 | NR1120 |
| 125 | 122.6 | 122.1 | 2.1 | 1.9 | 3.3 | 3.1 | 1.6 | 1.3 | 0.4 | NR1125 |
| 130 | 127.6 | 127.1 | 2.1 | 1.9 | 3.3 | 3.1 | 1.6 | 1.3 | 0.4 | NR1130 |
| 140 | 137.6 | 137.1 | 2.5 | 2.3 | 3.3 | 3.1 | 2.2 | 1.9 | 0.6 | NR1140 |
| 145 | 142.6 | 142.1 | — | — | 3.3 | 3.1 | 2.2 | 1.9 | 0.6 | NR1145 |
| 150 | 147.6 | 147.1 | 2.5 | 2.3 | 3.3 | 3.1 | 2.2 | 1.9 | 0.6 | NR1150 |
| 165 | 161.8 | 161.3 | 3.3 | 3.1 | 3.7 | 3.5 | 2.2 | 1.9 | 0.6 | NR1165 |
| 175 | 171.8 | 171.3 | 3.3 | 3.1 | — | — | 2.2 | 1.9 | 0.6 | NR1175 |
| 180 | 176.8 | 176.3 | — | — | 3.7 | 3.5 | 2.2 | 1.9 | 0.6 | NR1180 |
| 190 | 186.8 | 186.3 | 3.3 | 3.1 | 3.7 | 3.5 | 2.2 | 1.9 | 0.6 | NR1190 |
| 200 | 196.8 | 196.3 | 3.3 | 3.1 | — | — | 2.2 | 1.9 | 0.6 | NR1200 |



Remarks:

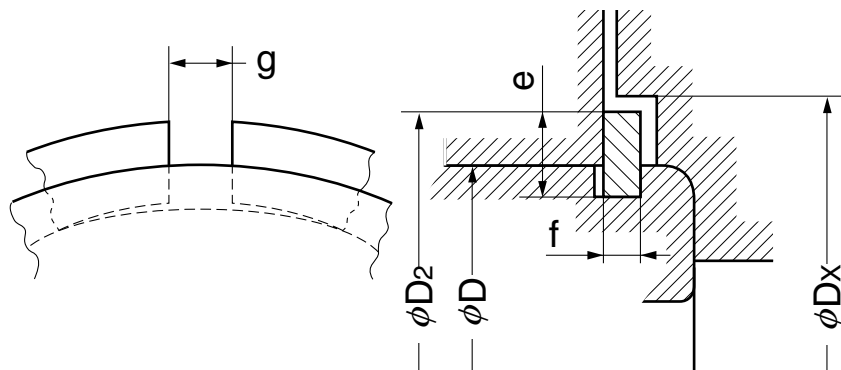
Chamfer at groove side of outer ring clears a fillet radius of:
 0.3 mm in dimension series 18 up to and including D = 78 mm and
 in dimension series 19 up to and including D = 47 mm;
 0.5 mm in dimension series 18 over D = 78 mm and
 in dimension series 19 over D = 47 mm

Table 4.5.2 Snap Ring Dimensions for Bearing Dimension Series 18 and 19

(1/3)

Unit: mm

| Snap ring No. | Snap ring dimensions | | | | After snap ring mounting | | Applicable bearing | | | Diameter of end cover bore Dx |
|---------------|----------------------|------|-------------|------|--------------------------|--|------------------------------------|------------------|----|-------------------------------|
| | Section height e | | Thickness f | | | | Bearing outside diameter Nominal D | Dimension series | | |
| | | | | | 18 | 19 | | | | |
| | Max | Min | Max | Min | Gap g | Outside diameter of snap ring D ₂ (Max) | Bearing bore diameter d | | | |
| NR1022 | 2.0 | 1.85 | 0.7 | 0.6 | 2 | 24.8 | 22 | — | 10 | 25.5 |
| NR1024 | 2.0 | 1.85 | 0.7 | 0.6 | 2 | 26.8 | 24 | — | 12 | 27.5 |
| NR1028 | 2.05 | 1.9 | 0.85 | 0.75 | 3 | 30.8 | 28 | — | 15 | 31.5 |
| NR1030 | 2.05 | 1.9 | 0.85 | 0.75 | 3 | 32.8 | 30 | — | 17 | 33.5 |
| NR1032 | 2.05 | 1.9 | 0.85 | 0.75 | 3 | 34.8 | 32 | 20 | — | 35.5 |
| NR1034 | 2.05 | 1.9 | 0.85 | 0.75 | 3 | 36.8 | 34 | 22 | — | 37.5 |
| NR1037 | 2.05 | 1.9 | 0.85 | 0.75 | 3 | 39.8 | 37 | 25 | 20 | 40.5 |
| NR1039 | 2.05 | 1.9 | 0.85 | 0.75 | 3 | 41.8 | 39 | — | 22 | 42.5 |
| NR1040 | 2.05 | 1.9 | 0.85 | 0.75 | 3 | 42.8 | 40 | 28 | — | 43.5 |
| NR1042 | 2.05 | 1.9 | 0.85 | 0.75 | 3 | 44.8 | 42 | 30 | 25 | 45.5 |
| NR1044 | 2.05 | 1.9 | 0.85 | 0.75 | 4 | 46.8 | 44 | 32 | — | 47.5 |
| NR1045 | 2.05 | 1.9 | 0.85 | 0.75 | 4 | 47.8 | 45 | — | 28 | 48.5 |
| NR1047 | 2.05 | 1.9 | 0.85 | 0.75 | 4 | 49.8 | 47 | 35 | 30 | 50.5 |
| NR1052 | 2.05 | 1.9 | 0.85 | 0.75 | 4 | 54.8 | 52 | 40 | 32 | 55.5 |
| NR1055 | 2.05 | 1.9 | 0.85 | 0.75 | 4 | 57.8 | 55 | — | 35 | 58.5 |

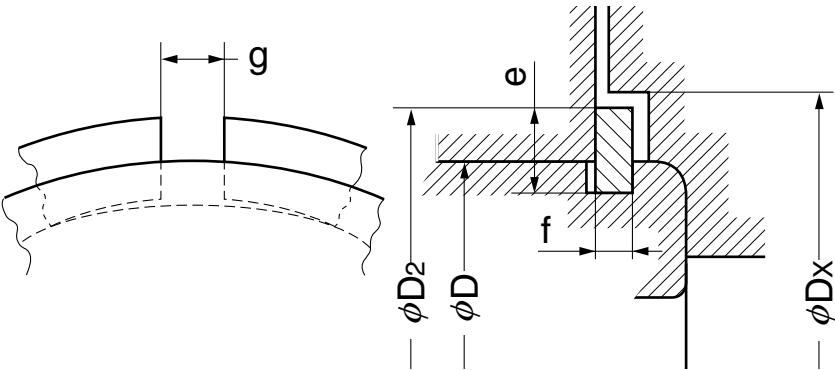


Remarks:

Chamfer at groove side of outer ring clears a fillet radius of:
 0.3 mm in dimension series 18 up to and including $D = 78$ mm and
 in dimension series 19 up to and including $D = 47$ mm;
 0.5 mm in dimension series 18 over $D = 78$ mm and
 in dimension series 19 over $D = 47$ mm

Table 4.5.2 Snap Ring Dimensions for Bearing Dimension Series 18 and 19

| Snap ring No. | Snap ring dimensions | | | | After snap ring mounting | | Applicable bearing | | | Diameter of end cover bore Dx |
|---------------|----------------------|------|-------------|------|--------------------------|--|------------------------------------|-------------------------|----|-------------------------------|
| | Section height e | | Thickness f | | Gap g | Outside diameter of snap ring D ₂ (Max) | Bearing outside diameter Nominal D | Dimension series | | |
| | Max | Min | Max | Min | | | | 18 | 19 | |
| | | | | | | | | Bearing bore diameter d | | |
| NR1058 | 2.05 | 1.9 | 0.85 | 0.75 | 4 | 60.8 | 58 | 45 | — | 61.5 |
| NR1062 | 2.05 | 1.9 | 0.85 | 0.75 | 4 | 64.8 | 62 | — | 40 | 65.5 |
| NR1065 | 2.05 | 1.9 | 0.85 | 0.75 | 4 | 67.8 | 65 | 50 | — | 68.5 |
| NR1068 | 2.05 | 1.9 | 0.85 | 0.75 | 5 | 70.8 | 68 | — | 45 | 72 |
| NR1072 | 2.05 | 1.9 | 0.85 | 0.75 | 5 | 74.8 | 72 | 55 | 50 | 76 |
| NR1078 | 3.25 | 3.1 | 1.12 | 1.02 | 5 | 82.7 | 78 | 60 | — | 84 |
| NR1080 | 3.25 | 3.1 | 1.12 | 1.02 | 5 | 84.4 | 80 | — | 55 | 86 |
| NR1085 | 3.25 | 3.1 | 1.12 | 1.02 | 5 | 89.4 | 85 | 65 | 60 | 91 |
| NR1090 | 3.25 | 3.1 | 1.12 | 1.02 | 5 | 94.4 | 90 | 70 | 65 | 96 |
| NR1095 | 3.25 | 3.1 | 1.12 | 1.02 | 5 | 99.4 | 95 | 75 | — | 101 |
| NR1100 | 3.25 | 3.1 | 1.12 | 1.02 | 5 | 104.4 | 100 | 80 | 70 | 106 |
| NR1105 | 4.04 | 3.89 | 1.12 | 1.02 | 5 | 110.7 | 105 | — | 75 | 112 |



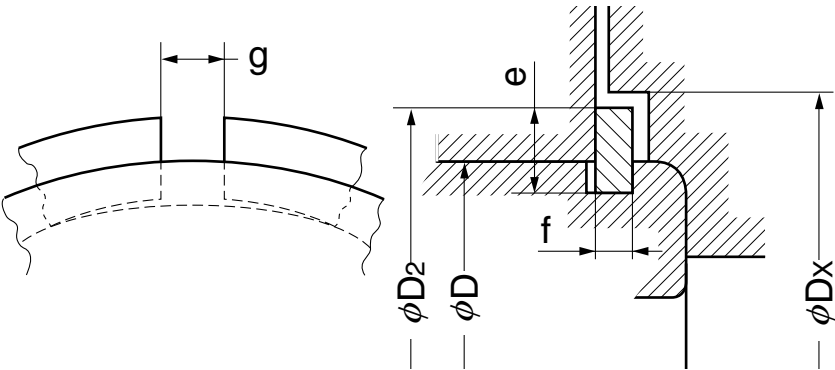
Remarks:
Chamfer at groove side of outer ring clears a fillet radius of:
0.3 mm in dimension series 18 up to and including D = 78 mm and
in dimension series 19 up to and including D = 47 mm;
0.5 mm in dimension series 18 over D = 78 mm and
in dimension series 19 over D = 47 mm

Table 4.5.2 Snap Ring Dimensions for Bearing Dimension Series 18 and 19

(3/3)

Unit: mm 

| Snap ring No. | Snap ring dimensions | | | | After snap ring mounting | | Applicable bearing | | | Diameter of end cover bore Dx |
|---------------|----------------------|------|-------------|------|--------------------------|--|------------------------------------|------------------|-----|-------------------------------|
| | Section height e | | Thickness f | | | | Bearing outside diameter Nominal D | Dimension series | | |
| | | | | | 18 | 19 | | | | |
| | Max | Min | Max | Min | Gap g | Outside diameter of snap ring D ₂ (Max) | Bearing bore diameter d | | | |
| NR1110 | 4.04 | 3.89 | 1.12 | 1.02 | 5 | 115.7 | 110 | 85 | 80 | 117 |
| NR1115 | 4.04 | 3.89 | 1.12 | 1.02 | 5 | 120.7 | 115 | 90 | — | 122 |
| NR1120 | 4.04 | 3.89 | 1.12 | 1.02 | 7 | 125.7 | 120 | 95 | 85 | 127 |
| NR1125 | 4.04 | 3.89 | 1.12 | 1.02 | 7 | 130.7 | 125 | 100 | 90 | 132 |
| NR1130 | 4.04 | 3.89 | 1.12 | 1.02 | 7 | 135.7 | 130 | 105 | 95 | 137 |
| NR1140 | 4.04 | 3.89 | 1.7 | 1.6 | 7 | 145.7 | 140 | 110 | 100 | 147 |
| NR1145 | 4.04 | 3.89 | 1.7 | 1.6 | 7 | 150.7 | 145 | — | 105 | 152 |
| NR1150 | 4.04 | 3.89 | 1.7 | 1.6 | 7 | 155.7 | 150 | 120 | 110 | 157 |
| NR1165 | 4.85 | 4.7 | 1.7 | 1.6 | 7 | 171.5 | 165 | 130 | 120 | 173 |
| NR1175 | 4.85 | 4.7 | 1.7 | 1.6 | 10 | 181.5 | 175 | 140 | — | 183 |
| NR1180 | 4.85 | 4.7 | 1.7 | 1.6 | 10 | 186.5 | 180 | — | 130 | 188 |
| NR1190 | 4.85 | 4.7 | 1.7 | 1.6 | 10 | 196.5 | 190 | 150 | 140 | 198 |
| NR1200 | 4.85 | 4.7 | 1.7 | 1.6 | 10 | 206.5 | 200 | 160 | — | 208 |



Remarks:

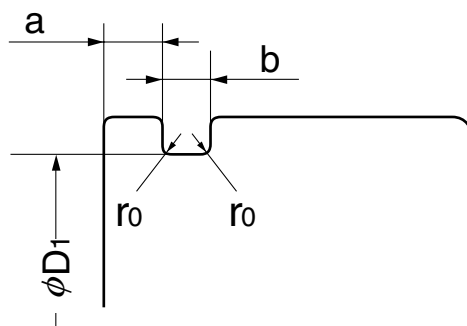
Chamfer at groove side of outer ring clears a fillet radius of:
0.3 mm in dimension series 18 up to and including D = 78 mm and
in dimension series 19 up to and including D = 47 mm;
0.5 mm in dimension series 18 over D = 78 mm and
in dimension series 19 over D = 47 mm

Table 4.5.3 Dimensions of Snap Ring Grooves for Bearing Diameter Series 0, 2, 3 and 4

(1/4)

Unit: mm

| Bearing outside diameter Nominal D | Snap ring groove diameter D ₁ | | Snap ring groove location a | | | | Snap ring groove width b | | Fillet radius at snap ring groove bottom r ₀ | Applicable snap ring |
|--|--|-------|-----------------------------|------|----------------------------|------|--------------------------------|------|---|-------------------------|
| | | | Diameter series 0 | | Diameter series 2, 3, 4 | | | | | |
| | Max | Min | Max | Min | Max | Min | Max | Min | Max | |
| 13 | 12.04 | 11.91 | — | — | 1.1 | 0.95 | 1.05 | 0.8 | 0.2 | NR 13 |
| 16 | 15.16 | 15.04 | — | — | 1.2 | 1.05 | 1.05 | 0.8 | 0.2 | NR 16 |
| 19 | 18.25 | 18.1 | 1.73 | 1.55 | 1.73 | 1.55 | 1.05 | 0.8 | 0.2 | NR 19 |
| 22 | 21.11 | 20.95 | 1.73 | 1.55 | 1.73 | 1.55 | 1.05 | 0.8 | 0.2 | NR 22 |
| 24 | 23 | 22.85 | 1.73 | 1.55 | 1.73 | 1.55 | 1.05 | 0.8 | 0.2 | NR 24 |
| 26 | 25.15 | 25 | 1.73 | 1.55 | 1.73 | 1.55 | 1.05 | 0.8 | 0.2 | NR 26 |
| 28 | 26.7 | 26.4 | 1.73 | 1.55 | 1.73 | 1.55 | 1.2 | 0.95 | 0.25 | NR 28 |
| 30 | 28.17 | 27.91 | — | — | 2.06 | 1.9 | 1.65 | 1.35 | 0.4 | NR 30 |
| 32 | 30.15 | 29.9 | 2.06 | 1.9 | 2.06 | 1.9 | 1.65 | 1.35 | 0.4 | NR 32 |
| 35 | 33.17 | 32.92 | 2.06 | 1.9 | 2.06 | 1.9 | 1.65 | 1.35 | 0.4 | NR 35 |
| 37 | 34.77 | 34.52 | — | — | 2.06 | 1.9 | 1.65 | 1.35 | 0.4 | NR 37 |
| 40 | 38.1 | 37.85 | — | — | 2.06 | 1.9 | 1.65 | 1.35 | 0.4 | NR 40 |
| 42 | 39.75 | 39.5 | 2.06 | 1.9 | 2.06 | 1.9 | 1.65 | 1.35 | 0.4 | NR 42 |



Remarks:

1. These dimensions are not applied to dimension series 00, 82 and 83.
2. Chamfer at groove side of outer ring clears a fillet radius of:
0.3 mm in diameter series 0 up to and including D = 35 mm,
0.5 mm in diameter series 0 over D = 35 mm and for all diameters
in diameter series 2, 3, and 4

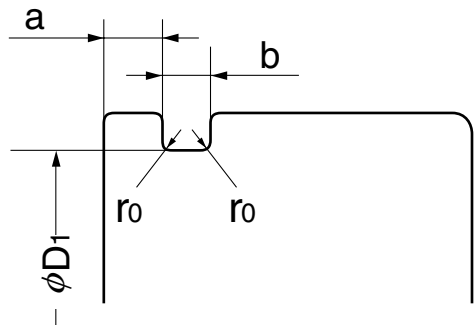


Table 4.5.3 Dimensions of Snap Ring Grooves for Bearing Diameter Series 0, 2, 3 and 4

(24)

Unit: mm ▲

| Bearing outside diameter Nominal D | Snap ring groove diameter D ₁ | | Snap ring groove location a | | | | Snap ring groove width b | | Fillet radius at snap ring groove bottom r ₀ | Applicable snap ring |
|--|--|-------|-----------------------------|------|----------------------------|------|--------------------------------|------|---|-------------------------|
| | | | Diameter series 0 | | Diameter series 2, 3, 4 | | | | | |
| | Max | Min | Max | Min | Max | Min | Max | Min | Max | |
| 44 | 41.75 | 41.5 | 2.06 | 1.9 | — | — | 1.65 | 1.35 | 0.4 | NR 44 |
| 47 | 44.6 | 44.35 | 2.06 | 1.9 | 2.46 | 2.31 | 1.65 | 1.35 | 0.4 | NR 47 |
| 50 | 47.6 | 47.35 | — | — | 2.46 | 2.31 | 1.65 | 1.35 | 0.4 | NR 50 |
| 52 | 49.73 | 49.48 | 2.06 | 1.9 | 2.46 | 2.31 | 1.65 | 1.35 | 0.4 | NR 52 |
| 55 | 52.6 | 52.35 | 2.08 | 1.88 | — | — | 1.65 | 1.35 | 0.4 | NR 55 |
| 56 | 53.6 | 53.35 | — | — | 2.46 | 2.31 | 1.65 | 1.35 | 0.4 | NR 56 |
| 58 | 55.6 | 55.35 | 2.08 | 1.88 | 2.46 | 2.31 | 1.65 | 1.35 | 0.4 | NR 58 |
| 62 | 59.61 | 59.11 | 2.08 | 1.88 | 3.28 | 3.07 | 2.2 | 1.9 | 0.6 | NR 62 |
| 65 | 62.6 | 62.1 | — | — | 3.28 | 3.07 | 2.2 | 1.9 | 0.6 | NR 65 |
| 68 | 64.82 | 64.31 | 2.49 | 2.29 | 3.28 | 3.07 | 2.2 | 1.9 | 0.6 | NR 68 |
| 72 | 68.81 | 68.3 | — | — | 3.28 | 3.07 | 2.2 | 1.9 | 0.6 | NR 72 |
| 75 | 71.83 | 71.32 | 2.49 | 2.29 | 3.28 | 3.07 | 2.2 | 1.9 | 0.6 | NR 75 |



Remarks:

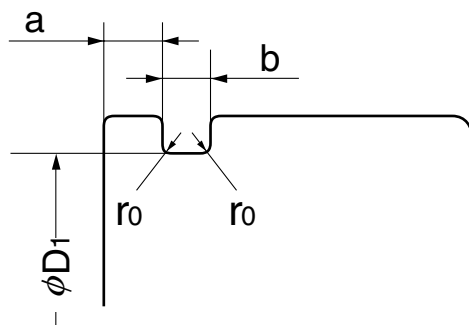
- 1. These dimensions are not applied to dimension series 00, 82 and 83.
- 2. Chamfer at groove side of outer ring clears a fillet radius of:
0.3 mm in diameter series 0 up to and including D = 35 mm,
0.5 mm in diameter series 0 over D = 35 mm and for all diameters
in diameter series 2, 3, and 4

Table 4.5.3 Dimensions of Snap Ring Grooves for Bearing Diameter Series 0, 2, 3 and 4

(3/4)

Unit: mm ▲

| Bearing outside diameter Nominal D | Snap ring groove diameter D ₁ | | Snap ring groove location a | | | | Snap ring groove width b | | Fillet radius at snap ring groove bottom r ₀ | Applicable snap ring |
|--|--|--------|-----------------------------|------|----------------------------|------|--------------------------------|-----|---|-------------------------|
| | | | Diameter series 0 | | Diameter series 2, 3, 4 | | | | | |
| | Max | Min | Max | Min | Max | Min | Max | Min | Max | |
| 80 | 76.81 | 76.3 | 2.49 | 2.29 | 3.28 | 3.07 | 2.2 | 1.9 | 0.6 | NR 80 |
| 85 | 81.81 | 81.31 | — | — | 3.28 | 3.07 | 2.2 | 1.9 | 0.6 | NR 85 |
| 90 | 86.79 | 86.28 | 2.87 | 2.67 | 3.28 | 3.07 | 3 | 2.7 | 0.6 | NR 90 |
| 95 | 91.82 | 91.31 | 2.87 | 2.67 | — | — | 3 | 2.7 | 0.6 | NR 95 |
| 100 | 96.8 | 96.29 | 2.87 | 2.67 | 3.28 | 3.07 | 3 | 2.7 | 0.6 | NR100 |
| 110 | 106.81 | 106.3 | 2.87 | 2.67 | 3.28 | 3.07 | 3 | 2.7 | 0.6 | NR110 |
| 115 | 111.81 | 111.3 | 2.87 | 2.67 | — | — | 3 | 2.7 | 0.6 | NR115 |
| 120 | 115.21 | 114.71 | — | — | 4.06 | 3.86 | 3.4 | 3.1 | 0.6 | NR120 |
| 125 | 120.22 | 119.71 | 2.87 | 2.67 | 4.06 | 3.86 | 3.4 | 3.1 | 0.6 | NR125 |
| 130 | 125.22 | 124.71 | 2.87 | 2.67 | 4.06 | 3.86 | 3.4 | 3.1 | 0.6 | NR130 |
| 140 | 135.23 | 134.72 | 3.71 | 3.45 | 4.9 | 4.65 | 3.4 | 3.1 | 0.6 | NR140 |
| 145 | 140.23 | 139.73 | 3.71 | 3.45 | — | — | 3.4 | 3.1 | 0.6 | NR145 |



Remarks:

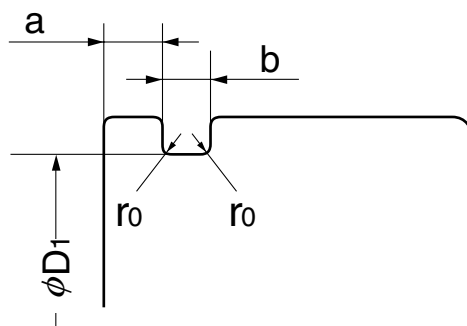
1. These dimensions are not applied to dimension series 00, 82 and 83.
2. Chamfer at groove side of outer ring clears a fillet radius of:
0.3 mm in diameter series 0 up to and including D = 35 mm,
0.5 mm in diameter series 0 over D = 35 mm and for all diameters
in diameter series 2, 3, and 4

Table 4.5.3 Dimensions of Snap Ring Grooves for Bearing Diameter Series 0, 2, 3 and 4

(4/4)

Unit: mm ▲

| Bearing outside diameter Nominal D | Snap ring groove diameter D ₁ | | Snap ring groove location a | | | | Snap ring groove width b | | Fillet radius at snap ring groove bottom r ₀ | Applicable snap ring |
|--|--|--------|-----------------------------|------|----------------------------|------|--------------------------------|-----|---|-------------------------|
| | | | Diameter series 0 | | Diameter series 2, 3, 4 | | | | | |
| | Max | Min | Max | Min | Max | Min | Max | Min | Max | |
| 150 | 145.24 | 144.73 | 3.71 | 3.45 | 4.9 | 4.65 | 3.4 | 3.1 | 0.6 | NR150 |
| 160 | 155.22 | 154.71 | 3.71 | 3.45 | 4.9 | 4.65 | 3.4 | 3.1 | 0.6 | NR160 |
| 170 | 163.65 | 163.14 | 3.71 | 3.45 | 5.69 | 5.44 | 3.8 | 3.5 | 0.6 | NR170 |
| 180 | 173.66 | 173.15 | 3.71 | 3.45 | 5.69 | 5.44 | 3.8 | 3.5 | 0.6 | NR180 |
| 190 | 183.64 | 183.13 | — | — | 5.69 | 5.44 | 3.8 | 3.5 | 0.6 | NR190 |
| 200 | 193.65 | 193.14 | 5.69 | 5.44 | 5.69 | 5.44 | 3.8 | 3.5 | 0.6 | NR200 |
| 210 | 203.6 | 203.1 | 5.69 | 5.44 | — | — | 3.8 | 3.5 | 1 | NR210 |
| 215 | 208.6 | 208.1 | — | — | 5.69 | 5.44 | 3.8 | 3.5 | 1 | NR215 |
| 225 | 217 | 216.5 | 6.5 | 6.2 | 6.5 | 6.2 | 4.9 | 4.5 | 1 | NR225 |
| 230 | 222 | 221.5 | — | — | 6.5 | 6.2 | 4.9 | 4.5 | 1 | NR230 |
| 240 | 232 | 231.5 | 6.5 | 6.2 | 6.5 | 6.2 | 4.9 | 4.5 | 1 | NR240 |
| 250 | 242 | 241.5 | — | — | 6.5 | 6.2 | 4.9 | 4.5 | 1 | NR250 |



Remarks:

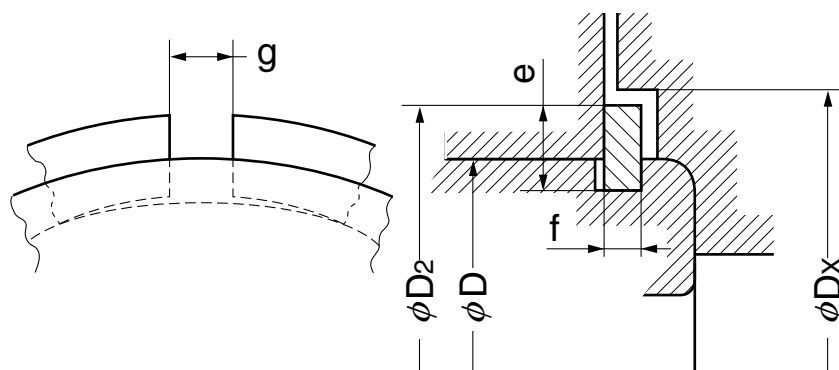
1. These dimensions are not applied to dimension series 00, 82 and 83.
2. Chamfer at groove side of outer ring clears a fillet radius of:
0.3 mm in diameter series 0 up to and including D = 35 mm,
0.5 mm in diameter series 0 over D = 35 mm and for all diameters
in diameter series 2, 3, and 4

Table 4.5.4 Snap Ring Dimensions for Bearing Diameter Series 0, 2, 3 and 4

(1/4)

Unit: mm

| Snap ring No. | Snap ring dimensions | | | | After snap ring mounting | | Applicable bearing | | | | Diameter of end cover bore Dx (Min) | |
|------------------|----------------------|------|-------------|------|-----------------------------|---|--|------------------|----|----|---|------|
| | Section height e | | Thickness f | | | | Bearing outside diameter Nominal D | Dimension series | | | | |
| | | | | | 0 | 2 | | 3 | 4 | | | |
| | Max | Min | Max | Min | Gap g | Outside diameter of snap ring D ₂ (Max) | Bearing bore diameter d | | | | | |
| NR 13 | 1.15 | 1.0 | 0.7 | 0.6 | 3 | 14.3 | 13 | — | 4 | 3 | — | 14.5 |
| NR 16 | 1.65 | 1.5 | 0.7 | 0.6 | 3 | 18.5 | 16 | — | 5 | 4 | — | 19 |
| NR 19 | 1.65 | 1.5 | 0.7 | 0.6 | 3 | 21.5 | 19 | 7 | 6 | 5 | — | 22 |
| NR 22 | 2.00 | 1.85 | 0.7 | 0.6 | 3 | 25.1 | 22 | 8 | 7 | 6 | — | 25.5 |
| NR 24 | 2.00 | 1.85 | 0.7 | 0.6 | 3 | 27 | 24 | 9 | 8 | — | — | 27.5 |
| NR 26 | 2.00 | 1.85 | 0.7 | 0.6 | 3 | 29.2 | 26 | 10 | 9 | 7 | — | 30 |
| NR 28 | 2.05 | 1.90 | 0.85 | 0.75 | 3 | 30.8 | 28 | 12 | — | 8 | — | 31.5 |
| NR 30 | 3.25 | 3.1 | 1.12 | 1.02 | 3 | 34.7 | 30 | — | 10 | 9 | 8 | 35.5 |
| NR 32 | 3.25 | 3.1 | 1.12 | 1.02 | 3 | 36.7 | 32 | 15 | 12 | — | 9 | 37.5 |
| NR 35 | 3.25 | 3.1 | 1.12 | 1.02 | 3 | 39.7 | 35 | 17 | 15 | 10 | — | 40.5 |
| NR 37 | 3.25 | 3.1 | 1.12 | 1.02 | 3 | 41.3 | 37 | — | — | 12 | 10 | 42 |
| NR 40 | 3.25 | 3.1 | 1.12 | 1.02 | 3 | 44.6 | 40 | — | 17 | — | — | 45.5 |
| NR 42 | 3.25 | 3.1 | 1.12 | 1.02 | 3 | 46.3 | 42 | 20 | — | 15 | 12 | 47 |



Remarks:

1. These dimensions are not applied to dimension series 00, 82 and 83.
2. Chamfer at groove side of outer ring clears a fillet radius of:
0.3 mm in diameter series 0 up to and including $D = 35$ mm,
0.5 mm in diameter series 0 over $D = 35$ mm and for all diameters in diameter series 2, 3, and 4

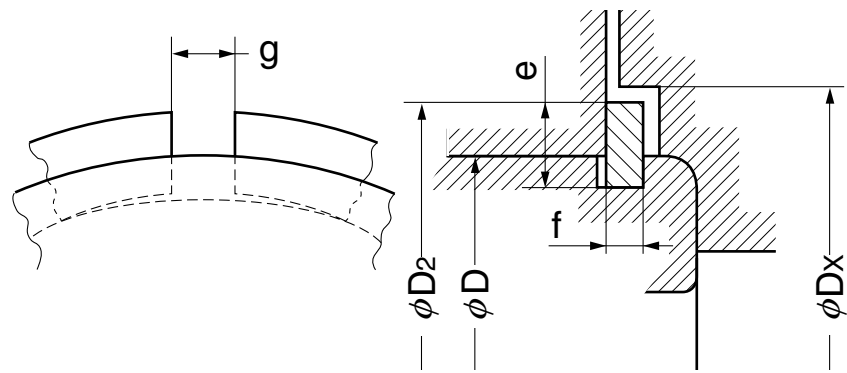


Table 4.5.4 Snap Ring Dimensions for Bearing Diameter Series 0, 2, 3 and 4

(2/4)

Unit: mm ▲

| Snap ring No. | Snap ring dimensions | | | | After snap ring mounting | | Applicable bearing | | | | Diameter of end cover bore Dx (Min) | |
|------------------|----------------------|------|-------------|------|-----------------------------|---|--|------------------|----|----|---|------|
| | Section height e | | Thickness f | | | | Bearing outside diameter Nominal D | Dimension series | | | | |
| | | | | | 0 | 2 | | 3 | 4 | | | |
| | Max | Min | Max | Min | Gap g | Outside diameter of snap ring D ₂ (Max) | Bearing bore diameter d | | | | | |
| NR 44 | 3.25 | 3.1 | 1.12 | 1.02 | 3 | 48.3 | 44 | 22 | — | — | — | 49 |
| NR 47 | 4.04 | 3.89 | 1.12 | 1.02 | 4 | 52.7 | 47 | 25 | 20 | 17 | — | 53.5 |
| NR 50 | 4.04 | 3.89 | 1.12 | 1.02 | 4 | 55.7 | 50 | — | 22 | — | — | 56.5 |
| NR 52 | 4.04 | 3.89 | 1.12 | 1.02 | 4 | 57.9 | 52 | 28 | 25 | 20 | 15 | 58.5 |
| NR 55 | 4.04 | 3.89 | 1.12 | 1.02 | 4 | 60.7 | 55 | 30 | — | — | — | 61.5 |
| NR 56 | 4.04 | 3.89 | 1.12 | 1.02 | 4 | 61.7 | 56 | — | — | 22 | — | 62.5 |
| NR 58 | 4.04 | 3.89 | 1.12 | 1.02 | 4 | 63.7 | 58 | 32 | 28 | — | — | 64.5 |
| NR 62 | 4.04 | 3.89 | 1.7 | 1.6 | 4 | 67.7 | 62 | 35 | 30 | 25 | 17 | 68.5 |
| NR 65 | 4.04 | 3.89 | 1.7 | 1.6 | 4 | 70.7 | 65 | — | 32 | — | — | 71.5 |
| NR 68 | 4.85 | 4.7 | 1.7 | 1.6 | 5 | 74.6 | 68 | 40 | — | 28 | — | 76 |
| NR 72 | 4.85 | 4.7 | 1.7 | 1.6 | 5 | 78.6 | 72 | — | 35 | 30 | 20 | 80 |
| NR 75 | 4.85 | 4.7 | 1.7 | 1.6 | 5 | 81.6 | 75 | 45 | — | 32 | — | 83 |



Remarks:

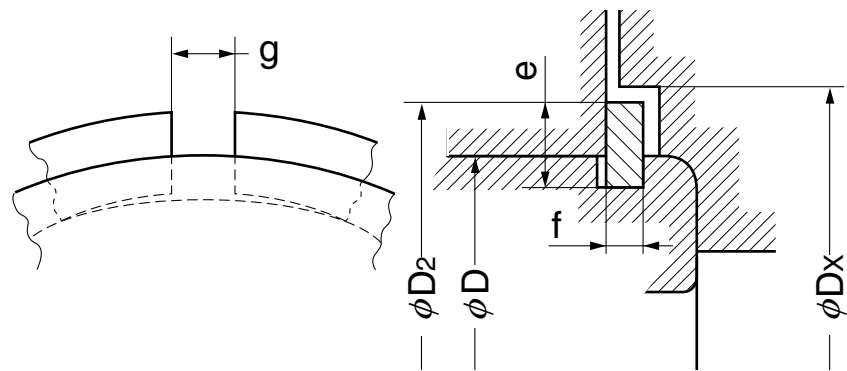
- 1. These dimensions are not applied to dimension series 00, 82 and 83.
- 2. Chamfer at groove side of outer ring clears a fillet radius of:
0.3 mm in diameter series 0 up to and including D = 35 mm,
0.5 mm in diameter series 0 over D = 35 mm and for all diameters
in diameter series 2, 3, and 4

Table 4.5.4 Snap Ring Dimensions for Bearing Diameter Series 0, 2, 3 and 4

(3/4)

Unit: mm ▲

| Snap ring No. | Snap ring dimensions | | | | After snap ring mounting | | Applicable bearing | | | | | Diameter of end cover bore Dx (Min) |
|------------------|----------------------|------|-------------|------|-----------------------------|---|--|------------------|----|----|----|---|
| | Section height e | | Thickness f | | | | Bearing outside diameter Nominal D | Dimension series | | | | |
| | | | | | 0 | 2 | | 3 | 4 | | | |
| | Max | Min | Max | Min | Gap g | Outside diameter of snap ring D ₂ (Max) | Bearing bore diameter d | | | | | |
| NR 80 | 4.85 | 4.7 | 1.7 | 1.6 | 5 | 86.6 | 80 | 50 | 40 | 35 | 25 | 88 |
| NR 85 | 4.85 | 4.7 | 1.7 | 1.6 | 5 | 91.6 | 85 | — | 45 | — | — | 93 |
| NR 90 | 4.85 | 4.7 | 2.46 | 2.36 | 5 | 96.5 | 90 | 55 | 50 | 40 | 30 | 98 |
| NR 95 | 4.85 | 4.7 | 2.46 | 2.36 | 5 | 101.6 | 95 | 60 | — | — | — | 103 |
| NR100 | 4.85 | 4.7 | 2.46 | 2.36 | 5 | 106.5 | 100 | 65 | 55 | 45 | 35 | 108 |
| NR110 | 4.85 | 4.7 | 2.46 | 2.36 | 5 | 116.6 | 110 | 70 | 60 | 50 | 40 | 118 |
| NR115 | 4.85 | 4.7 | 2.46 | 2.36 | 5 | 121.6 | 115 | 75 | — | — | — | 123 |
| NR120 | 7.21 | 7.06 | 2.82 | 2.72 | 7 | 129.7 | 120 | — | 65 | 55 | 45 | 131.5 |
| NR125 | 7.21 | 7.06 | 2.82 | 2.72 | 7 | 134.7 | 125 | 80 | 70 | — | — | 136.5 |
| NR130 | 7.21 | 7.06 | 2.82 | 2.72 | 7 | 139.7 | 130 | 85 | 75 | 60 | 50 | 141.5 |
| NR140 | 7.21 | 7.06 | 2.82 | 2.72 | 7 | 149.7 | 140 | 90 | 80 | 65 | 55 | 152 |
| NR145 | 7.21 | 7.06 | 2.82 | 2.72 | 7 | 154.7 | 145 | 95 | — | — | — | 157 |



Remarks:

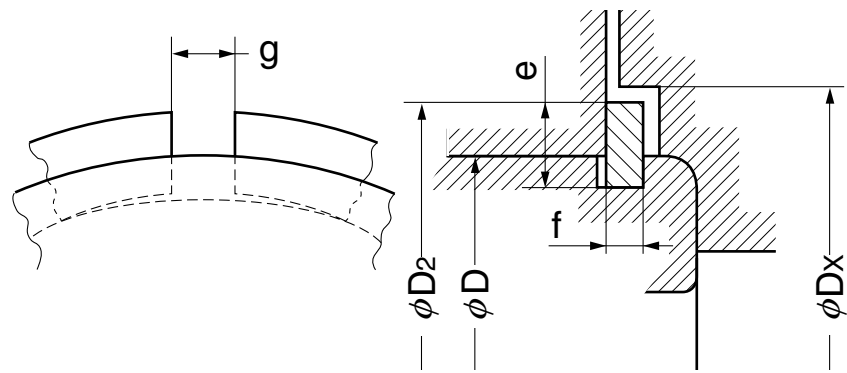
1. These dimensions are not applied to dimension series 00, 82 and 83.
2. Chamfer at groove side of outer ring clears a fillet radius of:
0.3 mm in diameter series 0 up to and including D = 35 mm,
0.5 mm in diameter series 0 over D = 35 mm and for all diameters
in diameter series 2, 3, and 4

Table 4.5.4 Snap Ring Dimensions for Bearing Diameter Series 0, 2, 3 and 4

(44)

Unit: mm ▲

| Snap ring No. | Snap ring dimensions | | | | After snap ring mounting | | Applicable bearing | | | | | Diameter of end cover bore Dx (Min) |
|---------------|----------------------|------|-------------|------|--------------------------|--|------------------------------------|------------------|-----|-----|-----|--|
| | Section height e | | Thickness f | | | | Bearing outside diameter Nominal D | Dimension series | | | | |
| | | | | | 0 | 2 | | 3 | 4 | | | |
| | Max | Min | Max | Min | Gap g | Outside diameter of snap ring D ₂ (Max) | Bearing bore diameter d | | | | | |
| NR150 | 7.21 | 7.06 | 2.82 | 2.72 | 7 | 159.7 | 150 | 100 | 85 | 70 | 60 | 162 |
| NR160 | 7.21 | 7.06 | 2.82 | 2.72 | 7 | 169.7 | 160 | 105 | 90 | 75 | 65 | 172 |
| NR170 | 9.6 | 9.45 | 3.1 | 3 | 10 | 182.9 | 170 | 110 | 95 | 80 | — | 185 |
| NR180 | 9.6 | 9.45 | 3.1 | 3 | 10 | 192.9 | 180 | 120 | 100 | 85 | 70 | 195 |
| NR190 | 9.6 | 9.45 | 3.1 | 3 | 10 | 202.9 | 190 | — | 105 | 90 | 75 | 205 |
| NR200 | 9.6 | 9.45 | 3.1 | 3 | 10 | 212.9 | 200 | 130 | 110 | 95 | 80 | 215 |
| NR210 | 9.6 | 9.45 | 3.1 | 3 | 10 | 222.8 | 210 | 140 | — | — | 85 | 225 |
| NR215 | 9.6 | 9.45 | 3.1 | 3 | 10 | 227.8 | 215 | — | 120 | 100 | — | 230 |
| NR225 | 10 | 9.85 | 3.5 | 3.4 | 10 | 237 | 225 | 150 | — | 105 | 90 | 240 |
| NR230 | 10 | 9.85 | 3.5 | 3.4 | 10 | 242 | 230 | — | 130 | — | — | 245 |
| NR240 | 10 | 9.85 | 3.5 | 3.4 | 10 | 252 | 240 | 160 | — | 110 | 95 | 255 |
| NR250 | 10 | 9.85 | 3.5 | 3.4 | 10 | 262 | 250 | — | 140 | — | 100 | 265 |

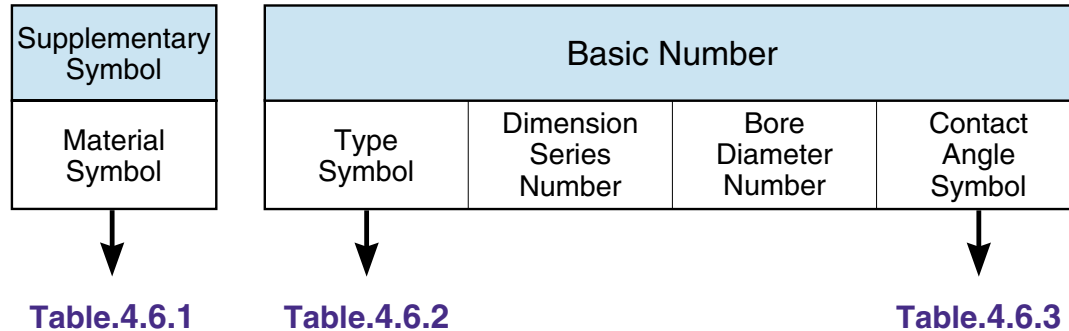


Remarks:

- 1. These dimensions are not applied to dimension series 00, 82 and 83.
- 2. Chamfer at groove side of outer ring clears a fillet radius of:
0.3 mm in diameter series 0 up to and including D = 35 mm,
0.5 mm in diameter series 0 over D = 35 mm and for all diameters in diameter series 2, 3, and 4

4.6 Nachi Bearing Numbers

Fig 4.8 NACHI Bearing Prefixes and Suffixes



Note 1:

Denotes polyamide cages for angular contact ball bearing of contact angle symbol C.

Remarks:

1. Symbol in parentheses can be omitted.
2. Code marked with "*" is not marked on bearing.
3. Bearing modification symbol NR is marked without R on bearing.

| Supplementary symbol | | | | | | | | |
|-----------------------|-------------|----------------|-------------------|------------------|-------------|--------------------|--------------|--------------|
| Special Design Symbol | Cage Symbol | Seal or shield | Ring modification | *Duplex mounting | *Sleeve | Internal clearance | Tolerance | *Grease |
| ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| Table.4.6.4 | Table.4.6.5 | Table.4.6.6 | Table.4.6.7 | Table.4.6.8 | Table.4.6.9 | Table.4.6.10 | Table.4.6.11 | Table.4.6.12 |



Table 4.6.1 Material Symbol

| Prefix | Description |
|--------|---------------------|
| B– | Case hardened steel |
| C– | Case hardened steel |
| D– | Case hardened steel |
| H– | High speed steel |
| S– | Stainless steel |

Table 4.6.2 Type Symbol

| Prefix | Description |
|--------|--|
| N | Cylindrical roller bearings |
| NU | |
| NF | |
| NJ | |
| NP | |
| NUP | |
| NH | |
| NNU | |
| NN | |
| R | Cylindrical roller bearing roller assembly and outer or inner ring |

Table 4.6.8 *Duplex mounting

| Suffix | Description |
|------------|--|
| DB | Back-to-back mounting |
| DF | Face-to-face mounting |
| DT | Tandem mounting |
| KB | DB mounting with spacer to outer ring |
| + α | Spacer (α is nominal width in mm) |
| U DU | Flush ground angular contact ball bearing |

Table 4.6.7 Ring modification

| Suffix | Description |
|--------|--|
| K | Tapered bore: 1/12 taper on bearing bore |
| K30 | Tapered bore: 1/30 taper on bearing bore |
| N | Snap ring groove on outer ring without snap ring |
| NR | Snap ring on outer ring |

Table 4.6.4 Special Design Symbol

| Suffix | Description |
|--------|--|
| A | Inner ring, bearing width variation for Tapered roller bearing |
| E | Roller bearing design change |
| J | Tapered roller bearing rings interchangeable |
| S26 | Heat stabilized |
| S28 | Heat stabilized |
| W20 | Oil holes in outer ring |
| W33 | Oil holes and groove in outer ring |
| E2 | Spherical roller bearing with machined cage |
| EX | High capacity spherical roller bearing |
| A2X | High speed spherical roller bearing |
| AEX | High speed and high capacity spherical roller bearing |
| V | Special design for vibrating machine |

Table 4.6.3 Contact Angle Symbol

| Suffix | Description | |
|--------|--|---|
| C | Single row Angular contact ball bearings | Nominal contact angle over 10° under 22° (standard 15°) |
| (A) | | Nominal contact angle over 22° under 32° (standard 30°) |
| B | | Nominal contact angle over 32° under 45° (standard 40°) |
| D | Tapered roller bearings | Nominal contact angle over 24° under 32° |
| C | | Nominal contact angle over 17° under 24° |

Table 4.6.5 Cage Symbol

| Suffix | Description |
|--------|---|
| F | Machined mild steel cage |
| G | Non-metallic cage |
| L | Machined light alloy cage |
| MY | Machined bronze cage |
| V | No cage |
| Y | Pressed non-ferrous metal cage (Note 1) |

Table 4.6.6 Seal or shield

| Suffix | | Description |
|--------|-------|---------------------------|
| ZE | Z | Shield one side |
| ZZE | ZZ | Shield both sides |
| NKE | NK | Labyrinth seal one side |
| -2NKE | -2NK | Labyrinth seal both sides |
| NSE | NSL | Contact seal one side |
| -2NSE | -2NSL | Contact seal both sides |

Table 4.6.10 Internal clearance

| Suffix | Description |
|--------|---|
| C1 | Radial clearance C1 |
| C2 | Radial clearance C2 |
| (CN) | Normal Radial clearance |
| C3 | Radial clearance C3 |
| C4 | Radial clearance C4 |
| C5 | Radial clearance C5 |
| C1P | Radial clearance C1P (Note 2) |
| C2P | Radial clearance C2P (Note 2) |
| ⋮ | ⋮ |
| C6P | Radial clearance C6P (Note 2) |
| C9na | Cylindrical roller bearing (C9) (Note 3) |
| C1na | Cylindrical roller bearing (C1) (Note 3) |
| C2na | Cylindrical roller bearing (C2) (Note 3) |
| Cna | Cylindrical roller bearing (Normal) (Note 3) |
| C3na | Cylindrical roller bearing (C3) (Note 3) |
| C4na | Cylindrical roller bearing (C4) (Note 3) |
| C5na | Cylindrical roller bearing (C5) (Note 3) |
| CM | Electric motor bearing radial clearance (of deep groove ball bearing and of non-interchangeable cylindrical roller bearing) |
| CT | Radial clearance for electric motor bearing (interchangeable cylindrical roller bearings) |

Note 2: Extra small ball bearing and miniature ball bearing

Note 3: Non-interchangeable clearance

Table 4.6.9 *Sleeve

| Suffix | Description |
|--------|-------------------|
| +H | Adapter sleeve |
| +AH | Withdrawal sleeve |

Table 4.6.11 Tolerance

| Suffix | Description |
|--------|--------------------------------|
| (0) | JIS class 0 (ISO Normal class) |
| P6 | JIS class 6 (ISO class 6) |
| P6X | JIS class 6X |
| P5 | JIS class 5 (ISO class 5) |
| P4 | JIS class 4 (ISO class 4) |
| P2 | JIS class 2 (ISO class 2) |
| UP | NACHI class UP |

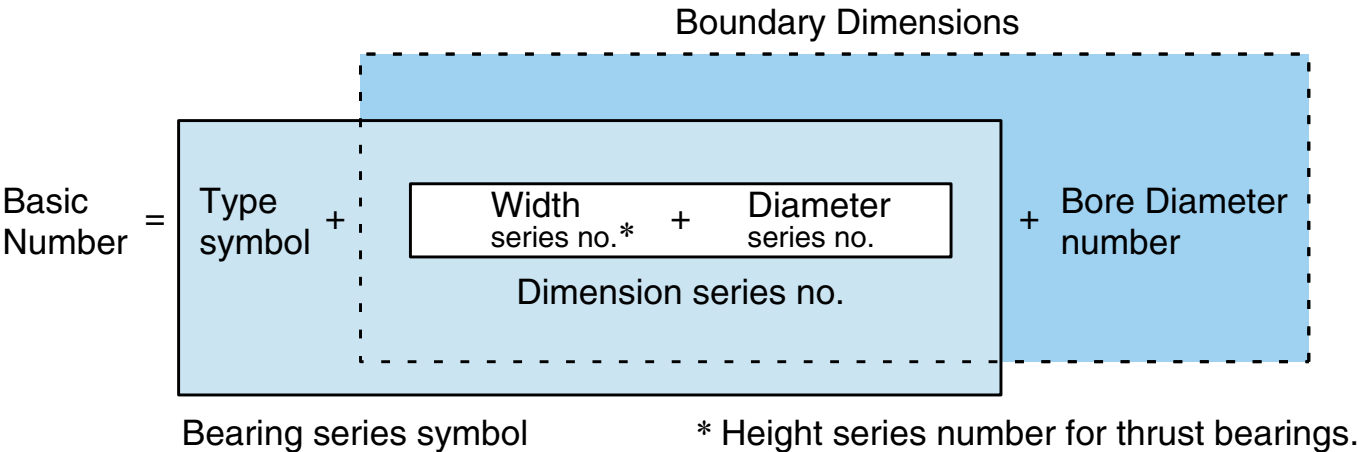
Table 4.6.12 *Grease

| Suffix | Description |
|--------|---------------------------|
| ADC | Shell Andoc C |
| AV2 | Shell Alvania grease No.2 |
| BC325 | Esso Beacon 325 |
| MTSRL | Multemp SRL |

NACHI Rolling Contact Bearing Numbers ••• Examples

The NACHI part number for rolling contact bearings consists of the basic number and supplementary codes. The part number defines the bearing configuration, tolerance, general boundary dimensions, and other specifications.

NACHI uses supplemental prefix and suffix symbols as shown in Fig. 4.8. The NACHI basic number consists of the following:



Bore Diameter Number

| | | | | | | | | | | | | | | | | | |
|----------------------|---------------|---|---|---|---|---|----|----|----|----|----|---------------|------|-----|----------------|------|------|
| Bore (mm) | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 12 | 15 | 17 | 20 | 25 | | 480 | 500 | 530 | |
| Bore diameter number | 4 | 5 | 6 | 7 | 8 | 9 | 00 | 01 | 02 | 03 | 04 | 05 | | 96 | /500 | /530 | |
| Remarks | Bore Diameter | | | | | | — | | | | | (bore dia.)/5 | | | /bore diameter | | |



Example 1

6 2 04 ZZE C3 P6

- Tolerance symbol (JIS/ISO class 6)
- Internal clearance symbol (C3)
- Shields (2 shields)
- Bore diameter number (20 mm)
- Diameter series no. (series 2)
- Type symbol
(Single row deep groove ball bearing)

Example 2

7 2 10 C Y DB /GL P4

- Tolerance symbol (JIS/ISO class 4)
- Internal clearance (Light preload)
- Duplex mounting (Back-to-back)
- Cage symbol (Polyamide cage)
- Contact angle symbol (15° angle)
- Bore diameter number (50 mm)
- Diameter series no. (series 2)
- Type symbol
(single row angular contact ball bearing)

Example 3

2 3 0 34 E W33 K

- Ring modification symbol
(1/12 tapered bore)
- Special design symbol
(Oil hole and groove in outer ring)
- Special design symbol (improvement)
- Bore diameter number (170 mm bore)
- Diameter series no. (Series 0)
- Width series no. (Series 3)
- Type symbol
(Spherical roller bearing)

Example 4

5 1 2 08

- Bore diameter number (40 mm)
- Diameter series no. (series 2)
- Height series no. (Series 1)
- Type symbol (Thrust ball bearing)



5. Accuracy of Bearings

Introduction

5.1 Tolerance Values for Radial Bearings (Except Tapered Roller Bearings)

- Table 5.1.1 Tolerance Values of Inner Ring and of Outer Ring Width
- Table 5.1.2 Tolerance Values of Outer Ring

5.2 Tolerance Values for Metric Tapered Roller Bearings

- Table 5.2.1 Tolerance Values of Inner Ring
- Table 5.2.2 Tolerance Values of Outer Ring
- Table 5.2.3 Deviations of Single Ring Width, Bearing Width and Duplex/Stack Mounted Bearing Width

5.3 Tolerance Values for Thrust Ball Bearings

- Table 5.3.1 Tolerance Values of Shaft Washer Bore Diameter
- Table 5.3.2 Tolerance Values of Housing Washer Outside Diameter
- Table 5.3.3 Height Tolerances of Thrust Ball Bearings (with Flat Seat) and Center Washers (Class 0)

5.4 Tolerance Values of Spherical Roller Thrust Bearings (Class 0)

- Table 5.4.1 Tolerance Values of Inner Rings
- Table 5.4.2 Tolerance Values of Outer Rings

5.5 Tolerance Values of Tapered Roller Bearings - Inch Series

- Table 5.5.1 Tolerance of Inner Ring (Cone) Bore
- Table 5.5.2 Tolerance of Outer Ring (Cup) Outside Diameter
- Table 5.5.3 Tolerance of Bearing Width and Duplex/Stack Mounted Bearing Width
- Table 5.5.4 Radial Runout of Assembled Bearing Inner Ring and Outer Ring

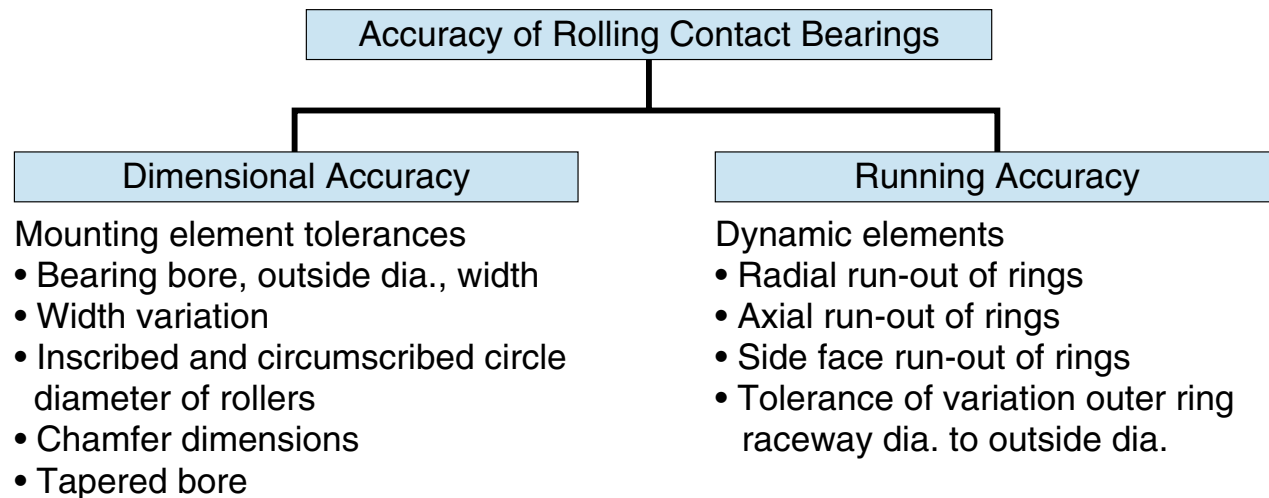
5.6 Chamfer Dimensions

5.7 Tapered Bores

5. Accuracy of Rolling Contact Bearings

The tolerance of rolling contact bearings includes dimensional and running accuracy. According to JIS (1), tolerance is classified into 6 classes; class 0, 6, 6X, 5, 4 and 2 with accuracy ascending from class 0 to 2.

Applicable tolerance classes to individual bearing types and applicable standards are shown in the next page.



Bearing types and tolerance classes



| Bearing Type | | Tolerance class | | | | | Related Standard | Reference Tables |
|------------------------------------|---------------|-----------------|---------|---------|---------|----------|------------------|--|
| Deep groove Ball Bearings | | JIS 0 | JIS 6 | JIS 5 | JIS 4 | JIS 2 | JIS B 1514 | 5.1.1 5.1.2 |
| Angular Contact Ball Bearings | | JIS 0 | JIS 6 | JIS 5 | JIS 4 | JIS 2 | JIS B 1514 | 5.1.1 5.1.2 |
| Self-aligning Ball Bearings | | JIS 0 | — | — | — | — | | |
| Cylindrical Roller Bearings | | JIS 0 | JIS 6 | JIS 5 | JIS 4 | JIS 2 | | |
| Spherical Roller (Radial) Bearings | | JIS 0 | — | — | — | — | | |
| Tapered Roller Bearings | Metric Series | JIS 0 JIS 6X | JIS 6 | JIS 5 | JIS 4 | — | JIS B 1514 | 5.2.1 5.2.2 5.2.3 |
| | Inch Series | CLASS 4 | CLASS 2 | CLASS 3 | CLASS 0 | CLASS 00 | ANSI / ABMA 19 | 5.5.1 5.5.2 5.5.3 5.5.4 |
| Thrust, Ball Bearings | | JIS 0 | JIS 6 | JIS 5 | JIS 4 | — | JIS B 1514 | 5.3.1 5.3.2 5.3.3 |
| Spherical Roller Thrust Bearings | | JIS 0 | — | — | — | — | JIS B 1514 | 5.4.1 5.4.2 |

Metric Radial Bearings (Except Tapered Roller Bearings) Class Comparison

| | | | | | | | | | |
|---------------------|-----------------------|-----------------|--------------|---------|---------|---------|---------|--------------------|---|
| Comparative Classes | ISO ⁽²⁾ | | NORMAL CLASS | CLASS 6 | CLASS 5 | CLASS 4 | CLASS 2 | ISO 492 ISO 582 | — |
| | DIN ⁽³⁾ | | P0 | P6 | P5 | P4 | P2 | DIN 620 | — |
| | ANSI ⁽⁴⁾ / | Ball Bearings | ABEC 1 | ABEC 3 | ABEC 5 | ABEC 7 | ABEC 9 | ANSI / ABMA 20 | — |
| | ABMA ⁽⁵⁾ | Roller Bearings | RBEC 1 | RBEC 3 | RBEC 5 | — | — | ANSI / ABMA 20 | — |

(1) Japanese Industrial Standard (2) International Organization for Standardization (3) German Industrial Standards

(4) American National Standards Institute (5) American Bearing Manufacturers Association

Remarks: For tolerances of chamfer dimensions, see Table 5.6; for accuracy of tapered bore, see Table 5.7.

Table 5.1.1 Tolerance Values of Inner Ring and of Outer Ring Width

(1/4)

Unit: μm

| Bearing bore diameter Nominal d (mm) | | Bearing with cylindrical bore | | | | | | | | | | | | | |
|---|-------|--|------|---------|-----|---------|-----|---------|-----|---------|------|---|-----|---------|------|
| | | Single plane mean bore diameter deviation Δd_{mp} | | | | | | | | | | Deviation of a single bore diameter (2) Δd_s | | | |
| | | Class 0 | | Class 6 | | Class 5 | | Class 4 | | Class 2 | | Class 4 Diameter series 0,1,2,3,4 | | | |
| | | | | | | | | | | | | Class 2 | | 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 | 1000 | 0 | -100 | - | - | - | - | - | - | - | - | - | - | - | - |
| 1000 | 1250 | 0 | -125 | - | - | - | - | - | - | - | - | - | - | - | - |
| 1250 | 1600 | 0 | -160 | - | - | - | - | - | - | - | - | - | - | - | - |
| 1600 | 2000 | 0 | -200 | - | - | - | - | - | - | - | - | - | - | - | - |

Notes: (1) This diameter is included in this group.

(2) Applies to bearings with cylindrical bore.

(3) Width deviation and variation of outer ring are the same with of inner ring. Outer ring width variation of classes 5, 4 and 2 are listed in Table 5.1.2.

(4) Applies to the rings of single bearings made for paired of stack mounting.

(5) Applies to radial ball bearings such as deep groove ball bearing, angular contact ball bearings.

Remarks: The high deviation of bearing cylindrical bore diameter specified in this table does not apply within a distance of $1.2 \times r$ (max) from the ring face.

Table 5.1.1 Tolerance Values of Inner Ring and of Outer Ring Width

(2/4)

Unit: μm

| Bearing bore diameter Nominal d (mm) | | Bearing with cylindrical bore | | | | | | | | | | | | | | | |
|---|-------|--|-----|-----------------|-------|-----|-----------------|-------|-----------|----------------------------------|-----------|---------|-----|---------|-----|---------|-----|
| | | Bore diameter variation in a single radial plane (2) | | | | | | | | Main bore diameter variation (2) | | | | | | | |
| | | Vd_p | | | | | | | | Vd_{mp} | | | | | | | |
| | | Class 0 | | Class 6 | | | Class 5 | | | Class 4 | | Class 2 | | Class 0 | | Class 6 | |
| | | Diameter series | | Diameter series | | | Diameter series | | | Diameter series | | Class 2 | | Class 0 | | Class 6 | |
| Over | Incl. | 7,8,9 | 0,1 | 2,3,4 | 7,8,9 | 0,1 | 2,3,4 | 7,8,9 | 0,1,2,3,4 | 7,8,9 | 0,1,2,3,4 | 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 | 1000 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 1000 | 1250 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 1250 | 1600 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 1600 | 2000 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |

Notes: (1) This diameter is included in this group.

(2) Applies to bearings with cylindrical bore.

(3) Width deviation and variation of outer ring are the same with of inner ring. Outer ring width variation of classes 5, 4 and 2 are listed in Table 5.1.2.

(4) Applies to the rings of single bearings made for paired of stack mounting.

(5) Applies to radial ball bearings such as deep groove ball bearing, angular contact ball bearings.

Remarks: The high deviation of bearing cylindrical bore diameter specified in this table does not apply within a distance of $1.2 \times r$ (max) from the ring face.

Table 5.1.1 Tolerance Values of Inner Ring and of Outer Ring Width

(3/4)

Unit: μm

| Bearing bore diameter Nominal d (mm) | | Deviation of a single inner ring width (or a single outer ring width) (2) ΔB_S (or ΔC_S) | | | | | | | | | | Inner (or outer) ring width variation V_{BS} (or V_{CS}) | | | | |
|---|-------|--|-------|--------------------|------|---------|------|-------------------------------------|------|--------------------|------|--|---------|---------|---------|---------|
| | | Single bearing | | | | | | Paired or stack mounted bearing (4) | | | | Inner ring (or outer ring) (3) | | | | |
| | | | | | | | | | | | | Inner ring | | | | |
| | | Class 0 Class 6 | | Class 5 Class 4 | | Class 2 | | Class 0 Class 6 | | Class 5 Class 4 | | Class 0 | Class 6 | Class 5 | Class 4 | Class 2 |
| Over | Incl. | 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 | 12 | 12 | 5 | 2.5 | 1.5 |
| 2.5 | 10 | 0 | – 120 | 0 | – 40 | 0 | – 40 | 0 | –250 | 0 | –250 | 15 | 15 | 5 | 2.5 | 1.5 |
| 10 | 18 | 0 | – 120 | 0 | – 80 | 0 | – 80 | 0 | –250 | 0 | –250 | 20 | 20 | 5 | 2.5 | 1.5 |
| 18 | 30 | 0 | – 120 | 0 | –120 | 0 | –120 | 0 | –250 | 0 | –250 | 20 | 20 | 5 | 2.5 | 1.5 |
| 30 | 50 | 0 | – 120 | 0 | –120 | 0 | –120 | 0 | –250 | 0 | –250 | 20 | 20 | 5 | 3 | 1.5 |
| 50 | 80 | 0 | – 150 | 0 | –150 | 0 | –150 | 0 | –380 | 0 | –250 | 25 | 25 | 6 | 4 | 1.5 |
| 80 | 120 | 0 | – 200 | 0 | –200 | 0 | –200 | 0 | –380 | 0 | –380 | 25 | 25 | 7 | 4 | 2.5 |
| 120 | 150 | 0 | – 250 | 0 | –250 | 0 | –250 | 0 | –500 | 0 | –380 | 30 | 30 | 8 | 5 | 2.5 |
| 150 | 180 | 0 | – 250 | 0 | –250 | 0 | –250 | 0 | –500 | 0 | –380 | 30 | 30 | 8 | 5 | 4 |
| 180 | 250 | 0 | – 300 | 0 | –300 | 0 | –300 | 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 | 1000 | 0 | –1000 | – | – | – | – | – | – | – | – | 80 | – | – | – | – |
| 1000 | 1250 | 0 | –1250 | – | – | – | – | – | – | – | – | 100 | – | – | – | – |
| 1250 | 1600 | 0 | –1600 | – | – | – | – | – | – | – | – | 120 | – | – | – | – |
| 1600 | 2000 | 0 | –2000 | – | – | – | – | – | – | – | – | 140 | – | – | – | – |

Notes: (1) This diameter is included in this group.

(2) Applies to bearings with cylindrical bore.

(3) Width deviation and variation of outer ring are the same with of inner ring. Outer ring width variation of classes 5, 4 and 2 are listed in Table 5.1.2.

(4) Applies to the rings of single bearings made for paired or stack mounting.

(5) Applies to radial ball bearings such as deep groove ball bearing, angular contact ball bearings.

Remarks: The high deviation of bearing cylindrical bore diameter specified in this table does not apply within a distance of $1.2 \times r$ (max) from the ring face.

Table 5.1.1 Tolerance Values of Inner Ring and of Outer Ring Width

(4/4)

Unit: μm 

| Bearing bore diameter Nominal d (mm) | | Radial runout of assembled bearing inner ring K_{ia} | | | | | Inner ring reference face runout with bore S_d | | | Assembled bearing inner ring face runout with raceway S_{ia} (5) | | |
|---|-------|---|---------|---------|---------|---------|---|---------|---------|---|---------|---------|
| | | Class 0 | Class 6 | Class 5 | Class 4 | Class 2 | Class 5 | Class 4 | Class 2 | Class 5 | Class 4 | Class 2 |
| | | Max | Max | Max | Max | Max | Max | Max | Max | Max | Max | Max |
| Over | Incl. | | | | | | | | | | | |
| 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 | 1000 | 90 | — | — | — | — | — | — | — | — | — | — |
| 1000 | 1250 | 100 | — | — | — | — | — | — | — | — | — | — |
| 1250 | 1600 | 120 | — | — | — | — | — | — | — | — | — | — |
| 1600 | 2000 | 140 | — | — | — | — | — | — | — | — | — | — |

Notes: (1) This diameter is included in this group.

(2) Applies to bearings with cylindrical bore.

(3) Width deviation and variation of outer ring are the same with of inner ring. Outer ring width variation of classes 5, 4 and 2 are listed in Table 5.1.2.

(4) Applies to the rings of single bearings made for paired of stack mounting.

(5) Applies to radial ball bearings such as deep groove ball bearing, angular contact ball bearings.

Remarks: The high deviation of bearing cylindrical bore diameter specified in this table does not apply within a distance of $1.2 \times r$ (max) from the ring face.

Table 5.1.2 Tolerance Values of Outer Ring

(1/4)

Unit: μm

| Bearing outside diameter Nominal D (mm) | | Bearing outside diameter | | | | | | | | | | | | | |
|---|-------|--|-------|---------|------|---------|------|---------|------|---------------|-------|--|------|---------|-------|
| | | Single plane mean outside diameter deviation | | | | | | | | | | Deviation of a single outside diameter | | | |
| | | ΔD_{mp} | | | | | | | | | | ΔD_s | | | |
| | | Class 0 | | Class 6 | | Class 5 | | Class 4 | | Class 2 | | Class 4 | | | |
| | | | | | | | | | | | | Diameter series | | Class 2 | |
| | | | | | | | | | | 0, 1, 2, 3, 4 | | | | | |
| Over | Incl. | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low |
| 2.5 ⁽¹⁾ | 6 | 0 | − 8 | 0 | − 7 | 0 | − 5 | 0 | − 4 | 0 | − 2.5 | 0 | − 4 | 0 | − 2.5 |
| 6 | 18 | 0 | − 8 | 0 | − 7 | 0 | − 5 | 0 | − 4 | 0 | − 2.5 | 0 | − 4 | 0 | − 2.5 |
| 18 | 30 | 0 | − 9 | 0 | − 8 | 0 | − 6 | 0 | − 5 | 0 | − 4 | 0 | − 5 | 0 | − 4 |
| 30 | 50 | 0 | − 11 | 0 | − 9 | 0 | − 7 | 0 | − 6 | 0 | − 4 | 0 | − 6 | 0 | − 4 |
| 50 | 80 | 0 | − 13 | 0 | − 11 | 0 | − 9 | 0 | − 7 | 0 | − 4 | 0 | − 7 | 0 | − 4 |
| 80 | 120 | 0 | − 15 | 0 | − 13 | 0 | − 10 | 0 | − 8 | 0 | − 5 | 0 | − 8 | 0 | − 5 |
| 120 | 150 | 0 | − 18 | 0 | − 15 | 0 | − 11 | 0 | − 9 | 0 | − 5 | 0 | − 9 | 0 | − 5 |
| 150 | 180 | 0 | − 25 | 0 | − 18 | 0 | − 13 | 0 | − 10 | 0 | − 7 | 0 | − 10 | 0 | − 7 |
| 180 | 250 | 0 | − 30 | 0 | − 20 | 0 | − 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 | 1000 | 0 | − 100 | 0 | − 60 | — | — | — | — | — | — | — | — | — | — |
| 1000 | 1250 | 0 | − 125 | — | — | — | — | — | — | — | — | — | — | — | — |
| 1250 | 1600 | 0 | − 160 | — | — | — | — | — | — | — | — | — | — | — | — |
| 1600 | 2000 | 0 | − 200 | — | — | — | — | — | — | — | — | — | — | — | — |
| 2000 | 2500 | 0 | − 250 | — | — | — | — | — | — | — | — | — | — | — | — |

Notes: (1) This diameter is included in this group.

(2) Applies before mounting and after removal of internal or external snap ring.

(3) Applies to radial ball bearings such as deep groove ball bearings, angular contact ball bearings.

(4) Outer ring width variation of class 0 and 6 are listed in Table 5.1.1.

(5) Applies to radial ball bearings such as deep groove ball bearing, angular contact ball bearings.

Remarks: The high deviation of bearing cylindrical bore diameter specified in this table does not apply within a distance of $1.2 \times r$ (max) from the ring face.

Table 5.1.2 Tolerance Values of Outer Ring

(2/4)

Unit: μm

| Bearing outside diameter Nominal D (mm) | | Bearing outside diameter | | | | | | | | | | | | |
|---|-------|---|-----|-----------------------|-------|-----------------|-----|-----------------------|-----------|-----------------|-----------|-----------------|-----------|--------------|
| | | Outside diameter variation in a single radial plane (2) | | | | | | | | | | | | |
| | | V_{Dp} | | | | | | | | | | | | |
| | | Class 0 | | | | Class 6 | | | | Class 5 | | Class 4 | | Class 2 |
| | | Open bearing | | Seal · shield bearing | | Open bearing | | Seal · shield bearing | | Open bearing | | Open bearing | | Open bearing |
| | | Diameter series | | Diameter series | | Diameter series | | Diameter series | | Diameter series | | Diameter series | | |
| Over | Incl. | 7,8,9 | 0,1 | 2,3,4 | 2,3,4 | 7,8,9 | 0,1 | 2,3,4 | 0,1,2,3,4 | 7,8,9 | 0,1,2,3,4 | 7,8,9 | 0,1,2,3,4 | Max |
| Max | Max | Max | Max | Max | 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 | 18 | 10 | 8 | 6 | 10 | 9 | 7 | 5 | 9 | 5 | 4 | 4 | 3 | 2.5 |
| 18 | 30 | 12 | 9 | 7 | 12 | 10 | 8 | 6 | 10 | 6 | 5 | 5 | 4 | 4 |
| 30 | 50 | 14 | 11 | 8 | 16 | 11 | 9 | 7 | 13 | 7 | 5 | 6 | 5 | 4 |
| 50 | 80 | 16 | 13 | 10 | 20 | 14 | 11 | 8 | 16 | 9 | 7 | 7 | 5 | 4 |
| 80 | 120 | 19 | 19 | 11 | 26 | 16 | 16 | 10 | 20 | 10 | 8 | 8 | 6 | 5 |
| 120 | 150 | 23 | 23 | 14 | 30 | 19 | 19 | 11 | 25 | 11 | 8 | 9 | 7 | 5 |
| 150 | 180 | 31 | 31 | 19 | 38 | 23 | 23 | 14 | 30 | 13 | 10 | 10 | 8 | 7 |
| 180 | 250 | 38 | 38 | 23 | — | 25 | 25 | 15 | — | 15 | 11 | 11 | 8 | 8 |
| 250 | 315 | 44 | 44 | 26 | — | 31 | 31 | 19 | — | 18 | 14 | 13 | 10 | 8 |
| 315 | 400 | 50 | 50 | 30 | — | 35 | 35 | 21 | — | 20 | 15 | 15 | 11 | 10 |
| 400 | 500 | 56 | 56 | 34 | — | 41 | 41 | 25 | — | 23 | 17 | — | — | — |
| 500 | 630 | 63 | 63 | 38 | — | 48 | 48 | 29 | — | 28 | 21 | — | — | — |
| 630 | 800 | 94 | 94 | 55 | — | 56 | 56 | 34 | — | 35 | 26 | — | — | — |
| 800 | 1000 | 125 | 125 | 75 | — | 75 | 75 | 45 | — | — | — | — | — | — |
| 1000 | 1250 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 1250 | 1600 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 1600 | 2000 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 2000 | 2500 | — | — | — | — | — | — | — | — | — | — | — | — | — |

Notes: (1) This diameter is included in this group.

(2) Applies before mounting and after removal of internal or external snap ring.

(3) Applies to radial ball bearings such as deep groove ball bearings, angular contact ball bearings.

(4) Outer ring width variation of class 0 and 6 are listed in Table 5.1.1.

(5) Applies to radial ball bearings such as deep groove ball bearing, angular contact ball bearings.

Remarks: The high deviation of bearing cylindrical bore diameter specified in this table does not apply within a distance of $1.2 \times r$ (max) from the ring face.

Table 5.1.2 Tolerance Values of Outer Ring

(3/4)

Unit: μm

| Bearing outside diameter Nominal D (mm) | | Bearing outside diameter | | | | | Radial runout of assembled bearing outer ring | | | | | Variation of bearing outside surface generatrix inclination with outer ring reference face | | |
|---|-------|-------------------------------------|---------|---------|---------|---------|---|---------|---------|---------|---------|--|---------|---------|
| | | Mean outside diameter variation (2) | | | | | V_{Dmp} | | | | | S_D | | |
| | | Class 0 | Class 6 | Class 5 | Class 4 | Class 2 | Class 0 | Class 6 | 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 | Max | Max |
| 2.5 ⁽¹⁾ | 6 | 6 | 5 | 3 | 2 | 1.5 | 15 | 8 | 5 | 3 | 1.5 | 8 | 4 | 1.5 |
| 6 | 18 | 6 | 5 | 3 | 2 | 1.5 | 15 | 8 | 5 | 3 | 1.5 | 8 | 4 | 1.5 |
| 18 | 30 | 7 | 6 | 3 | 2.5 | 2 | 15 | 9 | 6 | 4 | 2.5 | 8 | 4 | 1.5 |
| 30 | 50 | 8 | 7 | 4 | 3 | 2 | 20 | 10 | 7 | 5 | 2.5 | 8 | 4 | 1.5 |
| 50 | 80 | 10 | 8 | 5 | 3.5 | 2 | 25 | 13 | 8 | 5 | 4 | 8 | 4 | 1.5 |
| 80 | 120 | 11 | 10 | 5 | 4 | 2.5 | 35 | 18 | 10 | 6 | 5 | 9 | 5 | 2.5 |
| 120 | 150 | 14 | 11 | 6 | 5 | 2.5 | 40 | 20 | 11 | 7 | 5 | 10 | 5 | 2.5 |
| 150 | 180 | 19 | 14 | 7 | 5 | 3.5 | 45 | 23 | 13 | 8 | 5 | 10 | 5 | 2.5 |
| 180 | 250 | 23 | 15 | 8 | 6 | 4 | 50 | 25 | 15 | 10 | 7 | 11 | 7 | 4 |
| 250 | 315 | 26 | 19 | 9 | 7 | 4 | 60 | 30 | 18 | 11 | 7 | 13 | 8 | 5 |
| 315 | 400 | 30 | 21 | 10 | 8 | 5 | 70 | 35 | 20 | 13 | 8 | 13 | 10 | 7 |
| 400 | 500 | 34 | 25 | 12 | — | — | 80 | 40 | 23 | — | — | 15 | — | — |
| 500 | 630 | 38 | 29 | 14 | — | — | 100 | 50 | 25 | — | — | 18 | — | — |
| 630 | 800 | 55 | 34 | 18 | — | — | 120 | 60 | 30 | — | — | 20 | — | — |
| 800 | 1000 | 75 | 45 | — | — | — | 140 | 75 | — | — | — | — | — | — |
| 1000 | 1250 | — | — | — | — | — | 160 | — | — | — | — | — | — | — |
| 1250 | 1600 | — | — | — | — | — | 190 | — | — | — | — | — | — | — |
| 1600 | 2000 | — | — | — | — | — | 220 | — | — | — | — | — | — | — |
| 2000 | 2500 | — | — | — | — | — | 250 | — | — | — | — | — | — | — |

Notes: (1) This diameter is included in this group.

(2) Applies before mounting and after removal of internal or external snap ring.

(3) Applies to radial ball bearings such as deep groove ball bearings, angular contact ball bearings.

(4) Outer ring width variation of class 0 and 6 are listed in Table 5.1.1.

(5) Applies to radial ball bearings such as deep groove ball bearing, angular contact ball bearings.

Remarks: The high deviation of bearing cylindrical bore diameter specified in this table does not apply within a distance of $1.2 \times r$ (max) from the ring face.



Table 5.1.2 Tolerance Values of Outer Ring

(4/4)

| Bearing outside diameter Nominal D (mm) | | Assembled bearing outer ring face runout with raceway S_{ea} (3) | | | Outer ring width variation V_{Cs} (4) | | |
|---|-------|--|---------|---------|---|---------|---------|
| | | Class 5 | Class 4 | Class 2 | Class 5 | Class 4 | Class 2 |
| | | Max | Max | Max | Max | Max | Max |
| Over | Incl. | | | | | | |
| 2.5 ⁽¹⁾ | 6 | 8 | 5 | 1.5 | 5 | 2.5 | 1.5 |
| 6 | 18 | 8 | 5 | 1.5 | 5 | 2.5 | 1.5 |
| 18 | 30 | 8 | 5 | 2.5 | 5 | 2.5 | 1.5 |
| 30 | 50 | 8 | 5 | 2.5 | 5 | 2.5 | 1.5 |
| 50 | 80 | 10 | 5 | 4 | 6 | 3 | 1.5 |
| 80 | 120 | 11 | 6 | 5 | 8 | 4 | 2.5 |
| 120 | 150 | 13 | 7 | 5 | 8 | 5 | 2.5 |
| 150 | 180 | 14 | 8 | 5 | 8 | 5 | 2.5 |
| 180 | 250 | 15 | 10 | 7 | 10 | 7 | 4 |
| 250 | 315 | 18 | 10 | 7 | 11 | 7 | 5 |
| 315 | 400 | 20 | 13 | 8 | 13 | 8 | 7 |
| 400 | 500 | 23 | — | — | 15 | — | — |
| 500 | 630 | 25 | — | — | 18 | — | — |
| 630 | 800 | 30 | — | — | 20 | — | — |
| 800 | 1000 | — | — | — | — | — | — |
| 1000 | 1250 | — | — | — | — | — | — |
| 1250 | 1600 | — | — | — | — | — | — |
| 1600 | 2000 | — | — | — | — | — | — |
| 2000 | 2500 | — | — | — | — | — | — |

Notes: (1) This diameter is included in this group.

(2) Applies before mounting and after removal of internal or external snap ring.

(3) Applies to radial ball bearings such as deep groove ball bearings, angular contact ball bearings.

(4) Outer ring width variation of class 0 and 6 are listed in Table 5.1.1.

(5) Applies to radial ball bearings such as deep groove ball bearing, angular contact ball bearings.

Remarks: The high deviation of bearing cylindrical bore diameter specified in this table does not apply within a distance of $1.2 \times r$ (max) from the ring face.

Table 5.2.1 Tolerance Values of Inner Ring (1/2)

Unit: μm

| Bearing bore diameter Nominal d (mm) | | Bearing bore diameter | | | | | | | | | | | |
|--------------------------------------|-----|---|-----|--------------------|-----|---------|-----|--|-----|---|---------|---------|---------|
| | | Single plane mean bore diameter Δd_{mp} | | | | | | Deviation of a single bore diameter Δd_s | | Bore diameter variation in a single radial plane Vd_p | | | |
| | | Class 0 Class 6X | | Class 6 Class 5 | | Class 4 | | Class 4 | | Class 0 Class 6X | Class 6 | Class 5 | Class 4 |
| | | High | Low | High | Low | High | Low | High | Low | Max | Max | Max | Max |
| 10 | 18 | 0 | -12 | 0 | -7 | 0 | -5 | 0 | -5 | 12 | 7 | 5 | 4 |
| 18 | 30 | 0 | -12 | 0 | -8 | 0 | -6 | 0 | -6 | 12 | 8 | 6 | 5 |
| 30 | 50 | 0 | -12 | 0 | -10 | 0 | -8 | 0 | -8 | 12 | 10 | 8 | 6 |
| 50 | 80 | 0 | -15 | 0 | -12 | 0 | -9 | 0 | -9 | 15 | 12 | 9 | 7 |
| 80 | 120 | 0 | -20 | 0 | -15 | 0 | -10 | 0 | -10 | 20 | 15 | 11 | 8 |
| 120 | 180 | 0 | -25 | 0 | -18 | 0 | -13 | 0 | -13 | 25 | 18 | 14 | 10 |
| 180 | 250 | 0 | -30 | 0 | -22 | 0 | -15 | 0 | -15 | 30 | 22 | 17 | 11 |
| 250 | 315 | 0 | -35 | - | - | - | - | - | - | 35 | - | - | - |
| 315 | 400 | 0 | -40 | - | - | - | - | - | - | 40 | - | - | - |
| 400 | 500 | 0 | -45 | - | - | - | - | - | - | - | - | - | - |
| 500 | 630 | 0 | -50 | - | - | - | - | - | - | - | - | - | - |
| 630 | 800 | 0 | -75 | - | - | - | - | - | - | - | - | - | - |

Remarks:

1. The high deviation of bearing bore diameter specified in this table does not apply within a distance of $1.2 \times r$ (max) from the ring face.
2. Some of these tolerances conform with the NACHI Standard.

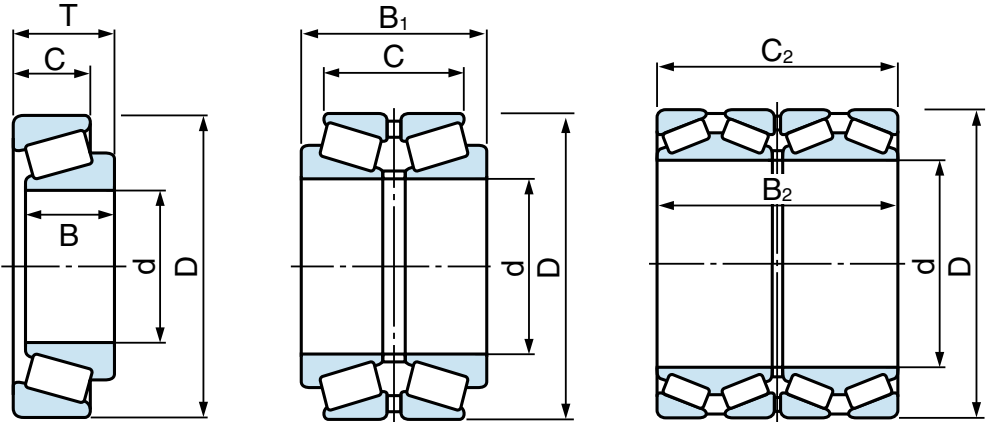


Table 5.2.1 Tolerance Values of Inner Ring (2/2)

Unit: μm

| Bearing bore diameter Nominal d (mm) | | Bearing bore diameter | | | | Radial runout of assembled bearing inner ring | | | | Inner ring reference face runout with bore | | Assembled bearing inner ring face runout with raceway |
|--------------------------------------|-------|--|---------|---------|---------|---|---------|---------|---------|--|---------|---|
| | | Mean bore diameter variation Vd_{mp} | | | | K_{ia} | | | | S_d | | |
| | | Class 0 Class 6X | Class 6 | Class 5 | Class 4 | Class 0 Class 6X | Class 6 | Class 5 | Class 4 | | | |
| | | | | | | | | | | | Class 5 | |
| Over | Incl. | Max | Max | Max | Max | Max | Max | Max | Max | Max | Max | Max |
| 10 | 18 | 9 | 5 | 5 | 4 | 15 | 7 | 5 | 3 | 7 | 3 | 3 |
| 18 | 30 | 9 | 6 | 5 | 4 | 18 | 8 | 5 | 3 | 8 | 4 | 4 |
| 30 | 50 | 9 | 8 | 5 | 5 | 20 | 10 | 6 | 4 | 8 | 4 | 4 |
| 50 | 80 | 11 | 9 | 6 | 5 | 25 | 10 | 7 | 4 | 8 | 5 | 4 |
| 80 | 120 | 15 | 11 | 8 | 5 | 30 | 13 | 8 | 5 | 9 | 5 | 5 |
| 120 | 180 | 19 | 14 | 9 | 7 | 35 | 18 | 11 | 6 | 10 | 6 | 7 |
| 180 | 250 | 23 | 16 | 11 | 8 | 50 | 20 | 13 | 8 | 11 | 7 | 8 |
| 250 | 315 | 26 | — | — | — | 60 | — | — | — | — | — | — |
| 315 | 400 | 30 | — | — | — | 70 | — | — | — | — | — | — |
| 400 | 500 | — | — | — | — | 70 | — | — | — | — | — | — |
| 500 | 630 | — | — | — | — | 85 | — | — | — | — | — | — |
| 630 | 800 | — | — | — | — | 100 | — | — | — | — | — | — |

Remarks:

1. The high deviation of bearing bore diameter specified in this table does not apply within a distance of $1.2 \times r$ (max) from the ring face.
2. Some of these tolerances conform with the NACHI Standard.

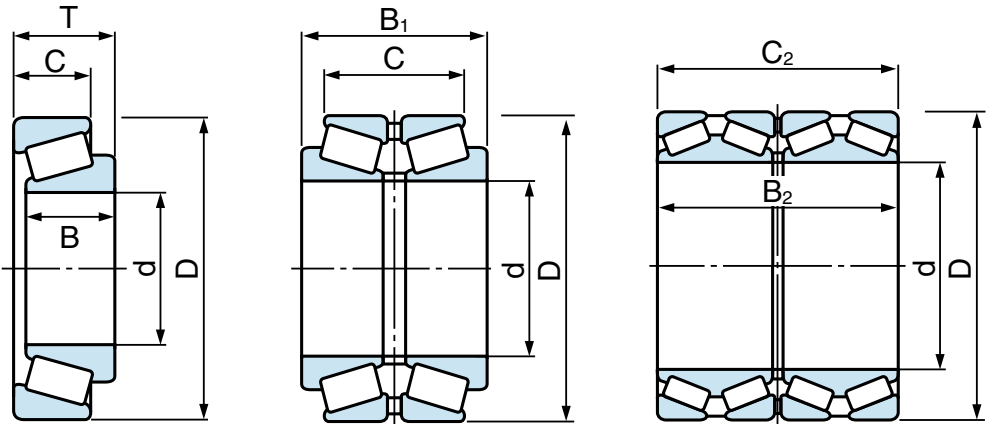


Table 5.2.2 Tolerance Values of Outer Ring

(1/2)

Unit: μm

| Bearing outside diameter Nominal D (mm) | | Bearing outside diameter | | | | | | | | | | | |
|---|------|--|------|--------------------|-----|---|-----|---------|-----|--|---------|---------|---------|
| | | Single plane mean outside diameter deviation ΔD_{mp} | | | | Deviation of a single outside diameter ΔD_s | | | | Outside diameter variation in a single radial plane V_{Dp} | | | |
| | | Class 0 Class 6X | | Class 6 Class 5 | | Class 4 | | Class 4 | | Class 0 Class 6X | Class 6 | Class 5 | Class 4 |
| | | High | Low | High | Low | High | Low | High | Low | Max | Max | Max | Max |
| 18 | 30 | 0 | -12 | 0 | -8 | 0 | -6 | 0 | -6 | 12 | 8 | 6 | 5 |
| 30 | 50 | 0 | -14 | 0 | -9 | 0 | -7 | 0 | -7 | 14 | 9 | 7 | 5 |
| 50 | 80 | 0 | -16 | 0 | -11 | 0 | -9 | 0 | -9 | 16 | 11 | 8 | 7 |
| 80 | 120 | 0 | -18 | 0 | -13 | 0 | -10 | 0 | -10 | 18 | 13 | 10 | 8 |
| 120 | 150 | 0 | -20 | 0 | -15 | 0 | -11 | 0 | -11 | 20 | 15 | 11 | 8 |
| 150 | 180 | 0 | -25 | 0 | -18 | 0 | -13 | 0 | -13 | 25 | 18 | 14 | 10 |
| 180 | 250 | 0 | -30 | 0 | -20 | 0 | -15 | 0 | -15 | 30 | 20 | 15 | 11 |
| 250 | 315 | 0 | -35 | 0 | -25 | 0 | -18 | 0 | -18 | 35 | 25 | 19 | 14 |
| 315 | 400 | 0 | -40 | 0 | -28 | 0 | -20 | 0 | -20 | 40 | 28 | 22 | 15 |
| 400 | 500 | 0 | -45 | - | - | - | - | - | - | 45 | - | - | - |
| 500 | 630 | 0 | -50 | - | - | - | - | - | - | 50 | - | - | - |
| 630 | 800 | 0 | -75 | - | - | - | - | - | - | - | - | - | - |
| 800 | 1000 | 0 | -100 | - | - | - | - | - | - | - | - | - | - |

- Remarks: 1. The low deviation of bearing outside diameter specified in this table does not apply within a distance of $1.2 \times r$ (max) from the ring face.
2. Some of these tolerances conform with the NACHI Standard.

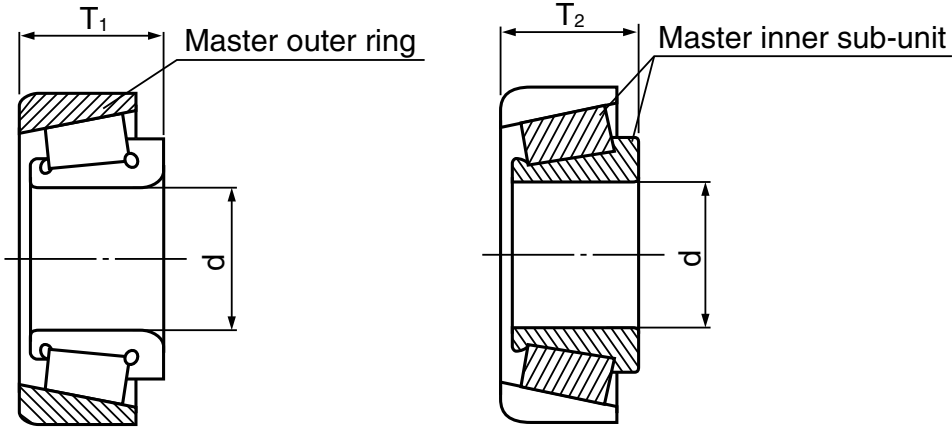


Table 5.2.2 Tolerance Values of Outer Ring

(2/2)

Unit: μm

| Bearing outside diameter Nominal D (mm) | | Bearing outside diameter | | | | Radial runout of assembled bearing outer ring | | | | Variation of bearing outside surface generatrix inclination with outer ring reference face S_D | | Assembled bearing outer ring face runout with raceway S_{ea} |
|---|-------|---|---------|---------|---------|---|---------|---------|---------|--|---------|--|
| | | Mean outside diameter variation V_{Dmp} | | | | | | | | | | |
| | | Class 0 | Class 6 | Class 5 | Class 4 | Class 0 | Class 6 | Class 5 | Class 4 | Class 5 | Class 4 | Class 4 |
| | | Class 6X | | | | Class 6X | | | | Class 5 | Class 4 | Class 5 |
| Over | Incl. | Max | Max | Max | Max | Max | Max | Max | Max | Max | Max | Max |
| 18 | 30 | 9 | 6 | 5 | 4 | 18 | 9 | 6 | 4 | 8 | 4 | 5 |
| 30 | 50 | 11 | 7 | 5 | 5 | 20 | 10 | 7 | 5 | 8 | 4 | 5 |
| 50 | 80 | 12 | 8 | 6 | 5 | 25 | 13 | 8 | 5 | 8 | 4 | 5 |
| 80 | 120 | 14 | 10 | 7 | 5 | 35 | 18 | 10 | 6 | 9 | 5 | 6 |
| 120 | 150 | 15 | 11 | 8 | 6 | 40 | 20 | 11 | 7 | 10 | 5 | 7 |
| 150 | 180 | 19 | 14 | 9 | 7 | 45 | 23 | 13 | 8 | 10 | 5 | 8 |
| 180 | 250 | 23 | 15 | 10 | 8 | 50 | 25 | 15 | 10 | 11 | 7 | 10 |
| 250 | 315 | 26 | 19 | 13 | 9 | 60 | 30 | 18 | 11 | 13 | 8 | 10 |
| 315 | 400 | 30 | 21 | 14 | 10 | 70 | 35 | 20 | 13 | 13 | 10 | 13 |
| 400 | 500 | 34 | — | — | — | 80 | — | — | — | — | — | — |
| 500 | 630 | 38 | — | — | — | 100 | — | — | — | — | — | — |
| 630 | 800 | — | — | — | — | 120 | — | — | — | — | — | — |
| 800 | 1000 | — | — | — | — | 120 | — | — | — | — | — | — |

- Remarks: 1. The low deviation of bearing outside diameter specified in this table does not apply within a distance of $1.2 \times r$ (max) from the ring face.
2. Some of these tolerances conform with the NACHI Standard.

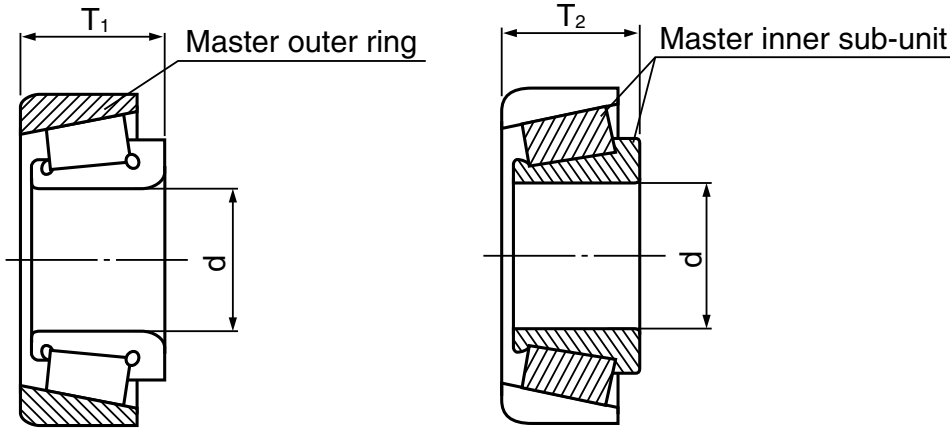


Table 5.2.3

Deviations of Single Ring Width,
Bearing Width and Duplex/Stack Mounted Bearing Width

(1/3)

Unit: μm

| Bearing bore diameter Nominal d (mm) | | Deviation of a single inner ring width ΔB_s | | | | | | Deviation of a single outer ring width ΔC_s | | | | | |
|---|-------|--|------|----------|-----|--------------------|------|--|------|----------|------|--------------------|------|
| | | Class 0 Class 6 | | Class 6X | | Class 5 Class 4 | | Class 0 Class 6 | | Class 6X | | Class 5 Class 4 | |
| Over | Incl. | 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 |
| 18 | 30 | 0 | -120 | 0 | -50 | 0 | -200 | 0 | -120 | 0 | -100 | 0 | -200 |
| 30 | 50 | 0 | -120 | 0 | -50 | 0 | -240 | 0 | -120 | 0 | -100 | 0 | -240 |
| 50 | 80 | 0 | -150 | 0 | -50 | 0 | -300 | 0 | -150 | 0 | -100 | 0 | -300 |
| 80 | 120 | 0 | -200 | 0 | -50 | 0 | -400 | 0 | -200 | 0 | -100 | 0 | -400 |
| 120 | 180 | 0 | -250 | 0 | -50 | 0 | -500 | 0 | -250 | 0 | -100 | 0 | -500 |
| 180 | 250 | 0 | -300 | 0 | -50 | 0 | -600 | 0 | -300 | 0 | -100 | 0 | -600 |
| 250 | 315 | 0 | -350 | 0 | -50 | — | — | 0 | -350 | 0 | -100 | — | — |
| 315 | 400 | 0 | -400 | 0 | -50 | — | — | 0 | -400 | 0 | -100 | — | — |
| 400 | 500 | 0 | -450 | — | — | — | — | 0 | -450 | — | — | — | — |
| 500 | 630 | 0 | -500 | — | — | — | — | 0 | -500 | — | — | — | — |
| 630 | 800 | 0 | -750 | — | — | — | — | 0 | -750 | — | — | — | — |

Remarks: Effective width of an inner sub-unit T₁ is the bearing width obtained when this sub-unit is mated with a master outer ring.
 Effective width of an outer ring T₂ is the bearing width obtained when this ring is mated with a master inner sub-unit.



Table 5.2.3

Deviations of Single Ring Width,
Bearing Width and Duplex/Stack Mounted Bearing Width

(2/3)

Unit: μm

| Bearing bore diameter Nominal d (mm) | | Deviation of a actual bearing width ΔT_s | | | | | | Deviation of the actual effective width of inner sub-unit ΔT_{1s} | | | |
|---|-------|---|------|----------|-----|--------------------|------|--|------|----------|-----|
| | | Class 0 Class 6 | | Class 6X | | Class 5 Class 4 | | Class 0 | | Class 6X | |
| Over | Incl. | High | Low | High | Low | High | Low | High | Low | High | Low |
| 10 | 18 | +200 | 0 | +100 | 0 | +200 | -200 | +100 | 0 | + 50 | 0 |
| 18 | 30 | +200 | 0 | +100 | 0 | +200 | -200 | +100 | 0 | + 50 | 0 |
| 30 | 50 | +200 | 0 | +100 | 0 | +200 | -200 | +100 | 0 | + 50 | 0 |
| 50 | 80 | +200 | 0 | +100 | 0 | +200 | -200 | +100 | 0 | + 50 | 0 |
| 80 | 120 | +200 | -200 | +100 | 0 | +200 | -200 | +100 | -100 | + 50 | 0 |
| 120 | 180 | +350 | -250 | +150 | 0 | +350 | -250 | +150 | -150 | + 50 | 0 |
| 180 | 250 | +350 | -250 | +150 | 0 | +350 | -250 | +150 | -150 | + 50 | 0 |
| 250 | 315 | +350 | -250 | +200 | 0 | — | — | +150 | -150 | +100 | 0 |
| 315 | 400 | +400 | -400 | +200 | 0 | — | — | +200 | -200 | +100 | 0 |
| 400 | 500 | +400 | -400 | — | — | — | — | — | — | — | — |
| 500 | 630 | +500 | -500 | — | — | — | — | — | — | — | — |
| 630 | 800 | +600 | -600 | — | — | — | — | — | — | — | — |

Remarks: Effective width of an inner sub-unit T₁ is the bearing width obtained when this sub-unit is mated with a master outer ring.
Effective width of an outer ring T₂ is the bearing width obtained when this ring is mated with a master inner sub-unit.



Table 5.2.3 Deviations of Single Ring Width, Bearing Width and Duplex/Stack Mounted Bearing Width Unit: μm (3/3)

| Bearing bore diameter Nominal d (mm) | | Deviation of the actual effective width of outer sub-unit ΔT_{2S} | | | | Deviation of duplex/stack mounted bearing width | | | |
|---|-------|---|------|----------|-----|---|-------|---------------------------------------|-------|
| | | | | | | ΔB_{1S} | | $\Delta B_{2S} \bullet \Delta C_{2S}$ | |
| | | Class 0 | | Class 6X | | Duplex mounted bearing class 0 | | Four row bearing class 0 | |
| Over | Incl. | High | Low | High | Low | High | Low | High | Low |
| 10 | 18 | +100 | 0 | + 50 | 0 | + 200 | – 200 | – | – |
| 18 | 30 | +100 | 0 | + 50 | 0 | + 200 | – 200 | – | – |
| 30 | 50 | +100 | 0 | + 50 | 0 | + 240 | – 240 | – | – |
| 50 | 80 | +100 | 0 | + 50 | 0 | + 300 | – 300 | + 400 | – 400 |
| 80 | 120 | +100 | –100 | + 50 | 0 | + 400 | – 400 | + 500 | – 500 |
| 120 | 180 | +200 | –100 | +100 | 0 | + 500 | – 500 | + 600 | – 600 |
| 180 | 250 | +200 | –100 | +100 | 0 | + 600 | – 600 | + 750 | – 750 |
| 250 | 315 | +200 | –100 | +100 | 0 | + 700 | – 700 | + 900 | – 900 |
| 315 | 400 | +200 | –200 | +100 | 0 | + 800 | – 800 | +1000 | –1000 |
| 400 | 500 | – | – | – | – | + 900 | – 900 | +1200 | –1200 |
| 500 | 630 | – | – | – | – | +1000 | –1000 | +1200 | –1200 |
| 630 | 800 | – | – | – | – | +1500 | –1500 | +1500 | –1500 |

Remarks: Effective width of an inner sub-unit T_1 is the bearing width obtained when this sub-unit is mated with a master outer ring.
 Effective width of an outer ring T_2 is the bearing width obtained when this ring is mated with a master inner sub-unit.

Table 5.3.1 Tolerance Values of
Shaft Washer Bore Diameter

Unit: μm

| Bearing bore diameter Nominal d or d ₂ (mm) | | Single plane mean bore diameter deviation | | Bore diameter variation, in a single radial plane | | Washer thickness (raceway to back face or raceway) variation (1) | | | | | |
|---|-------|---|-------|---|------|--|-----|-----|-----|-----|-----|
| | | Δd_{mp} or Δd_{2mp} | | Vd_p or Vd_{2p} | | S_i (or S_e) | | | | | |
| | | Class 0 Class 6 Class 5 | | Class 0 Class 6 Class 5 | | Class 0 Class 6 Class 5 Class 4 | | | | | |
| | | High | Low | High | Low | Max | Max | Max | Max | Max | Max |
| Over | Incl. | | | | | | | | | | |
| – | 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 | 1000 | 0 | – 100 | – | – | – | – | 45 | 30 | 15 | – |
| 1000 | 1250 | 0 | – 125 | – | – | – | – | 50 | 35 | 18 | – |

Table 5.3.2 Tolerance Values of Housing
Washer Outside Diameter

Unit: μm

| Bearing outside diameter Nominal D (mm) | | Mean outside diameter deviation, in a single plane | | Outside diameter variation in a single radial plane | |
|--|-------|--|-------|---|------|
| | | ΔD_{mp} | | V_{Dp} | |
| | | Class 0 Class 6 Class 5 | | Class 0 Class 6 Class 5 | |
| | | High | Low | High | Low |
| Over | Incl. | | | | |
| 10 | 18 | 0 | – 11 | 0 | – 7 |
| 18 | 30 | 0 | – 13 | 0 | – 8 |
| 30 | 50 | 0 | – 16 | 0 | – 9 |
| 50 | 80 | 0 | – 19 | 0 | – 11 |
| 80 | 120 | 0 | – 22 | 0 | – 13 |
| 120 | 180 | 0 | – 25 | 0 | – 15 |
| 180 | 250 | 0 | – 30 | 0 | – 20 |
| 250 | 315 | 0 | – 35 | 0 | – 25 |
| 315 | 400 | 0 | – 40 | 0 | – 28 |
| 400 | 500 | 0 | – 45 | 0 | – 33 |
| 500 | 630 | 0 | – 50 | 0 | – 38 |
| 630 | 800 | 0 | – 75 | 0 | – 45 |
| 800 | 1000 | 0 | – 100 | – | – |
| 1000 | 1250 | 0 | – 125 | – | – |
| 1250 | 1600 | 0 | – 160 | – | – |

Note: (1) For double acting bearings, use size classification d, not d₂.
Raceway to back face thickness variation of housing washer Se applies to the bearing with seat.

Table 5.3.3 Height Tolerances of Thrust Ball Bearings (with Flat Seat) and Center Washers (Class 0) Unit: μm

| Bearing bore diameter Nominal d (mm) | | Deviation of single height, T ΔT_s | | Deviation of single height, T ₂ of double direction thrust bearing (1) ΔT_{2s} | | Deviation of single height, T ₁ of double direction thrust bearing (1) ΔT_{1s} | | Deviation of center washer height (1) ΔB_s | |
|--------------------------------------|-------|--|------|---|------|---|------|--|------|
| Over | Incl. | High | Low | High | Low | High | Low | High | Low |
| — | 30 | 0 | − 75 | 0 | − 75 | + 50 | −150 | 0 | − 50 |
| 30 | 50 | 0 | −100 | 0 | −100 | + 75 | −200 | 0 | − 75 |
| 50 | 80 | 0 | −125 | 0 | −125 | +100 | −250 | 0 | −100 |
| 80 | 120 | 0 | −150 | 0 | −150 | +125 | −300 | 0 | −125 |
| 120 | 180 | 0 | −175 | 0 | −175 | +150 | −350 | 0 | −150 |
| 180 | 250 | 0 | −200 | 0 | −200 | +175 | −400 | 0 | −175 |
| 250 | 315 | 0 | −225 | 0 | −225 | +200 | −450 | 0 | −200 |
| 315 | 400 | 0 | −300 | 0 | −300 | +250 | −600 | 0 | −250 |

Note: (1) For double acting bearings, use size classification d, not d₂.
(2) Height deviations ΔT_s , ΔT_{1s} , ΔT_{2s} apply to the bearings with flat seat.

Table 5.4.1 Tolerance Values of Inner Rings Unit: μm

| Bearing bore diameter Nominal d (mm) | | Single plane mean bore diameter deviation Δd_{mp} | | Bore diameter variation, in a single radial plane Vdp | References | | |
|--------------------------------------|-------|---|-----|---|---|--|------|
| Over | Incl. | High | Low | | Inner ring reference face runout with bore Sd | Deviation of single height, ΔT_s | |
| | | | | 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 |

Table 5.4.2 Tolerance Values of Outer Rings Unit: μm

| Bearing bore diameter Nominal D (mm) | | Outside diameter deviation ΔD_{mp} | |
|--------------------------------------|-------|--|------|
| 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 | 1000 | 0 | −100 |

Remarks: The high deviation of bearing bore diameter specified in this table does not apply within a distance of $1.2 \times r$ (max) from the ring face.
The low deviation of bearing outside diameter specified in this table does not apply within a distance of $1.2 \times r$ (max) from the ring face.

Table 5.5.1 Tolerance of Inner Ring (Cone) Bore

Unit: μm

| Bearing bore diameter Nominal d mm (inch) | | Deviation of single bore diameter Δd_s | | | | | | | |
|--|---------------|--|-----|---------|-----|---------|-----|----------|-----|
| | | Class 4 | | Class 3 | | Class 0 | | Class 00 | |
| Over | Incl. | High | Low | High | Low | High | Low | High | Low |
| — | 76.200 (3) | + 13 | 0 | +13 | 0 | +13 | 0 | +8 | 0 |
| 76.200 (3) | 304.800 (12) | + 25 | 0 | +13 | 0 | +13 | 0 | +8 | 0 |
| 304.800 (12) | 609.600 (24) | + 51 | 0 | +25 | 0 | — | — | — | — |
| 609.600 (24) | 914.400 (36) | + 76 | 0 | +38 | 0 | — | — | — | — |
| 914.400 (36) | 1219.200 (48) | +102 | 0 | +51 | 0 | — | — | — | — |
| 1219.200 (48) | — | +127 | 0 | +76 | 0 | — | — | — | — |

Table 5.5.2 Tolerance of Outer Ring (Cup) Outside Diameter

Unit: μm

| Bearing outside diameter Nominal D mm (inch) | | Deviation of single outside diameter ΔD_s | | | | | | | |
|---|---------------|---|-----|---------|-----|---------|-----|----------|-----|
| | | Class 4 | | Class 3 | | Class 0 | | Class 00 | |
| Over | Incl. | High | Low | High | Low | High | Low | High | Low |
| — | 304.800 (12) | + 25 | 0 | +13 | 0 | +13 | 0 | +8 | 0 |
| 304.800 (12) | 609.600 (24) | + 51 | 0 | +25 | 0 | — | — | — | — |
| 609.600 (24) | 914.400 (36) | + 76 | 0 | +38 | 0 | — | — | — | — |
| 914.400 (36) | 1219.200 (48) | +102 | 0 | +51 | 0 | — | — | — | — |
| 1219.200 (48) | — | +127 | 0 | +76 | 0 | — | — | — | — |

Table 5.5.3 Tolerance of Bearing Width and Duplex/Stack Mounted Bearing Width

Unit: μm

| Bearing bore diameter Nominal d mm (inch) | | Bearing outside diameter Nominal D mm (inch) | | Deviation of the actual bearing width ΔT_s | | | | | |
|---|---------------|--|--------------|--|------|---------|------|---------------------|------|
| | | | | Class 4 | | Class 3 | | Class 0 Class 00 | |
| | | | | High | Low | High | Low | High | Low |
| — | 101.600 (4) | — | — | +203 | 0 | +203 | −203 | +203 | −203 |
| 101.600 (4) | 304.800 (12) | — | — | +356 | −254 | +203 | −203 | +203 | −203 |
| 304.800 (12) | 609.600 (24) | — | 508.000 (20) | +381 | −381 | +203 | −203 | — | — |
| 304.800 (12) | 609.600 (24) | 508.000 (20) | — | +381 | −381 | +381 | −381 | — | — |
| 609.600 (24) | — | — | — | +381 | −381 | +381 | −381 | — | — |

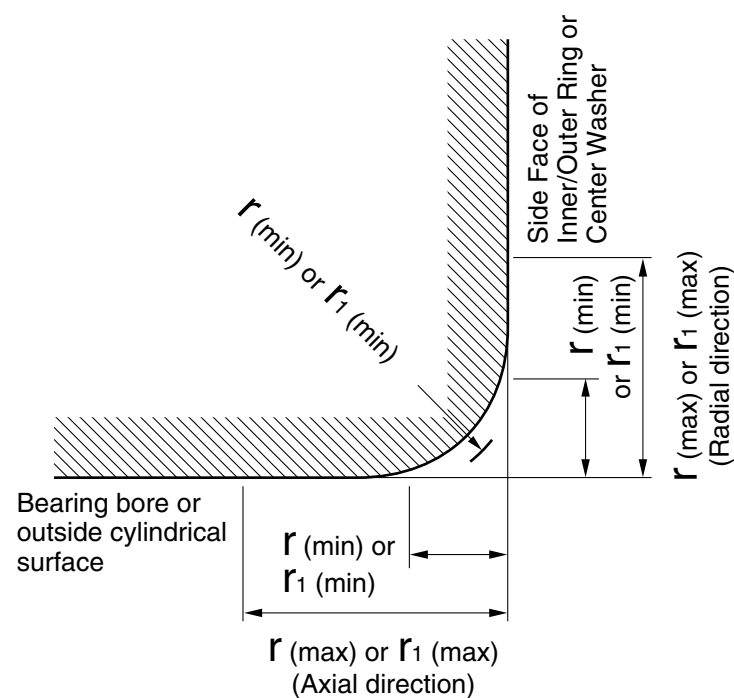
Note: (1) Deviation of the actual bearing width B_2 , and C_2 for row tapered roller bearing is $\pm 1524 \mu\text{m}$ for the tolerance classes of 4, 3 and 0.

Table 5.5.4 Radial Runout of Assembled Bearing Inner Ring and Outer Ring

Unit: μm

| Bearing outside diameter Nominal D mm (inch) | | Radial runout of assembled bearing inner ring K_{ia} and of assembled bearing outer ring K_{ea} (Max) | | | |
|--|--------------|--|---------|---------|----------|
| Over | Incl. | Class 4 | Class 3 | Class 0 | Class 00 |
| — | 304.800 (14) | 51 | 8 | 4 | 2 |
| 304.800 (12) | 609.600 (24) | 51 | 18 | — | — |
| 609.600 (24) | 914.400 (36) | 76 | 51 | — | — |
| 914.400 (36) | — | 76 | 76 | — | — |

5.6 Chamfer Dimension Limits



r : Chamfer dimensions of inner ring and outer ring.
 r_1 : Chamfer dimensions of inner ring and outer ring (front face) or of inner ring of double direction thrust bearing.

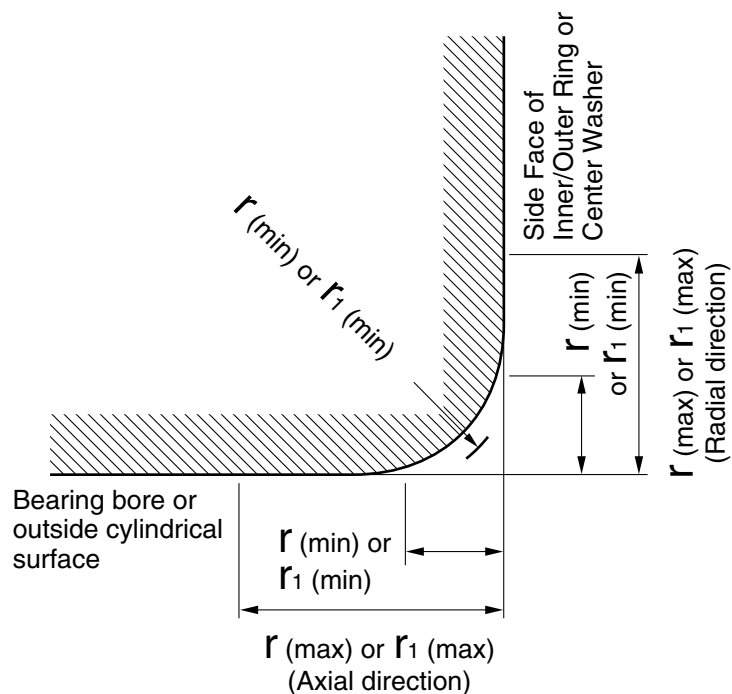
Remarks: The exact shape of the chamfer surface is not specified, but its contour in an axial plane shall not be allowed to project beyond the imaginary circular arc, of radius r min, tangential to the ring face and the bore or outside cylindrical surface of the ring (see figure).

Table 5.6.1 Chamfer Dimension Limits of Radial Bearings Except Tapered Roller Bearings (1/2)
Unit: mm

| Smallest permissible chamfer dimensions of inner and outer rings r (min) or r_1 (min) | Bearing bore diameter Nominal d | | Largest permissible chamfer dimensions of inner and outer rings r (max) or r_1 (max) | | Reference Shaft and housing fillet radius 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 | 40 — | 0.6 0.8 | 1 1 | 0.3 |
| 0.6 | — 40 | 40 — | 1 1.3 | 2 2 | 0.6 |
| 1 | — 50 | 50 — | 1.5 1.9 | 3 3 | 1 |
| 1.1 | — 120 | 120 — | 2 2.5 | 3.5 4 | 1 |
| 1.5 | — 120 | 120 — | 2.3 3 | 4 5 | 1.5 |

Remarks: For bearings with a width of 2mm or less the r max values for the radial direction apply also in the axial direction.

[Continue→]



r : Chamfer dimensions of inner ring and outer ring.

r_1 : Chamfer dimensions of inner ring and outer ring (front face) or of inner ring of double direction thrust bearing.

Remarks: The exact shape of the chamfer surface is not specified, but its contour in an axial plane shall not be allowed to project beyond the imaginary circular arc, of radius r min, tangential to the ring face and the bore or outside cylindrical surface of the ring (see figure).

Table 5.6.1 Chamfer Dimension Limits of Radial Bearings Except Tapered Roller Bearings

2/2)

Unit: mm

| Smallest permissible chamfer dimensions of inner and outer rings r (min) or r_1 (min) | Bearing bore diameter Nominal d | | Largest permissible chamfer dimensions of inner and outer rings r (max) or r_1 (max) | | Reference Shaft and housing fillet radius r_a |
|--|-----------------------------------|-----------------|---|-----------------|---|
| | Over | Incl. | Radial direction | Axial direction | Max |
| 2 | — 80 220 | 80 220 — | 3 3.5 3.8 | 4.5 5 6 | 2 |
| 2.1 | — 280 | 280 — | 4 4.5 | 6.5 7 | 2 |
| 2.5 | — 100 280 | 100 280 — | 3.8 4.5 5 | 6 6 7 | 2 |
| 3 | — 280 | 280 — | 5 5.5 | 8 8 | 2.5 |
| 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 |

Remarks: For bearings with a width of 2mm or less the r max values for the radial direction apply also in the axial direction.





Table 5.6.2 Chamfer Dimension Limits of Tapered Roller Bearings Unit: mm

| Smallest permissible chamfer dimensions of inner and outer rings r (min) | Bearing bore diameter or outside diameter (1) d or D | | Largest permissible chamfer dimensions of inner and outer rings r (max) | | Reference |
|---|---|------------------------|--|------------------------|--|
| | Over | Incl. | Radial direction | Axial direction | Shaft and housing fillet radius r_a |
| | | | | | Max |
| 0.3 | — 40 | 40 — | 0.7 0.9 | 1.4 1.6 | 0.3 |
| 0.6 | — 40 | 40 — | 1.1 1.3 | 1.7 2 | 0.6 |
| 1 | — 50 | 50 — | 1.6 1.9 | 2.5 3 | 1 |
| 1.5 | — 120 250 | 120 250 — | 2.3 2.8 3.5 | 3 3.5 4 | 1.5 |
| 2 | — 120 250 | 120 250 — | 2.8 3.5 4 | 4 4.5 5 | 2 |
| 2.5 | — 120 250 | 120 250 — | 3.5 4 4.5 | 5 5.5 6 | 2 |
| 3 | — 120 250 400 | 120 250 400 — | 4 4.5 5 5.5 | 5.5 6.5 7 7.5 | 2.5 |
| 4 | — 120 250 400 | 120 250 400 — | 5 5.5 6 6.5 | 7 7.5 8 8.5 | 3 |
| 5 | — 180 | 180 — | 6.5 7.5 | 8 9 | 4 |
| 6 | — 180 | 180 — | 7.5 9 | 10 11 | 5 |

Table 5.6.3 Chamfer Dimension Limits of Thrust Bearings Unit: mm

| Smallest permissible chamfer dimensions of inner and outer rings r (min) or r_1 (min) | Largest permissible single chamfer dimensions of inner and outer rings r (max) or r_1 (max) | Reference |
|--|--|--|
| | | Shaft and housing fillet radius r_a |
| | Radial direction and axial direction | Max |
| 0.05 0.08 0.1 | 0.1 0.16 0.2 | 0.05 0.08 0.1 |
| 0.15 0.2 0.3 | 0.3 0.5 0.8 | 0.15 0.2 0.3 |
| 0.6 1 1.1 | 1.5 2.2 2.7 | 0.6 1 1 |
| 1.5 2 2.1 | 3.5 4 4.5 | 1.5 2 2 |
| 3 4 5 | 5.5 6.5 8 | 2.5 3 4 |
| 6 7.5 9.5 | 10 12.5 15 | 5 6 8 |
| 12 15 19 | 18 21 25 | 10 12 15 |

Note: (1) d and D are applied to inner ring and outer ring respectively.



5.7 Tolerances for Tapered Bores

d : Bearing bore diameter, nominal

d_1 : Basic diameter at the theoretical large end of a tapered bore

in case of 1/12 taper $d_1 = d + \frac{1}{12}B$

in case of 1/30 taper $d_1 = d + \frac{1}{30}B$

Δd_{mp} : Mean bore diameter deviation at theoretical small end of a tapered bore

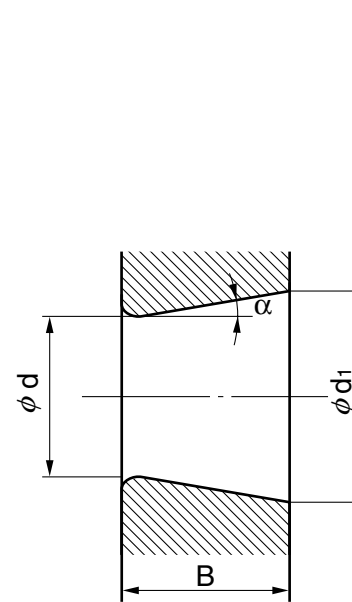
Δd_{1mp} : Mean bore diameter deviation at theoretical large end of a tapered bore

B : Bearing inner ring width, nominal

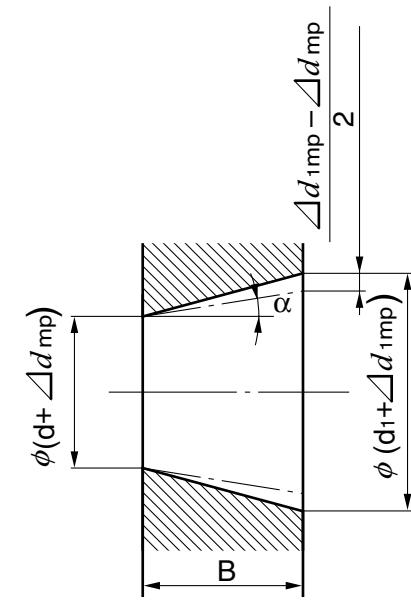
α : Nominal taper angle (half of cone angle)

in case of 1/12 taper $\alpha = 2^\circ 23' 9.4''$
 $= 2.38594^\circ$
 $= 0.041643 \text{ rad}$

in case of 1/30 taper $\alpha = 0^\circ 57' 17.4''$
 $= 0.95484^\circ$



Theoretical tapered bore



Tapered bore with actual mean diameters at their deviations

[Table 5.7.1 1/12 Tapered Bore \(Class 0\)](#)

[Table 5.7.2 1/30 Tapered Bore \(Class 0\)](#)

Table 5.7.1 1/12 Tapered Bore (Class 0)Unit: μm

| Nominal bearing bore dimension d (mm) | | Mean bore diameter deviation at theoretical small end of a tapered bore | | Bore diameter variation in a single radial plane (1)(2) | | |
|---------------------------------------|-------|---|-----|---|-----|--------|
| | | | | | | |
| | | Δd_{mp} | | $\Delta d_{1mp} - \Delta d_{mp}$ | | Vd_p |
| Over | Incl. | High | Low | High | Low | Max |
| 10 | 10 | + 22 | 0 | + 15 | 0 | 9 |
| 18 | 18 | + 27 | 0 | + 18 | 0 | 11 |
| 30 | 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 | 1000 | +140 | 0 | + 90 | 0 | — |
| 1000 | 1250 | +165 | 0 | +105 | 0 | — |
| 1250 | 1600 | +195 | 0 | +125 | 0 | — |

Note: (1) Applicable to all radial planes of tapered bore.

(2) Not applicable to bearings of diameter series 7 and 8.

Table 5.7.2 1/30 Tapered Bore (Class 0)Unit: μm

| Nominal bearing bore dimension d (mm) | | Mean bore diameter deviation at theoretical small end of a tapered bore | | Bore diameter variation in a single radial plane (1)(2) | | |
|---------------------------------------|-------|---|-----|---|-----|--------|
| | | | | | | |
| | | Δd_{mp} | | $\Delta d_{1mp} - \Delta d_{mp}$ | | Vd_p |
| Over | Incl. | High | Low | High | Low | Max |
| 50 | 80 | +15 | 0 | +30 | 0 | 19 |
| 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 |

Note: (1) Applicable to all radial planes of tapered bore.

(2) Not applicable to bearings of diameter series 7 and 8.

6. Internal Clearance of Rolling Contact Bearings

Bearing internal clearance refers to the distances between the bearing rings and rolling elements as shown in Fig. 6.1 and Fig. 6.2. The amount of alternating radial movement of the free bearing rings is defined as radial clearance, and the amount of alternating axial movement of the free bearing rings is defined as axial clearance.

The term internal clearance refers to a state where no force is applied to the bearing rings and rolling elements, i.e., an unloaded state.

Since a stabilizing, measuring load is applied to bearings when measuring the internal clearance, some elastic deformation occurs to the bearing rings and rolling elements, and the measured internal clearance will be larger than the real clearance by the value of deformation. The amount of elastic deformation caused by the measuring load may be disregarded for roller bearings, but must be compensated for when measuring ball bearing clearance because it will skew the internal clearance measurement.

Internal clearance values are described in the JIS (ISO) and the Japan Bearing Industrial Association Standards (BAS) as follows:

| | | |
|-----------------------------|---|-------------------------|
| Deep-groove ball bearings | } | JIS B1520 (ISO 5753) |
| Self-aligning ball bearings | | |
| Cylindrical roller bearings | | |
| Spherical roller bearings | | |

For electric motor

| | | |
|-----------------------------|---|----------|
| Deep-groove ball bearings | } | BAS 1003 |
| Cylindrical roller bearings | | |

Bearings not covered by either JIS (ISO) or BAS are standardized by NACHI. [Tables 6.1 through 6.7](#) show internal clearance values for NACHI bearings.

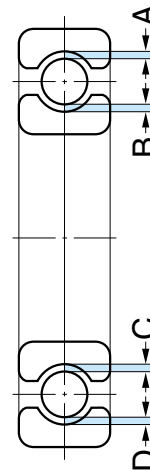


Fig. 6.1
Radial Clearance
 $= A+B+C+D$

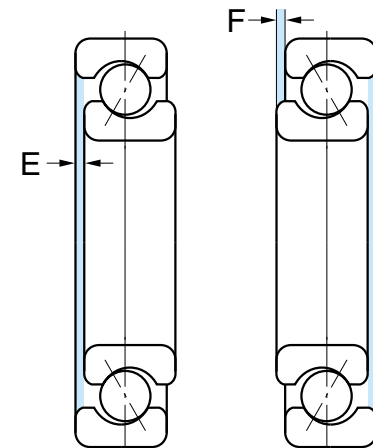


Fig. 6.2
Axial Clearance
 $= E+F$





Table 6.1 Radial Internal Clearance of Deep-groove Ball Bearings (with Cylindrical Bore) (JIS)

Table 6.2 Radial Internal Clearance of Extra-small and Miniature Ball Bearings (NACHI)

Table 6.3 Radial Internal Clearance of Self-aligning Ball Bearings (JIS)

Radial Internal Clearance of Cylindrical Roller Bearings

- Table 6.4.1 Radial Internal Clearance of Cylindrical Roller Bearings with Cylindrical Bore (JIS)
- Table 6.4.2 Non-interchangeable Radial Internal Clearance of Cylindrical Roller Bearings with Tapered Bore (NACHI)

Radial Internal Clearance of Spherical Roller Bearings

- Table 6.5.1 Radial Internal Clearance of Spherical Roller Bearings with Cylindrical Bore (JIS)
- Table 6.5.2 Radial Internal Clearance of Spherical Roller Bearings with Tapered Bore (JIS)

Table 6.6 Radial Internal Clearance of Double-row and Duplex Tapered Roller Bearings with Cylindrical Bore (NACHI)

Radial Internal Clearance of Bearings for Electric Motor

- Table 6.7.1 Radial Internal Clearance of Deep-groove Ball Bearings (BAS)
- Table 6.7.2 Radial Internal Clearance of Cylindrical Roller Bearings (BAS)

Table 6.1 Radial Internal Clearance of Deep-groove Ball Bearings (with Cylindrical Bore) (JIS) (1/2) Unit: μm

| Bearing bore dia. Nominal d (mm) | | Radial clearance | | | | | | | | | |
|--|-------|------------------|-----|-------------|-----|-----|-----|-----|-----|-----|-----|
| | | C2 | | CN (Normal) | | C3 | | C4 | | C5 | |
| Over | Incl. | min | max | min | max | min | max | min | max | min | max |
| 2.5 | 6 | 0 | 7 | 2 | 13 | 8 | 23 | — | — | — | — |
| 6 | 10 | 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 |





Table 6.1 Radial Internal Clearance of Deep-groove Ball Bearings (with Cylindrical Bore) (JIS) (2/2) Unit: μm

| Bearing bore dia. Nominal d (mm) | | Radial clearance | | | | | | | | | |
|--|-------|------------------|-----|-------------|-----|-----|-----|-----|-----|-----|------|
| | | C2 | | CN (Normal) | | C3 | | C4 | | C5 | |
| Over | Incl. | min | max | min | max | min | max | min | max | min | max |
| 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 |
| 800 | 900 | 20 | 160 | 140 | 320 | 300 | 500 | 480 | 700 | 670 | 940 |
| 900 | 1000 | 20 | 170 | 150 | 350 | 330 | 550 | 530 | 770 | 740 | 1040 |
| 1000 | 1120 | 20 | 180 | 160 | 380 | 360 | 600 | 580 | 850 | 820 | 1150 |
| 1120 | 1250 | 20 | 190 | 170 | 410 | 390 | 650 | 630 | 920 | 890 | 1260 |

Table 6.2 Radial Internal Clearance of Extra-small and Miniature Ball Bearings (NACHI)

Unit: μm

| Bearing bore dia. Nominal d (mm) | | Radial clearance | | | | | | | | | | | |
|--|-------|------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | | C1P | | C2P | | C3P | | C4P | | C5P | | C6P | |
| Over | Incl. | min | max | min | max | min | max | min | max | min | max | min | max |
| — | 10 | 0 | 5 | 3 | 8 | 5 | 10 | 8 | 13 | 13 | 20 | 20 | 28 |

Remarks: The standard internal clearance is C3P.

Table 6.3 Radial Internal Clearance of Self-aligning Ball Bearings (JIS)

Unit: μm

| Bearing bore dia. Nominal d (mm) | | Radial clearance, cylindrical bore | | | | | | | | | | Radial clearance, tapered bore | | | | | | | | | |
|--|-------|------------------------------------|-----|-------------|-----|-----|-----|-----|-----|-----|-----|--------------------------------|-----|-------------|-----|-----|-----|-----|-----|-----|-----|
| | | C2 | | CN (Normal) | | C3 | | C4 | | C5 | | C2 | | CN (Normal) | | 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 |

Radial Internal Clearance of Cylindrical Roller Bearings

Table 6.4.1 Radial Internal Clearance of Cylindrical Roller Bearings with Cylindrical Bore (JIS)

Unit: μm

| Bearing bore diameter Nominal d (mm) | | Radial clearance | | | | | | | | | |
|--|-------|------------------|-----|-------------|-----|-----|-----|-----|-----|-----|-----|
| | | C2 | | CN (Normal) | | C3 | | C4 | | C5 | |
| Over | Incl. | 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 |
| 24 | 30 | 0 | 25 | 20 | 45 | 35 | 60 | 50 | 75 | 70 | 95 |
| 30 | 40 | 5 | 30 | 25 | 50 | 45 | 70 | 60 | 85 | 80 | 105 |
| 40 | 50 | 5 | 35 | 30 | 60 | 50 | 80 | 70 | 100 | 95 | 125 |
| 50 | 65 | 10 | 40 | 40 | 70 | 60 | 90 | 80 | 110 | 110 | 140 |
| 65 | 80 | 10 | 45 | 40 | 75 | 65 | 100 | 90 | 125 | 130 | 165 |
| 80 | 100 | 15 | 50 | 50 | 85 | 75 | 110 | 105 | 140 | 155 | 190 |
| 100 | 120 | 15 | 55 | 50 | 90 | 85 | 125 | 125 | 165 | 180 | 220 |
| 120 | 140 | 15 | 60 | 60 | 105 | 100 | 145 | 145 | 190 | 200 | 245 |
| 140 | 160 | 20 | 70 | 70 | 120 | 115 | 165 | 165 | 215 | 225 | 275 |
| 160 | 180 | 25 | 75 | 75 | 125 | 120 | 170 | 170 | 220 | 250 | 300 |
| 180 | 200 | 35 | 90 | 90 | 145 | 140 | 195 | 195 | 250 | 275 | 330 |
| 200 | 225 | 45 | 105 | 105 | 165 | 160 | 220 | 220 | 280 | 305 | 365 |
| 225 | 250 | 45 | 110 | 110 | 175 | 170 | 235 | 235 | 300 | 330 | 395 |
| 250 | 280 | 55 | 125 | 125 | 195 | 190 | 260 | 260 | 330 | 370 | 440 |
| 280 | 315 | 55 | 130 | 130 | 205 | 200 | 275 | 275 | 350 | 410 | 485 |
| 315 | 355 | 65 | 145 | 145 | 225 | 225 | 305 | 305 | 385 | 455 | 535 |
| 355 | 400 | 100 | 190 | 190 | 280 | 280 | 370 | 370 | 460 | 510 | 600 |
| 400 | 450 | 110 | 210 | 210 | 310 | 310 | 410 | 410 | 510 | 565 | 665 |
| 450 | 500 | 110 | 220 | 220 | 330 | 330 | 440 | 440 | 550 | 625 | 735 |

Table 6.4.2 Non-interchangeable Radial Internal Clearance of Cylindrical Roller Bearings with Tapered Bore (NACHI) Unit: μm

| Bearing bore diameter Nominal d (mm) | | Radial clearance | | | | | |
|--------------------------------------|-------|------------------|-----|------|-----|------|-----|
| | | C9na | | C1na | | C2na | |
| Over | Incl. | min | max | min | max | min | max |
| 14 | 18 | 5 | 10 | 10 | 20 | 20 | 30 |
| 18 | 24 | 5 | 10 | 10 | 20 | 20 | 30 |
| 24 | 30 | 5 | 10 | 15 | 25 | 25 | 35 |
| 30 | 40 | 5 | 12 | 15 | 25 | 25 | 40 |
| 40 | 50 | 5 | 15 | 17 | 30 | 30 | 45 |
| 50 | 65 | 5 | 15 | 20 | 35 | 35 | 50 |
| 65 | 80 | 10 | 20 | 25 | 40 | 40 | 60 |
| 80 | 100 | 10 | 25 | 35 | 55 | 45 | 70 |
| 100 | 120 | 10 | 25 | 40 | 60 | 50 | 80 |
| 120 | 140 | 15 | 30 | 45 | 70 | 60 | 90 |
| 140 | 160 | 15 | 35 | 50 | 75 | 65 | 100 |
| 160 | 180 | 15 | 35 | 55 | 85 | 75 | 110 |
| 180 | 200 | 20 | 40 | 60 | 90 | 80 | 120 |
| 200 | 225 | 20 | 45 | 60 | 95 | 90 | 135 |
| 225 | 250 | 25 | 50 | 65 | 100 | 100 | 150 |
| 250 | 280 | 25 | 55 | 75 | 110 | 110 | 165 |
| 280 | 315 | 30 | 60 | 80 | 120 | 120 | 180 |
| 315 | 355 | 30 | 65 | 90 | 135 | 135 | 200 |
| 355 | 400 | 35 | 75 | 100 | 150 | 150 | 225 |
| 400 | 450 | 40 | 85 | 110 | 170 | 170 | 255 |
| 450 | 500 | 45 | 95 | 120 | 190 | 190 | 285 |

Remarks: JIS (ISO) has not standardized non-interchangeable radial clearance for tapered bore bearings.

Radial Internal Clearance of Spherical Roller Bearings

Table 6.5.1 Radial Internal Clearance of Spherical Roller Bearings with Cylindrical Bore (JIS)

Unit: μm

| Bearing bore diameter Nominal d (mm) | | Radial clearance | | | | | | | | | |
|--|-------|------------------|-----|-------------|-----|-----|-----|-----|------|------|------|
| | | C2 | | CN (Normal) | | C3 | | C4 | | C5 | |
| Over | Incl. | min | max | min | max | min | max | min | max | min | max |
| 14 | 18 | 10 | 20 | 20 | 35 | 35 | 45 | 45 | 60 | 60 | 75 |
| 18 | 24 | 10 | 20 | 20 | 35 | 35 | 45 | 45 | 60 | 60 | 75 |
| 24 | 30 | 15 | 25 | 25 | 40 | 40 | 55 | 55 | 75 | 75 | 95 |
| 30 | 40 | 15 | 30 | 30 | 45 | 45 | 60 | 60 | 80 | 80 | 100 |
| 40 | 50 | 20 | 35 | 35 | 55 | 55 | 75 | 75 | 100 | 100 | 125 |
| 50 | 65 | 20 | 40 | 40 | 65 | 65 | 90 | 90 | 120 | 120 | 150 |
| 65 | 80 | 30 | 50 | 50 | 80 | 80 | 110 | 110 | 145 | 145 | 180 |
| 80 | 100 | 35 | 60 | 60 | 100 | 100 | 135 | 135 | 180 | 180 | 225 |
| 100 | 120 | 40 | 75 | 75 | 120 | 120 | 160 | 160 | 210 | 210 | 260 |
| 120 | 140 | 50 | 95 | 95 | 145 | 145 | 190 | 190 | 240 | 240 | 300 |
| 140 | 160 | 60 | 110 | 110 | 170 | 170 | 220 | 220 | 280 | 280 | 350 |
| 160 | 180 | 65 | 120 | 120 | 180 | 180 | 240 | 240 | 310 | 310 | 390 |
| 180 | 200 | 70 | 130 | 130 | 200 | 200 | 260 | 260 | 340 | 340 | 430 |
| 200 | 225 | 80 | 140 | 140 | 220 | 220 | 290 | 290 | 380 | 380 | 470 |
| 225 | 250 | 90 | 150 | 150 | 240 | 240 | 320 | 320 | 420 | 420 | 520 |
| 250 | 280 | 100 | 170 | 170 | 260 | 260 | 350 | 350 | 460 | 460 | 570 |
| 280 | 315 | 110 | 190 | 190 | 280 | 280 | 370 | 370 | 500 | 500 | 630 |
| 315 | 355 | 120 | 200 | 200 | 310 | 310 | 410 | 410 | 550 | 550 | 690 |
| 355 | 400 | 130 | 220 | 220 | 340 | 340 | 450 | 450 | 600 | 600 | 750 |
| 400 | 450 | 140 | 240 | 240 | 370 | 370 | 500 | 500 | 660 | 660 | 820 |
| 450 | 500 | 140 | 260 | 260 | 410 | 410 | 550 | 550 | 720 | 720 | 900 |
| 500 | 560 | 150 | 280 | 280 | 440 | 440 | 600 | 600 | 780 | 780 | 1000 |
| 560 | 630 | 170 | 310 | 310 | 480 | 480 | 650 | 650 | 850 | 850 | 1100 |
| 630 | 710 | 190 | 350 | 350 | 530 | 530 | 700 | 700 | 920 | 920 | 1190 |
| 710 | 800 | 210 | 390 | 390 | 580 | 580 | 770 | 770 | 1010 | 1010 | 1300 |
| 800 | 900 | 230 | 430 | 430 | 650 | 650 | 860 | 860 | 1120 | 1120 | 1440 |
| 900 | 1000 | 260 | 480 | 480 | 710 | 710 | 930 | 930 | 1220 | 1220 | 1570 |

Table 6.5.2 Radial Internal Clearance of Spherical Roller Bearings with Tapered Bore (JIS)

Unit: μm

| Bearing bore diameter Nominal d (mm) | | Radial clearance | | | | | | | | | |
|--|-------|------------------|-----|-------------|-----|-----|------|------|------|------|------|
| | | C2 | | CN (Normal) | | C3 | | C4 | | C5 | |
| Over | Incl. | min | max | min | max | min | max | min | max | min | max |
| 18 | 24 | 15 | 25 | 25 | 35 | 35 | 45 | 45 | 60 | 60 | 75 |
| 24 | 30 | 20 | 30 | 30 | 40 | 40 | 55 | 55 | 75 | 75 | 95 |
| 30 | 40 | 25 | 35 | 35 | 50 | 50 | 65 | 65 | 85 | 85 | 105 |
| 40 | 50 | 30 | 45 | 45 | 60 | 60 | 80 | 80 | 100 | 100 | 130 |
| 50 | 65 | 40 | 55 | 55 | 75 | 75 | 95 | 95 | 120 | 120 | 160 |
| 65 | 80 | 50 | 70 | 70 | 95 | 95 | 120 | 120 | 150 | 150 | 200 |
| 80 | 100 | 55 | 80 | 80 | 110 | 110 | 140 | 140 | 180 | 180 | 230 |
| 100 | 120 | 65 | 100 | 100 | 135 | 135 | 170 | 170 | 220 | 220 | 280 |
| 120 | 140 | 80 | 120 | 120 | 160 | 160 | 200 | 200 | 260 | 260 | 330 |
| 140 | 160 | 90 | 130 | 130 | 180 | 180 | 230 | 230 | 300 | 300 | 380 |
| 160 | 180 | 100 | 140 | 140 | 200 | 200 | 260 | 260 | 340 | 340 | 430 |
| 180 | 200 | 110 | 160 | 160 | 220 | 220 | 290 | 290 | 370 | 370 | 470 |
| 200 | 225 | 120 | 180 | 180 | 250 | 250 | 320 | 320 | 410 | 410 | 520 |
| 225 | 250 | 140 | 200 | 200 | 270 | 270 | 350 | 350 | 450 | 450 | 570 |
| 250 | 280 | 150 | 220 | 220 | 300 | 300 | 390 | 390 | 490 | 490 | 620 |
| 280 | 315 | 170 | 240 | 240 | 330 | 330 | 430 | 430 | 540 | 540 | 680 |
| 315 | 355 | 190 | 270 | 270 | 360 | 360 | 470 | 470 | 590 | 590 | 740 |
| 355 | 400 | 210 | 300 | 300 | 400 | 400 | 520 | 520 | 650 | 650 | 820 |
| 400 | 450 | 230 | 330 | 330 | 440 | 440 | 570 | 570 | 720 | 720 | 910 |
| 450 | 500 | 260 | 370 | 370 | 490 | 490 | 630 | 630 | 790 | 790 | 1000 |
| 500 | 560 | 290 | 410 | 410 | 540 | 540 | 680 | 680 | 870 | 870 | 1100 |
| 560 | 630 | 320 | 460 | 460 | 600 | 600 | 760 | 760 | 980 | 980 | 1230 |
| 630 | 710 | 350 | 510 | 510 | 670 | 670 | 850 | 850 | 1090 | 1090 | 1360 |
| 710 | 800 | 390 | 570 | 570 | 750 | 750 | 960 | 960 | 1220 | 1220 | 1500 |
| 800 | 900 | 440 | 640 | 640 | 840 | 840 | 1070 | 1070 | 1370 | 1370 | 1690 |
| 900 | 1000 | 490 | 710 | 710 | 930 | 930 | 1190 | 1190 | 1520 | 1520 | 1860 |

Table 6.6 Radial Internal Clearance of Double-row and Duplex Tapered Roller Bearings with Cylindrical Bore (NACHI)

Unit: μm

| Bearing bore diameter Nominal d (mm) | | Radial clearance | | | | | | | | | | | |
|--------------------------------------|-----|------------------|-----|-----|-----|-------------|-----|-----|-----|-----|-----|-----|-----|
| | | C1 | | C2 | | CN (Normal) | | C3 | | C4 | | C5 | |
| | | min | max | min | max | min | max | min | max | min | max | min | max |
| 14 | 18 | 2 | 10 | 10 | 20 | 20 | 30 | 35 | 45 | 45 | 55 | 65 | 75 |
| 18 | 24 | 2 | 10 | 10 | 20 | 20 | 30 | 35 | 45 | 45 | 55 | 65 | 75 |
| 24 | 30 | 2 | 10 | 10 | 25 | 25 | 35 | 40 | 50 | 50 | 60 | 70 | 80 |
| 30 | 40 | 2 | 12 | 12 | 25 | 25 | 40 | 45 | 55 | 55 | 70 | 80 | 95 |
| 40 | 50 | 2 | 15 | 15 | 30 | 30 | 45 | 50 | 65 | 65 | 80 | 95 | 110 |
| 50 | 65 | 2 | 15 | 15 | 35 | 35 | 50 | 55 | 75 | 75 | 90 | 110 | 130 |
| 65 | 80 | 5 | 20 | 20 | 40 | 40 | 60 | 70 | 90 | 90 | 110 | 130 | 150 |
| 80 | 100 | 5 | 25 | 25 | 45 | 45 | 70 | 80 | 105 | 105 | 125 | 155 | 180 |
| 100 | 120 | 5 | 25 | 25 | 50 | 50 | 80 | 95 | 120 | 120 | 145 | 180 | 205 |
| 120 | 140 | 10 | 30 | 30 | 60 | 60 | 90 | 105 | 135 | 135 | 160 | 200 | 230 |
| 140 | 160 | 10 | 35 | 35 | 65 | 65 | 100 | 115 | 150 | 150 | 180 | 225 | 260 |
| 160 | 180 | 10 | 35 | 35 | 75 | 75 | 110 | 125 | 165 | 165 | 200 | 250 | 285 |
| 180 | 200 | 10 | 40 | 40 | 80 | 80 | 120 | 140 | 180 | 180 | 220 | 275 | 315 |
| 200 | 225 | 10 | 45 | 45 | 90 | 90 | 135 | 155 | 200 | 200 | 240 | 305 | 350 |
| 225 | 250 | 15 | 50 | 50 | 100 | 100 | 150 | 170 | 215 | 215 | 265 | 330 | 380 |
| 250 | 280 | 15 | 55 | 55 | 110 | 110 | 165 | 185 | 240 | 240 | 295 | 370 | 420 |
| 280 | 315 | 15 | 60 | 60 | 120 | 120 | 180 | 205 | 265 | 265 | 325 | 410 | 470 |
| 315 | 355 | 15 | 65 | 65 | 135 | 135 | 200 | 225 | 295 | 295 | 360 | 455 | 520 |
| 355 | 400 | 20 | 75 | 75 | 150 | 150 | 225 | 255 | 330 | 330 | 405 | 510 | 585 |
| 400 | 450 | 20 | 85 | 85 | 170 | 170 | 255 | 285 | 370 | 370 | 455 | 565 | 650 |
| 450 | 500 | 20 | 95 | 95 | 190 | 190 | 285 | 315 | 410 | 410 | 505 | 625 | 720 |

Radial Internal Clearance of Bearings for Electric Motor

Table 6.7.1 Radial Internal Clearance of Deep-groove Ball Bearings (BAS) Unit: μm

| Bearing bore diameter Nominal d (mm) | | Radial clearance CM | |
|--------------------------------------|-------|---------------------|-----|
| Over | Incl. | min | max |
| 10 ⁽¹⁾ | 18 | 4 | 11 |
| 18 | 30 | 5 | 12 |
| 30 | 50 | 9 | 17 |
| 50 | 80 | 12 | 22 |
| 80 | 120 | 18 | 30 |
| 120 | 160 | 24 | 38 |

Note: (1) 10 mm is included in this group.
Remarks: The value in this table is under the condition of unloaded state.

Table 6.7.2 Radial Internal Clearance of Cylindrical Roller Bearings (BAS) Unit: μm

| Bearing bore diameter Nominal d (mm) | | Radial clearance | | | |
|--------------------------------------|-------|--------------------|-----|------------------------|-----|
| | | Interchangeable CT | | Non-interchangeable CT | |
| Over | Incl. | min | max | min | max |
| 24 | 40 | 15 | 35 | 15 | 30 |
| 40 | 50 | 20 | 40 | 20 | 35 |
| 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 |
| 180 | 200 | 65 | 105 | 65 | 100 |

Remarks: "Interchangeability" in this table means interchangeability between NACHI bearings only not with other brand bearings.

7. Materials for Rolling Contact Bearings

A rolling contact bearing consist of one or more rings and rolling elements (which directly support the loads) and, usually, a cage which keeps the rolling elements at equal intervals. Both rolling and sliding movements occur between these parts.

7.1 Bearing Ring and Rolling Elements

Because of high, repetitive stress to the rolling contact areas, fatigue phenomenon will occur to the bearing material after a duration of operation. Loading stress ultimately dislodges a surface section and the bearing fails. To delay the advent of material fatigue, bearing ring and rolling element materials should have the following properties:

- High level of hardness
- High rolling contact fatigue resistance
- Good wear resistance
- Dimensional stability
- Good mechanical strength

Standard NACHI material for bearing rings and rolling elements is vacuum-degassed, high-carbon, chrome bearing steel. See [Table 7.1](#).

For applications requiring a higher degree of reliability, bearing steel using a vacuum-melting process or electroslag solution (ESR).

The NACHI steel used for standard bearings is SUJ2 (JIS) steel. For large size bearings, SUJ3 or SUJ5 steels are used for hardenability.

If impact resistance is required, SNCM series steel may be used (see [Table 7.2](#)).

In addition to the above, high-speed steel may be used for bearings for applications requiring tolerance to high temperatures.

Stainless steel may be used for bearings operating in a corrosive atmosphere.

Ceramic materials may be used for special applications.

7.2 Cage Material

Materials for cages are required to have the following properties:

- Good wear resistance
- Dimensional stability
- Good mechanical strength



[Continue→]



Cold-rolled steel (see [Table 7.5](#)) is used for pressed cages. High-tensile-strength brass castings or machined-steel are used for machined cages (see [Tables 7.6](#) and [7.7](#)). Polyamide resin are used depending on the type of bearing and the application. For selection of cage material, it is important to consider the operating conditions. Polyamide cages should not be used at temperatures above 120°C or below -40°C. Polyamide cages should not be used in vacuum because they become brittle due to dehydration. Polyamide cages may be affected by the use of specific lubricants.

Brass cages should not be used at temperatures in excess 300°C.
Brass cages are not suitable in Ammonia (e.g. in refrigeration) because Ammonia causes season cracking in brass.

Table 7.1 High-Carbon Chrome Bearing Steel

Table 7.2 Case Hardening Steel

Table 7.3 High-Speed Steel

Table 7.4 Stainless Steel

Table 7.5 Cold Rolled Steel Strip and Cold Rolled Steel Sheet and Plate for Pressed Cage

Table 7.6 High Tensile Strength Brass Casting for Machined Cage

Table 7.7 Steel for Machined Cage

Table 7.1 High-Carbon Chrome Bearing Steel

| Standard | Symbol | Chemical composition (%) | | | | | | |
|----------|--------|--------------------------|-------------|-------------|---------|---------|-------------|-------------|
| | | C | Si | Mn | P | S | Cr | Mo |
| JIS | SUJ 2 | 0.95 ~ 1.10 | 0.15 ~ 0.35 | ≤ 0.50 | ≤ 0.025 | ≤ 0.025 | 1.30 ~ 1.60 | ≤ 0.08 |
| | SUJ 3 | 0.95 ~ 1.10 | 0.40 ~ 0.70 | 0.90 ~ 1.15 | ≤ 0.025 | ≤ 0.025 | 0.90 ~ 1.20 | ≤ 0.08 |
| | SUJ 4 | 0.95 ~ 1.10 | 0.15 ~ 0.35 | ≤ 0.50 | ≤ 0.025 | ≤ 0.025 | 1.30 ~ 1.60 | 0.10 ~ 0.25 |
| | SUJ 5 | 0.95 ~ 1.10 | 0.40 ~ 0.70 | 0.90 ~ 1.15 | ≤ 0.025 | ≤ 0.025 | 0.90 ~ 1.20 | 0.10 ~ 0.25 |
| SAE | 52100 | 0.98 ~ 1.10 | 0.15 ~ 0.35 | 0.25 ~ 0.45 | ≤ 0.025 | ≤ 0.025 | 1.30 ~ 1.60 | ≤ 0.10 |

Table 7.2 Case Hardening Steel

| Standard | Symbol | Chemical composition (%) | | | | | | | |
|----------|---------|--------------------------|-------------|-------------|---------|---------|-------------|-------------|-------------|
| | | C | Si | Mn | P | S | Ni | Cr | Mo |
| JIS | SNCM220 | 0.17 ~ 0.23 | 0.15 ~ 0.35 | 0.60 ~ 0.90 | ≤ 0.030 | ≤ 0.030 | 0.40 ~ 0.70 | 0.40 ~ 0.65 | 0.15 ~ 0.30 |
| | SNCM420 | 0.17 ~ 0.23 | 0.15 ~ 0.35 | 0.40 ~ 0.70 | ≤ 0.030 | ≤ 0.030 | 1.60 ~ 2.00 | 0.40 ~ 0.65 | 0.15 ~ 0.30 |
| | SNCM815 | 0.12 ~ 0.18 | 0.15 ~ 0.35 | 0.30 ~ 0.60 | ≤ 0.030 | ≤ 0.030 | 4.00 ~ 4.50 | 0.70 ~ 1.00 | 0.15 ~ 0.30 |
| | SCr420 | 0.18 ~ 0.23 | 0.15 ~ 0.35 | 0.60 ~ 0.85 | ≤ 0.030 | ≤ 0.030 | — | 0.90 ~ 1.20 | — |
| SAE | 8620 | 0.18 ~ 0.23 | 0.15 ~ 0.35 | 0.70 ~ 0.90 | ≤ 0.035 | ≤ 0.040 | 0.40 ~ 0.70 | 0.40 ~ 0.60 | 0.15 ~ 0.25 |
| | 4320 | 0.17 ~ 0.22 | 0.15 ~ 0.35 | 0.45 ~ 0.65 | ≤ 0.035 | ≤ 0.040 | 1.65 ~ 2.00 | 0.40 ~ 0.60 | 0.20 ~ 0.30 |

Table 7.3 High-Speed Steel

| Standard | Symbol | Chemical composition (%) | | | | | | | | | | | |
|----------|--------|--------------------------|--------|--------|---------|---------|-------------|-------------|-------------|--------|--------|--------|--------|
| | | C | Si | Mn | P | S | Cr | Mo | V | Ni | Cu | Co | W |
| AISI | M50 | 0.77 ~ 0.85 | ≤ 0.25 | ≤ 0.35 | ≤ 0.015 | ≤ 0.015 | 3.75 ~ 4.25 | 4.00 ~ 4.50 | 0.90 ~ 1.10 | ≤ 0.15 | ≤ 0.10 | ≤ 0.25 | ≤ 0.25 |

Table 7.4 Stainless Steel

| Standard | Symbol | Chemical composition (%) | | | | | | |
|----------|---------|--------------------------|--------|--------|---------|---------|---------------|--------|
| | | C | Si | Mn | P | S | Cr | Mo |
| JIS | SUS440C | 0.95 ~ 1.20 | ≤ 1.00 | ≤ 1.00 | ≤ 0.040 | ≤ 0.030 | 16.00 ~ 18.00 | ≤ 0.75 |

Table 7.5 Cold Rolled Steel Strip and Cold Rolled Steel Sheet and Plate for Pressed Cage

| Standard | Symbol | Chemical composition (%) | | | | |
|----------|--------|--------------------------|--------|-------------|---------|---------|
| | | C | Si | Mn | P | S |
| BAS | SPB 1 | ≤ 0.10 | ≤ 0.04 | 0.25 ~ 0.45 | ≤ 0.030 | ≤ 0.030 |
| | SPB 2 | 0.13 ~ 0.20 | ≤ 0.04 | 0.25 ~ 0.60 | ≤ 0.030 | ≤ 0.030 |
| JIS | SPCC | ≤ 0.12 | — | ≤ 0.50 | ≤ 0.040 | ≤ 0.045 |

Table 7.6 High Tensile Strength Brass Casting for Machined Cage

| Standard | Symbol | Chemical composition (%) | | | | | | | | | |
|----------|--------------------|--------------------------|-------------|-----------|-----------|-----------|-----------|-------|-----------|-------|--------|
| | | Cu | Zn | Mn | Fe | Al | Sn | Ni | Pb | Si | Others |
| BAS | HB _S CR | 55.0 ~ 62.0 | 33.0 ~ 37.0 | 2.0 ~ 4.0 | 0.5 ~ 1.5 | 0.1 ~ 1.0 | 0.1 ~ 1.0 | ≤ 1.0 | 0.1 ~ 1.0 | ≤ 0.2 | ≤ 1.0 |
| JIS | HB _S C1 | 55.0 ~ 60.0 | Residue | ≤ 1.5 | 0.5 ~ 1.5 | 0.5 ~ 1.5 | ≤ 1.0 | ≤ 1.0 | ≤ 0.4 | ≤ 0.1 | — |
| | HB _S C2 | 55.0 ~ 60.0 | 30.0 ~ 42.0 | 0.1 ~ 3.5 | 0.5 ~ 2.0 | 0.5 ~ 2.0 | ≤ 1.0 | ≤ 1.0 | ≤ 0.4 | ≤ 0.1 | — |

Table 7.7 Steel for Machined Cage

| Standard | Symbol | Chemical composition (%) | | | | |
|----------|--------|--------------------------|-------------|-------------|---------|---------|
| | | C | Si | Mn | P | S |
| JIS | S25C | 0.22 ~ 0.28 | 0.15 ~ 0.35 | 0.30 ~ 0.60 | ≤ 0.030 | ≤ 0.035 |



8. Application of Bearings

8.1 Fits and Clearance

8.2 Preload and Rigidity

8.3 Shaft and Housing Selection

8.4 Sealing Devices

8.5 Lubrication

8.6 Speed Limits

8.7 Friction and Temperature Rise

8.8 Mounting and Dismounting

8. Application of Rolling Contact Bearings

8.1 Fits and Clearance

8.1.1 Importance of Fit

To get the best performance from a rolling contact bearing, the fit between the inner ring and shaft, and outer ring and housing must be correct. If the mating surfaces lack interference, the bearing ring may move circumferentially on the shaft or in the housing. This phenomenon is called creep. Once mating surfaces start to creep, the bearing ring will begin to wear excessively and the shaft and/or housing may be damaged. Abrasive debris may enter the bearing to cause abnormal heating or vibration.

Creep is often impossible to prevent by mere fastening of the bearing in an axial direction. To prevent creep, the bearing rings that support the rotating load must be provided with necessary interference. The bearing rings that support stationary load normally do not require interference unless contact corrosion from vibration is a concern.

8.1.2 Selection of Fit

To select the most appropriate fit, the following items must be considered:

- direction of load
- characteristics of load
- magnitude of load
- temperature conditions
- mounting, and dismounting conditions

For general recommendations see [Table 8.1](#).

For mounting bearings in a thin-walled housing or on a hollow shaft, large interference than normal must be provided.

Split-housing applications requiring high precision or tight housing bore fits are not recommended. (A split housing may cause the outer ring to deform).

For application of bearings subjected to vibration, an interference fit should be applied to both inner and outer rings.

[Tables 8.2 through 8.14](#) describe general fit recommendations. For fits not covered by these tables, please contact NACHI.



Table 8.1 Fits vs. Load Characteristics

Table 8.2.1 Bearing Bore (1) Fits for Radial Bearings

Table 8.2.2 Bearing Outside Diameter (1) Fits for Radial Bearings

Table 8.3.1 Bearing Bore or Center Washer Bore (1) Fits for Thrust Bearings

Table 8.3.2 Bearing Outside Diameter (1) Fits for Thrust Bearings

Table 8.4 Shaft Tolerances (1) for Radial Bearings

Table 8.5 Shaft Tolerances for Thrust Bearings

Table 8.6 Housing Bore Tolerances (1) for Radial Bearings (Except Inch-series Tapered Roller Bearings)

Table 8.7 Housing Bore Tolerances for Thrust Bearings

Fits of Inch Series Tapered Roller Bearings with Shafts

Table 8.8.1 For Bearings with ABMA Classes 4 and 2

Table 8.8.2 For Bearings with ABMA Classes 3 and 0

Fits of Inch Series Tapered Roller Bearings with Housings

Table 8.9.1 For Bearings with ABMA Classes 4 and 2

Table 8.9.2 For Bearings with ABMA Classes 3 and 0

Amounts of Fits: Radial Bearings with Tolerance JIS Class 0 (ISO Normal Class)

Table 8.10.1 Inner Ring with Shaft

Table 8.10.2 Outer Ring with Housing

Amounts of Fits: Radial Bearings with Tolerance JIS (ISO) Class 6

Table 8.11.1 Inner Ring with Shaft

Table 8.11.2 Outer Ring with Housing

Amounts of Fits: Radial Bearings with Tolerance JIS (ISO) Class 5

Table 8.12.1 Inner Ring with Shaft

Table 8.12.2 Outer Ring with Housing

Amounts of Fits: Radial Bearings with Tolerance JIS (ISO) Class 4

Table 8.13.1 Inner Ring with Shaft

Table 8.13.2 Outer Ring with Housing

Amounts of Fits: Thrust Bearings with Tolerance JIS (ISO) Class 0

Table 8.14.1 Shaft Washer or Center Washer with Shaft

Table 8.14.2 Housing Washer with Housing

Table 8.1 Fits vs. Load Characteristics

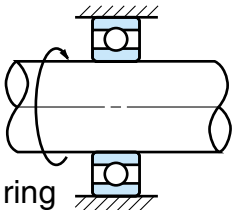
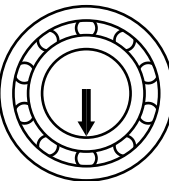
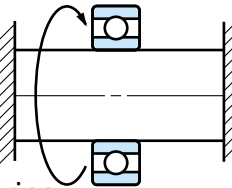
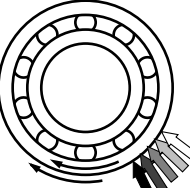
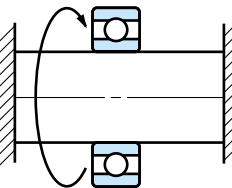
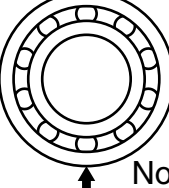
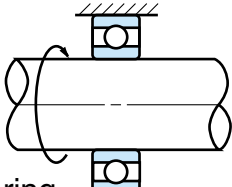
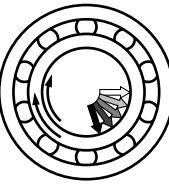
| Rotating condition | Type of load | Load conditions | Fit | |
|--|---|------------------------------|------------------|------------------|
| | | | Inner ring | Outer ring |
|  inner ring |  Non-rotating | Rotating inner ring load | Interference fit | Loose fit |
|  outer ring |  Rotating | Stationary outer ring load | | |
|  outer ring |  Non-rotating | Rotating outer ring load | Loose fit | Interference fit |
|  inner ring |  Rotating | Stationary inner ring load | | |
| Load direction not constant because of fluctuation unbalanced load | Rotating or Non-rotating | Indeterminate direction load | Interference fit | Interference fit |

Table 8.2.1 Bearing Bore ⁽¹⁾ Fits for Radial Bearings

| Bearing tolerance class | Fit class vs. load type | | | | | | | | |
|-------------------------|---|-----|-----|------------|------------|--------------------|-----|------------------------------|------------|
| | For rotating inner ring load and indeterminate direction load | | | | | | | For rotating outer ring load | |
| Class 0, class 6 | r 6 | p 6 | n 6 | m 5 m 6 | k 5 k 6 | j 5 j 6 js 6 | h 5 | h 5 h 6 | g 5 g 6 |
| Class 5, class 4 | — | — | — | m 5 | k 4 | js 4 | h 4 | h 5 | — |

Table 8.2.2 Bearing Outside Diameter ⁽¹⁾ Fits for Radial Bearings

| Bearing tolerance class | Fit class vs. load type | | | | | | | | | |
|-------------------------|------------------------------|------------|------------|-----|----------------------------------|------------|------------|------------------------------|-----|-----|
| | For rotating inner ring load | | | | For indeterminate direction load | | | For rotating outer ring load | | |
| Class 0, class 6 | — | J 6 J 7 | H 6 H 7 | G 7 | M 7 | K 6 K 7 | J 6 J 7 | P 7 | N 7 | M 7 |
| Class 5, class 4 | K 5 | Js 5 | H 5 | — | — | — | — | — | — | M 5 |

Table 8.3.1 Bearing Bore or Center Washer Bore ⁽¹⁾ Fits for Thrust Bearings

| Bearing tolerance class | Fit class vs. load type | | | |
|-------------------------|-------------------------|--|-----|--------------------|
| | For centric axial load | For composite load (spherical roller thrust bearing) | | |
| Class 0 | j 6 js 6 | n 6 | m 6 | k 6 j 6 js 6 |

Table 8.3.2 Bearing Outside Diameter ⁽¹⁾ Fits for Thrust Bearings

| Bearing tolerance class | Fit class vs. load type | |
|-------------------------|-------------------------|--|
| | For centric axial load | For composite load (spherical roller thrust bearing) |
| Class 0 | — | M 7 H 7 |

Note: (1) These dimensional fits are based on JIS B 1514.

Table 8.4 Shaft Tolerances ⁽¹⁾ for Radial Bearings

| Operating conditions | | Shaft diameter (mm) | | Tolerance symbols | Remarks | Examples of application (Reference) |
|--------------------------------|---|-------------------------|--|-------------------|---|-------------------------------------|
| | | Bell bearings | Cylindrical roller bearings Tapered roller bearings | | | |
| Bearings with cylindrical bore | | | | | | |
| Rotating outer ring load | When the inner ring is required to move on the shaft easily | For all shaft diameters | | g6 | When high precision is required, adopt g5 and h5 respectively. For large bearings, f6 is adopted because of easy bearing movement in axial direction. | Driven wheel |
| | When the inner ring is required to move on the shaft easily | For all shaft diameters | | h6 | | Tension pully, rope sheave |

Note: (1) Shaft tolerances in this table are applied to solid steel shaft for bearings with tolerance class 0 and 6.
Remarks: Heavy load $P > 0.12Cr$, Normal Load $0.06Cr < P \leq 0.12Cr$, Light Load $P \leq 0.06Cr$ Cr: Basic Dynamic Load Rating



Table 8.4 Shaft Tolerances ⁽¹⁾ for Radial Bearings

(2/3)

| Operating conditions | | Shaft diameter (mm) | | | Tolerance symbols | Remarks | Examples of application (Reference) |
|--|--------------------------------|---------------------|--|---------------------------|-------------------|---|--|
| | | Bell bearings | Cylindrical roller bearings Tapered roller bearings | Spherical roller bearings | | | |
| Rotating inner ring load or indeterminate direction load | Light load or fluctuating load | 18 under and incl. | — | — | h5 | When high precision is required, adopt j5, k5 and m5 instead of j6, k5 and m6 respectively | Electrical appliance, machining tool, pump, blower, haulage car |
| | | 18 Over 100 Incl. | 40 under and incl. | — | j6 | | |
| | | 100 Over 200 Incl. | 40 Over 140 Incl. | — | k6 | | |
| | | — | 140 Over 200 Incl. | — | m6 | | |
| | Normal load or heavy load | 18 under and incl. | — | — | j5 | The tolerances of k6 and m6 instead of k5 and m5 can be used for single row tapered roller bearings and single row angular contact ball bearings. | Electric motor, turbine, pump, internal combustion engine, wood working machine, bearing application in general. |
| | | 18 Over 100 Incl. | 40 under and incl. | 40 under and incl. | k5 | | |
| | | 100 Over 200 Incl. | 40 Over 100 Incl. | 40 Over 65 Incl. | m5 | | |
| | | — | 100 Over 140 Incl. | 65 Over 100 Incl. | m6 | | |
| | | — | 140 Over 200 Incl. | 100 Over 140 Incl. | n6 | | |
| | | — | 200 Over 400 Incl. | 140 Over 200 Incl. | p6 | | |
| | | — | — | 280 Over | r6 | | |
| | Composite load | — | 50 Over 140 Incl. | 50 Over 100 Incl. | n6 | A bearing with an internal clearance larger than the normal clearance is required | Axles of locomotive and passenger train, traction motor |
| | | — | 140 Over 200 Incl. | 100 Over 140 Incl. | p6 | | |
| | | — | 200 Over | 140 Over | r6 | | |

Note: (1) Shaft tolerances in this table are applied to solid steel shaft for bearings with tolerance class 0 and 6.

Remarks: Heavy load $P > 0.12C_r$, Normal Load $0.06C_r < P \leq 0.12C_r$, Light Load $P \leq 0.06C_r$ C_r : Basic Dynamic Load Rating

**Table 8.4 Shaft Tolerances ⁽¹⁾ for Radial Bearings****(3/3)**

| Operating conditions | Shaft diameter (mm) | | | Tolerance symbols | Remarks | Examples of application (Reference) |
|---|-------------------------|--|---------------------------|-------------------|--|---|
| | Bell bearings | Cylindrical roller bearings Tapered roller bearings | Spherical roller bearings | | | |
| Centric axial load | 250 under and incl. | | | j6 | — | — |
| | 250 Over | | | js6, j6 | | |
| Bearing with tapered bore (with sleeve) | | | | | | |
| For all load condition | For all shaft condition | | | h9/IT5 | h10/IT7 instead of h9/IT5 can be used for power transmission shaft. IT5 and IT7 mean the form error (out of roundness, taper) should be limited within the tolerance ranges of IT5 and IT7 | Railroad car axle, bearing application in general |

Note: (1) Shaft tolerances in this table are applied to solid steel shaft for bearings with tolerance class 0 and 6.

Remarks: Heavy load $P > 0.12C_r$, Normal Load $0.06C_r < P \leq 0.12C_r$, Light Load $P \leq 0.06C_r$ C_r : Basic Dynamic Load Rating

Table 8.5 Shaft Tolerances for Thrust Bearings

| Operating conditions | | Shaft diameter (mm) | Tolerance symbols |
|---|---|---------------------|-------------------|
| Centric axial load (Thrust ball bearings and spherical roller thrust bearings) | | 250 under and incl. | j6 |
| | | 250 Over | js6, j6 |
| Composite load (Spherical roller thrust bearings) | Rotating outer ring load | 250 under and incl. | j6 |
| | | 250 Over | js6, j6 |
| | Rotation inner ring load or indeterminate direction load | 200 under and incl. | k6 |
| | | 200 Over 400 Incl. | m6 |
| | | 400 Over | n6 |

Table 8.7 Housing Bore Tolerances for Thrust Bearings

| Operating conditions | | Tolerance symbols | Remarks |
|--|---|-------------------|---|
| Centric axial load (All thrust bearings) | Thrust ball bearing | H8 | When high accuracy is not required, radial clearance will be provided between outer ring (housing washer)/aligning housing washer and housing |
| | Spherical roller thrust bearing; When housing is located in radial direction by another bearing. | — | 0.001D is recommended as a radial clearance between outer ring and housing. D: outside diameter of housing washer |
| Composite load (Spherical roller thrust bearings) | Stationary outer ring load or indeterminate direction load | H7 J7 | — |
| | Rotating outer ring load | K7 M7 | In case when the radial load is comparatively large, bearing application in general |

Table 8.6 Housing Bore Tolerances ⁽¹⁾ for Radial Bearings (Except Inch-series Tapered Roller Bearings) (1/2)

| Operating conditions | | | Tolerance symbols | Outer ring movement (2) | Examples of application (Reference) |
|--|---|---|---|---|---|
| Monoblock housing | Rotating outer ring load | When a heavy load is applied to a thin-walled housing or impact load | P7 | Outer ring can not be moved in axial direction. | Automotive wheel (roller bearing) |
| | | Normal load or heavy load | N7 | | Automotive wheel (ball bearing) |
| | | Light load or fluctuating load | M7 | | Conveyer roller, pulley, tension pulley |
| | Indeterminate direction load | Heavy impact load | | | Traction motor |
| | Indeterminate direction load | Heavy load or normal load; When the outer ring is not required to move in axial direction | K7 | Outer ring can not be moved in axial direction as a rule. | Electric motor, pump, crank shaft |
| | | Monoblock or split housing | Normal load or light load; When it is desirable that the outer ring can be moved in axial direction | J7 | Outer ring can be moved in axial direction. |
| Impact load; When no-load condition occurs instantaneously | Railroad car axle | | | | |
| Rotating inner ring load | All kinds of load | | H7 | Outer ring can be moved easily in axial direction. | Railroad car axle, bearing application in general |
| | Normal load or light load | | H8 | | Gear transmission |
| | When thermal conduction through the shaft is caused | | G7 | | Paper mill (Drying cylinder) |

Note: (1) The tolerances in this table are applied to cast iron or steel housing for bearings with tolerance class 0 and 6.
Tighter fit is adopted for light alloy housing.
(2) Outer ring of non-separable bearing



**Table 8.6 Housing Bore Tolerances ⁽¹⁾ for Radial Bearings (Except Inch-series Tapered Roller Bearings) (2/2)**

| Operating conditions | | | Tolerance symbols | Outer ring movement ⁽²⁾ | Examples of application (Reference) |
|----------------------|--|---|-------------------|---|--|
| Monoblock housing | When extremely high accuracy is required | Fluctuating load; When extremely accurate rotation and high rigidity are required | N6 | Outer ring can not be moved in axial direction. | Main shaft of machine tool (roller bearing, outside diameter is over 125 mm) |
| | | | M6 | | Main shaft of machine tool (roller bearing outside diameter is under and including 125 mm) |
| | | Indeterminate direction light load; When extremely accurate rotation is required. | K6 | Outer ring can not be moved in axial direction as a rule. | Main shaft of grinding machine, ball bearing on grinding wheel side High speed centrifugal compressor, clamping side bearing |
| | | When extremely accurate rotation is required and it is desirable that the outer ring can be moved in axial direction. | J6 | Outer ring can be moved in axial direction. | Main shaft of grinding machine, ball bearing on driving side High speed centrifugal compressor, floating side bearing |

Note: (1) The tolerances in this table are applied to cast iron or steel housing for bearings with tolerance class 0 and 6.

Tighter fit is adopted for light alloy housing.

(2) Outer ring of non-separable bearing

Table 8.8 Fits of Inch Series Tapered Roller Bearings with Shafts

Table 8.8.1 For Bearings with ABMA Classes 4 and 2 Unit: μm

| Operating conditions | | | Bearing bore diameter Nominal d (mm) | | Bearing bore deviation | | Shaft diameter deviation | | Amounts ⁽¹⁾ | |
|--|---|--|---|-------|---------------------------|-----|--------------------------|------|------------------------|------|
| | | | Over | Incl. | High | Low | High | Low | Max | Min |
| Rota- ting inner ring load | Normal load No impact | | — | 76.2 | +13 | 0 | + 38 | + 26 | 38T | 12T |
| | | | 76.2 | 304.8 | +25 | 0 | + 64 | + 38 | 64T | 13T |
| | | | 304.8 | 609.6 | +51 | 0 | +127 | + 76 | 127T | 25T |
| | | | 609.6 | 914.4 | +76 | 0 | +191 | +114 | 191T | 38T |
| | Heavy load High speed rotation Impact load | | — | 76.2 | +13 | 0 | + 64 | + 38 | 64T | 25T |
| | | | 76.2 | 304.8 | +25 | 0 | { | (2) | | |
| | | | 304.8 | 609.6 | +51 | 0 | | | | |
| | | | 609.6 | 914.4 | +76 | 0 | | | | |
| Rota- ting outer ring load | Normal load No impact | Non-ground shaft (When the inner ring is not required to move in axial direction.) | — | 76.2 | +13 | 0 | + 13 | 0 | 13T | 13L |
| | | | 76.2 | 304.8 | +25 | 0 | + 25 | 0 | 25T | 25L |
| | | | 304.8 | 609.6 | +51 | 0 | + 51 | 0 | 51T | 51L |
| | | | 609.6 | 914.4 | +76 | 0 | + 76 | 0 | 76T | 76L |
| | Normal load No impact | Ground shaft (When the inner ring is required to move in axial direction) | — | 76.2 | +13 | 0 | 0 | − 13 | 0 | 26L |
| | | | 76.2 | 304.8 | +25 | 0 | 0 | − 25 | 0 | 51L |
| | | | 304.8 | 609.6 | +51 | 0 | 0 | − 51 | 0 | 102L |
| | | | 609.6 | 914.4 | +76 | 0 | 0 | − 76 | 0 | 152L |

Note:
(1) T: Tight fit L: Loose fit
(2) Mean amounts of tight fits are d/2000 mm

Table 8.8.2 For Bearings with ABMA Classes 3 and 0

 Unit: μm

| Operating conditions | | Bearing bore diameter Nominal d (mm) | | Bearing bore deviation | | Shaft diameter deviation | | Amounts ⁽¹⁾ | |
|--|---|---|-------|---------------------------|-----|--------------------------|-----|------------------------|-----|
| | | Over | Incl. | High | Low | High | Low | Max | Min |
| Rota- ting inner ring load | Main shaft of precision machine tool | — | 304.8 | +13 | 0 | + 38 | +18 | 31T | 5T |
| | | 304.8 | 609.6 | +25 | 0 | + 64 | +38 | 64T | 13T |
| | | 609.6 | 914.4 | +38 | 0 | +102 | +63 | 102T | 25T |
| | Heavy load High speed rotation Impact load | — | 76.2 | +13 | 0 | (2) | | | |
| | | 76.2 | 304.8 | +13 | 0 | | | | |
| | | 304.8 | 609.6 | +25 | 0 | | | | |
| | | 609.6 | 914.4 | +38 | 0 | | | | |
| | Main shaft of precision machine tool | — | 304.8 | +13 | 0 | + 13 | +18 | 31T | 5T |
| | | 304.8 | 609.6 | +25 | 0 | + 64 | +38 | 64T | 13T |
| | | 609.6 | 914.4 | +38 | 0 | +102 | +63 | 102T | 25T |

Note:

(1) T: Tight fit L: Loose fit

 (2) Mean amounts of tight fits are $d/4000\text{mm}$

(3) This table is not applied to the bearing with tolerance class 0 whose bore diameter is over 241.3 mm

Table 8.9 Fits of Inch Series Tapered Roller Bearings with Housings

Table 8.9.1 For Bearings with ABMA Classes 4 and 2 Unit: μm

| Operating conditions | | Bearing outside diameter Nominal D (mm) | | Bearing outside diameter deviation | | Housing bore diameter deviation | | Amounts ⁽¹⁾ | |
|-----------------------------------|--|--|-------|---------------------------------------|-----|------------------------------------|------|------------------------|------|
| | | Over | Incl. | High | Low | High | Low | Max | Min |
| Rotating inner ring load | Floating side or Clamping side | — | 76.2 | +25 | 0 | + 76 | + 50 | 25L | 76L |
| | | 76.2 | 127.0 | +25 | 0 | + 76 | + 50 | 25L | 76L |
| | | 127.0 | 304.8 | +25 | 0 | + 76 | + 50 | 25L | 76L |
| | | 304.8 | 609.6 | +51 | 0 | +152 | +102 | 51L | 152L |
| | | 609.6 | 914.4 | +76 | 0 | +229 | +152 | 76L | 229L |
| | Outer ring location in axial direction can be adjusted | — | 76.2 | +25 | 0 | + 25 | 0 | 25T | 25L |
| | | 76.2 | 127.0 | +25 | 0 | + 25 | 0 | 25T | 25L |
| | | 127.0 | 304.8 | +25 | 0 | + 51 | 0 | 25T | 51L |
| | | 304.8 | 609.6 | +51 | 0 | + 76 | + 26 | 25T | 76L |
| | | 609.6 | 914.4 | +76 | 0 | +127 | + 51 | 25T | 127L |
| | Outer ring location in axial direction can not be adjusted | — | 76.2 | +25 | 0 | — 13 | — 39 | 64T | 13T |
| | | 76.2 | 127.0 | +25 | 0 | — 25 | — 51 | 76T | 25T |
| | | 127.0 | 304.8 | +25 | 0 | — 25 | — 51 | 76T | 25T |
| | | 304.8 | 609.6 | +51 | 0 | — 25 | — 76 | 127T | 25T |
| | | 609.6 | 914.4 | +76 | 0 | — 25 | —102 | 178T | 25T |
| Rotating outer ring load | Outer ring location in axial direction can not be adjusted | — | 76.2 | +25 | 0 | — 13 | — 39 | 64T | 13T |
| | | 76.2 | 127.0 | +25 | 0 | — 25 | — 51 | 76T | 25T |
| | | 127.0 | 304.8 | +25 | 0 | — 25 | — 51 | 76T | 25T |
| | | 304.8 | 609.6 | +51 | 0 | — 25 | — 76 | 127T | 25T |
| | | 609.6 | 914.4 | +76 | 0 | — 25 | —102 | 178T | 25T |

Note: (1) T: Tight fit L: Loose fit

Table 8.9.2 For Bearings with ABMA Classes 3 and 0

 Unit: μm

| Operating conditions | | Bearing outside diameter Nominal D (mm) | | Bearing outside diameter deviation | | Housing bore diameter deviation | | Amounts ⁽¹⁾ | |
|-----------------------------------|--|--|-------|---------------------------------------|-----|------------------------------------|-----|------------------------|-----|
| | | Over | Incl. | High | Low | High | Low | Max | Min |
| Rotating inner ring load | Floating side | – | 152.4 | +13 | 0 | +38 | +26 | 13L | 38L |
| | | 152.4 | 304.8 | +13 | 0 | +38 | +26 | 13L | 38L |
| | | 304.8 | 609.6 | +25 | 0 | +64 | +38 | 13L | 64L |
| | | 609.6 | 914.4 | +38 | 0 | +89 | +51 | 13L | 89L |
| | Clamping side | – | 152.4 | +13 | 0 | +25 | +13 | 0 | 25L |
| | | 152.4 | 304.8 | +13 | 0 | +25 | +13 | 0 | 25L |
| | | 304.8 | 609.6 | +25 | 0 | +51 | +25 | 0 | 51L |
| | | 609.6 | 914.4 | +38 | 0 | +76 | +38 | 0 | 76L |
| | Outer ring location in axial direction can be adjusted | – | 152.4 | +13 | 0 | +13 | 0 | 13T | 13L |
| | | 152.4 | 304.8 | +13 | 0 | +25 | 0 | 13T | 25L |
| | | 304.8 | 609.6 | +25 | 0 | +25 | 0 | 25T | 25L |
| | | 609.6 | 914.4 | +38 | 0 | +38 | 0 | 38T | 38L |
| | Outer ring location in axial direction can not be adjusted | – | 152.4 | +13 | 0 | 0 | –12 | 25T | 0 |
| | | 152.4 | 304.8 | +13 | 0 | 0 | –25 | 38T | 0 |
| | | 304.8 | 609.6 | +25 | 0 | 0 | –26 | 51T | 0 |
| | | 609.6 | 914.4 | +38 | 0 | 0 | –38 | 76T | 0 |
| Rotating outer ring load | Normal load | – | 152.4 | +13 | 0 | –13 | –25 | 38T | 13T |
| | Outer ring location in axial direction can not be adjusted | 152.4 | 304.8 | +13 | 0 | –13 | –38 | 51T | 13T |
| | | 304.8 | 609.6 | +25 | 0 | –13 | –39 | 64T | 13T |
| | | 609.6 | 914.4 | +38 | 0 | –13 | –51 | 89T | 13T |

Note: (1) T: Tight fit L: Loose fit

(2) This tables is not applied to the bearing with tolerance class 0 whose bore diameter is over 304.8 mm.

Table 8.10 Amounts of Fits: Radial Bearings with Tolerance JIS Class 0 (ISO Normal Class)

Table 8.10.1 Inner Ring with Shaft

(1/2)

Unit: μm

| Nominal diameter (mm) | | Single plane mean bore diameter deviation of bearing Δd_{mp} | | Shaft with tolerance grade IT5 | | | | | | | | | |
|--------------------------|-------|--|-----|--------------------------------|-----|-------|-----|-------|-------|-------|-------|-------|-------|
| | | | | m5 | | k5 | | j5 | | h5 | | g5 | |
| | | | | Tight | | Tight | | Tight | Loose | Tight | Loose | Tight | Loose |
| | | | | Max | Min | Max | Min | Max | Max | Max | Max | Max | Max |
| Over | Incl. | High | Low | | | | | | | | | | |
| 3 | 6 | 0 | - 8 | - | - | - | - | 11 | 2 | 8 | 5 | 4 | 9 |
| 6 | 10 | 0 | - 8 | - | - | - | - | 12 | 2 | 8 | 6 | 3 | 11 |
| 10 | 18 | 0 | - 8 | - | - | 17 | 1 | 13 | 3 | 8 | 8 | 2 | 14 |
| 18 | 30 | 0 | -10 | - | - | 21 | 2 | 15 | 4 | 10 | 9 | 3 | 16 |
| 30 | 50 | 0 | -12 | 32 | 9 | 25 | 2 | 18 | 5 | 12 | 11 | 3 | 20 |
| 50 | 80 | 0 | -15 | 39 | 11 | 30 | 2 | 21 | 7 | 15 | 13 | 5 | 23 |
| 80 | 120 | 0 | -20 | 48 | 13 | 38 | 3 | 26 | 9 | 20 | 15 | 8 | 27 |
| 120 | 140 | | | | | | | | | | | | |
| 140 | 160 | 0 | -25 | 58 | 15 | 46 | 3 | - | - | 25 | 18 | 11 | 32 |
| 160 | 180 | | | | | | | | | | | | |
| 180 | 200 | | | | | | | | | | | | |
| 200 | 225 | 0 | -30 | 67 | 17 | 54 | 4 | - | - | 30 | 20 | 15 | 35 |
| 225 | 250 | | | | | | | | | | | | |
| 250 | 280 | | | | | | | | | | | | |
| 280 | 315 | 0 | -35 | - | - | - | - | - | - | 35 | 23 | 18 | 40 |
| 315 | 355 | | | | | | | | | | | | |
| 355 | 400 | 0 | -40 | - | - | - | - | - | - | 40 | 25 | 22 | 43 |
| 400 | 450 | | | | | | | | | | | | |
| 450 | 500 | 0 | -45 | - | - | - | - | - | - | 45 | 27 | 25 | 47 |





Table 8.10 Amounts of Fits: Radial Bearings with Tolerance JIS Class 0 (ISO Normal Class)

Table 8.10.1 Inner Ring with Shaft (2/2) Unit: μm

| Nominal diameter (mm) | | Shaft with tolerance grade IT6 | | | | | | | | | | | | | | | | |
|-----------------------------|-------|--------------------------------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-------|-------|-------|-------|-------|-----|
| | | r6 | | p6 | | n6 | | m6 | | k6 | | j6 | | h6 | | g6 | | |
| | | Tight | | Tight | | Tight | | Tight | | Tight | | Tight | Loose | Tight | Loose | Tight | Loose | |
| Over | Incl. | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Max | Max | Max | Max | Max | Max |
| 3 | 6 | — | — | — | — | — | — | — | — | — | — | 14 | 2 | 8 | 8 | 4 | 12 | |
| 6 | 10 | — | — | — | — | — | — | — | — | — | — | 15 | 2 | 8 | 9 | 3 | 14 | |
| 10 | 18 | — | — | — | — | — | — | — | — | 20 | 1 | 16 | 3 | 8 | 11 | 2 | 17 | |
| 18 | 30 | — | — | — | — | — | — | — | — | 25 | 2 | 19 | 4 | 10 | 13 | 3 | 20 | |
| 30 | 50 | — | — | — | — | 45 | 17 | 37 | 9 | 30 | 2 | 23 | 5 | 12 | 16 | 3 | 25 | |
| 50 | 80 | — | — | — | — | 54 | 20 | 45 | 11 | 36 | 2 | 27 | 7 | 15 | 19 | 5 | 29 | |
| 80 | 120 | — | — | 76 | 37 | 65 | 23 | 55 | 13 | 45 | 3 | 33 | 9 | 20 | 22 | 8 | 34 | |
| 120 | 140 | 113 | 63 | | | | | | | | | | | | | | | |
| 140 | 160 | 115 | 65 | 93 | 43 | 77 | 27 | 65 | 15 | 53 | 3 | 39 | 11 | 25 | 25 | 11 | 39 | |
| 160 | 180 | 118 | 68 | | | | | | | | | | | | | | | |
| 180 | 200 | 136 | 77 | | | | | | | | | | | | | | | |
| 200 | 225 | 139 | 80 | 109 | 50 | 90 | 31 | 76 | 17 | 63 | 4 | 46 | 13 | 30 | 29 | 15 | 44 | |
| 225 | 250 | 143 | 84 | | | | | | | | | | | | | | | |
| 250 | 280 | 161 | 94 | 123 | 56 | — | — | — | — | — | — | 51 | 16 | 35 | 32 | 18 | 49 | |
| 280 | 315 | 165 | 98 | | | | | | | | | | | | | | | |
| 315 | 355 | 184 | 108 | 138 | 62 | — | — | — | — | — | — | 58 | 18 | 40 | 36 | 22 | 54 | |
| 355 | 400 | 190 | 114 | | | | | | | | | | | | | | | |
| 400 | 450 | 211 | 126 | — | — | — | — | — | — | — | — | 65 | 20 | 45 | 40 | 26 | 60 | |
| 450 | 500 | 217 | 132 | | | | | | | | | | | | | | | |

Table 8.10 Amounts of Fits: Radial Bearings with Tolerance JIS Class 0 (ISO Normal Class)

Table 8.10.2 Outer Ring with Housing

(1/2)

Unit: μm

| Nominal diameter (mm) | | Single plane mean outside diameter deviation of bearing ΔD_{mp} | | Housing with tolerance grade IT6 | | | | | |
|-----------------------------|-------|--|-----|----------------------------------|-------|-------|-------|-------|-------|
| | | | | K6 | | J6 | | H6 | |
| | | | | Tight | Loose | Tight | Loose | Tight | Loose |
| Over | Incl. | High | Low | Max | Max | Max | Max | Max | Max |
| 6 | 10 | 0 | − 8 | 7 | 10 | 4 | 13 | 0 | 17 |
| 10 | 18 | 0 | − 8 | 9 | 10 | 5 | 14 | 0 | 19 |
| 18 | 30 | 0 | − 8 | 11 | 11 | 5 | 17 | 0 | 22 |
| 30 | 50 | 0 | −11 | 13 | 14 | 6 | 21 | 0 | 27 |
| 50 | 80 | 0 | −13 | 15 | 17 | 6 | 26 | 0 | 32 |
| 80 | 120 | 0 | −15 | 18 | 19 | 6 | 31 | 0 | 37 |
| 120 | 150 | 0 | −18 | 21 | 22 | 7 | 36 | 0 | 43 |
| 150 | 180 | 0 | −25 | 21 | 29 | 7 | 43 | 0 | 50 |
| 180 | 250 | 0 | −30 | 24 | 35 | 7 | 52 | 0 | 59 |
| 250 | 315 | 0 | −35 | 27 | 40 | 7 | 60 | 0 | 67 |
| 315 | 400 | 0 | −40 | 29 | 47 | 7 | 69 | 0 | 76 |
| 400 | 500 | 0 | −45 | 32 | 53 | 7 | 78 | 0 | 85 |



Table 8.10 Amounts of Fits: Radial Bearings with Tolerance JIS Class 0 (ISO Normal Class)



Table 8.10.2 Outer Ring with Housing

(2/2)

Unit: μm

| Nominal diameter (mm) | | Housing with tolerance grade IT7 | | | | | | | | | | | | | |
|-----------------------|-------|----------------------------------|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-----|
| | | P7 | | N7 | | M7 | | K7 | | J7 | | H7 | | G7 | |
| | | Tight | | Tight | Loose | Tight | Loose | Tight | Loose | Tight | Loose | Tight | Loose | Loose | |
| Over | Incl. | Max | Min | Max | Max | Max | Max | Max | Max | Max | Max | Max | Max | Min | Max |
| 6 | 10 | 24 | 1 | 19 | 4 | 15 | 8 | 10 | 13 | 7 | 16 | 0 | 23 | 5 | 28 |
| 10 | 18 | 29 | 3 | 23 | 3 | 18 | 8 | 12 | 14 | 8 | 18 | 0 | 26 | 6 | 32 |
| 18 | 30 | 35 | 5 | 28 | 2 | 21 | 9 | 15 | 15 | 9 | 21 | 0 | 30 | 7 | 37 |
| 30 | 50 | 42 | 6 | 33 | 3 | 25 | 11 | 18 | 18 | 11 | 25 | 0 | 36 | 9 | 45 |
| 50 | 80 | 51 | 8 | 39 | 4 | 30 | 13 | 21 | 22 | 12 | 31 | 0 | 43 | 10 | 53 |
| 80 | 120 | 59 | 9 | 45 | 5 | 35 | 15 | 25 | 25 | 13 | 37 | 0 | 50 | 12 | 62 |
| 120 | 150 | 68 | 10 | 52 | 6 | 40 | 18 | 28 | 30 | 14 | 44 | 0 | 58 | 14 | 72 |
| 150 | 180 | 68 | 3 | 60 | 13 | 40 | 25 | 28 | 37 | 14 | 51 | 0 | 65 | 14 | 79 |
| 180 | 250 | 79 | 3 | 60 | 16 | 46 | 30 | 33 | 43 | 16 | 60 | 0 | 76 | 15 | 91 |
| 250 | 315 | 88 | 1 | 66 | 21 | 52 | 35 | 36 | 51 | 16 | 71 | 0 | 87 | 17 | 104 |
| 315 | 400 | 98 | 1 | 73 | 24 | 57 | 40 | 40 | 57 | 18 | 79 | 0 | 97 | 18 | 115 |
| 400 | 500 | 108 | 0 | 80 | 28 | 63 | 45 | 45 | 63 | 20 | 88 | 0 | 108 | 20 | 128 |

Table 8.11 Amounts of Fits: Radial Bearings with Tolerance JIS (ISO) Class 6

Table 8.11.1 Inner Ring with Shaft

(1/2)

Unit: μm

| Nominal diameter (mm) | | Single plane mean bore diameter deviation of bearing Δd_{mp} | | Shaft with tolerance grade IT5 | | | | | | | | | |
|--------------------------|-------|---|-----|--------------------------------|-----|-------|-----|-------|-------|-------|-------|-------|-------|
| | | | | m5 | | k5 | | j5 | | h5 | | g5 | |
| | | | | Tight | | Tight | | Tight | Loose | Tight | Loose | Tight | Loose |
| | | | | Max | Min | Max | Min | Max | Max | Max | Max | Max | Max |
| Over | Incl. | High | Low | | | | | | | | | | |
| 3 | 6 | 0 | - 7 | - | - | - | - | 10 | 2 | 7 | 5 | 3 | 9 |
| 6 | 10 | 0 | - 7 | - | - | - | - | 11 | 2 | 7 | 6 | 2 | 11 |
| 10 | 18 | 0 | - 7 | - | - | 16 | 1 | 12 | 3 | 7 | 8 | 1 | 14 |
| 18 | 30 | 0 | - 8 | - | - | 19 | 2 | 13 | 4 | 8 | 9 | 1 | 16 |
| 30 | 50 | 0 | -10 | 30 | 9 | 23 | 2 | 16 | 5 | 10 | 11 | 1 | 20 |
| 50 | 80 | 0 | -12 | 36 | 11 | 27 | 2 | 18 | 7 | 12 | 13 | 2 | 23 |
| 80 | 120 | 0 | -15 | 43 | 13 | 33 | 3 | 21 | 9 | 15 | 15 | 3 | 27 |
| 120 | 140 | 0 | -18 | 51 | 15 | 39 | 3 | - | - | 18 | 18 | 4 | 32 |
| 140 | 160 | | | | | | | | | | | | |
| 160 | 180 | | | | | | | | | | | | |
| 180 | 200 | 0 | -22 | 59 | 17 | 46 | 4 | - | - | 22 | 20 | 7 | 35 |
| 200 | 225 | | | | | | | | | | | | |
| 225 | 250 | | | | | | | | | | | | |





Table 8.11 Amounts of Fits: Radial Bearings with Tolerance JIS (ISO) Class 6

Table 8.11.1 Inner Ring with Shaft (2/2) Unit: μm

| Nominal diameter (mm) | | Shaft with tolerance grade IT6 | | | | | | | | | | | | | | | |
|-----------------------|-------|--------------------------------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-------|-------|-------|-------|-------|
| | | r6 | | p6 | | n6 | | m6 | | k6 | | j6 | | h6 | | g6 | |
| | | Tight | | Tight | | Tight | | Tight | | Tight | | Tight | Loose | Tight | Loose | Tight | Loose |
| Over | Incl. | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Max | Max | Max | Max | Max |
| 3 | 6 | — | — | — | — | — | — | — | — | — | — | 13 | 2 | 7 | 8 | 3 | 12 |
| 6 | 10 | — | — | — | — | — | — | — | — | — | — | 14 | 2 | 7 | 9 | 2 | 14 |
| 10 | 18 | — | — | — | — | — | — | — | — | 19 | 1 | 15 | 3 | 7 | 11 | 1 | 17 |
| 18 | 30 | — | — | — | — | — | — | — | — | 23 | 2 | 17 | 4 | 8 | 13 | 1 | 20 |
| 30 | 50 | — | — | — | — | 43 | 17 | 35 | 9 | 28 | 2 | 21 | 5 | 10 | 16 | 1 | 25 |
| 50 | 80 | — | — | — | — | 51 | 20 | 42 | 11 | 33 | 2 | 24 | 7 | 12 | 19 | 2 | 29 |
| 80 | 120 | — | — | 74 | 37 | 60 | 23 | 50 | 13 | 40 | 3 | 28 | 9 | 15 | 22 | 3 | 34 |
| 120 | 140 | 106 | 63 | 86 | 43 | 70 | 27 | 58 | 15 | 46 | 3 | 32 | 11 | 18 | 25 | 4 | 39 |
| 140 | 160 | 108 | 65 | | | | | | | | | | | | | | |
| 160 | 180 | 111 | 68 | | | | | | | | | | | | | | |
| 180 | 200 | 128 | 77 | 101 | 50 | 82 | 31 | 68 | 17 | 55 | 4 | 38 | 13 | 22 | 29 | 7 | 44 |
| 200 | 225 | 131 | 80 | | | | | | | | | | | | | | |
| 225 | 250 | 135 | 84 | | | | | | | | | | | | | | |

Table 8.11 Amounts of Fits: Radial Bearings with Tolerance JIS (ISO) Class 6

Table 8.11.2 Outer Ring with Housing (1/2) Unit: μm

| Nominal diameter (mm) | | Single plane mean outside diameter deviation of bearing ΔD_{mp} | | Housing with tolerance grade IT6 | | | | | |
|--------------------------|-------|---|-----|----------------------------------|-------|-------|-------|-------|-------|
| | | | | K6 | | J6 | | H6 | |
| | | | | Tight | Loose | Tight | Loose | Tight | Loose |
| Over | Incl. | High | Low | Max | Max | Max | Max | Max | Max |
| 6 | 10 | 0 | − 7 | 7 | 9 | 4 | 12 | 0 | 16 |
| 10 | 18 | 0 | − 7 | 9 | 9 | 5 | 13 | 0 | 18 |
| 18 | 30 | 0 | − 8 | 11 | 10 | 5 | 16 | 0 | 21 |
| 30 | 50 | 0 | − 9 | 13 | 12 | 6 | 19 | 0 | 25 |
| 50 | 80 | 0 | −11 | 15 | 15 | 6 | 24 | 0 | 30 |
| 80 | 120 | 0 | −13 | 18 | 17 | 6 | 29 | 0 | 35 |
| 120 | 150 | 0 | −15 | 21 | 19 | 7 | 33 | 0 | 40 |
| 150 | 180 | 0 | −18 | 21 | 22 | 7 | 36 | 0 | 43 |
| 180 | 250 | 0 | −20 | 24 | 25 | 7 | 42 | 0 | 49 |
| 250 | 315 | 0 | −25 | 27 | 30 | 7 | 50 | 0 | 57 |
| 315 | 400 | 0 | −28 | 29 | 35 | 7 | 57 | 0 | 64 |



Table 8.11 Amounts of Fits: Radial Bearings with Tolerance JIS (ISO) Class 6



Table 8.11.2 Outer Ring with Housing

(2/2)

Unit: μm

| Nominal diameter (mm) | | Housing with tolerance grade IT7 | | | | | | | | | | | | | |
|--------------------------|-------|----------------------------------|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-----|
| | | P7 | | N7 | | M7 | | K7 | | J7 | | H7 | | G7 | |
| | | Tight | | Tight | Loose | Tight | Loose | Tight | Loose | Tight | Loose | Tight | Loose | Loose | |
| | | Max | Min | Max | Max | Max | Max | Max | Max | Max | Max | Max | Max | Min | Max |
| Over | Incl. | | | | | | | | | | | | | | |
| 6 | 10 | 24 | 2 | 19 | 3 | 15 | 7 | 10 | 12 | 7 | 15 | 0 | 22 | 5 | 27 |
| 10 | 18 | 29 | 4 | 23 | 2 | 18 | 7 | 12 | 13 | 8 | 17 | 0 | 25 | 6 | 31 |
| 18 | 30 | 35 | 6 | 28 | 1 | 21 | 8 | 15 | 14 | 9 | 20 | 0 | 29 | 7 | 36 |
| 30 | 50 | 42 | 8 | 33 | 1 | 25 | 9 | 18 | 16 | 11 | 23 | 0 | 34 | 9 | 43 |
| 50 | 80 | 51 | 10 | 39 | 2 | 30 | 11 | 21 | 20 | 12 | 29 | 0 | 41 | 10 | 51 |
| 80 | 120 | 59 | 11 | 45 | 3 | 35 | 13 | 25 | 23 | 13 | 35 | 0 | 48 | 12 | 60 |
| 120 | 150 | 68 | 13 | 52 | 3 | 40 | 15 | 28 | 27 | 14 | 41 | 0 | 55 | 14 | 69 |
| 150 | 180 | 68 | 10 | 60 | 6 | 40 | 18 | 28 | 30 | 14 | 44 | 0 | 58 | 14 | 72 |
| 180 | 250 | 79 | 13 | 60 | 6 | 46 | 20 | 33 | 33 | 16 | 50 | 0 | 66 | 15 | 81 |
| 250 | 315 | 88 | 11 | 66 | 11 | 52 | 25 | 36 | 41 | 16 | 61 | 0 | 77 | 17 | 94 |
| 315 | 400 | 98 | 13 | 73 | 12 | 57 | 28 | 40 | 45 | 18 | 67 | 0 | 85 | 18 | 103 |

Table 8.12 Amounts of Fits: Radial Bearings with Tolerance JIS (ISO) Class 5

Table 8.12.1 Inner Ring with Shaft

Unit: μm

| Nominal diameter (mm) | | Single plane mean bore diameter deviation of bearing Δd_{mp} | | Shaft with tolerance grade IT4 | | | | | | | | Shaft with tolerance grade IT5 | | | |
|-----------------------|-------|--|-----|--------------------------------|-----|-------|-----|-------|-------|-------|-------|--------------------------------|-----|-------|-------|
| | | | | m4 | | k4 | | js4 | | h4 | | m5 | | h5 | |
| | | | | Tight | | Tight | | Tight | Loose | Tight | Loose | Tight | | Tight | Loose |
| Over | Incl. | High | Low | Max | Min | Max | Min | Max | Max | Max | Max | Max | Min | Max | Max |
| 3 | 6 | 0 | − 5 | 13 | 4 | 10 | 1 | 7 | 2 | 5 | 4 | 14 | 4 | 5 | 5 |
| 6 | 10 | 0 | − 5 | 15 | 6 | 10 | 1 | 7 | 2 | 5 | 4 | 17 | 6 | 5 | 6 |
| 10 | 18 | 0 | − 5 | 17 | 7 | 11 | 1 | 7.5 | 2.5 | 5 | 5 | 20 | 7 | 5 | 8 |
| 18 | 30 | 0 | − 6 | 20 | 8 | 14 | 2 | 9 | 3 | 6 | 6 | 23 | 8 | 6 | 9 |
| 30 | 50 | 0 | − 8 | 24 | 9 | 17 | 2 | 11.5 | 3.5 | 8 | 7 | 28 | 9 | 8 | 11 |
| 50 | 80 | 0 | − 9 | 28 | 11 | 19 | 2 | 13 | 4 | 9 | 8 | 33 | 11 | 9 | 13 |
| 80 | 120 | 0 | −10 | 33 | 13 | 23 | 3 | 15 | 5 | 10 | 10 | 38 | 13 | 10 | 15 |
| 120 | 180 | 0 | −13 | 40 | 15 | 28 | 3 | 19 | 6 | 13 | 12 | 46 | 15 | 13 | 18 |
| 180 | 250 | 0 | −15 | 46 | 17 | 33 | 4 | 22 | 7 | 15 | 14 | 52 | 17 | 15 | 20 |

Table 8.12 Amounts of Fits: Radial Bearings with Tolerance JIS (ISO) Class 5

Table 8.12.2 Outer Ring with Housing

Unit: μm

| Nominal diameter (mm) | | Single plane mean outside diameter deviation of bearing ΔD_{mp} | | Housing with tolerance grade IT5 | | | | | | | |
|-----------------------|-------|---|-----|----------------------------------|-------|-------|-------|-------|-------|-------|-------|
| | | | | M5 | | K5 | | Js5 | | H5 | |
| | | | | Tight | Loose | Tight | Loose | Tight | Loose | Tight | Loose |
| | | | | Max | Max | Max | Max | Max | Max | Max | Max |
| Over | Incl. | High | Low | Max | Max | Max | Max | Max | Max | Max | Max |
| 6 | 10 | 0 | − 5 | 10 | 1 | 5 | 6 | 3 | 8 | 0 | 11 |
| 10 | 18 | 0 | − 5 | 12 | 1 | 6 | 7 | 4 | 9 | 0 | 13 |
| 18 | 30 | 0 | − 6 | 14 | 1 | 8 | 7 | 4.5 | 10.5 | 0 | 15 |
| 30 | 50 | 0 | − 7 | 16 | 2 | 9 | 9 | 5.5 | 12.5 | 0 | 18 |
| 50 | 80 | 0 | − 9 | 19 | 3 | 10 | 12 | 6.5 | 15.5 | 0 | 22 |
| 80 | 120 | 0 | −10 | 23 | 2 | 13 | 12 | 7.5 | 17.5 | 0 | 25 |
| 120 | 150 | 0 | −11 | 27 | 2 | 15 | 14 | 9 | 20 | 0 | 29 |
| 150 | 180 | 0 | −13 | 27 | 4 | 15 | 16 | 9 | 22 | 0 | 31 |
| 180 | 250 | 0 | −15 | 31 | 4 | 18 | 17 | 10 | 25 | 0 | 35 |
| 250 | 315 | 0 | −18 | 36 | 5 | 20 | 21 | 11.5 | 29.5 | 0 | 41 |
| 315 | 400 | 0 | −20 | 39 | 6 | 22 | 23 | 12.5 | 32.5 | 0 | 45 |

Table 8.13 Amounts of Fits: Radial Bearings with Tolerance JIS (ISO) Class 4

Table 8.13.1 Inner Ring with Shaft

Unit: μm

| Nominal diameter (mm) | | Single plane mean bore diameter deviation of bearing Δd_{mp} | | Shaft with tolerance grade IT4 | | | | | | | | Shaft with tolerance grade IT5 | | | |
|-----------------------|-------|--|-----|--------------------------------|-----|-------|-----|-------|-------|-------|-------|--------------------------------|-----|-------|-------|
| | | | | m4 | | k4 | | js4 | | h4 | | m5 | | h5 | |
| | | | | Tight | | Tight | | Tight | Loose | Tight | Loose | Tight | | Tight | Loose |
| Over | Incl. | High | Low | Max | Min | Max | Min | Max | Max | Max | Max | Max | Min | Max | Max |
| 3 | 6 | 0 | - 4 | 12 | 4 | 9 | 1 | 6 | 2 | 4 | 4 | 13 | 4 | 4 | 5 |
| 6 | 10 | 0 | - 4 | 14 | 6 | 9 | 1 | 6 | 2 | 4 | 4 | 16 | 6 | 4 | 6 |
| 10 | 18 | 0 | - 4 | 16 | 7 | 10 | 1 | 6.5 | 2.5 | 4 | 5 | 19 | 7 | 4 | 8 |
| 18 | 30 | 0 | - 5 | 19 | 8 | 13 | 2 | 8 | 3 | 5 | 6 | 22 | 8 | 5 | 9 |
| 30 | 50 | 0 | - 6 | 22 | 9 | 15 | 2 | 9.5 | 3.5 | 6 | 7 | 26 | 9 | 6 | 11 |
| 50 | 80 | 0 | - 7 | 26 | 11 | 17 | 2 | 11 | 4 | 7 | 8 | 31 | 11 | 7 | 13 |
| 80 | 120 | 0 | - 8 | 31 | 13 | 21 | 3 | 13 | 5 | 8 | 10 | 36 | 13 | 8 | 15 |
| 120 | 180 | 0 | 10 | 37 | 15 | 25 | 3 | 16 | 6 | 10 | 12 | 43 | 15 | 10 | 18 |
| 180 | 250 | 0 | -12 | 43 | 17 | 30 | 4 | 19 | 7 | 12 | 14 | 49 | 17 | 12 | 20 |

Table 8.13 Amounts of Fits: Radial Bearings with Tolerance JIS (ISO) Class 4

Table 8.13.2 Outer Ring with Housing

Unit: μm

| Nominal diameter (mm) | | Single plane mean outside diameter deviation of bearing ΔD_{mp} | | Housing with tolerance grade IT5 | | | | | | | |
|-----------------------|-------|---|-----|----------------------------------|-------|-------|-------|-------|-------|-------|-------|
| | | | | M5 | | K5 | | Js5 | | H5 | |
| | | | | Tight | Loose | Tight | Loose | Tight | Loose | Tight | Loose |
| Over | Incl. | High | Low | Max | Max | Max | Max | Max | Max | Max | Max |
| 6 | 10 | 0 | − 4 | 10 | 0 | 5 | 5 | 3 | 7 | 0 | 10 |
| 10 | 18 | 0 | − 4 | 12 | 0 | 6 | 6 | 4 | 8 | 0 | 12 |
| 18 | 30 | 0 | − 5 | 14 | 0 | 8 | 6 | 4.5 | 9.5 | 0 | 14 |
| 30 | 50 | 0 | − 6 | 16 | 1 | 9 | 8 | 5.5 | 11.5 | 0 | 17 |
| 50 | 80 | 0 | − 7 | 19 | 1 | 10 | 10 | 6.5 | 13.5 | 0 | 20 |
| 80 | 120 | 0 | − 8 | 23 | 0 | 13 | 10 | 7.5 | 15.5 | 0 | 23 |
| 120 | 150 | 0 | − 9 | 27 | 0 | 15 | 12 | 9 | 18 | 0 | 27 |
| 150 | 180 | 0 | −10 | 27 | 1 | 15 | 13 | 9 | 19 | 0 | 28 |
| 180 | 250 | 0 | −11 | 31 | 0 | 18 | 13 | 10 | 21 | 0 | 31 |
| 250 | 315 | 0 | −13 | 36 | 0 | 20 | 16 | 11.5 | 24.5 | 0 | 36 |
| 315 | 400 | 0 | −15 | 39 | 1 | 22 | 18 | 12.5 | 27.5 | 0 | 40 |

Table 8.14 Amounts of Fits: Thrust Bearings with Tolerance JIS (ISO) Class 0

Table 8.14.1 Shaft Washer or Center Washer with Shaft

Unit: μm

| Nominal diameter (mm) | | Single plane mean bore diameter deviation of bearing Δd_{mp} | | Shaft with tolerance grade IT6 | | | | | | | |
|-----------------------|-------|--|-----|--------------------------------|-----|-------|-----|-------|-----|-------|-------|
| | | | | n6 | | m6 | | k6 | | j6 | |
| | | | | Tight | | Tight | | Tight | | Tight | Loose |
| | | | | Max | Min | Max | Min | Max | Min | Max | Max |
| Over | Incl. | High | Low | | | | | | | | |
| 6 | 10 | 0 | − 8 | − | − | − | − | 18 | 1 | 15 | 2 |
| 10 | 18 | 0 | − 8 | − | − | − | − | 20 | 1 | 16 | 3 |
| 18 | 30 | 0 | −10 | − | − | − | − | 25 | 2 | 19 | 4 |
| 30 | 50 | 0 | −12 | − | − | − | − | 30 | 2 | 23 | 5 |
| 50 | 80 | 0 | −15 | − | − | − | − | 36 | 2 | 27 | 7 |
| 80 | 120 | 0 | −20 | − | − | − | − | 45 | 3 | 33 | 9 |
| 120 | 180 | 0 | −25 | − | − | − | − | 53 | 3 | 39 | 11 |
| 180 | 250 | 0 | −30 | − | − | 76 | 17 | 63 | 4 | 46 | 13 |
| 250 | 315 | 0 | −35 | − | − | 87 | 20 | − | − | 51 | 16 |
| 315 | 400 | 0 | −40 | − | − | 97 | 21 | − | − | 58 | 18 |
| 400 | 500 | 0 | −45 | 125 | 40 | − | − | − | − | 65 | 20 |

Table 8.14 Amounts of Fits: Thrust Bearings with Tolerance JIS (ISO) Class 0

Table 8.14.2 Housing Washer with Housing

Unit: μm

| Nominal diameter (mm) | | Single plane mean outside diameter deviation of bearing ΔD_{mp} | | Housing with tolerance grade IT7 | | | |
|-----------------------|-------|---|-----|----------------------------------|-------|-------|-------|
| | | | | M7 | | H7 | |
| | | | | Tight | Loose | Tight | Loose |
| Over | Incl. | High | Low | Max | Max | Max | Max |
| 10 | 18 | 0 | -11 | 18 | 11 | 0 | 29 |
| 18 | 30 | 0 | -13 | 21 | 13 | 0 | 34 |
| 30 | 50 | 0 | -16 | 25 | 16 | 0 | 41 |
| 50 | 80 | 0 | -19 | 30 | 19 | 0 | 49 |
| 80 | 120 | 0 | -22 | 35 | 22 | 0 | 57 |
| 120 | 180 | 0 | -25 | 40 | 25 | 0 | 65 |
| 180 | 250 | 0 | -30 | 46 | 30 | 0 | 76 |
| 250 | 315 | 0 | -35 | 52 | 35 | 0 | 87 |
| 315 | 400 | 0 | -40 | 57 | 40 | 0 | 97 |
| 400 | 500 | 0 | -45 | 63 | 45 | 0 | 108 |

8.1.3 Calculating Fits

The fits for bearings are often determined empirically according to [Table 8.1 through Table 8.14](#). These tables are NOT to be used for the following cases:

- If special materials are used for interfaces.
- If a hollow shaft is used.
- For high-precision applications.

(1) Reduction of Interference due to Bearing Load

When load is applied through a rotating inner ring, the ring will deform slightly and a gap will occur between the ring and the shaft at a position 180° from the point of load. This gap and “arc-of-no-contact” will increase as the load becomes heavier. A gearing effect will also occur due to the difference in diameters of rotation of the interfacing parts.

Formula (8.1) and Fig. 8.1 define the reduction (millimeters) in interference fit of the inner ring due to bearing load.

where:

$$\Delta dF = 0.08 \times 10^{-3} \sqrt{\frac{d}{B}} F_r \quad \dots\dots\dots (8.1)$$

| | |
|-------------|--|
| ΔdF | : Reduction in interference of inner ring fit due to bearing load (mm) |
| d | : Bearing bore (shaft diameter) (mm) |
| B | : Bearing inner ring width (mm) |
| F_r | : Radial load on the bearing (N) |

If the radial load is greater than 20% of the basic static load rating C_{or} , Formula (8.2) is to be used.

$$\Delta dF \geq 0.02 \times 10^{-3} \frac{F_r}{B} \quad \dots\dots\dots (8.2)$$

Calculation example: 6

Object: to obtain the amount of reduction in interference from bearing load where F_r on a single-row, Deep-groove ball bearing number 6320 is 21000N.

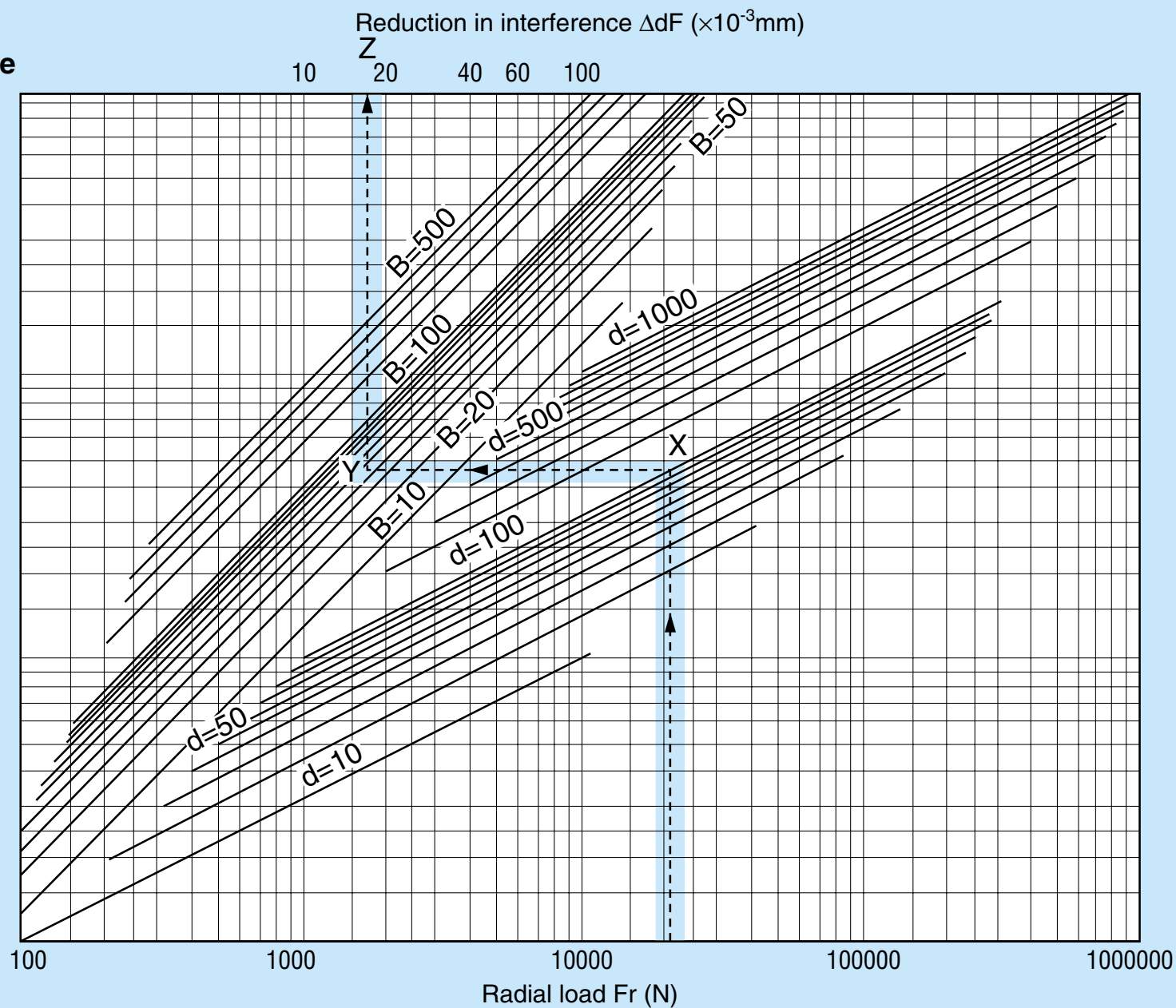
From the dimensional tables, $d=100$ mm, $B=47$ mm. From Fig. 8.1;

- Find 21000 on the line of F_r . Move vertically and intersect the line of $d=100$ (at point X).
- From the point X, move parallel with line F_r and intersect the line of $B=47$ (at point Y).
- Extend vertically from point Y. The intercept with the chart upper limit at point Z indicates the reduction dF (mm) of interference. In this case, $\Delta dF_{loss}=0.017$ (mm).

Fig. 8.1 Change in interference due to load

[→Continue]

Fig. 8.1
Change in interference
due to load





(2) Reduction in Interference due to temperature difference

Operating temperature differences will generally exist between the inner ring and shaft or the outer ring and bearing housing. Fits must be adjusted for differences of thermal expansion coefficients in the mating materials.

- If the bearing temperature is higher than that of the shaft, increase the fit.
- If heat is transferred through the shaft, the fit becomes tighter due to thermal expansion of the shaft. In such cases, increase the radial internal clearance of the bearing.
- When the outer ring temperature is higher than the housing, reduce the fit with the housing and the radial internal clearance of the bearing.
- If the housing temperature is hotter than the bearing outer ring, check the rates of thermal expansion. It will probably be necessary to increase the fit due to larger growth of the housing bore.

Reduction of interference fit of the inner ring due to temperature differentials can be calculated using Formula (8.3) and Fig. 8.2.

$$\Delta dT = 0.0015 \Delta T \cdot d \cdot 10^{-3} \quad \dots \dots (8.3)$$

where:

ΔdT : Reduction in interference of inner ring fit due to temperature difference (mm)

ΔT : Temperature difference between bearing and housing ambient (°C)

d : Bearing bore (shaft diameter) (mm)

Calculation example: 7

Obtain the reduction in interference for a temperature difference of 20°C existing between housing ambient temperature and internal temperature of a bearing with a bore diameter of 100 mm. From Fig. 8.2.

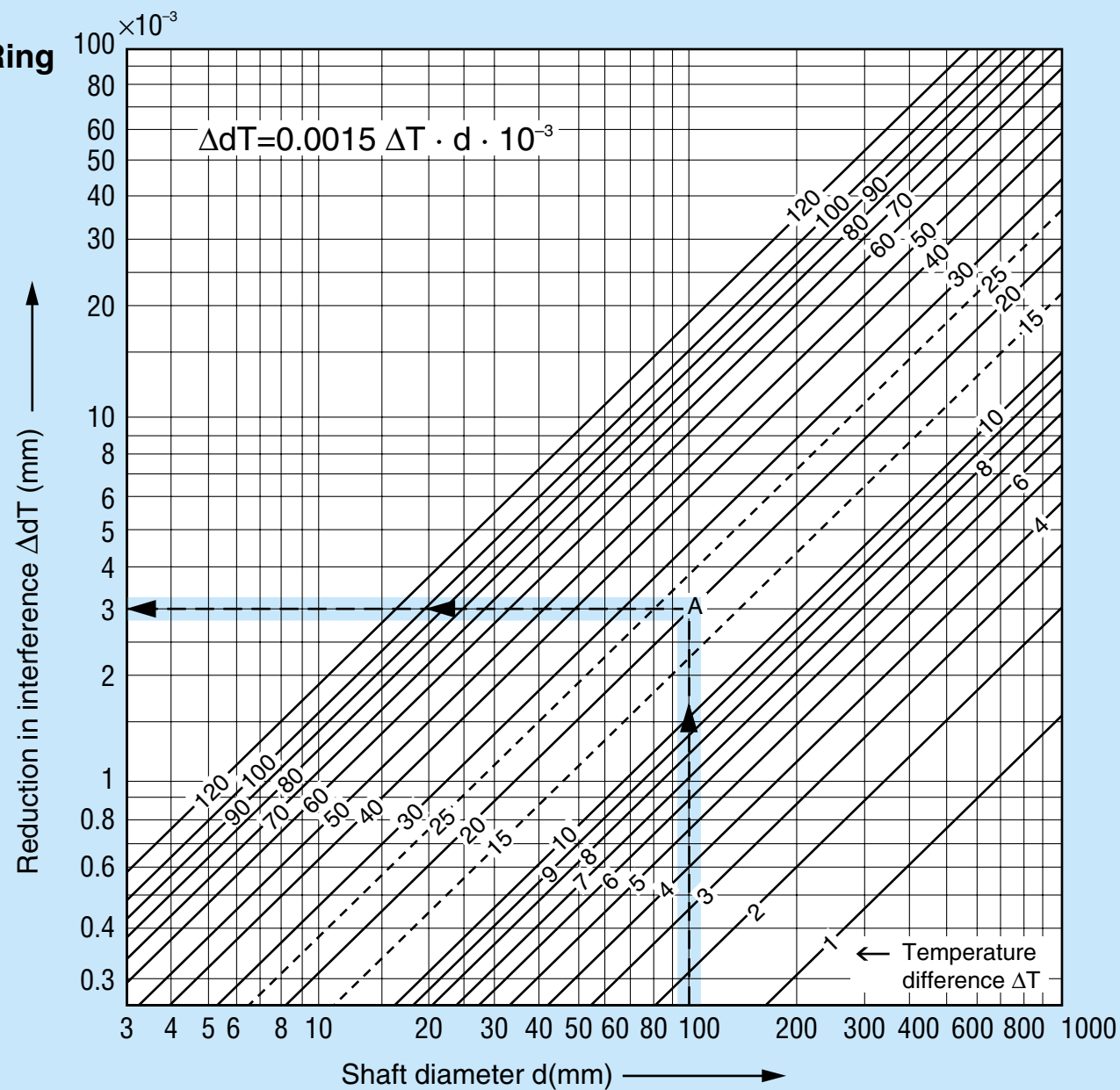
(a) Find the bore diameter $d=100$ on the horizontal axis. Draw a vertical line from the point until it intersects the line of temperature difference of 20 °C at point A.

(b) Extend a line horizontally from point A left to the Y-axis. The reduction in interference can be read from the intersection with the vertical axis as $\Delta dT=0.003\text{mm}$.

Fig. 8.2 Reduction in Interference of Inner Ring Due to Temperature Difference



Fig. 8.2
Reduction in Interference of Inner Ring
Due to Temperature Difference





(3) Surface Finish Effects on Interference

Since surface asperities are subjected to smoothing when bearings are press-fit, the effective fit becomes smaller than the calculated fit. The amount of reduction in fit is dependent on the surface finish of the interfacing materials.

Effective fit of the inner ring to a solid shaft is calculated using Formulas (8.4.1), and (8.4.2).

For ground and polished shafts,

$$\Delta d_e = \frac{d}{d+2} \Delta d_a \quad \dots\dots\dots (8.4.1)$$

where:

Δd_e : Effective interference (mm)
 Δd_a : Calculated interference (mm)
 d : Bearing bore diameter (mm)

For machined shafts,

$$\Delta d_e = \frac{d}{d+3} \Delta d_a \quad \dots\dots\dots (8.4.2)$$

(4) Necessary Interference for Inner Rings

Formulas (8.1), (8.2), (8.3), (8.4.1) and (8.4.2) have been used to calculate the effects of Load, Temperature, and Surface Finish in interference. To summarize the effects to a total required interference for the inner ring and shaft (where inner ring rotates against load), refer to Formulas (8.5.1) and (8.5.2).

For ground and polished shafts,

$$\Delta d_a \geq (\Delta d_F + \Delta d_T) \left(\frac{d+2}{d} \right) \quad \dots\dots\dots (8.5.1)$$

For machined shafts,

$$\Delta d_a \geq (\Delta d_F + \Delta d_T) \left(\frac{d+3}{d} \right) \quad \dots\dots\dots (8.5.2)$$



(5) Expansion Stress from Fits

When interference is provided, the bearing ring undergoes tensile stress. If the stress is excessive, the bearing ring will be damaged. When an inner ring is fitted to a solid steel shaft, stress, σ_i , should be limited to 100MPa or smaller using Formula (8.6). Empirically, the criterion of interference 0.001 of shaft diameter,

$$\sigma_i = \frac{E}{2} \cdot \frac{\Delta d_e}{d} \left\{ 1 + \left(\frac{d}{d_i} \right)^2 \right\} \dots\dots\dots (8.6)$$

where:

σ_i : Maximum bore diameter surface stress (MPa)
 E : Vertical elastic coefficient for steel: 2.07×10^5 (MPa)
 Δd_e : Effective interference (mm)
 d : Bearing bore diameter (mm)
 d_i : Mean outside diameter of inner ring (mm)

Cylindrical roller bearings; and Self-aligning ball bearings
of series 22 and 23:

$$d_i \doteq 0.25(D+3d)$$

where:

D : Bearing outside diameter (mm)

All other bearings:

$$d_i \doteq 0.1(3D+7d)$$

(6) Fits for Inner Rings with Hollow Shafts

Equivalent effective fit for a hollow shaft.

(a) Calculate the interference, Δd_a for a solid shaft of the identical diameter inner ring with either Table 8.4 or Formulas (8.5.1) and (8.5.2).

(b) Calculate interference Δd_{ha} for a hollow shaft and inner ring with Formula (8.7).

$$\Delta d_{ha} = \frac{1 - \left(\frac{d_h}{d_i} \right)^2}{1 - \left(\frac{d_h}{d} \right)^2} \Delta d_a \dots\dots\dots (8.7)$$

where:

Δd_{ha} : Calculated interference of hollow shaft (mm)
 d_h : Bore diameter of hollow shaft (mm). For solid shaft, $d_h=0$
 d : bearing bore diameter (mm)
 Δd_a : Calculated interference of solid shaft and inner ring (mm)

(c) Expansion stress force from fits for hollow steel shaft is calculated using Formula (8.8).

$$\sigma_i = \frac{E}{2} \cdot \frac{\Delta d_e}{d} \cdot \frac{\left\{ 1 - \left(\frac{d_h}{d} \right)^2 \right\} \left\{ 1 + \left(\frac{d}{d_i} \right)^2 \right\}}{\left\{ 1 - \left(\frac{d_h}{d_i} \right)^2 \right\}} \dots\dots\dots (8.8)$$

(7) Outer Ring to Housing Fits

Interference fit must be provided between the outer ring and housing where there is rotating outer ring load or indeterminate load. Fits for outer ring and steel housing can be obtained by using Table 8.6 and maximum stress of the outer ring can be calculated with Formula (8.9).

$$\sigma_o = \frac{E}{2} \cdot \frac{\Delta D_e}{D} \cdot \frac{1 - \left(\frac{D}{D_h}\right)^2}{1 - \left(\frac{D_e}{D_h}\right)^2} \dots\dots\dots (8.9)$$

where:

- σ_o : Maximum outer ring bore surface stress (MPa)
- E : Vertical elastic coefficient for steel: 2.07×10^5 (MPa)
- ΔD_e : Effective interference (mm)
- D : Bearing outside diameter (mm)
- D_h : Housing outside diameter (mm)

(Note): If the housing is rigid body;

$D_h = \infty$

D_e = Mean bore diameter of outer ring
(mm)

Cylindrical roller bearings and Self-aligning ball bearings of series 22 and 23:

$D_e \doteq 0.25(3D+d)$

All other bearings:

$D_e \doteq 0.1(7D+3d)$

8.1.4 Selection of Bearing Clearance

The internal clearance of rolling contact bearings during operation (the operating clearance) is a factor which can affect bearing life, vibration, heat, sound, etc.

Theoretically, bearing life is maximum if bearings operate with a slight preload (a slight negative operating clearance). If a bearing is to operate with a slight preload, great care must be taken in the analysis and design of the application to be sure that preloads do not begin to rise during the bearing operation to a level which will lead to an upward spiraling of heat=greater preload=more heat=early bearing failure. And also a bearing with an excessive operating clearance will not perform its maximum load capability.

To prevent clearance problems, unmounted bearing clearance should be selected so that operating clearance will be slightly positive. (Note that bearings chosen for precision location functions are preloaded, but the amount of preload must be precisely controlled at assembly).

For non-separable, radial bearings, and for radial Cylindrical roller bearings, which are assembled in clearance groups with a set amount of “unmounted” internal clearance; the initial internal clearance will be the unmounted clearance minus clearance losses from mounting fits.

Typical clearance groups for the above types of bearings are:

C2 : less than Normal clearance

CN : Normal clearance

C3 : more than Normal clearance

CN (Normal) internal clearance is determined so that appropriate clearance will remain after the bearing is mounted to the shaft with an interference fit, but with no fit (no interference) between the outer ring and housing and the temperature difference between inner and outer ring is 10 °C or less.

Table 8.15 indicates examples of selection for clearance groups other than CN (Normal) internal clearance.

Bearing clearance varies during operation with respect to the temperature rise and the type and magnitude of load. For example, if large reduction of clearance is expected, more initial clearance is required.

Fig. 8.3 illustrates radial clearance of a single-row Deep-groove ball bearing.

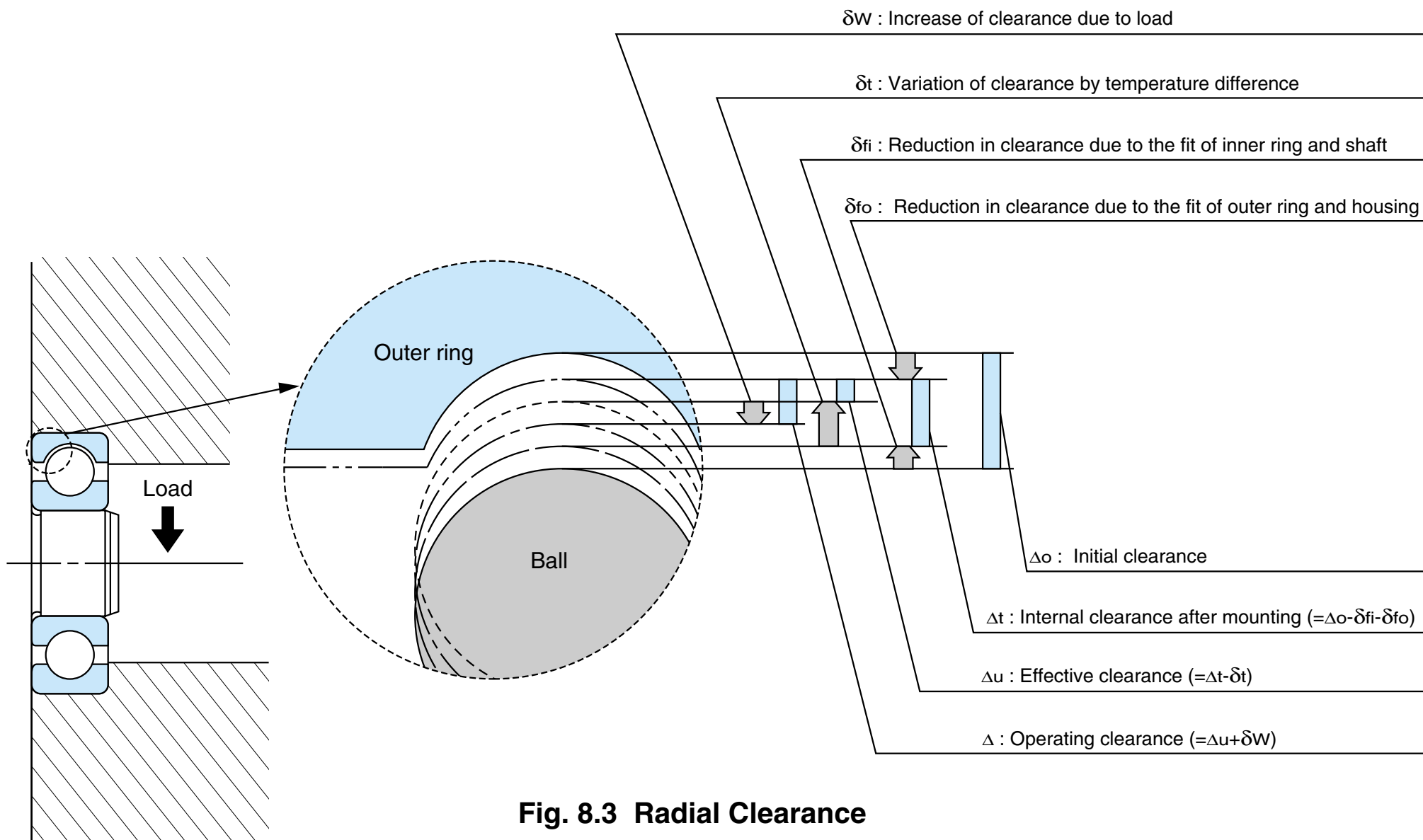
Table 8.15 Examples of Selection of Clearance Other Than CN (Normal) Clearance

Fig. 8.3 Radial Clearance

[→Continue]

Table 8.15 Examples of Selection of Clearance Other Than CN (Normal) Clearance

| Service Conditions | Clearance | Application Examples (reference) |
|---|-------------------------|--|
| Large interference for heavy or impact load | C3 clearance or larger | Railroad car axle |
| Interference in required for both inner and outer rings due to indeterminate heavy impact load | | Traction motor |
| Inner ring is exposed to high temperature. Outer ring exposed to low temperature. | | Pulp and paper machine dryer For outdoor use in cold area |
| When shaft has a large deflection. For increasing axial load capacity by increasing contact angle. | | Semi-floating axle of automobile Bearing of rail road car axle for carrying axial load. Thrust bearing of axles of rolling stock |
| When both inner and outer rings are clearance-fitted. | C2 clearance or smaller | Roll neck of rolling machine |
| For controlling vibration and sound. | | Small, special electric motors |
| For post-assembly adjustment of clearance such as controlling deviation of shaft, etc. | C9na , C1na | Cylindrical roller bearing for lathe main shaft |





(1) Operating Clearance

Operating clearance is defined as the clearance of a bearing operating in a machine at the operating temperature and load.

$$\Delta = \Delta_o - (\delta_t + \delta_f) + \delta_w \quad \dots\dots\dots (8.10)$$

where:

- Δ : Operating clearance (mm)
- Δ_o : Unmounted bearing clearance
- δ_t : Variation of clearance from temperature difference between inner and outer rings (mm)
- δ_f : Reduction in clearance due to the fit of inner and outer rings (mm)
- δ_w : Increase of clearance due to load (mm)

(2) Internal clearance reduction due to temperature difference between inner and outer rings

Under normal operating conditions, the temperature of the rolling contact bearing components is, in ascending order from the lowest to the highest; the outer ring, the inner ring, and the rolling elements.

Since it is extremely difficult to measure the temperature of the rolling elements, operating temperature is calculated under the assumption that the temperature of the rolling element is equal to that of the inner ring. Therefore, the reduction in clearance due to temperature difference between the inner and outer rings can be obtained by the following formula:

$$\delta_t = \alpha \cdot \Delta T \cdot D_o \quad \dots\dots\dots (8.11)$$

where:

- δ_t : Reduction in clearance due to temperature difference between inner and outer rings (mm)
- α : Linear expansion coefficient of bearing steel: 1.12×10^{-5} (1/ °C) for operating temperature 300°C or less
- ΔT : Temperature difference between the inner and outer rings (°C)
- D_o : Outer ring raceway diameter (mm)

$D_o \doteq 0.2(4D+d)$ for Deep-groove ball bearings and Spherical roller bearings.

$D_o \doteq 0.25(3D+d)$ for Cylindrical roller bearings.





(3) Reduction in clearance due to fit

When a bearing is mounted to a shaft or housing with an interference fit, the inner ring will expand or the outer ring will contract (due to the fit), causing reduction in the bearing internal clearance. Reduction in clearance due to fit can be calculated from the following formula:

$$\delta f = \delta f_i + \delta f_o \quad \dots\dots\dots (8.12) \quad \text{where:}$$

δf : Reduction in clearance due to fit (mm)
 δf_i : Reduction in clearance due to expansion of the inner ring (mm)
 δf_o : Reduction in clearance due to the contraction of the outer ring (mm)

$$\delta f_i = \Delta d_e \cdot \frac{d}{d_i} \cdot \frac{1 - \left(\frac{d_h}{d}\right)^2}{1 - \left(\frac{d_h}{d_i}\right)^2} \quad \dots\dots\dots (8.13)$$

$$\delta f_o = \Delta D_e \cdot \frac{D_e}{D} \cdot \frac{1 - \left(\frac{D}{D_h}\right)^2}{1 - \left(\frac{D_e}{D_h}\right)^2} \quad \dots\dots\dots (8.14)$$

where:
 Δd_e : Effective interference of the inner ring (mm)
 d : Bearing bore diameter (mm)
 d_i : Mean outside diameter of inner ring (mm)
 d_h : Inside diameter of hollow shaft (mm)
 (Note): For solid shaft, $d_h=0$
 ΔD_e : Effective interference of outer ring (mm)
 D : Bearing outside diameter (mm)
 D_e : Mean inside diameter of outer ring (mm)
 D_h : Housing outside diameter (mm)
 Note: If the housing is a rigid body, $D_h=\infty$.
 $d_i \doteq 0.25(D+3d)$ for Cylindrical roller bearings and Self-aligning Ball bearings of bearing series 22 and 23
 $d_i \doteq 0.1(3D+7d)$ for other bearings
 $D_e \doteq 0.25(3D+d)$ for Cylindrical roller bearings and Self-aligning Ball bearings of bearing series 22 and 23
 $D_e \doteq 0.1(7D+3d)$ for other bearings

For estimating δf , the following may be used:

$\delta f=0.7 (\Delta d_e+\Delta D_e)$ to

$0.9 (\Delta d_e+\Delta D_e)$,

with smaller values for heavy-section bearings (e.g. bearings of diameter series 4) and larger values for light-section bearing rings. (e.g. bearings of diameter series 9)



[Continue→]



(4) Increase of clearance due to load

When a bearing is subjected to a load, elastic deformation will occur and this deformation will cause an increase in internal clearance. [Table 8.16](#) outlines elastic deformation δr and δa .

Table 8.16 Load and Elastic Deformation



Table 8.16 Load and Elastic Deformation

| Bearing type | Approximation of deformation from radial load δr (mm) | Approximation of deformation from axial load δa (mm) |
|--|--|---|
| Self-aligning Ball bearings | $\delta r = \frac{0.00070}{\cos \alpha} \sqrt[3]{\frac{Po^2}{Dw}}$ | $\delta a = \frac{0.00070}{\sin \alpha} \sqrt[3]{\frac{P^2}{Dw}}$ |
| Deep groove ball bearings Angular Contact ball bearings | $\delta r = \frac{0.00044}{\cos \alpha} \sqrt[3]{\frac{Po^2}{Dw}}$ | $\delta a = \frac{0.00044}{\sin \alpha} \sqrt[3]{\frac{P^2}{Dw}}$ |
| Spherical roller bearings | $\delta r = \frac{0.00018}{\cos \alpha} \sqrt[4]{\frac{Po^3}{Lwe^2}}$ | $\delta a = \frac{0.00018}{\sin \alpha} \sqrt[4]{\frac{P^3}{Lwe^2}}$ |
| Cylindrical roller bearings Tapered roller bearings | $\delta r = \frac{0.000077}{\cos \alpha} \cdot \frac{Po^{0.9}}{Lwe^{0.8}}$ | $\delta a = \frac{0.000077}{\sin \alpha} \cdot \frac{P^{0.9}}{Lwe^{0.8}}$ |
| Thrust ball bearings | — | $\delta a = \frac{0.00052}{\sin \alpha} \sqrt[3]{\frac{P^2}{Dw}}$ |
| Po and P | $Po = \frac{5Fr}{iz \cos \alpha}$ | $P = \frac{Fa}{z \sin \alpha}$ |

where: Fr = Radial load (N)

Fa = Axial load (N)

α = Contact angle (°)

Dw = Diameter of ball or roller (mm)

Lwe = Effective roller length (mm)

i = Number of row of ball or roller

z = Number of ball or roller per row

8.2 Preload and Rigidity

Generally, rolling contact bearings are mounted so that in operation, there will be a small amount of internal clearance. Applications may sometimes require that the bearings be provided with appropriate negative clearance called "preload" when assembled. Preload has various purposes and effects. Since an incorrect amount of preload may adversely affect the rolling resistance, life, temperature rise, sound, etc. of bearings; extreme care must be taken when applying preload.

8.2.1 Purposes of Preload

- (1) Increases rigidity of a shaft (that is, preloading can help to decrease the deflection of shafting).
- (2) Enhances rotating accuracy of shaft. Minimizes axial movements and helps to prevent vibration and decrease noise.
- (3) Prevents fretting caused by external vibration.

Item 1 and 2 are pertinent with respect to proper gear engagement, rotating accuracy of precision machinery and resonance of electric motor rotors.

8.2.2 Preloading Method and Measurement

(1) Preloading method

Preloading can be accomplished using one or more of the following methods:

- a) Use of springs (disc and coil springs) "Constant-pressure" preloading.
- b) Use of clamping nut "Fixed-position" preloading.
- c) Use of spacer (spacer and shim) "Fixed-position" preloading.

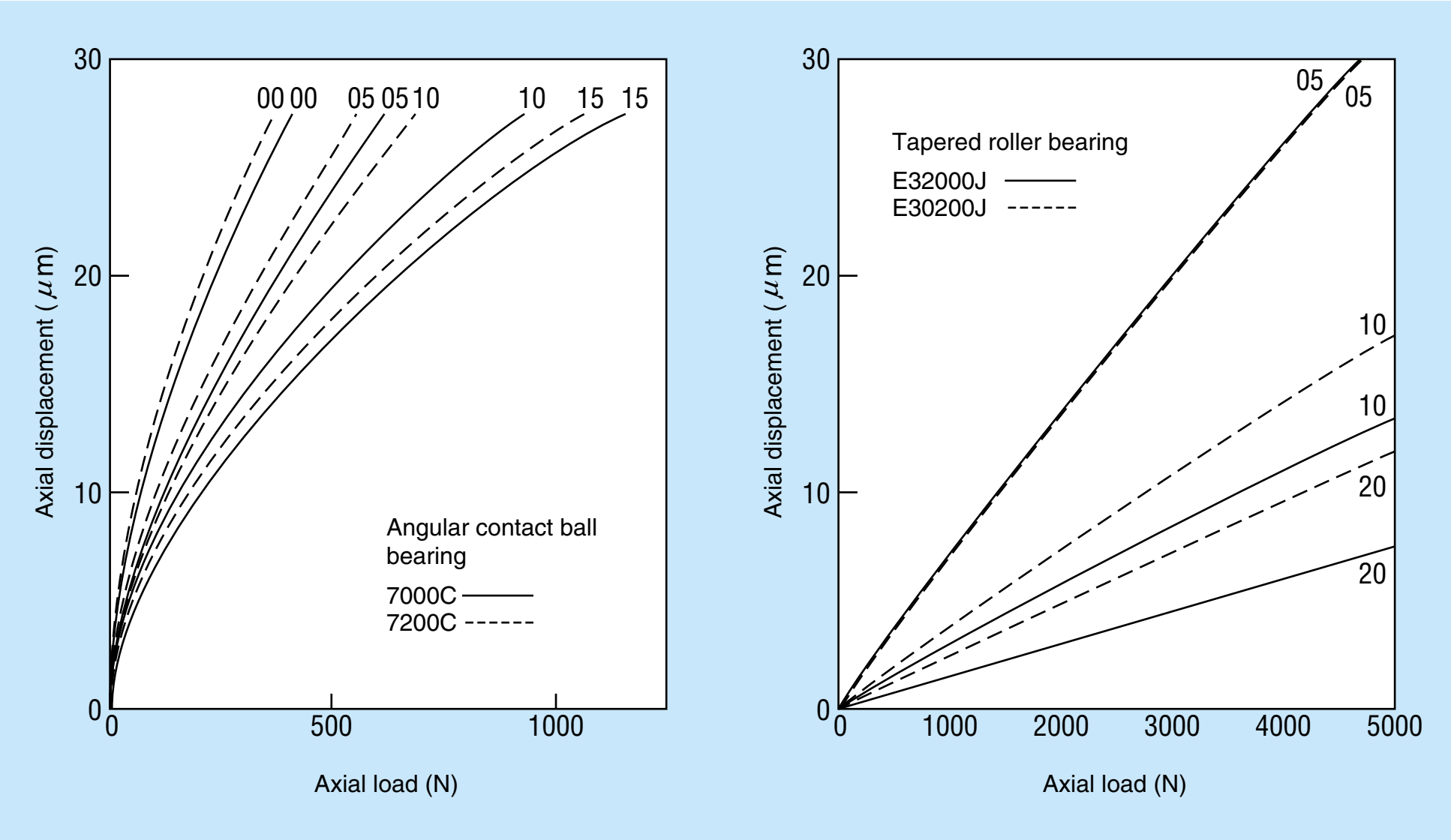
(2) Measurement of preloading amount

- a) Measuring method using axial load.
 - If preloading is done using springs, the preloading amount is determined by the amount of spring displacement.
 - If preloading is done using a clamping nut, the preload amount is determined by the relationship of the fastening torque of the nut and clamping force.
- b) Measuring method using the bearing axial displacement ([Fig. 8.4](#)).

Preload amount is determined by relationship of axial load on the bearing and resulting axial displacement.
- c) Measuring method using start-up friction torque of the bearing. Relationship between axial load and friction torque should be known for this method.

[Fig 8.4 Axial Load and Axial Displacement](#)

Fig 8.4 Axial Load and Axial Displacement



8.2.3 Effect of Preloading

To illustrate the effects of preloading on a duplex Tapered roller bearing set, apply the formula from [Table 8.16](#) to calculate a set of curves for bearing A and bearing B. The example bearing set (see Fig. 8.5) is preloaded (fixed-position), and external load, T_w , is applied.

Load distribution to the two units of bearing in terms of the axial displacement will be calculated using the graphical solution procedures described as follows:

- (1) Draw $T-\delta a$ curve of bearing A.
- (2) Take preload T_p on axis T , determine intersection P with the curve of bearing A, and draw $T-\delta a$ curve of bearing B through point P .
- (3) Connect the two curves with a length equivalent to the value of external load T_w .
- (4) Load T_a and T_b equivalent to this point will become the load of the individual bearings under external load T_w .
- (5) Disposition of bearing is obtained by the disposition δw of bearing B.

The disposition of bearing B will be obtained by subtracting disposition to T_p from the counterpart to T_b . The reason for this is that if the bearings are preloaded, the disposition of both bearings becomes constant within a range where preload is not offset to zero by an external load ($O - O'$ in Fig. 8.5 is constant). In other words, bearing A becomes loosened by the amount displaced by the external load on bearing B. If the external load increases and preload is eliminated, load T_b on bearing B will be equal to the external load T_w and the load on bearing A becomes zero. Magnitude of the external load causing loss of preload is represented by T_{po} in Fig. 8.5.

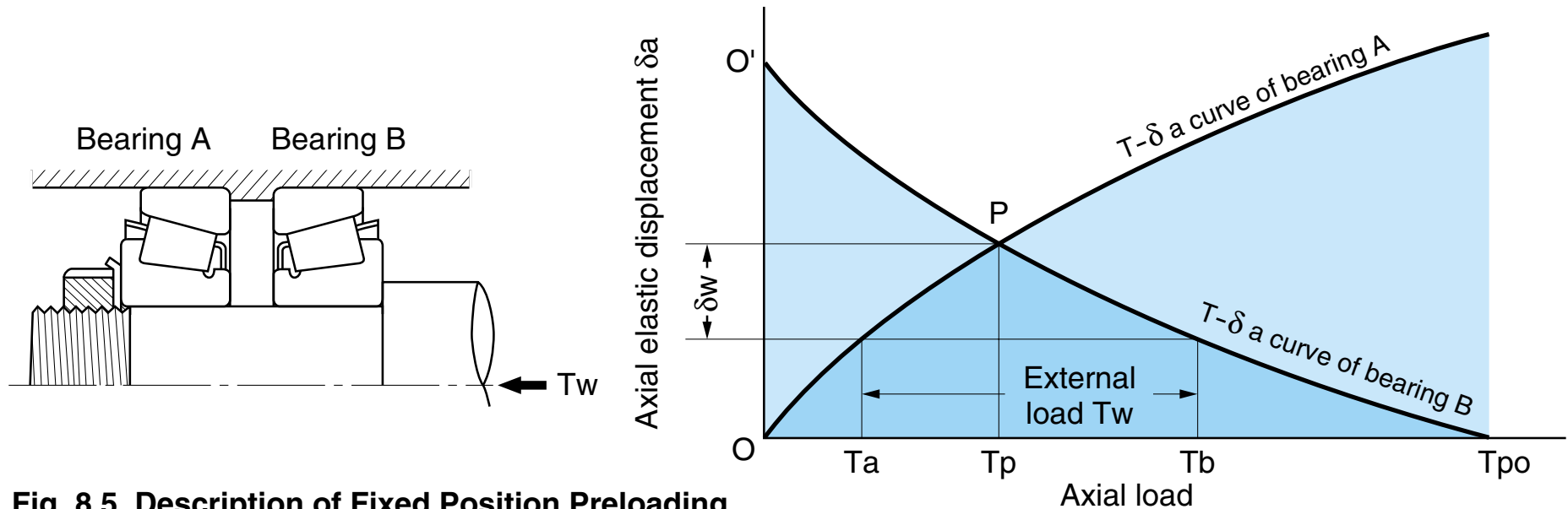
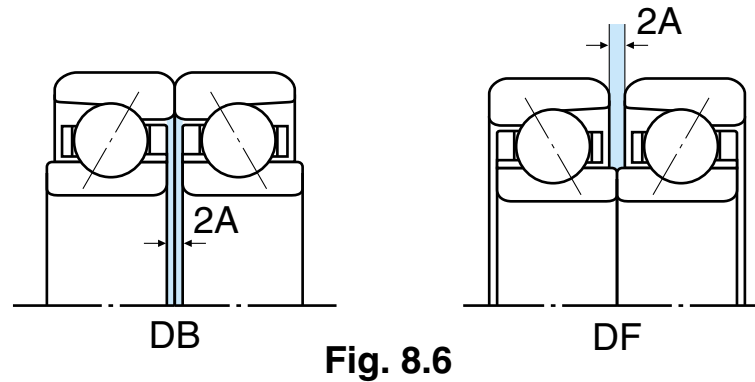


Fig. 8.5 Description of Fixed Position Preloading

8.2.4 Duplex Bearing Preload, Clearance

The preload of duplex bearings can be defined as the clearance, $2A$ as shown in Fig. 8.6.



If preloading is an application necessity, it is very important that a very thorough application analysis is made, since, if an excessive amount of preload is applied, there can be abnormal heating, increase in rotating torque and / or a sharp drop in bearing life. [Table 8.17](#) shows standard preload and [Table 8.18](#) outlines target amount of fits for precision (tolerance class 5 or 4), Angular Contact ball bearings.

[Table 8.17 Standard Preload Amounts for Precision \(tolerance class 5 or 4\) Angular Contact Ball Bearings](#)

[Table 8.18 Target Interference Values for Precision \(tolerance class 5 or 4\) Angular Contact Ball Bearings](#)

Table 8.17 Standard Preload Amounts for Precision (tolerance class 5 or 4) Angular Contact Ball Bearings

Unit: N

| Preload (N) Bore diameter number | 7000C (DB , DF) | | | | 7200C (DB , DF) | | | | 7300C (DB , DF) | | | |
|--|-----------------|-----|-----|------|-----------------|-----|-----|------|-----------------|-----|------|------|
| | E | L | M | H | E | L | M | H | E | L | M | H |
| 00 | 20 | 50 | 100 | 145 | 30 | 70 | 145 | 195 | 50 | 100 | 195 | 295 |
| 01 | 20 | 50 | 100 | 145 | 30 | 70 | 145 | 195 | 50 | 100 | 195 | 295 |
| 02 | 20 | 50 | 100 | 145 | 30 | 70 | 145 | 195 | 50 | 100 | 195 | 295 |
| 03 | 20 | 50 | 100 | 145 | 30 | 70 | 145 | 195 | 50 | 100 | 195 | 295 |
| 04 | 50 | 100 | 195 | 295 | 70 | 145 | 295 | 490 | 100 | 195 | 390 | 590 |
| 05 | 50 | 100 | 195 | 295 | 70 | 145 | 295 | 490 | 100 | 195 | 390 | 590 |
| 06 | 50 | 100 | 195 | 390 | 70 | 145 | 295 | 590 | 100 | 195 | 390 | 685 |
| 07 | 70 | 145 | 295 | 390 | 100 | 195 | 490 | 590 | 145 | 295 | 590 | 685 |
| 08 | 70 | 145 | 295 | 590 | 100 | 195 | 490 | 785 | 145 | 295 | 590 | 980 |
| 09 | 70 | 145 | 295 | 590 | 100 | 195 | 490 | 785 | 145 | 295 | 590 | 980 |
| 10 | 70 | 145 | 295 | 590 | 100 | 195 | 490 | 785 | 145 | 295 | 590 | 980 |
| 11 | 100 | 195 | 390 | 785 | 145 | 295 | 590 | 980 | 195 | 390 | 785 | 1470 |
| 12 | 100 | 195 | 390 | 785 | 145 | 295 | 590 | 980 | 195 | 390 | 785 | 1470 |
| 13 | 100 | 195 | 390 | 785 | 145 | 295 | 590 | 980 | 195 | 390 | 785 | 1470 |
| 14 | 145 | 295 | 590 | 1170 | 195 | 390 | 785 | 1470 | 295 | 590 | 980 | 1960 |
| 15 | 145 | 295 | 590 | 1170 | 195 | 390 | 785 | 1470 | 295 | 590 | 980 | 1960 |
| 16 | 145 | 295 | 590 | 1170 | 195 | 390 | 785 | 1470 | 295 | 590 | 980 | 1960 |
| 17 | 195 | 390 | 785 | 1470 | 295 | 490 | 980 | 1960 | 390 | 785 | 1470 | 2940 |
| 18 | 195 | 390 | 785 | 1470 | 295 | 490 | 980 | 1960 | 390 | 785 | 1470 | 2940 |
| 19 | 195 | 390 | 785 | 1470 | 295 | 490 | 980 | 1960 | 390 | 785 | 1470 | 2940 |
| 20 | 195 | 390 | 785 | 1470 | 295 | 490 | 980 | 1960 | 390 | 785 | 1470 | 2940 |

**Table 8.18 Target Interference Values for Precision
(tolerance class 5 or 4) Angular Contact Ball Bearings**

Unit: μm

| Bearing bore diameter Nominal d (mm) | | Shaft to inner ring Interference | Bearing outside diameter Nominal D (mm) | | Housing to outer ring |
|--|-------|--|---|-------|--------------------------|
| Over | Incl. | | Over | Incl. | Clearance |
| — | 18 | 0 ~ 2 | — | 18 | — |
| 18 | 30 | 0 ~ 3 | 18 | 30 | 2 ~ 6 |
| 30 | 50 | 0 ~ 3 | 30 | 50 | 2 ~ 6 |
| 50 | 80 | 0 ~ 4 | 50 | 80 | 3 ~ 9 |
| 80 | 120 | 0 ~ 4 | 80 | 120 | 3 ~ 9 |
| 120 | 150 | — | 120 | 150 | 4 ~ 12 |
| 150 | 180 | — | 150 | 180 | 4 ~ 12 |
| 180 | 250 | — | 180 | 250 | 5 ~ 15 |

Remarks: Regarding the fit of housing and outer ring, take the smaller values of target clearance for the clamping side bearing and the larger values for the floating side.

8.2.5 Thrust Bearing Minimum Axial Loads

When rotated at relatively high speeds, the contact angle between rolling elements and raceways of a thrust bearing changes due to centrifugal force. This can cause a skidding (sliding) action between the rolling elements and the raceways. This skidding action may cause smearing and scuffing on the rolling elements and raceway surfaces.

To prevent sliding action, thrust bearings must always be loaded with a minimum axial load. The minimum axial load is derived from Formulas (8.15), (8.16) and (8.17).

Thrust bearings can sustain axial load in only one direction. When a bi-directional axial load exists, preload must be provided by either using double bearings or springs (or load washers) to maintain the minimum axial load.

For vertical shafts, the axial load due to dead weight of the shaft (etc.), will often exceed the minimum axial load. Even in such cases, reversing axial loads may occur during operation causing the initial axial load to fall below the minimum load.

(1) Thrust ball bearing (adopt larger of values below)

$$F_{a \min} = K \cdot n^2 \quad \dots\dots\dots (8.15)$$

$$F_{a \min} = \frac{C_{0a}}{1000} \quad \dots\dots\dots (8.16)$$

where:

$F_{a \min}$: Minimum axial load (N)

K : [Minimum axial load factor](#)

n : Rotating speed (rpm)

C_{0a} : Basic static load rating (N)

(2) Spherical Roller Thrust Bearing

$$F_{a \min} = \frac{C_{0a}}{1000} \quad \dots\dots\dots (8.17)$$

Minimum axial factor K ($\times 10^{-6}$)

| Series Bore No. | 511 | 512, 522 | 513, 523 | 514, 524 |
|--------------------|------|----------|----------|----------|
| 00 | 1.03 | 1.55 | — | — |
| 01 | 1.26 | 1.92 | — | — |
| 02 | 1.56 | 3.36 | — | — |
| 03 | 1.84 | 4.09 | — | — |
| 04 | 3.42 | 7.33 | — | — |
| 05 | 7.19 | 13.1 | 20.4 | 43.8 |
| 06 | 9.36 | 17.2 | 33.1 | 81.4 |
| 07 | 11.2 | 32.8 | 58.3 | 128 |
| 08 | 20.4 | 49.7 | 97.2 | 221 |
| 09 | 24.6 | 57.9 | 138 | 316 |
| 10 | 29.3 | 66.8 | 211 | 440 |
| 11 | 44.6 | 133 | 326 | 656 |
| 12 | 64.7 | 160 | 375 | 956 |
| 13 | 72.0 | 179 | 428 | 1240 |
| 14 | 82.8 | 200 | 596 | 1580 |
| 15 | 94.3 | 222 | 808 | 1800 |
| 16 | 103 | 245 | 907 | 2230 |
| 17 | 116 | 359 | 1240 | 2740 |
| 18 | 187 | 528 | 1390 | 4320 |
| 20 | 363 | 850 | 1850 | 4790 |
| 22 | 423 | 1010 | 2740 | 8220 |

(1/2)

| Series Bore No. | 511 | 512, 522 | 513, 523 | 514, 524 |
|--------------------|-------|----------|----------|----------|
| 24 | 488 | 1130 | 4130 | 9980 |
| 26 | 648 | 1940 | 5140 | 16100 |
| 28 | 782 | 2150 | 6330 | 16900 |
| 30 | 886 | 2490 | 7140 | 25800 |
| 32 | 997 | 2880 | 9960 | 30000 |
| 34 | 1420 | 3940 | 11100 | 40100 |
| 36 | 1540 | 4330 | 15800 | 46330 |
| 38 | 2340 | 6290 | 23100 | — |
| 40 | 2520 | 6880 | 29700 | — |
| 44 | 3000 | 8130 | — | — |
| 48 | 4900 | 15900 | — | — |
| 52 | 5580 | 18400 | — | — |
| 56 | 9800 | 20400 | — | — |
| 60 | 14600 | 38000 | — | — |
| 64 | 16400 | 41800 | — | — |
| 68 | 18300 | 45700 | — | — |
| 72 | 20300 | 75600 | — | — |





Minimum axial factor K ($\times 10^{-6}$)

(2/2)

| Series Bore No. | 29 | 39 |
|--------------------|------|------|
| 00 | 1.55 | — |
| 01 | 1.92 | — |
| 02 | 2.64 | — |
| 03 | 3.30 | — |
| 04 | 3.82 | — |
| 04 1/2 | 6.41 | — |
| 05 | 7.51 | 14.2 |
| 06 | 9.72 | 28.9 |
| 07 | 20.1 | 52.3 |
| 08 | 25.1 | 81.0 |
| 09 | 31.6 | 140 |
| 10 | 46.1 | 209 |
| 11 | 54.4 | 284 |
| 12 | 60.7 | 350 |
| 13 | 86.0 | 426 |

| Series Bore No. | 29 | 39 |
|--------------------|------|------|
| 14 | 99.5 | 556 |
| 15 | 114 | 704 |
| 16 | 152 | 927 |
| 17 | 172 | 1210 |
| 18 | 187 | 1580 |
| 19 | 286 | 2010 |
| 20 | 321 | 2090 |
| 21 | 346 | 2390 |
| 22 | 361 | 3220 |
| 23 | 350 | 3940 |
| 24 | 538 | 4500 |
| 25 | 498 | — |
| 26 | — | — |
| 27 | — | — |
| 28 | 794 | — |

| Series Bore No. | O – |
|--------------------|------|
| 3 | 1.34 |
| 4 | 3.62 |
| 5 | 4.65 |
| 6 | 6.40 |
| 7 | 7.76 |
| 8 | 9.24 |
| 9 | 11.6 |
| 10 | 16.5 |
| 11 | 19.0 |
| 12 | 23.0 |
| 13 | 21.0 |
| 14 | 31.3 |
| 15 | 42.1 |
| 16 | 46.9 |
| 17 | 75.0 |

| Series Bore No. | O – |
|--------------------|------|
| 18 | 82.8 |
| 19 | 110 |
| 20 | 121 |
| 21 | 132 |
| 22 | 176 |
| 23 | 204 |
| 24 | 223 |
| 26 | 350 |
| 28 | 395 |
| 30 | 431 |
| 32 | 580 |
| 36 | 1100 |
| 40 | 1730 |
| 44 | 2840 |
| 48 | 3690 |

8.3 Shaft and Housing Selection

Care must be taken in the design and manufacture of shafts and housings since inaccuracies in these components will probably result in poor bearing performance.

8.3.1 Accuracy and Surface Finish; Shafts and Housings

For general service conditions, the fit surfaces for shafts and housing bores for rolling contact bearings can be made using lathes or fine boring machines.

For applications requiring high-running accuracy, or for very quiet operation, or where high loads exist, a ground finish will be necessary.

[Table 8.19](#) indicates the shaft and housing accuracy and surface roughness for normal service condition.

[Table 8. 19 Shaft and Housing Accuracy and Surface Roughness](#)

Table 8. 19 Shaft and Housing Accuracy and Surface Roughness

| Item | Shaft | Housing Bore |
|------------------------|--|---|
| Roundness | ≤ 0.5 times shaft diametral deviation | ≤ 0.5 times housing bore diametral deviation |
| Cylindricity | ≤ 0.5 times shaft diametral deviation within range of bearing width | ≤ 0.5 times housing bore diametral deviation within range of bearing width |
| Shoulder Squareness | ≤ 0.0003 (small bearing) ≤ 0.0004 (medium bearing) ≤ 0.0005 (large bearing) | |
| Fit Surface Rounghness | Ra<0.8 μm (small & medium bearing) Ra<1.6 μm (large bearing) | Ra<0.8 μm (small & medium bearing) Ra<3.2 μm (large bearing) |

8.3.2 Shaft and Housing Design; Recommendations

- Design shafts as short as possible and of sufficient diameter to prevent bending. Design the housing and supports for appropriate rigidity.
- Use care in specifying the roundness, cylindricity, and surface finish of shaft and housing fit surfaces. See [Table 8.19](#).
- Use care in specifying the squareness of the shaft shoulder to the shaft center and squareness of the housing shoulder to the housing. See [Table 8.19](#).
- Make sure that the radius, r_a , of the corner roundness is smaller than the bearing chamfer dimension, r , (minimum) or, r_1 (minimum) to prevent the shaft or housing from interfering with proper bearing seating. See [Fig. 8.7](#).

For radial bearings in general, determine the maximum value of radius r_a of the corner roundness and the minimum value of the shoulder height according to [Table 8.20](#).

When using a ground finish, provide an undercut as shown in [Fig. 8.8](#). See [Table 8.21](#) for undercut dimensions.

- When using a radius, (r_{a2}) of corner roundness larger than the bearing chamfer dimension (for enhancing the strength of the shaft or when shoulder height must be lower than specified in the dimension tables), install a spacer between the bearing and the shaft shoulder as shown in [Fig. 8.9](#) and [Fig. 8.10](#).
- For ease of dismounting, make the height of the shaft shoulder smaller than the inner ring outside (or land) diameter. If a higher shoulder is required for applying heavy axial load, install an undercut in the shaft as shown in [Fig. 8.11](#).
- Finish bearing mounting screws, or clamping nuts as right-angled to the shaft as possible and thread screws reverse to the rotating direction of the shaft.
- For split-type housings, carefully finish the matching faces of the split housing and install a relief on both sides of the bore diameter of the cap to prevent excessive force from being applied to the bearing when the housing cap is tightened.
- For light-alloy housings (having less rigidity), insert a steel bushing to provide additional rigidity. In general the interference fit is not enough to locate a bearing axially. In principle it is necessary to fix a bearing axially by same method.
- Generally, an interference fit is not adequate to axially locate a bearing. A shaft or housing backing shoulder should be used.

• [Fig. 8.8 Chamfer Dimension and Radius of Corner Roundness](#)

• [Fig. 8.9 Chamfer Dimension and Radius of Corner Roundness when Using a Spacer](#)

• [Fig. 8.10](#)

• [Fig. 8.11](#)

• [Table 8.20 Maximum Corner Radius and Minimum Shoulder Heights](#)

• [Table 8.21 Undercut dimensions for Ground Shaft Finish](#)

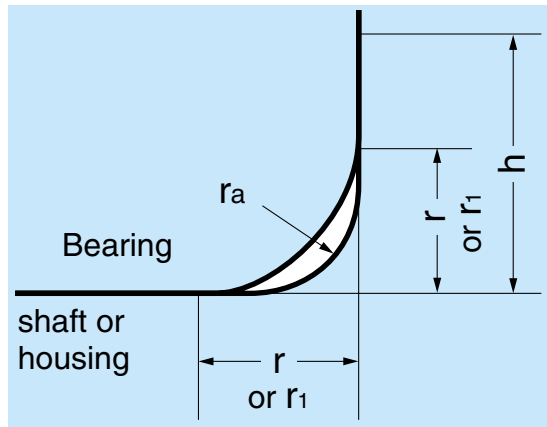


Fig. 8.7 Chamfer Dimension, Radius of Corner Roundness, and Shoulder Height

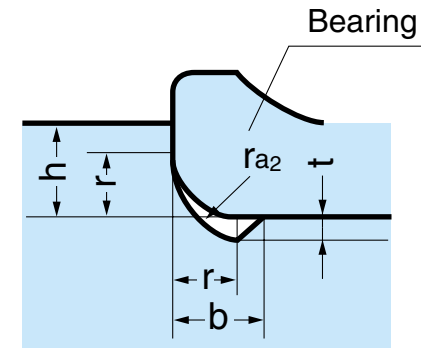


Fig. 8.8 Chamfer Dimension and Radius of Corner Roundness

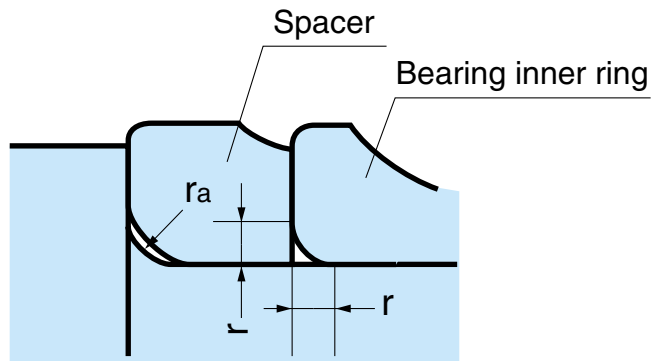


Fig. 8.9 Chamfer Dimension and Radius of Corner Roundness when Using a Spacer

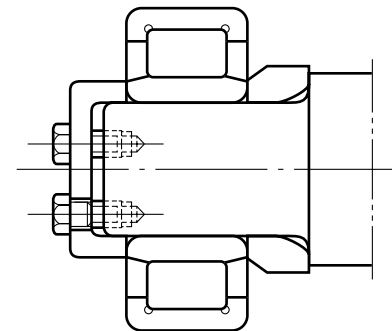


Fig. 8.10

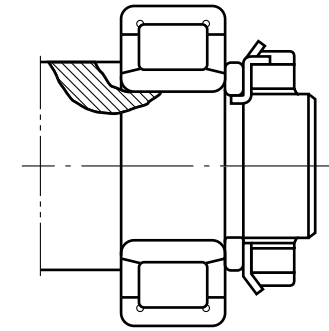


Fig. 8.11

Table 8.20 Maximum Corner Radius and Minimum Shoulder Heights

Unit: mm

| Minimum tolerance chamfer dimension r (min) or r1 (min) | Shaft or housing | | |
|--|---|-------------------------|-------------------|
| | Radius ra (max) of corner roundness | Shoulder height h (min) | |
| | | General cases | Special cases (1) |
| 0.1 | 0.1 | 0.4 | 0.4 |
| 0.15 | 0.15 | 0.6 | 0.6 |
| 0.2 | 0.2 | 0.8 | 0.8 |
| 0.3 | 0.3 | 1.25 | 1 |
| 0.6 | 0.6 | 2.25 | 2 |
| 1 | 1 | 2.75 | 2.5 |
| 1.1 | 1 | 3.5 | 3.25 |
| 1.5 | 1.5 | 4.25 | 4 |
| 2 | 2 | 5 | 4.5 |
| 2.1 | 2 | 6 | 5.5 |
| 2.5 | 2 | 6 | 5.5 |
| 3 | 2.5 | 7 | 6.5 |
| 4 | 3 | 9 | 8 |
| 5 | 4 | 11 | 10 |
| 6 | 5 | 14 | 12 |
| 7.5 | 6 | 18 | 16 |
| 9.5 | 8 | 22 | 20 |
| 12 | 10 | 27 | — |
| 15 | 12 | 32 | — |
| 19 | 15 | — | — |

Note (1) Data in the columns for special cases should be used when axial load is extremely small. The values Table 8. 21 do not apply to tapered roller bearings, spherical roller bearings and angular contact ball bearings.

Remarks: Symbols are based on Fig. 8.7.

Table 8.21 Undercut dimensions for Ground Shaft Finish

Unit: mm

| Minimum tolerance chamfer dimension r (min) or r1 (min) | Notch dimensions | | |
|---|------------------|-----|-----|
| | t | ra2 | 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 |

Remarks: Symbols are based on Fig. 8. 8.

8.3.3 Examples of Shaft Designs

(1) Cylindrical-bore Bearing Shaft Design

- If axial load is applied away from the shaft shoulder, the inner ring can be locked into position using; a) nuts and washers (Fig. 8.12a); b) nuts and lock washers (Fig. 8.12b); or end plates and bolts (Fig. 8.12c). When using a lock washer WITHOUT a shaft keyway or slot, it is recommended that the direction of the nut thread be made reverse to that of the shaft rotation. Note: Careful analysis of bearing load, shaft fits, and finishes, and bearing clearance may show that the shaft fit may be more than adequate to support the axial loading on the bearing.
- When not supporting axial load on the shaft-end on the side opposite the shaft shoulder, you may elect to insert a snap ring in a shaft groove to prevent the inner ring from moving axially. To remove clearance between the snap ring and bearing ring, shims or spacers can be inserted. See Fig. 8.13.
- Snap rings can be applied when using spacers between gears, or pulleys instead of using a shaft shoulder. If axial load will act on the snap ring, insert a shim or spacer between the bearing ring and the snap ring to prevent the axial load from applying bending stress to the snap ring, and to eliminate any axial clearance from between the snap ring and the ring groove. See Fig. 8.13.

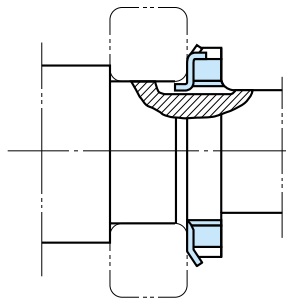
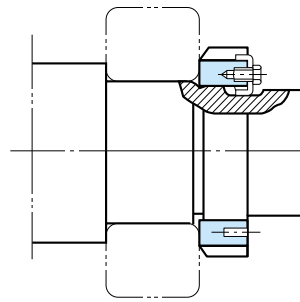
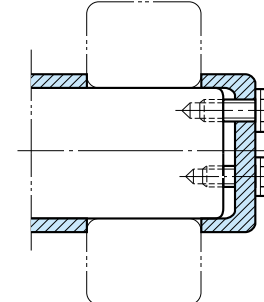


Fig. 8.12

(a) Shaft Nut and Washer



(b) Shaft Nut and Lock Washer



(c) End Plate and Bolts

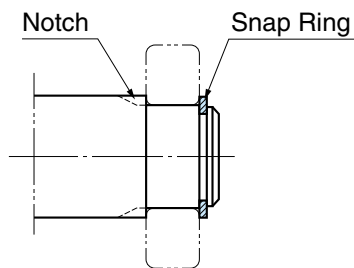
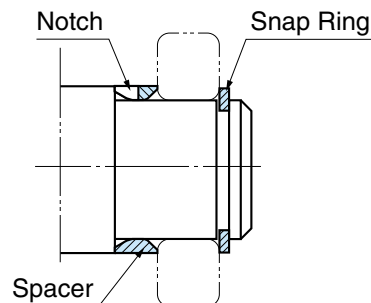
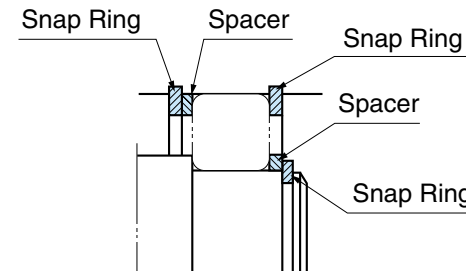


Fig. 8.13

(a) Snap Ring and Notched Shoulder



(b) Snap Ring and Notched Spacer



(c) Snap Ring and Spacer

(2) Tapered-bore Bearing Shaft Designs

Two methods of mounting tapered-bore bearings to a shaft are; direct mounting to a tapered shaft, or mounting to a cylindrical shaft using adapter or withdrawal sleeves.

Use of adapter or withdrawal sleeves may allow use of less expensive shaft seats (no tapering cost), permits use of a larger shaft tolerance and allows variable location of a bearing on a shaft. See Figs. 8.14 to 8.16. Since the dimensional accuracy of sleeves is not as high as that of bearings, sleeves are not appropriate for applications requiring high accuracy or high rotational speed.

- Normally, tapered-bore bearings used with adapters do not employ shaft shoulders.

To prevent nuts from loosening, use washers for shafts of diameters 200 mm or less, and lock plates for shafts of diameters 200 mm or more.

Nut thread direction to be made reverse to direction of rotation.

- For shafts with shoulders, mount the tapered-bore bearing with withdrawal sleeves with nuts and washer or end plates and bolts. See Fig. 8.17.

Nut thread direction should be reverse to direction of rotation.

- When accuracy is of primary importance, use the direct mount method using tapered-bore bearings mounted directly to tapered shafts. See Fig. 8.18.

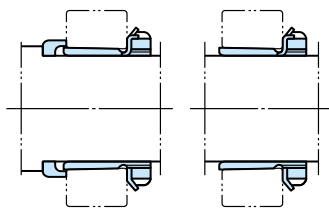


Fig. 8.14 Adapter Sleeve Mounting

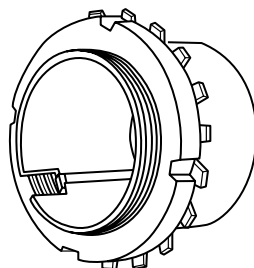


Fig. 8.15 Adapter Using Washer (Bearing Bore ≤ 200 mm)

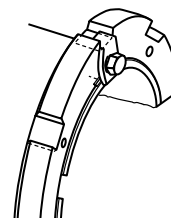


Fig. 8.16 Adapter Using Lock plate (Bearing Bore > 200 mm)

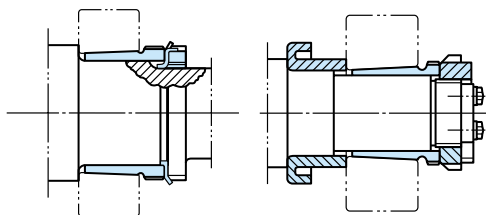


Fig. 8.17 Withdrawal Sleeve Mounting

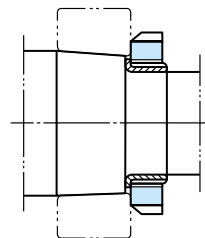


Fig. 8.18 Tapered Shaft Mounting Using Split Ring, Nut and Washer

8.3.4 Housing Designs

- When mounting two bearings to a common shaft, it is necessary to design a structure that allows linear expansion of the shaft due to temperature rise, and for mounting interval errors made during assembly. To accomplish this, mount one of the bearings to support both radial and axial loads. Fix the inner and outer rings to the shaft and housing so that neither ring will move axially. Mount the other bearing so it can move axially as the "free" side bearing capable of supporting only radial load.

If a bearing configuration is selected for the free side bearing which will not accommodate the linear movement of the shaft created by thermal expansion, select a housing fit which will permit axial movement of the outer ring in the housing.

- If a Cylindrical roller bearing with an N, NU, or RNU configuration is used for the free side bearing, then shaft expansion due to temperature rise can be relieved by axial movement of the inner ring of the bearing. See Fig. 8.19. Use of Cylindrical roller bearings may also facilitate assembly if an interference fit is required for both inner and outer rings (due to the load relationship).
- If Cylindrical roller bearings with an NF or NJ configuration are used at both ends of a shaft, axial clearance must be prevented from becoming too small. Referring to Fig. 8.20, make width B (inner ring spacer) larger than the distance A between the outer rings.
- If the amount of shaft expansion is small (due to small temperature rise or short shaft), and precise axial location is not needed then two units of non-separable configuration bearings may be used with both units having floating axial movement. In such cases, assemble the two units with axial clearance on both ends of the assembly. See Fig. 8.21. For mounting of two Deep-groove ball bearing pillow blocks with spherical outer ring bearing surfaces, lock and bolt the first pillow block into position, then lock the second block to the shaft. Pull the second block away from the first block while tightening the mounting bolts. Where axial expansion can not be handled by the clearance within the bearings, please consult NACHI.

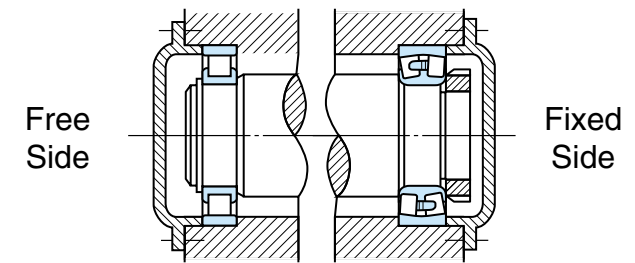


Fig. 8.19 N-Configuration Cylindrical Roller Bearing as Free Bearing

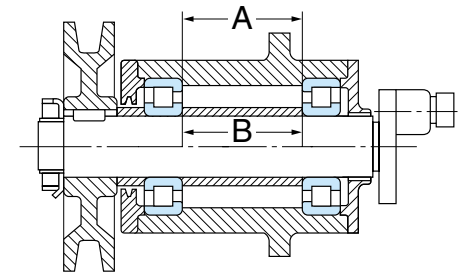


Fig. 8.20

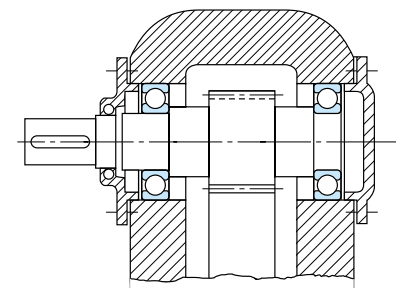


Fig. 8.21

- Pairs of single-row Angular Contact ball, or Tapered roller bearings are often used for axial positioning. When bearing spacing is large, axial expansion from temperature rise is best handled using an assembly as shown in Fig. 8.22, where the paired bearings take axial and radial loads and another bearing (in the Figure, an NU-configured Cylindrical roller bearing), permits linear shaft expansion.

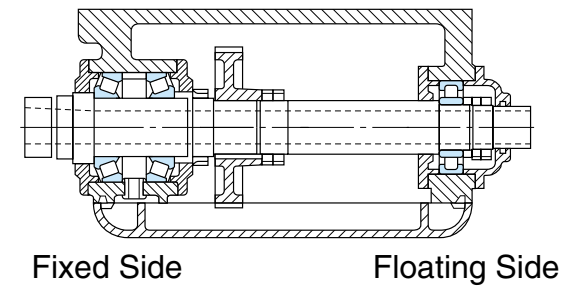


Fig. 8.22

- When using horizontally-split pillow blocks as the fixed side bearing, the outer ring is located by using one or two positioning rings. When one ring is used, place it to the side of the adapter nut as shown in Fig. 8.23. When two positioning rings are used, place one on each side of the bearing (also see Fig. 8.23). To use a horizontally-split pillow block as the floating side bearing, mount the bearing without positioning rings.

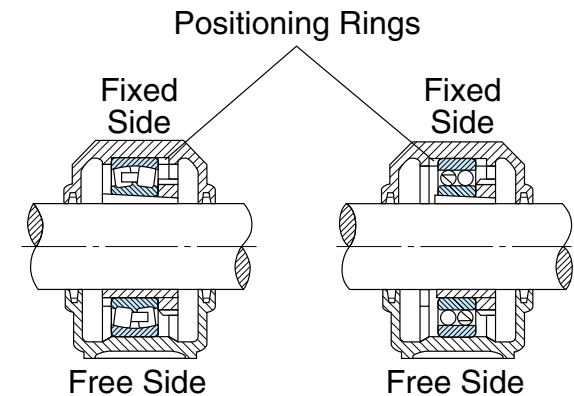


Fig. 8.23

- Determine the position of the fixed bearing by considering the machinery application and the balance of rated life of the individual bearings. For example, when a bevel gear is used (see Fig. 8.24), set the bevel gear side as the fixed side to maintain the accuracy of the gear engagement. For electric motors, the fixed side bearing is often positioned on the non-driving side where a lower amount of radial load is applied, in order to equalize the bearing equivalent load and rated life between the two bearings.

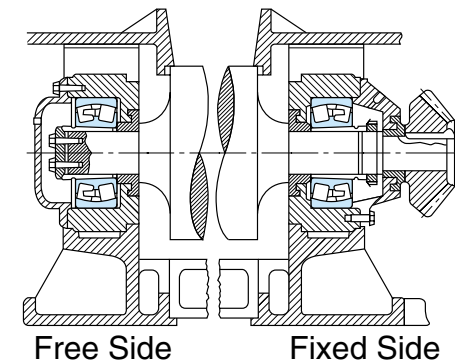


Fig. 8.24

8.4 Sealing Devices

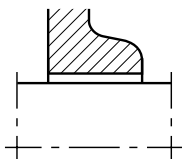
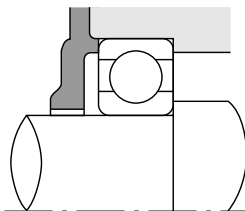
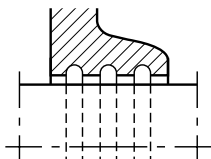
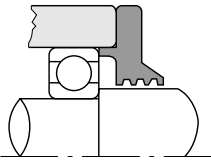
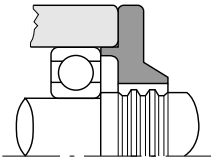
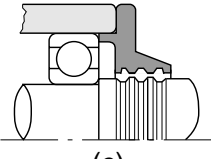
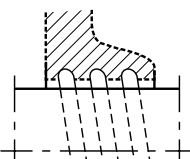
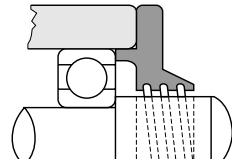
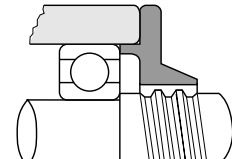
8.4.1 Sealing Device Requirements

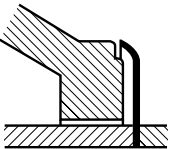
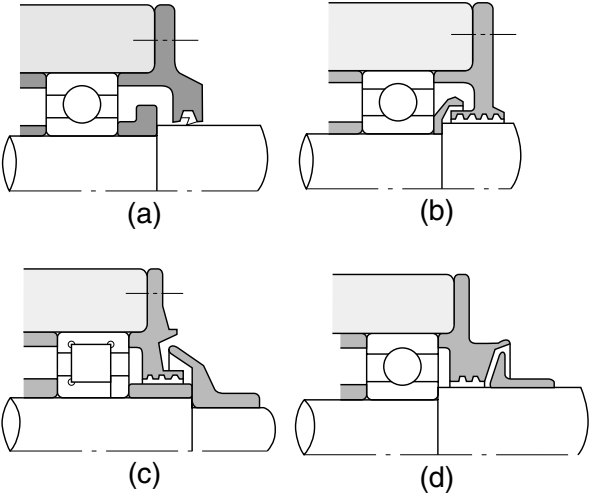
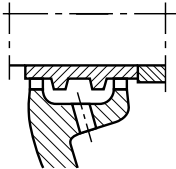
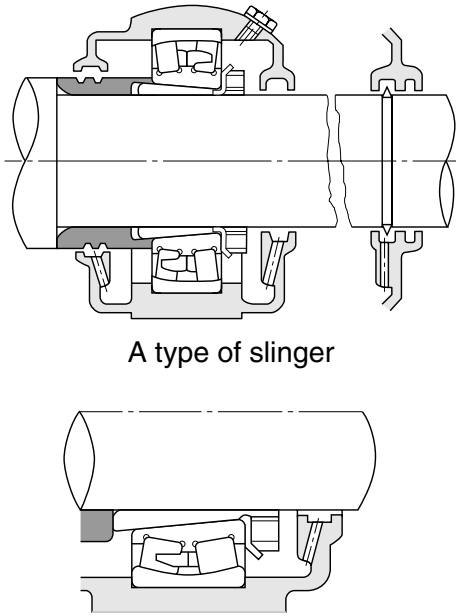
- Must effectively stop foreign material intrusion.
- Must not create excessive frictional loss or heat.
- Must be easy to mount, dismount, and maintain.
- Must be inexpensive.

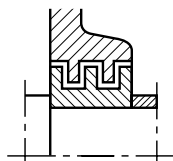
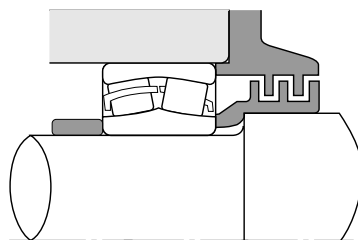
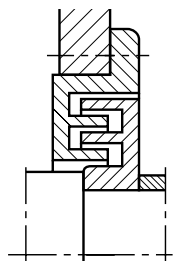
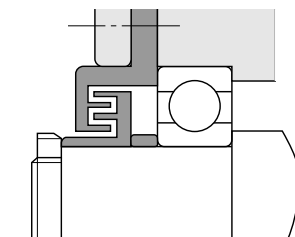
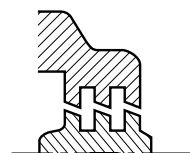
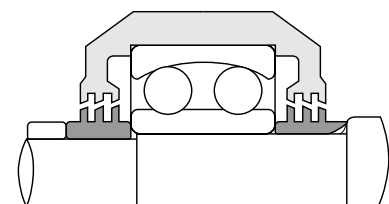
The lubrication method and sealing devices used must be compatible and appropriate for the application.

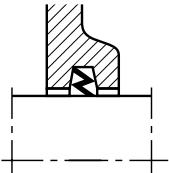
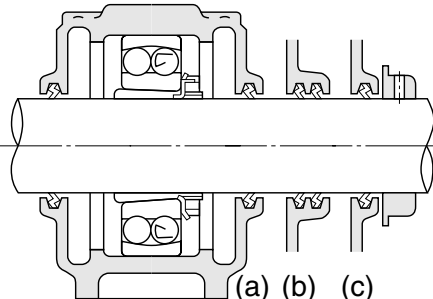
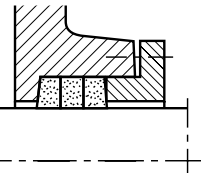
Integrally-sealed or shielded bearings may need separate, additional sealing devices if they are to be operated in an adverse atmosphere.

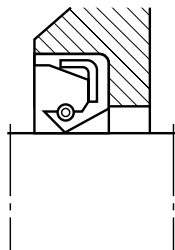
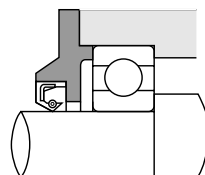
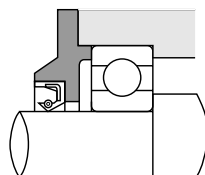
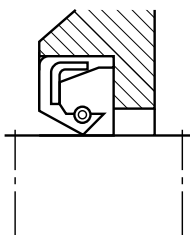
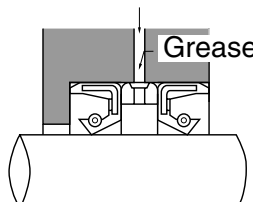
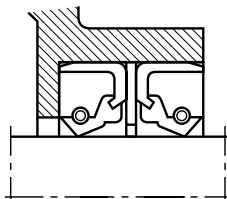
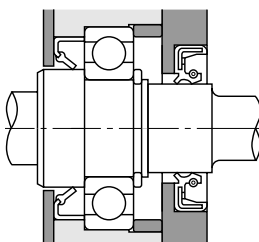
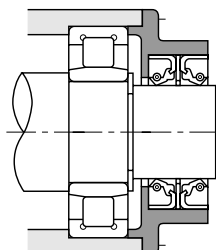
- Linear gap (simple gap type)
- Coaxial groove (oil groove type)
- Threaded groove
- Slinger type
- Slinger type (for oil lubrication)
- Radial labyrinth type
- Axial labyrinth type
- Self-aligning type labyrinth
- Seal ring type (felt, leather, rubber, plastic)
- Adjustable Seal type (includes metal packing O-ring, etc)
- Oil seal Type

| Type of Sealing Device | Design Example | | Design Precautions | | | | | | |
|-------------------------------------|--|---|--|-----------------|-----------------------|------------|------------|-------------------|-----------|
| Linear gap (simple gap type) |  |  | <div>1) Clearance between shaft and bearing housing</div> <table><tr><th>Shaft dia. (mm)</th><th>Radial clearance (mm)</th></tr><tr><td>50 or less</td><td>0.25 ~ 0.4</td></tr><tr><td>50 Over 200 Incl.</td><td>0.5 ~ 1.5</td></tr></table> | Shaft dia. (mm) | Radial clearance (mm) | 50 or less | 0.25 ~ 0.4 | 50 Over 200 Incl. | 0.5 ~ 1.5 |
| Shaft dia. (mm) | Radial clearance (mm) | | | | | | | | |
| 50 or less | 0.25 ~ 0.4 | | | | | | | | |
| 50 Over 200 Incl. | 0.5 ~ 1.5 | | | | | | | | |
| Coaxial groove (oil groove type) |  | <div> (a)  (b)</div> <div> (c)</div> | <div>2) Groove dimensions Width: 3 to 5 mm Depth: 4 to 5 mm</div> <div>3) Where possible, provide three grooves or more.</div> <div>4) Fill grooves with grease to aid in sealing out foreign material.</div> <div>5) The threaded grooves type is applicable to oil lubricated, applications where the shaft is horizontal and operates in a constant rotational direction. Thread grooves must be reverse to the rotation direction.</div> <div>6) Oil grooves are used alone only where preventional oil relatively clean. Oil grooves are for preventing oil leaks and are generally used in combination with other sealing devices.</div> | | | | | | |
| Threaded groove |  | <div> </div> | | | | | | | |

| Type of Sealing Device | Design Example | Design Precautions |
|------------------------------------|---|---|
| Slinger type |   | <ol style="list-style-type: none"> 1) Seal types that sling oil, prevent oil leakage and dust entry through the centrifugal force generated by a rotor attached to the shaft. 2) (a) and (b) are good for preventing oil leakage. 3) (c) and (d) are good for preventing dust and water intrusion. |
| Slinger type (for oil lubrication) |   <p>A type of slinger</p> | <ol style="list-style-type: none"> 1) Oil deposited in the grooves returns to the housing. |

| Type of Sealing Device | | Design Example | Design Precautions | | | | | | | | | | | |
|------------------------------|--|---|--|-----------------|----------------|--|--------|-------|------------|------------|-------|-------------------|-----------|-------|
| Radial labyrinth type |  |  | <div>1) Labyrinth Clearance</div> <table><tr><th rowspan="2">Shaft dia. (mm)</th><th colspan="2">Clearance (mm)</th></tr><tr><th>Radial</th><th>Axial</th></tr><tr><td>50 or less</td><td>0.25 ~ 0.4</td><td>1 ~ 2</td></tr><tr><td>50 Over 200 Incl.</td><td>0.5 ~ 1.5</td><td>2 ~ 5</td></tr></table> | Shaft dia. (mm) | Clearance (mm) | | Radial | Axial | 50 or less | 0.25 ~ 0.4 | 1 ~ 2 | 50 Over 200 Incl. | 0.5 ~ 1.5 | 2 ~ 5 |
| Shaft dia. (mm) | Clearance (mm) | | | | | | | | | | | | | |
| | Radial | Axial | | | | | | | | | | | | |
| 50 or less | 0.25 ~ 0.4 | 1 ~ 2 | | | | | | | | | | | | |
| 50 Over 200 Incl. | 0.5 ~ 1.5 | 2 ~ 5 | | | | | | | | | | | | |
| Axial labyrinth type |  |  | <div>2) Radial and axial labyrinth seals. The radial groove type requires a split housing.</div> <div>3) These seals are very suitable for the prevention of oil leakage of high speed shafts.</div> <div>4) For low speed rotation, apply grease to the grooves for better sealing.</div> <div>5) If angular misalignment exists, use self-aligning type labyrinth.</div> | | | | | | | | | | | |
| Self-aligning type labyrinth |  |  | | | | | | | | | | | | |

| Type of Sealing Device | Design Example | | Design Precautions | | | |
|---|---|--|--|--|-----------|-----------------------------------|
| Seal ring type (felt, leather, rubber, plastic) |  |  | 1) Sealing Material Temperature Range | Sealing material | | Operating temperature range °C |
| | | | Nitrile Acrylic Silicon Flourine Ethylene tetrafluoride Felt | -25 ~ 100 -15 ~ 130 -70 ~ 200 -30 ~ 200 -50 ~ 220 -40 ~ 120 | | |
| | 2) Sealing Material Speed Limits (m/s) | | Seal Material | Shaft diameter (mm) | | |
| | | | to 20 | 20 to 40 | 40 and up | |
| | | | 4 ~ 8 | 8 ~ 12 | 12 ~ 16 | |
| | | | 4 ~ 12 | 12 ~ 18 | 18 ~ 25 | |
| | | | 4 ~ 18 | 18 ~ 25 | 25 ~ 32 | |
| | | | 4 ~ 18 | 18 ~ 25 | 25 ~ 32 | |
| | | | Ethylene tetrafluoride | 15 | | |
| | | | Felt | 3.5 ~ 4.5 | | |
| Adjustable Seal type (includes metal packing O-ring, etc) |  | | These values apply when shafts have good surface finish, roundness, and run-out. | | | |
| | | | 3) Lubricate the sliding surfaces of seal and shaft. 4) These seal types are mainly applicable to grease lubricated bearings. 5) Install one to three pieces of felt ring. 6) For high speed applications, use hard seal material. Coat with mineral oil before mounting and insert tightly. 7) Felt will harden and lose elasticity under high temperature or speed. 8) Felt rings are good for relatively. clean, dust-free conditions. For application in excessively dusty conditions, synthetic rubber rings or additional seal made of synthetic rubber should be used. | | | |

| Type of Sealing Device | Design Example | | Design Precautions | | | | | | | | | | | | |
|--|---|---|--|-------------|----------------|---------------|------|-----------------|-----------------------------|--------|-----------------|-----------------------------|-------|-----------------|---|
| Oil seal Type |  |  (a)  (b) | <p>1) Speed and shaft Surface Roughness</p> <table><tr><th>Speed (m/s)</th><th>Surface Finish</th><th>Finish method</th></tr><tr><td>to 5</td><td>$Ra < 0.8\mu m$</td><td>Paper finish after grinding</td></tr><tr><td>5 ~ 10</td><td>$Ra < 0.4\mu m$</td><td>Paper finish after grinding</td></tr><tr><td>10-up</td><td>$Ra < 0.2\mu m$</td><td>Lapping, or superfinishing, or electro polishing after quenching and grinding</td></tr></table> | Speed (m/s) | Surface Finish | Finish method | to 5 | $Ra < 0.8\mu m$ | Paper finish after grinding | 5 ~ 10 | $Ra < 0.4\mu m$ | Paper finish after grinding | 10-up | $Ra < 0.2\mu m$ | Lapping, or superfinishing, or electro polishing after quenching and grinding |
| | Speed (m/s) | Surface Finish | Finish method | | | | | | | | | | | | |
| | to 5 | $Ra < 0.8\mu m$ | Paper finish after grinding | | | | | | | | | | | | |
| 5 ~ 10 | $Ra < 0.4\mu m$ | Paper finish after grinding | | | | | | | | | | | | | |
| 10-up | $Ra < 0.2\mu m$ | Lapping, or superfinishing, or electro polishing after quenching and grinding | | | | | | | | | | | | | |
|  |  | <p>2) Seal contact to shaft section should be minimum hardness of HRC40. HRC55 or even higher is desirable.</p> <p>3) Dimensional tolerance of seal contact to shaft section should be h9 and the counterpart for seal housing should be H8 or H7.</p> | | | | | | | | | | | | | |
|  |  Example 1  Example 2 | <p>4) Since there are various shapes and materials for seal, select those that meet purposes.</p> <p>5) Control the shaft eccentricity to under 0.02 to 0.05 mm where possible.</p> <p>6) Coat the contact surfaces of seal and shaft with lubricant at initial installation.</p> | | | | | | | | | | | | | |

8.5 Lubrication



8.5.1 Functions of Lubrication

The main purpose of lubricants in rolling contact bearings is to reduce friction and wear of each element. Lubricants perform this function by separating rolling and sliding surfaces with a very thin film of oil. Bearing performance and service life is largely dependent on the suitability of the lubricating system and lubricant to the application. Functions of lubrication in rolling contact bearings are:

- ① Lubrication of friction surfaces:
Reduction in;
 - 1) Rolling friction between the rolling elements and raceways.
 - 2) Sliding friction between roller end and guide faces of roller bearings.
 - 3) Sliding friction between the rolling elements and retainer.
 - 4) Sliding friction between the retainer and raceway guide surface.
- ② Removal of the heat from system produced by friction and external sources. An example of the heat removal function would be use of a circulating oil lubrication system for a high-speed application.
- ③ Dust-proofing and rust prevention:
 - 1) Prevention of foreign material from entering the bearing.
 - 2) Protection of bearing components from corrosion.
- ④ Relief of stress concentration:
 - 1) Uniform distribution of stress to the rolling contact surface.
 - 2) Relief of impact loads.

8.5.2 Lubrication Cautions

- ① Adequate lubricant film separation should be maintained between friction surfaces.
- ② Since the oil film required on contact surfaces is thermally feeble, adequate oil viscosity must be maintained.
- ③ Since lubricants tend to deteriorate with increase in temperature, bearing applications should be designed to keep the operating temperature as low as possible.
- ④ The lubricating system (method) must be suitable for the application and the lubricant must have appropriate properties.
- ⑤ The lubricant must be kept free from contamination.



8.5.3 Lubricating Methods

(1) Oil Lubrication

(1.1) Oil Bath Lubrication

- Oil bath lubrication is generally used for low-to-medium-speed operation.
- Excessive oil causes churning which can cause excessive temperature rise. Insufficient oil will probably lead to early bearing failure.
- Oil level gauges are recommended to check (and maintain) the proper oil level.
- Separation ribs may be installed at the bottom of the housing to reduce churning and or to dissipate heat. See Fig. 8.25.
- Static oil level should be at slightly below the center of the lowest rolling element of a bearing applied to a horizontal shaft. For vertical shafts, static oil level should cover 50% to 80% of the rolling element.
- When two or more bearings are used on a vertical shaft in the same housing, the lower bearing may create excessive temperature rise if an oil bath system is used (unless operated at very low speed). If excessive heat occurs, use a drip, splash, or circulating oil system.

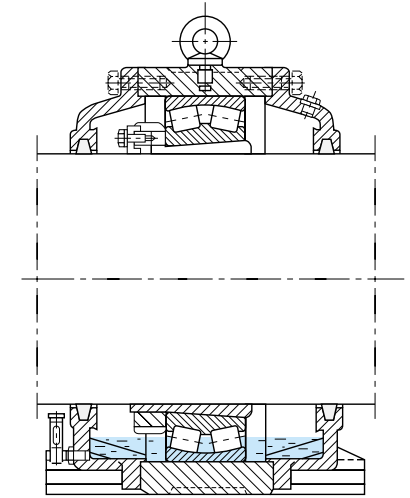


Fig. 8.25

(1.2) Splash Lubrication

- In splash lubrication, oil is splashed on the bearing by a rotating element (an impeller or "slinger") mounted on the shaft. The bearing is not immersed in the oil.
- In a gear box, the gears and bearings are often lubricated from a common oil reservoir with the gears serving as a slinger. Since oil viscosity for the gears may differ from that required for the bearings and the oil may contain particles worn from the gears, a separate lubrication system or method may provide improved bearing life. Sealed or shielded bearings and "magnetic" plugs are often used in conjunction with gear drives.
- A bearing on a vertical shaft can be provided with a conical rotary element under the bearing so that the oil rises on the conical surface and is atomized before entering the bearing. See Fig. 8.26.

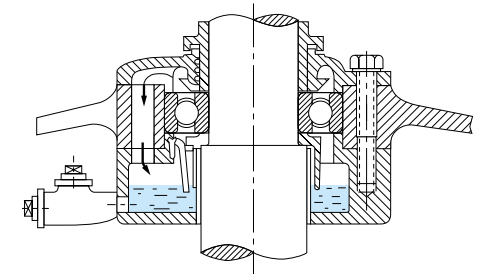


Fig. 8.26

(1.3) Drip Lubrication

- Drip lubrication is used for bearings operated at relatively high speeds under low-to-medium loads.
- Drip lubrication is generally used for the radial bearing on a vertical or inclined shaft and oil is fed directly to the bearing.
- The lubricating oil is contained in a lubricator, and is fed to the bearing through a wick which also serves as a filter. A sight window is provided to allow checking the oil level.

Fig. 8.27 shows a drip lubricating system provided with a lubricator on top of the housing. Oil is dripped onto the shaft nut in the bearing box, and is atomized before entering the bearing.

Fig. 8.28 shows an oil metering system designed to feed several oil drops per minute to the bearing.

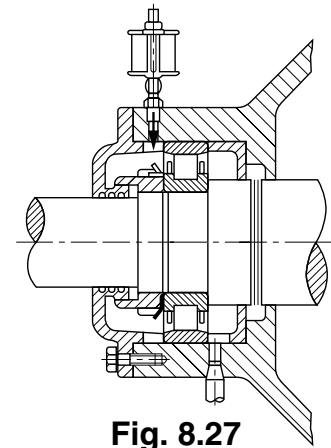


Fig. 8.27

(1.4) Circulating Oil Lubrication

- Circulating oil lubrication is used for two purposes:
 - 1) To cool the bearing.
 - 2) To automatically feed oil to a specific area from a central system.
- A circulating oil system consists of an oil pump, cooling device, filter and delivery piping. Circulating oil systems utilize the pumping action of the bearings and augment the cooling effects of slingers.
- Circulating oil lubrication includes: drip, forced, and spray-mist lubrication.
- In the circulating oil lubricating system, the bearing is provided with an oil inlet located on one side of the bearing, and an oil outlet on the other side of the bearing.
- The oil outlet should be larger than the oil inlet so that excess oil does not remain in the bearing housing.

Fig. 8.29 shows a circulating system with an oil passage in the area of the housing which carries no load. This system is for steam-heated calender rolls in a paper mill. Cooled oil is circulated through the inner wall of the housing and passes through both bearings.

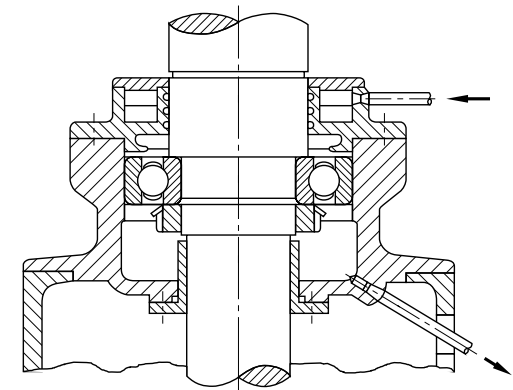


Fig. 8.28

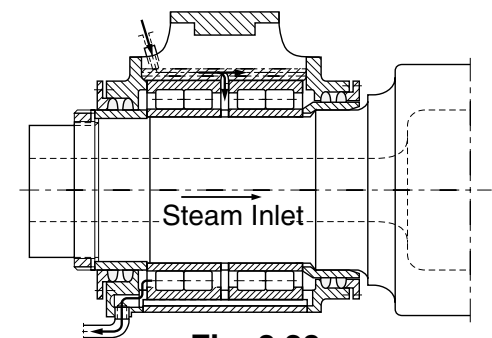


Fig. 8.29

(1.5) Forced Lubrication

Forced lubrication is used to feed oil under pressure to overcome internal housing pressure in high-speed operation.

- The oil outlet should have a cross section twice that of the oil inlet.
- A "jet" lube system is sometimes used in high-speed applications to target oil directly to the rolling and sliding components of the bearing. See Fig. 8.30. Excessive oil should be discharged with a pump.

(1.6) Disk Lubrication

Disk lubrication utilizes a disk on the shaft which rotates at high speed. The disk is partially submerged in oil, and splashes oil to an upper oil sump, which in turn delivers the oil to the bearing by gravity. Disk lubrication is used on the bearings of superchargers and blowers. See Fig. 8.31.

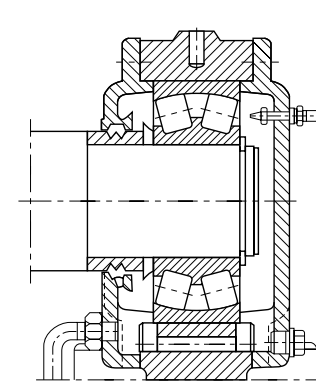


Fig. 8.30

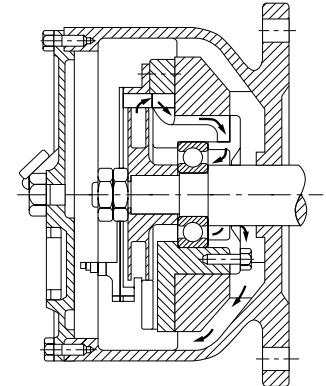


Fig. 8.31

(1.7) Spray Mist Lubrication

- Fig. 8.32 shows an example of spray lubrication, which uses a turbo-compressor impeller to force oil into the bearing.
- Fig. 8.33 shows an example of oil mist applied to an oil atomizer (0.5 to 5.0 cc/h).

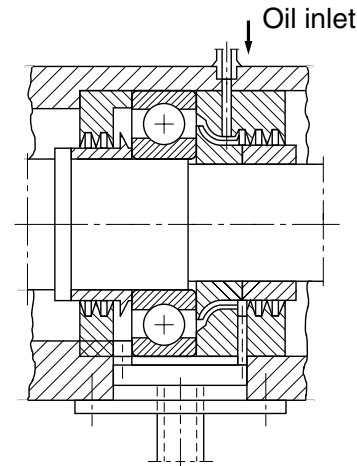
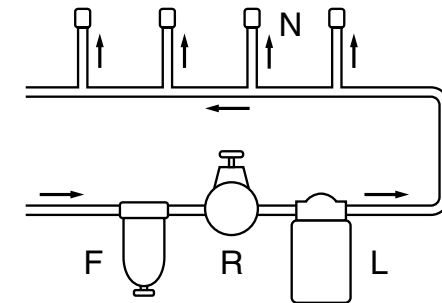


Fig. 8.32



F : air filter R : pressure regulator
L : oil atomizer N : nozzle

Fig. 8.33

(1.8) Oil/Air Lubrication

Using the oil/air lubrication, a very small amount of oil is mixed with a certain amount of compressed air with a constant-quantity piston and mixing valve. This mixture is supplied to rolling part of bearings.

Because oil/air lubrication can remove heat generation from bearings, this method is suited for high speed application such as machine tool.

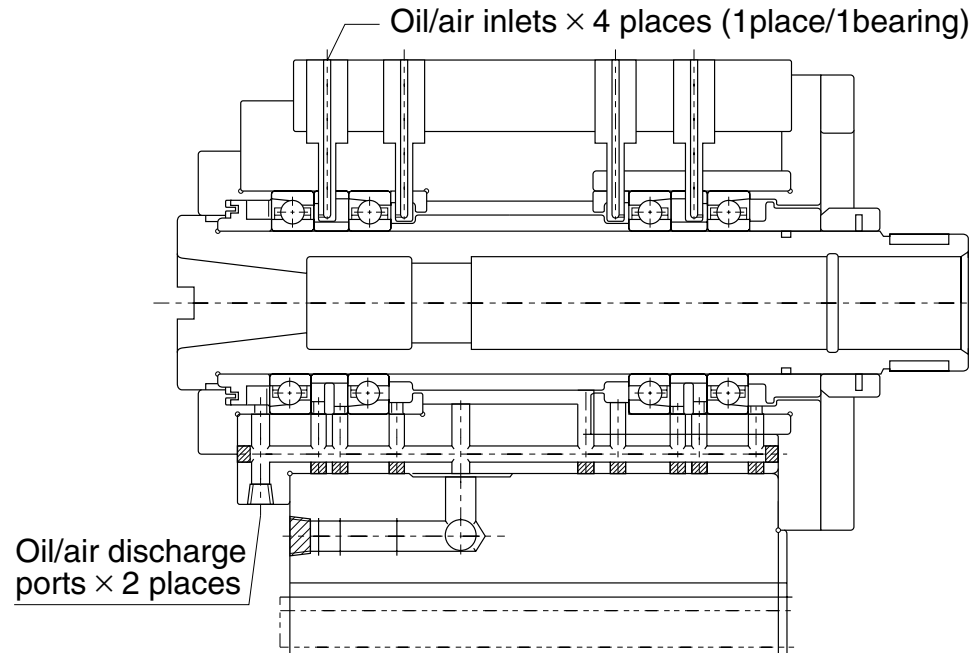


Fig. 8.34

(2) Grease Lubrication

In using grease lubrication, the following items should be considered:

- Select grease having correct properties.
- Grease must be delivered in the right amount to the correct bearing area.
- Determine method of relubrication. Different greases should not be mixed because it can cause a poor lubrication performance.
- Consider centralized lubrication for large-size machinery such as rolling mill equipment. See Fig. 8.35.1.

Fig. 8.35.2 shows a design utilizing a grease supply plate. Symbols S, R, and Z refer to the nozzle, oil groove, and supply plate, respectively.

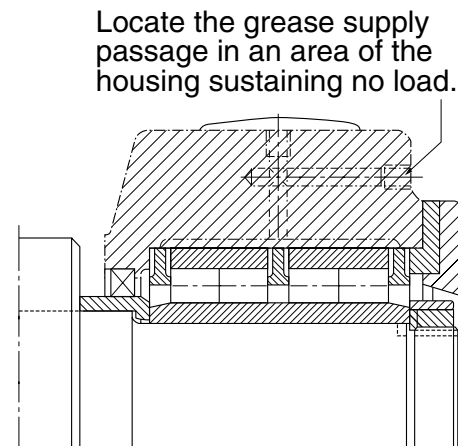


Fig. 8.35.1

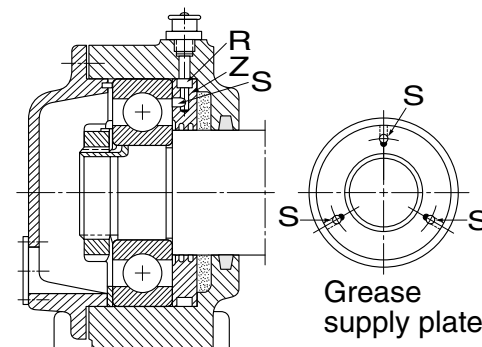


Fig. 8.35.2

8.5.4 Lubricants

Rolling contact bearings use two forms of lubricants; lubricating oil and grease. In some special applications, solid lubricant such as molybdenum-disulfide, graphite, or PTFE are used. The lubricant should have the following properties:

- Low impurity and moisture content
- Temperature stability
- Non-corrosiveness
- Load pressure resistance
- Anti-wear action
- Anti-friction action
- High mechanical stability

See Table 8.22 for a guide to selection of lubricating oil and grease.

Table 8.22 Guide to selecting Oil and Grease

| Operating Condition | Grease | Oil |
|-------------------------|--------------------------------------|---|
| Temperature | Available for range of -30° to +150° | Applicable for high temperatures (with circulating cooling) |
| Speed | Low to medium speeds | Applicable for high speed operation (depending on lube method) |
| Load | Low to medium loads | Suitable for high loads |
| Housing Design | Simple | Complicated by sealing requirements |
| Maintenance | Easy | Easy to difficult |
| Centralized Lubrication | Possible | Possible |
| Dust Filtration | Dependent on seal devices. | Possible (Circulating lubrication provides a filter to trap dust) |
| Rolling Resistance | Relatively high | Small (Correct oil quantity must be maintained) |

A wide variety of lubricating oils and greases are commercially available for rolling contact bearings. It is important to select oils or greases with base oils having a viscosity which is appropriate for the operating condition. Table 8.23.1 and [8.23.2](#) give generally recommended viscosities for bearings under normal operating conditions.

Table 8.23.1 Bearing types and Proper Viscosity of Lubricating Oils

| Bearing Type | Viscosity at Operating Temperature |
|--|------------------------------------|
| Deep Groove Ball Cylindrical Roller | Over 13 mm ² /s |
| Tapered Roller Spherical Roller | Over 20 mm ² /s |
| Spherical Roller thrust | Over 32 mm ² /s |

Remarks: 1mm²/s = 1cSt (centistokes)

Table 8.23.2 General Oil Selection Guide

(1) Lubricating Oil

Oils with a viscosity too low for the application may allow a partial loss of raceway to rolling element separation, leading to early bearing failure. Oils with too high a viscosity will cause an increase in torque, resulting in power loss and abnormal temperature rise. In general, as the load increases, increase the oil viscosity. As speed of rotation increases, decrease the oil viscosity. For Extra-small or Miniature ball bearings, low-viscosity lubricating oil will often be selected for low-torque requirements. [Table 8.23.2](#), and [Fig. 8.36](#) on following pages can be used to aid in selection of appropriate oil viscosity.

Fig 8.36 Viscosity-Temperture Line Diagram

Table 8.23.2 General Oil Selection Guide

| Bearing Operating Temperature (°C) | dn value | ISO Viscosity grade (VG) of lubricating oil | | Suitable bearing type(s) |
|------------------------------------|-------------------|---|----------------------|--|
| | | Normal load | Heavy or impact load | |
| -30 ~ 0 | Up to speed limit | 22 32 | 46 | All |
| 0 ~ 60 | Up to 15000 | 46 68 | 100 | All |
| | 15000 ~ 80000 | 32 46 | 68 | All |
| | 80000 ~ 150000 | 22 32 | 32 | Except thrust ball bearing |
| | 150000 ~ 500000 | 10 | 22 32 | Single row deep groove ball and cylindrical roller bearing |
| 60 ~ 100 | Up to 15000 | 150 | 220 | All |
| | 15000 ~ 80000 | 100 | 150 | All |
| | 80000 ~ 150000 | 68 | 100 150 | Except thrust ball bearing |
| | 150000 ~ 500000 | 32 46 | 68 | Single row deep groove ball and cylindrical roller bearing |
| 100 ~ 150 | Up to speed limit | 320 | | All |
| 0 ~ 60 | Up to speed limit | 46 68 | | Spherical roller bearings |
| 60 ~ 100 | Up to speed limit | 150 | | |

- Remarks:
1. This Table shows the guide for selecting oil, based on JIS K 2001 classification of Industrial Lubricating Oil Viscosity.
 2. Generally as load increases or speed decreases, viscosity is increased.
 3. This Table is applicable for oil bath lubrication and circulating oil lubrication.
 4. For information on operating conditions beyond those of This Table, contact NACHI.

Fig 8.36
Viscosity-Temperature
Line Diagram

Example:

Bearing Type : Cylindrical
roller bearing
Bearing Bore : 340mm
Rotating Speed : 500rpm
Operating temp : 70 °C

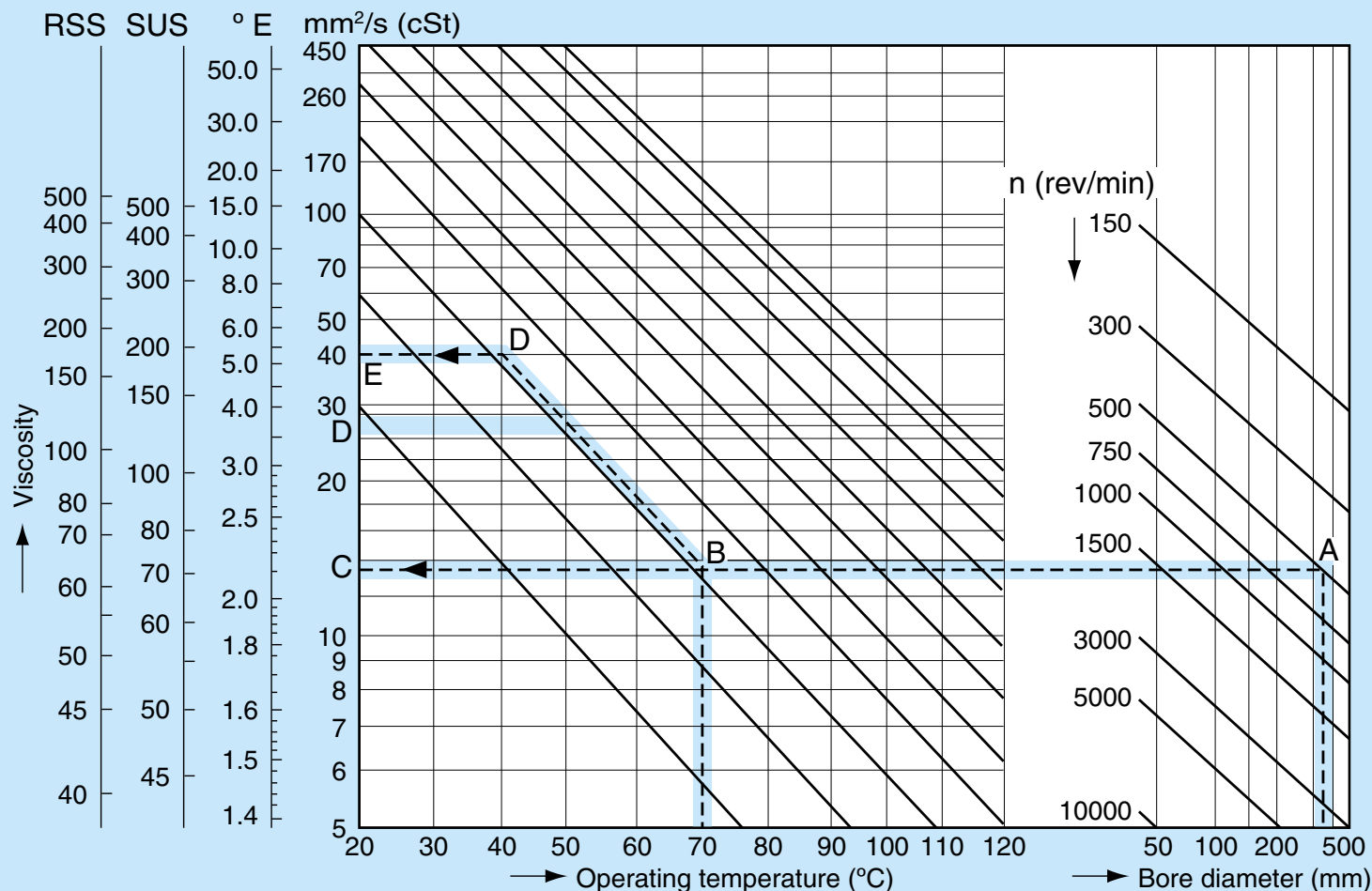


Fig. 8.36 can be used to select both the correct minimum viscosity at operating temperature and to establish the required oil viscosity rating (at 40°C) which will meet the specified minimum viscosity .

Find the intersection of 340 and 500 (see point A) and an horizontal line from point A to point C (intersection of Y-axis)

To find the minimum viscosity required AT THE OPERATING temperature: read the minimum viscosity required (13mm²/s) at point C.

To establish the required oil viscosity rating ;

- 1) At the intersection of A - C and a vertical line from 70 (point B), draw a line toward the 40° -axis line parallel to the closest viscosity-temperature line.
- 2) Draw a horizontal line from the point (point D) of intersection of the above line with the 40° -axis to the Y-axis (see point E).
- 3) Read the viscosity 40mm²/s at point E. As a result, ISO viscosity grade VG46 should be selected.

(2) Lubricating Grease

Lubricating grease is composed of a base oil, a thickener, and additives.

• Base Oil

Base oil refers to the liquid lubricant carried by a thickener. Mineral oils are widely used as the base oils for grease. Synthetic oils such as diester or silicone oil are also used for improving the heat resistance and stability of grease. In general, grease with a low-viscosity base oil is suitable for low temperatures and or low loads, while grease with a high viscosity base oil is suitable for high temperatures and or high loads.

Since lubricating performance is dependent on the thickener, additives, and viscosity, these components must be carefully selected to meet operating conditions.

• Thickener

The thickener has a sponge-like structure composed of a loose combination of fine fibers or particles. Thickeners are roughly divided into metal soap, and non-soap types as shown below.

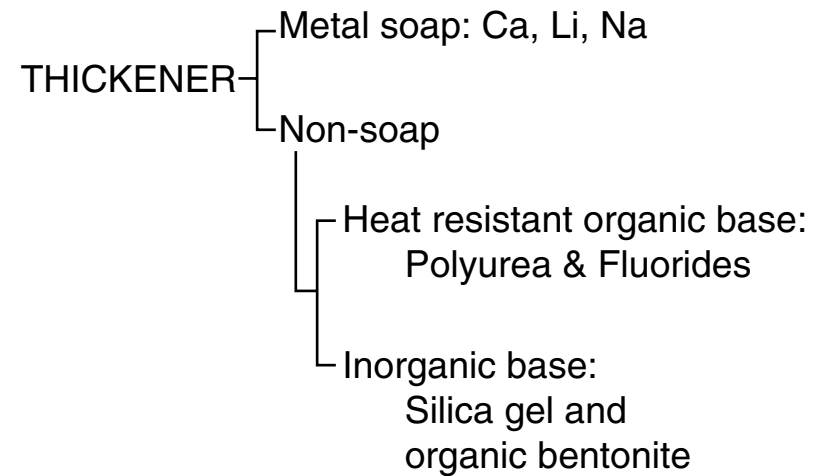
Sodium (Na) soap grease may react with water to form an emulsion, and should not be used for bearings operating in a high-moisture atmosphere.

• Additives

An additive is an agent that provides extreme pressure and rust resistance, anti-oxidation performance, and other properties to grease.

Various additives are added to grease to provide specific properties to the grease. Additives such as anti-oxidants, extreme pressure enhancers, and rust preventatives are often added to lubricating greases.

Anti-oxidant additives protect grease from oxidation and deterioration under thermal influence over a long period. Extreme pressure additives improve load resistance and impact resistance. Rust preventive additives protect the bearing and other surrounding components against rusting.



• Penetration

Penetration is a measure which indicates the solidity of grease. A measurement device has a cone with a specified weight and shape. The cone is penetrated into the sample grease for a specified time. Penetration is the depth to which the cone penetrates (in units of 1/10 mm).

• Dropping Point

Dropping point is the temperature at which a grease sample drops through a specified hole size after being heated and fluidized.

Table 8. 24 Grease Number and Penetration

| NLGI No. | ASTM Worked penetration | Grease is numbered differently by the grease manufacturers. Numbers 250 and 300 of cup and fiber grease generally use penetration (at 25°C), while most versatile greases employ NLGI penetration numbers such as 0, 1, and 2. |
|----------|-------------------------|--|
| 0 | 355 ~ 385 | |
| 1 | 310 ~ 340 | |
| 2 | 265 ~ 295 | |
| 3 | 220 ~ 250 | |
| 4 | 175 ~ 205 | |
| 5 | 130 ~ 160 | |
| 6 | 85 ~ 115 | |

(3) Lubrication Amount

① Oil

When oil bath lubrication is being used and a bearing is mounted with its axis horizontal, oil should be added until the static oil level is at the center of the lowest bearing rolling element. For vertical shafts, add oil to cover 50% to 80% of the rolling element.

② Grease

The rolling bearing and bearing housing should be filled until the grease occupies about 33 to 50 % of the respective volumes. Temperatures will tend to rise as speed increases (due to churning). Higher-speed operation will be more sensitive to excess grease fill, so it follows that at higher dmn values, the grease-fill quantity must be reduced.

a) Amount of Initial Grease Fill

The amount of initial grease-fill required is calculated from the following equations:

Ball bearing:

$$Q = \frac{d^{2.5}}{900} \quad \dots\dots\dots (8.18)$$

where:

Q =Amount of filling grease (g)
(specific gravity of grease=0.9)
d =Bore diameter of bearing (mm)

Roller bearing:

$$Q = \frac{d^{2.5}}{350} \quad \dots\dots\dots (8.19)$$

b) Relubrication Amount Added at Service

$$Q = 0.005 \times D \cdot B \quad \dots\dots\dots (8.20)$$

where:

Q =Amount of grease to add (g)
(specific gravity of grease=0.9)
D =Outside diameter of bearing (mm)
B =Inner ring width (mm)

③ Lubrication Interval

For a typical bearing, which operates at about 50°C, lubricant should be replaced once a year. If operating temperature is 100°C or more, the lubricant should be replaced more than once every three months even if it has good heat stability.

If oil bath lubricant becomes contaminated by water or foreign particles, it must be replaced immediately.

The grease relubrication interval can be estimated from Fig 8.37.

Fig. 8.37 Grease lubrication interval

④ Grease Service Life

For applications where relubrication is not possible or practical, grease service life may be estimated using Formula (8.21).

The following formula was derived using a grease with Lithium thickener and mineral oil base.

$$\log L = (0.018f - 0.025)T - 2.77f + 6.3 \quad \dots\dots\dots (8.20)$$

where:

L =Grease life (h)

f =(Operating speed) (rpm)/
(Bearing grease speed limit) (rpm)

If f is less than 0.25, f is set = 0.25

T =Operating temperature (°C)

If T is less than 30°C, T is set = 30.

Table 8.25 Grease Properties

Fig. 8.37
Grease lubrication interval

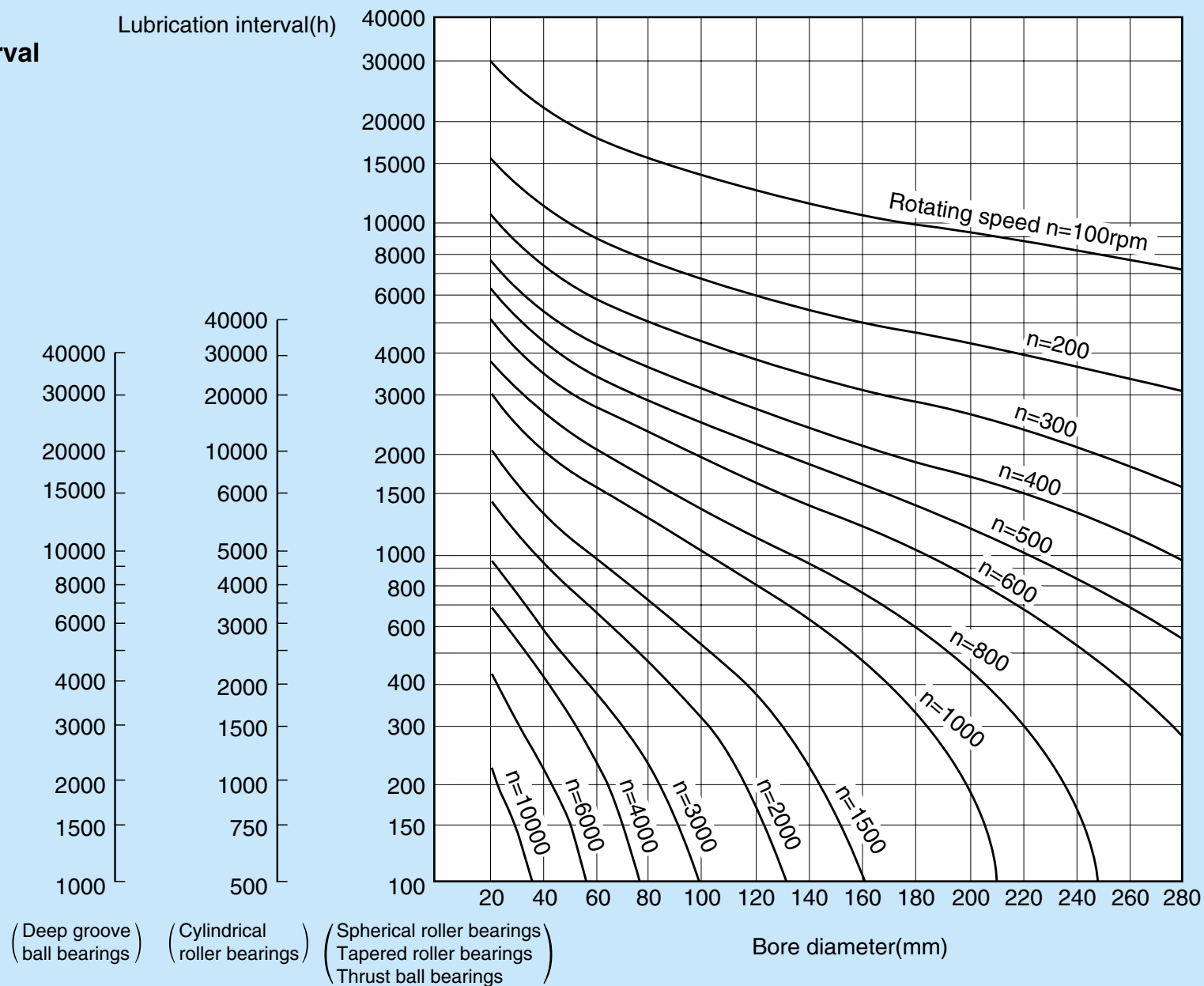


Table 8.25 Grease Properties

| <div> <div>Popular Name</div> <div>Thickener</div> <div>Base Oil</div> <div>Properties</div> </div> | Cup Grease | Fiber Grease | Aluminum Grease | General -purpose Grease | Diester Grease | Silicone Grease | Mixed Base Grease | Complex Grease | Non-Soap Base Grease | |
|---|---|--|---|---|--|---|-----------------------------|---|---|---------------|
| | Ca Soap | Na Soap | Al Soap | Li Soap | | | Ca + Na Soap, etc. | Li Complex Soap, etc. | Bentonite, Urea Fluoric, etc. | |
| | Mineral Oil | Mineral Oil | Mineral Oil | Mineral Oil | Diester Oil | Silicone Oil | Mineral Oil | Mineral Oil | Mineral Oil | Synthetic Oil |
| Dropping Point (°C) | 85 | 160 or Higher | 85 | 170 or Higher | | 200 or Higher | 150 or Higher | 200 or Higher | 250 or Higher | |
| Working Temperature (°C) | -20 ~ +70 | -10 ~ +120 | -10 ~ +80 | -30 ~ +120 | -50 ~ +130 | -50 ~ +170 | -30 ~ +120 | -30 ~ +140 | -10 ~ +130 | -50 ~ +200 |
| Water Resistance | Good | Poor | Good | Good | | | Poor for Na Soap | Good | Good | |
| Mechanical Stability | Fair | Good | Fair | Good | | | Good | Good | Good | |
| Remarks | Contains small amount of moisture for structure stability Not suitable for use at high temperature | Can not be used with water or moisture due to emulsification with water Used at relatively high temperature | Used in vibrating condition due to good tackiness | General purpose grease widely used small or medium size ball bearings | Suitable for low temperature operation | Wide working temperature range Mainly for light load conditions. | Used in large size bearings | Suitable for high temperature and heavy load conditions | Wide working temperature range Depending on combination of thickener and base oil used, good high temperature, low temperature or chemical stability can be obtained | |

- Note: 1. Greases with sodium (Na) soap thickener can not be used in applications there is a risk of water or high humidity because they became soft and flow out if they mix with water.
2. In case of mixing different brands of grease (not recommendable), please consult grease manufacturer to determine if there are any detrimental effects.
3. In case operating temperature are beyond what is shown in the table, please consult NACHI.

8.6 Speed Limit

- Bearings exceeding a certain operating speed will begin to create internal heat which may not be controllable.
- Speed limits vary with bearing types, dimensions, lubrication system, internal design of the bearing, and working loads. In addition, speed limits will vary according to the type of integral bearing seal which may be used (dependent on the speed of the seal contact area).
- The term "speed limit" refers to the estimated speed, in revolutions per minute, at which bearings will remain serviceable.

The dimension tables show speed limits for both grease and oil lubrication. Please note that the published speed limits are based on operation of properly lubricated, lightly-loaded bearings, installed on a horizontal shaft.

8.6.1 Speed Limit Correction for Load

As noted above, bearing speed limits will vary with respect to load. [Figs. 8.38.1](#) and [8.38.2](#) allow calculation of a speed limit correction factor which is applied to the speed limit tables.

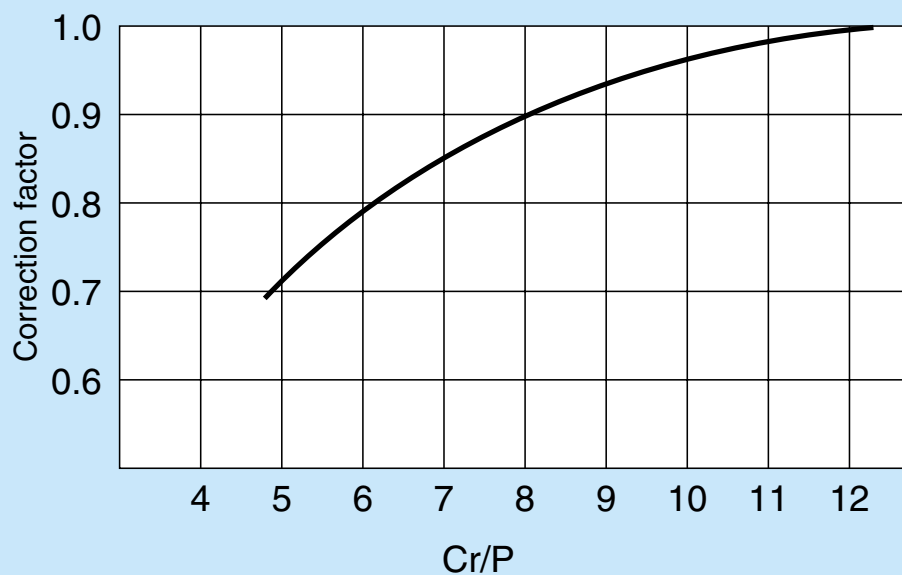
- In [Fig. 8.38.1](#), C_r is the basic dynamic load rating and P is the equivalent dynamic load. If C_r/P is < 13 , then the table speed limit is multiplied by the correction factor from the curve shown in [Fig. 8.38.1](#).
- In addition, if the ratio of the axial load (F_a) to the radial load (F_r) is larger than 0.3, that is, if $F_a/F_r > 0.3$, then the speed limit must be FURTHER multiplied by a correction factor as shown in [Fig. 8.38.2](#)
- Where the bearing is used at 75% or more of the speed limit, lubrication becomes a more sensitive operating consideration. If grease is to be used, then selection of the correct type and amount of grease is of paramount importance. If oil is used, then the correct selection of the feeding method and rate, and oil specification is of extreme importance.
- Please contact NACHI for help in cases where application rotating speed exceeds the corrected bearing speed limit.
- If the bearing is used in excess of the corrected speed limit, consideration must be given to the accuracy and clearance of the bearing; and to the material and shape of the retainer. Table 8.26 provides a guideline for maximum speed for bearings using special cages and internal design.

Table 8.26
Correction of Allowable Speed Limit
in High-speed Operation

| Bearing type | Correction Factor |
|---------------------------------|-------------------|
| Deep groove ball | 2.5 |
| Angular Contact ball | 2 |
| Cylindrical roller (single-row) | 2.5 |
| Tapered roller | 2 |
| Spherical roller | 1.5 |

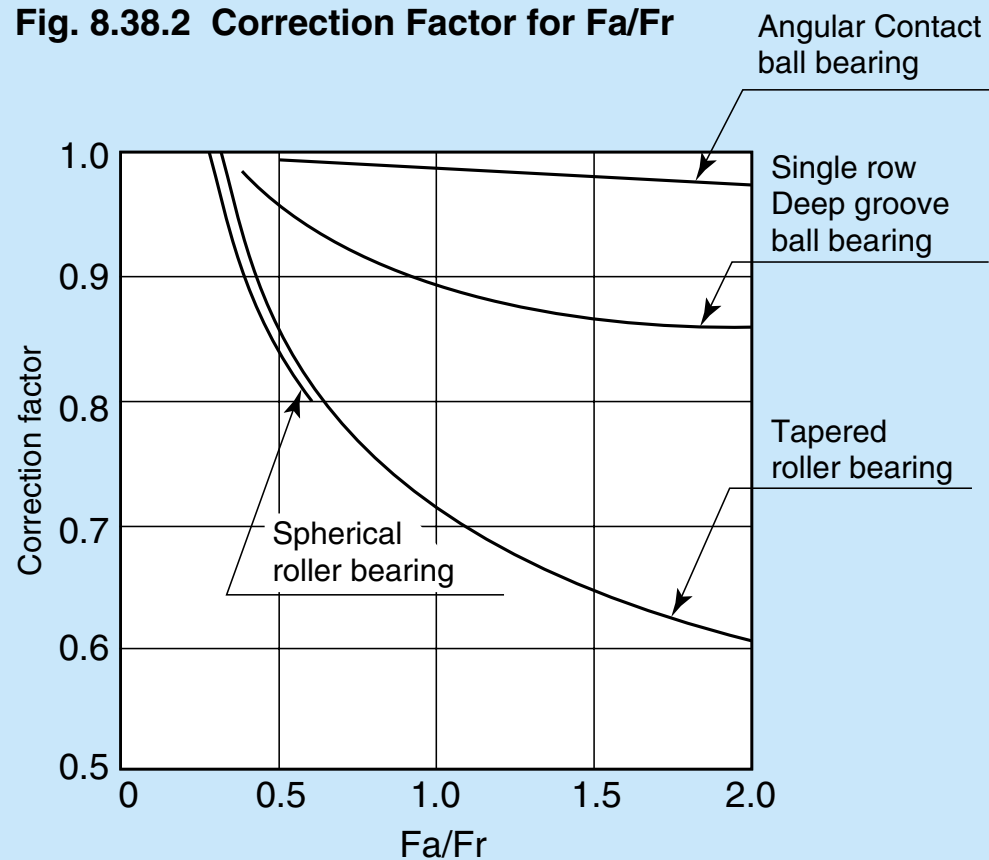
[Fig. 8.38.1 Correction Factor for Bearing Load](#)
[Fig. 8.38.2 Correction Factor for \$F_a/F_r\$](#)

Fig. 8.38.1 Correction Factor for Bearing Load



C_r : Dynamic load rating (N)
 P : Dynamic equivalent load (N)

Fig. 8.38.2 Correction Factor for F_a/F_r



F_a : Axial load (N)
 F_r : Radial load (N)

8.7 Friction and Temperature Rise

8.7.1 Friction Torque

Friction torque in rolling bearings will vary with the bearing load and the condition of the lubricant. Where the bearing load is light-to-normal ($P \leq 0.12C$) and the lubricant provides good separation between the rolling contact surfaces, bearing friction torque may be calculated using the following formula:

$$M = \mu \cdot F \cdot \frac{d}{2} \quad \dots\dots\dots (8.22)$$

where:

M = friction torque (N·mm)

μ = coefficient of friction

F = bearing load (N)

d = shaft diameter (mm)

The coefficient of friction for various bearing types is shown in Table 8.27.

Table 8.27 Coefficient of Friction

| Bearing type | Coefficient of friction (μ) | Load condition |
|---------------------------------------|-----------------------------------|----------------|
| Ball Bearings: Single row deep groove | 0.0010 ~ 0.0015 | Radial load |
| Single row angular contact | 0.0012 ~ 0.0018 | Radial load |
| Self-aligning | 0.0008 ~ 0.0012 | Radial load |
| Thrust | 0.0010 ~ 0.0015 | Axial load |
| Roller Bearings: Cylindrical | 0.0008 ~ 0.0012 | Radial load |
| Spherical | 0.0020 ~ 0.0025 | Radial load |
| Spherical thrust | 0.0020 ~ 0.0025 | Axial load |
| Tapered | 0.0018 ~ 0.0025 | Radial load |

8.7.2 Temperature Rise

- Temperature rise in bearings is caused by the conversion of friction energy into heat.
- Bearing temperature will generally rise quite abruptly during the initial stage of operation and then gradually climb until a steady state is reached. The steady state condition will exist if temperature rise from frictional energy is removed by the cooling "heat-sink" effect from the shaft and housing, and from heat conductance via the shaft, housing and lubricant.
- The time until equilibrium is attained depends on the difference between heating volume generated by the bearing and the heating volume removed by the cooling effect.
- If the equilibrium temperature is excessively high, then review of the bearing application should be done. The bearing internal clearance or preload, fits, bearing support structure, seal contact area surface finish, rotating speed, load, and lubrication type, amount, and delivery system are subjects for investigation where excessive temperature occurs.
- An abnormal temperature rise can cause a spiraling condition where no equilibrium will occur, thus leading to a break-down in the lubricant and lubricant film, with catastrophic results.

8.8 Mounting and Dismounting

Rolling bearings have higher accuracy than other parts in most equipment and are often considered to be the most important rotating component. Improper handling of bearings reduces machine accuracy and can cause early bearing failures. To attain predicted bearing performance, utmost care should be taken in handling bearings from the point-of-receipt through the mounting operation.

8.8.1 Storage and Handling

The major problems encountered during the bearing storage and retrieval operations are in rusting and impact damage to the parts.

- To protect bearings against rusting during storage, parts should be placed in a dry, clean, cool area. Bearings should not be subjected to extremes of humidity during storage.
- Impacts to bearings can create damage to the raceways, rolling elements, and cages. Do not drop bearings. Bearings which are dropped should not be used for service.

8.8.2 Mounting

Proper bearing mounting governs the life, accuracy, and performance of a bearing. Before mounting the bearing, carefully check the following points.

Check to see if:

- the job standards are established and the necessary jigs are prepared.
- the shaft and housing size, tolerance, and finish are defined and met.
- lubricant type and amount specified is at hand.
- inspection standards are established.
- the method of cleaning the bearing and relevant parts is clear.

(1) Mounting Precautions

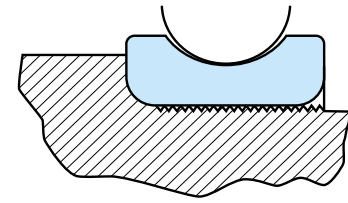
- Select a clean, dry place to handle the bearing, and keep necessary tools and workbench clean.
- Do not unpack the bearing until it is to be mounted.
- If the bearing is unpacked before mounting for acceptance inspection or for any other reason, follow these directions:

- a) If the bearing is to be mounted within a short time period, coat it with rust preventive oil and place it in a clean container.
- b) If the bearing will not be mounted in a short time, coat it with rust preventative oil and repack it in the original container.

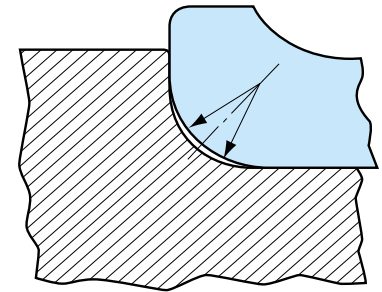
- Check to see that the lubricant drums, cans, tubes, or applicators are clean and or closed. Check to be sure that the bearing housing is clean and free from flaws, impressions, burrs, or any other defects.
- For grease lubrication, you may fill the new bearing with grease without cleaning the bearing. If the bearing is small or is used for high-speed operation, whether it is lubricated with oil or grease, wash the bearing with clean kerosene or warm, light oil to remove the rust preventative. However bearings with seals or shields must not be washed and heated. If gear oil is used for lubrication, clean the bearing to remove any rust preventive oil.

(2) Shaft

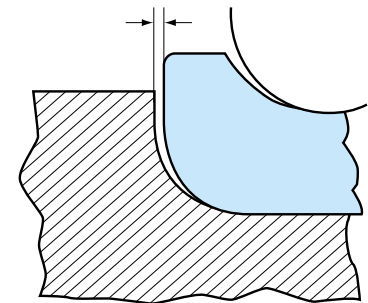
- Before mounting the bearing on the shaft, check to see that the shaft is finished to the specified size and accuracy.
- Check the shaft for surface finish. If the shaft fit surface has a poor surface finish (see Fig. 8.39), the surface may be smoothed during mounting, possibly resulting in bearing ring creep, shaft wear, and early bearing failure.
- Be sure that the shaft shoulders are finished at a right angle to the shaft axis, otherwise the bearing will be misaligned resulting in early bearing failure.
- Finish the corner radius of the shaft to the specified dimensions. Make sure the corner radius of the shaft is slightly smaller than that of the bearing as shown in Fig. 8.40. Never have the corner radius of the shaft larger than that of the bearing (see Fig. 8.41), otherwise, the bearing ring may be misaligned and early bearing failure will occur.
- Out-of-roundness of shaft
Make sure that the shaft is accurate to out-of-roundness and cylindricity specifications. The inner ring of the bearing is an elastic body, having a relatively thin wall, so if the inner ring is fitted to a shaft having poor roundness, the inner ring raceway will be deformed accordingly.
- Contact surface of oil seals
When using an oil seal, finish the seal contact surface to $Ra < 0.8 \mu m$. If the finish is rougher than $Ra < 0.8 \mu m$, the seal will gradually wear until it has no sealing effect. Also make sure that the contact surface is within the runout tolerance, otherwise oil leaks may occur since the seal lip may not stay in contact with the rotating shaft.



Surface finish
Fig. 8.39



Corner radius of shaft (Good)
Fig. 8.40



Corner radius of shaft (Poor)
Fig. 8.41



(3) Bearing Housing

- Purposes of the bearing housing are:

- a) to maintain the bearing position for load support.
- b) to protect the bearing from the intrusion of foreign material.
- c) to provide a structure that will keep the bearing well lubricated.

- Verify that the housing bore diameter is to design specifications. If a loose fit class of H or looser is specified, check to make certain that the bearing will move freely in the bearing housing during installation. On horizontally-split bearing housings such as used on pillow blocks, do not mix the caps and bases during a reassembly procedure since these parts are mated during manufacture. In the latter case, mixing may cause either pinching or looseness of the bearing.
- Allowance must be made for linear expansion of the shaft due to temperature rise. When two or more bearings are mounted on a single shaft, comply with the following directions:
Fix one bearing in the axial direction in the housing, and make sure that the other bearing(s) are free to move in an axial direction.

(4) Accessory Mounting Parts

Prior to bearing mounting, gather a set of the parts required for the mounting job. These accessory parts may include washers, adapters, withdrawal sleeves, spacer rings, slingers, oil seals, O-rings, shaft nuts, and snap rings for the shaft and or housing bore. Thoroughly clean these accessory parts and check them for appearance and size.

Other Precautions

- Be sure that the side of the shaft nut is at a right angle to the thread, otherwise, when tightened, the side of the shaft nut will make uneven contact with the side of the bearing causing early bearing failure. Use particular care when the bearing is used for high-accuracy applications such as lathes.
- Check the washer and spacer ring for parallelism of both sides.
- The oil seal and O-ring may create a temperature rise because the contact force is too great or because they are initially dry. Apply oil or grease to the contact surfaces to help prevent premature wear and reduce torque.



8.8.3 Bearing Mounting Considerations

When pressing a bearing into position, press against the ring with interference fit. Pressing through the rolling elements will cause damage, such as brinell marks or cracks to the elements and rings and the bearing will be unusable.

For inner ring rotating loads, the bearing is generally interference-fit to the shaft and either expansion fitting or press fitting can be used. expansion fitting may be the more appropriate method for mounting larger bore bearings.

A tapered-bore bearing can be mounted directly to a tapered shaft or with an adapter or withdrawal sleeve. When a withdrawal sleeve is used for larger bore bearings, the hydraulic mounting procedure will facilitate the process. Note that the use of hydraulic mounting of bearings to tapered journals is also very useful for larger bearing sizes.

For an outer ring rotating load, the bearing is usually interference-fitted with the housing. Either press fitting or shrink fitting may be used. In the case of the latter process, the bearing or bearing outer ring may be cooled to attain the fit.

(1) Mounting Cylindrical-bore Bearings

• Press fitting

Many cylindrical-bore bearing applications use press fitting with the shaft. Use a jig which matches the inner ring as shown in Fig. 8.42. Press fit the inner ring using a press or jack.

To press fit the inner and outer rings simultaneously, use a jig as shown in Fig. 8.43.

Apply high-viscosity oil to the shaft and the contact faces of the bearing before press fitting.

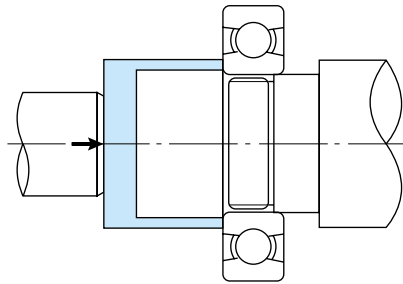


Fig. 8.42 Press Fitting of Inner Ring

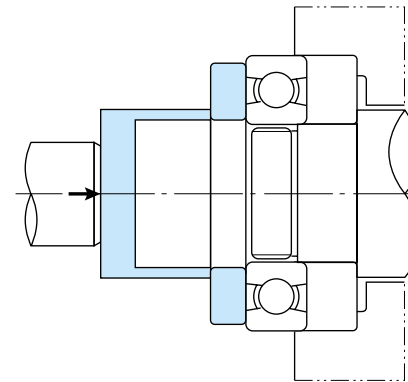


Fig. 8.43 Simultaneous Press Fitting of Inner Ring

• Expansion Fitting

Expansion fitting is an appropriate procedure for mounting larger bore bearings. This fitting procedure can be completed quickly without applying undue stress to the ring being fit. The ring may be heated using a heating tank or an induction heater. Bearing rings must not be heated to a temperature exceeding 120 °C.

Fig. 8.44 provides the amount of heat rise required, vs. bore size, to expand inner rings to net 6 interference fit classes.

After mounting a heated bearing, secure it in the required position otherwise the bearing will tend to move axially as it cools.

Caution: When expansion fitting rings onto a shaft or into a housing, be sure that the procedure can be completed smoothly and quickly. If the ring should misalign or stop movement before it has reached the desired fit position, it may be very difficult to reposition the ring to the correct fit position.

As noted above, adapter or withdrawal sleeves are used for mounting tapered-bore bearings to cylindrical shafts. Tapered-bore bearings are also mounted directly to tapered shafts. While these methods are technically not press or expansion fitting procedures, the resulting shaft fits are similar to those obtained using the press fitting procedure, and, in certain cases, these methods are far more convenient.

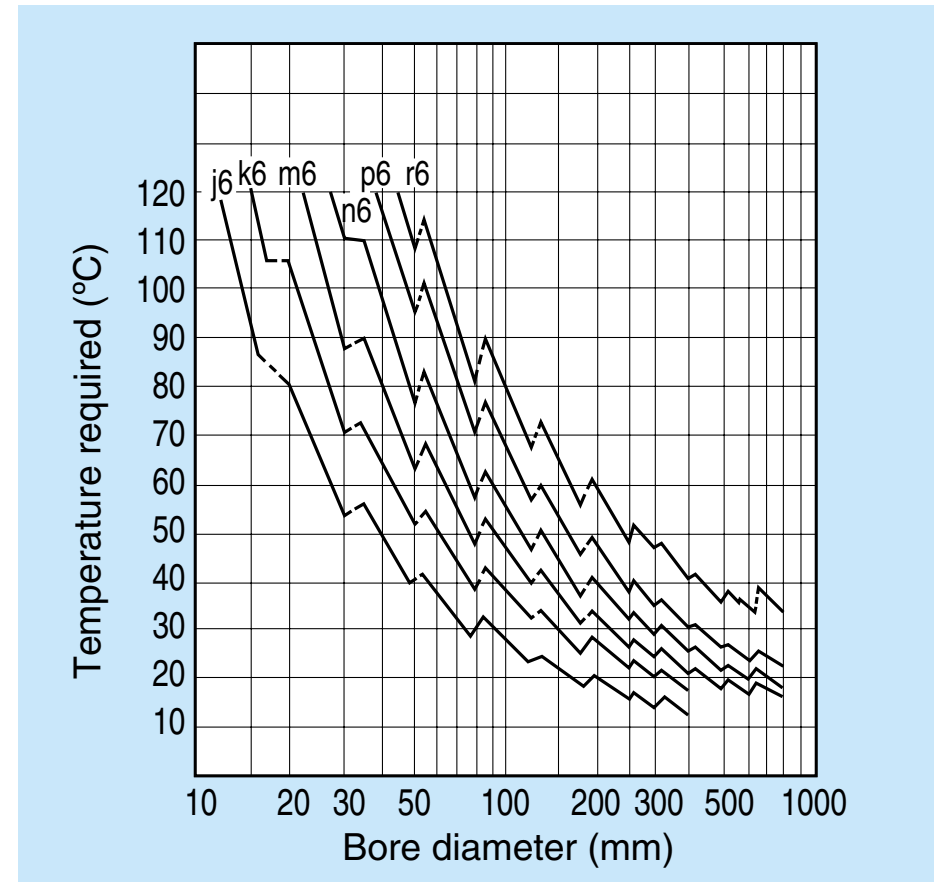


Fig. 8.44 Expansion Heat Required

(2) Mounting Tapered-bore Bearings

Using a split-sleeve adapter permits the mounting of tapered-bore bearings in any axial position on shaft but care must be taken to ensure that the bearing will be located at the correct position.

To mount a tapered-bore bearing using an adapter sleeve, first mount the bearing which is to be the stationary (fixed) bearing. Define and record the distance which the free bearing is expected to move in an axial direction in the housing.

Mount the free bearing so that the axial clearance provided for axial travel of the outer ring of the free bearing is on the outboard side (side farthest from the stationary bearing).

The required interference fit for tapered-bore, Spherical roller bearings can be attained using one of two methods:

[Continue→]



- a) by driving the bearing onto the sleeve by a predetermined distance; or,
 - b) by measurement of residual bearing internal clearance as the sleeve is pushed into the bearing inner ring (see [Table 8.28](#)).
- Since exact measurement of the axial drive-up distance is extremely difficult, the residual method is usually the method of choice.

The residual method involves measuring the bearing unmounted internal clearance and then pulling up the adapter sleeve until the measured clearance (the residual) = the unmounted (original) clearance - the reduction amount required to attain the correct interference fit (see [Table 8.28](#) for the reduction amount). Clearance measurements are made using a thickness (feeler) gauge. (Note that the thickness gauge should be inserted over two or three unloaded rollers on each row of rollers and that the bearing bore must be in a horizontal position with respect to the shaft axis, with the outer ring centered over the rolling elements).

[Table 8.28](#) shows axial movement and radial clearance reduction for the mounting of Spherical roller bearings.

Heating of larger tapered-bore bearings may be used in conjunction with measurement of travel distance but be sure to check the results using the residual method (taking the unmounted clearance measurements and the final, residual clearance, when the bearing is cool). Also be sure that the bearing is not heated to over 120 °C.

When using a withdrawal sleeve for large-bore bearings, use of a hydraulic assist procedure is recommended. See Fig. 8.45 which shows use of a hydraulic nut.

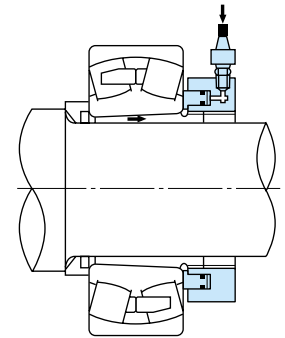


Fig. 8.45 Hydraulic Nut

Table 8.28 Tapered-bore Spherical Roller Bearings: Axial Movement and Radial Clearance Reduction

(3) Other Mounting Precautions

- For paired Tapered roller bearings, be sure to adjust the axial clearance to the specified value using shims where necessary.
- For bearing types with separable inner and outer members such as Cylindrical or Tapered roller bearings, mount the inner and outer ring separately and carefully assemble the shaft into the housing while making sure that no damage occurs to the inner or outer rings or rolling elements.



Table 8.28 Tapered-bore Spherical Roller Bearings: Axial Movement and Radial Clearance Reduction

| Nominal bore diameter d (mm) | | Radial clearance reduction (mm) | | Axial movement (mm) | | | |
|------------------------------|-------|---------------------------------|-------|---------------------|------|-------------|------|
| | | | | Taper: 1/12 | | Taper: 1/30 | |
| Over | Incl. | min | max | min | max | min | max |
| 30 | 40 | 0.020 | 0.025 | 0.35 | 0.4 | — | — |
| 40 | 50 | 0.025 | 0.030 | 0.4 | 0.45 | — | — |
| 50 | 65 | 0.030 | 0.040 | 0.45 | 0.6 | — | — |
| 65 | 80 | 0.040 | 0.050 | 0.6 | 0.75 | — | — |
| 80 | 100 | 0.045 | 0.060 | 0.7 | 0.9 | 1.75 | 2.25 |
| 100 | 120 | 0.050 | 0.070 | 0.75 | 1.1 | 1.9 | 2.75 |
| 120 | 140 | 0.065 | 0.090 | 1.1 | 1.4 | 2.75 | 3.5 |
| 140 | 160 | 0.075 | 0.100 | 1.2 | 1.6 | 3.0 | 4.0 |
| 160 | 180 | 0.080 | 0.110 | 1.3 | 1.7 | 3.25 | 4.25 |
| 180 | 200 | 0.090 | 0.120 | 1.4 | 1.9 | 3.5 | 5.0 |
| 200 | 225 | 0.100 | 0.140 | 1.6 | 2.2 | 4.0 | 5.5 |
| 225 | 250 | 0.110 | 0.150 | 1.7 | 2.4 | 4.25 | 6.0 |
| 250 | 280 | 0.120 | 0.170 | 1.9 | 2.7 | 4.75 | 6.75 |
| 280 | 315 | 0.130 | 0.190 | 2.0 | 3.0 | 5.0 | 7.5 |
| 315 | 355 | 0.150 | 0.210 | 2.4 | 3.3 | 6.0 | 8.25 |
| 355 | 400 | 0.170 | 0.230 | 2.6 | 3.6 | 6.5 | 9.0 |
| 400 | 450 | 0.200 | 0.260 | 3.1 | 4.0 | 7.75 | 10.0 |
| 450 | 500 | 0.210 | 0.280 | 3.3 | 4.4 | 8.25 | 11.0 |

8.8.4 Mounting and Dismounting Force

An approximate force necessary to install or remove an inner ring from a shaft may be calculated using the following equation.

$$K_a = f_k \cdot f_e \cdot \Delta d_e$$

..... (8.23)

where:

K_a

= press fit or dismount force (KN)

Δd_e

= effective interference (mm)

f_k

= factor from Table 8.29

f_e

= from following equation

Table. 8.29 Value f_k (Average)

| Condition | f_k |
|--|-------|
| Inner ring pressed to cylindrical shaft* | 39 |
| Inner ring pulled from cylindrical shaft | 59 |
| Inner ring press fit to tapered shaft or sleeve* | 54 |
| Inner ring pulled from tapered shaft | 44 |
| Tapered sleeve press fit between shaft & bearing* | 98 |
| Tapered sleeve pulled from between shaft & bearing | 108 |

* Shaft and bearing bore thinly coated with oil.

$$f_e = B \cdot \left[1 - \left(\frac{d}{d_i} \right)^2 \right]$$

where:

B

= inner ring width (mm)

d

= inner ring bore diameter (mm)

d_i

= mean inner ring outside diameter (mm)

d_i

$\doteq 0.25 (D+3d)$...for Cylindrical roller bearings and Self-aligning Ball bearing series 22 and 23

d_i

$\doteq 0.1 (3D+7d)$...for other bearings

where:

D

= Bearing outside diameter

Fig. 8.46 ~ 8.49 show dismount and press fit force by diameter series.

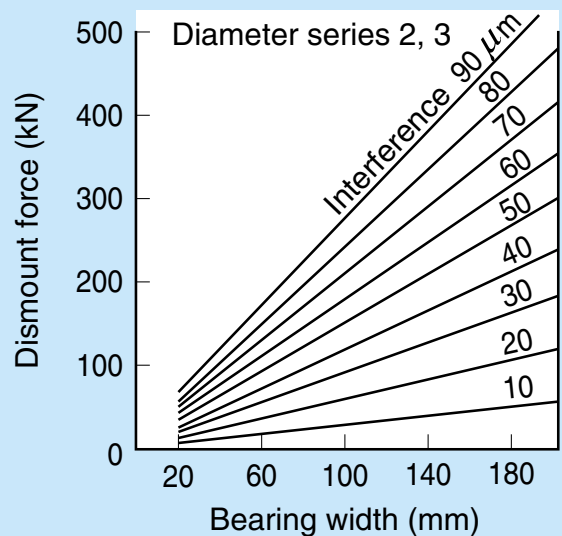


Fig. 8.46 Dismount Force

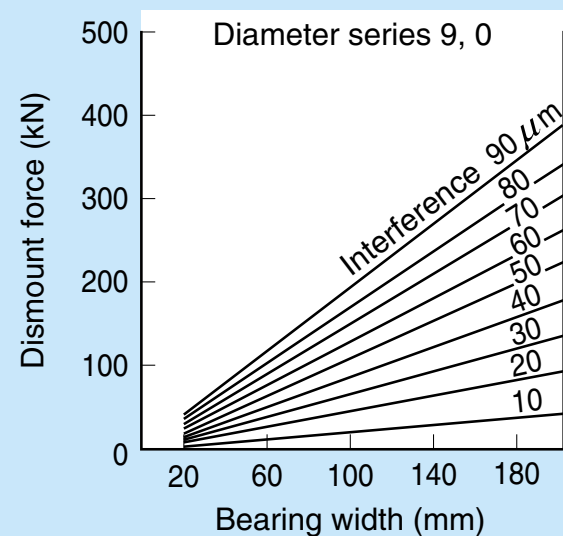


Fig. 8.47 Dismount Force

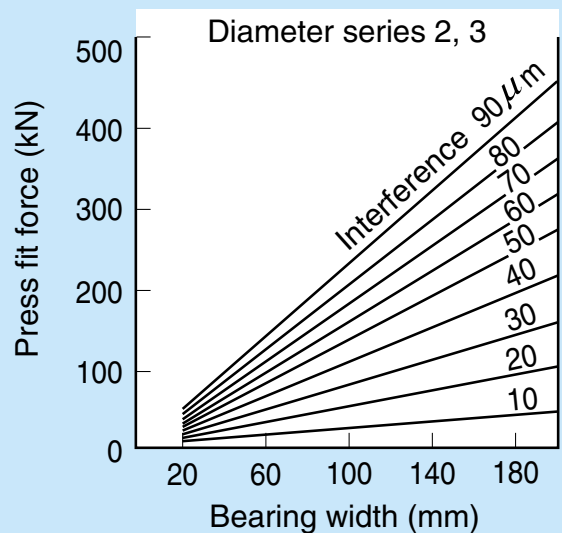


Fig. 8.48 Press-fit Force

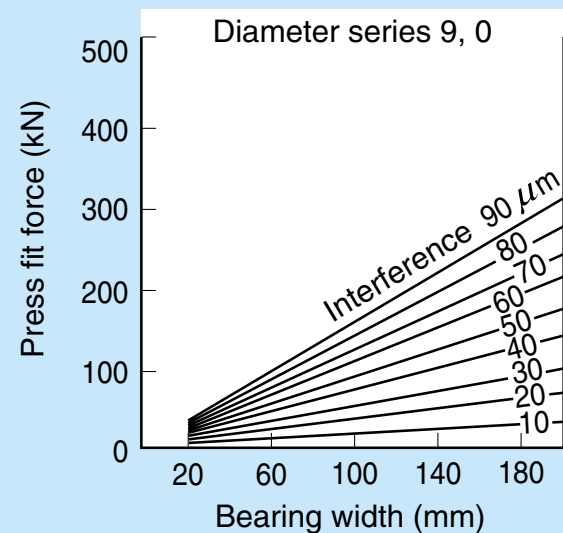


Fig. 8.49 Press-fit Force

8.8.5 Operation Inspection

Verify satisfactory service with a test run. General precautions for a test run are:

- Make sure that all drive covers are in place, all bolts and nuts are tight, and appropriate clearance is provided between the shaft and all stationary parts.
- If possible, manually turn the shaft to see if there is rubbing or abnormal noise.
- If the machine is large and the shaft cannot be turned by hand, start the machine at as low speed as possible and check for rubbing or abnormal noise while coasting the machine.
- If no trouble is found during the above checks, run the machine at the design speed until attaining a steady-state temperature.
- Recheck bolt and nut tightness. Check for oil leaks, and abnormal noise. If possible, extract a sample of the oil and check it for foreign matter.
- Begin regular operation.

If trouble is encountered during machine operation, refer to Section 9, "Trouble-shooting Bearing Problems".

8.8.6 Dismounting

Bearings may be dismounted for periodic machine inspection, or when machine break down has occurred. The condition of all rotating parts and interfaces should be checked and recorded to collect data for operating improvements. The recording of data is essential where a parts failure has occurred to enable a solution to any existing trouble.

In dismounting the bearing, check to see:

- If the bearing is satisfactorily mounted. (Bolts, and nuts tightened, interference of slinger with bearing housing, etc.)
- If there is (was) an adequate lube supply. Check for lubricant contamination and sample for residues.
- That the inner and outer ring have retained the fits as mounted.
- If the bearing clearance is as specified. If possible, measure the clearance of the mounted bearing.
- The condition of the bearing.

[Continue→]

Before starting to dismount a bearing, review the following points:

- Dismount method
- Fit conditions
- Jigs required for dismounting
 - Press (Fig. 8.50)
 - Spanner wrench (Fig. 8.51)
 - Puller (Fig. 8.52)
 - Special puller (Fig. 8.53)
 - Holder (Fig. 8.54)

To dismount a Cylindrical roller bearing, the inner ring may be locally heated with an induction heater to facilitate removal from the shaft. (See Fig. 8.55.)

For large-bore bearings, which are often difficult to dismount, a hydraulic nut or oil injector system is recommended. See Fig. 8.45 and Fig. 8.56 respectively.

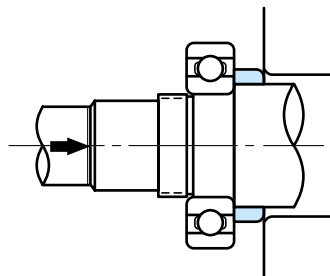
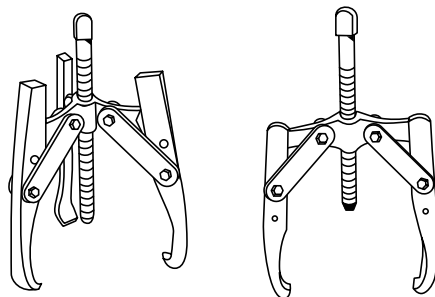


Fig. 8.50 Dismounting Bearing Using Press



3-jaw puller 2-jaw puller

Fig. 8.52

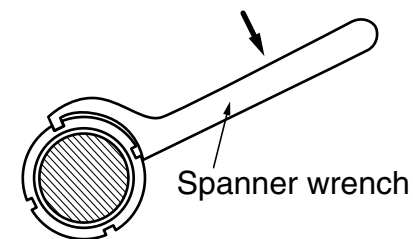


Fig. 8.51 Dismounting Bearing with Spanner Wrench

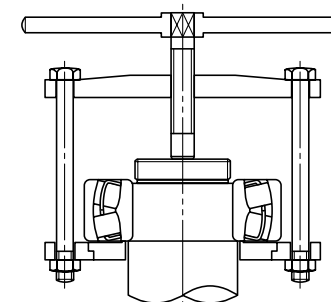


Fig. 8.53 Dismounting Bearing with Special Puller

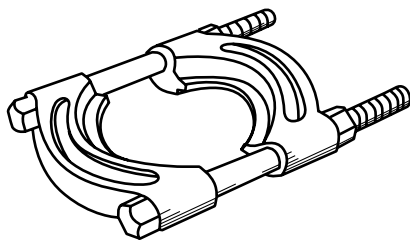


Fig. 8.54 Puller Attachment

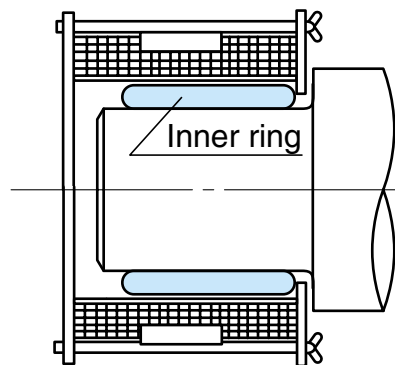


Fig. 8.55 Inner Ring Removal with Induction Heater

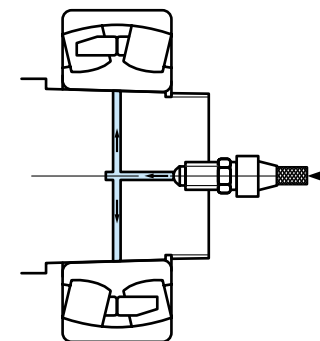


Fig. 8.56 Oil Injector

9. Trouble-shooting Bearing Problems

Rolling contact bearings must be carefully handled, mounted, and maintained in order to operate satisfactorily.

The cause of unsatisfactory operation must be determined to prevent recurrence. There are three categories of data which should be gathered to enable the correct diagnosis of bearing problems:

- Time of occurrence.
- Symptoms during operation.
- Condition of bearing.

Although the origin of bearing problems can sometimes be determined using data from only one of the data categories, quick and accurate analysis requires as much data as possible.

See Tables 9.1, [9.2](#) and [9.3](#).

Table 9.1 Time of Occurrence

| Cause Time of Occurrence | Bearing selection | Design or manufacture of other drive parts | Lubricant type, system or amount | Defective bearing | Bearing installation | Seal failure |
|--|-------------------|--|----------------------------------|-------------------|----------------------|--------------|
| Soon after installation | ○ | ○ | ○ | ○ | ○ | |
| Soon after periodic disassembly | | | ○ | | ○ | |
| Soon after re-lubrication | | | ○ | | | |
| After replacement or repair of other drive parts | | ○ | ○ | | ○ | |
| During normal operation | | | | | | ○ |

Table 9.2 Symptom During Operation

| Operation condition | | Cause | Remarks |
|---------------------------|---------------------------|--|---|
| Noise | Low level metallic sound | Impressions on raceway | Check with audiophone, vibration pickup, etc. |
| | High level metallic sound | Loss of clearance, poor lubrication | |
| | Irregular sound | Excess clearance, contaminants, defect of rolling element surface, improper lube | |
| | Ever-changing sound | Change of clearance by temperature rise Defect in progress on raceway | |
| Abnormal temperature rise | | Loss of clearance, creep, insufficient or excess lubricant, excess load | Use a surface thermometer. |
| Reduction in accuracy | | Raceway or rolling element broken by impurities, or insufficient lubricant | Example: Lathe: stick-slip marks Grinder: wavy pattern Cold roll mill: occulting wave pattern |
| Unstable operation | | Broken raceway, rolling element Foreign matter Excess clearance | Example: vibration |
| Contaminated lubricant | | Poor lubrication, foreign matter, wear | |

Table 9.3

(1) Premature Flaking
(2) Seizure
(3) Breakage

(4) Brinelling
(5) Fretting
(6) Smearing

(7) Excessive Wear
(8) Rusting, Corrosion
(9) Creep

(1) Premature Flaking

The repeated heavy stress cycle between the bearing raceway and rolling element surface results in fatigue cracks which become loosened from bearing materials.

■ Causes

- Abnormal axial load or excessive load caused by expanded shaft.
- Deflection or misalignment of shaft.
- Poor parallelism of inner and outer rings.
- Poor lubrication
- Rusting, Nicks, Galling from dirt, etc.

■ Countermeasures

- Abnormal axial load or excessive load caused by expanded shaft.
- Deflection or misalignment of shaft.
- Poor parallelism of inner and outer rings.
- Poor lubrication
- Rusting, Nicks, Galling from dirt, etc.



(2) Seizure

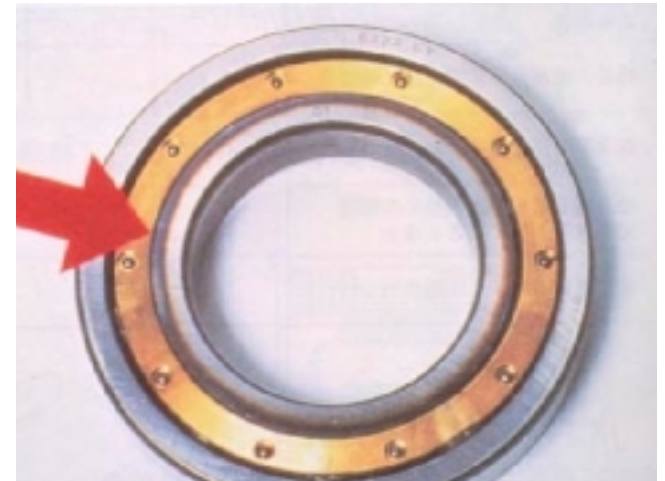
Bearing is seized up by excessive heat. Discoloration, softening and fusion of raceway and rolling element.

■ Causes

- Loss of clearance
- Operating over limiting speed
- Poor or improper lubricant.

■ Countermeasures

- Review fitting and bearing clearance.
- Review type of bearing.
- Select a proper lubricant, and feed it in proper quantity.



(3) Breakage

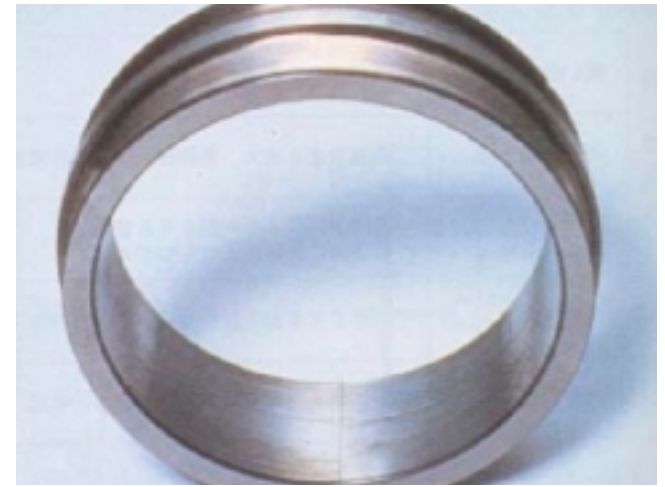
Splits and cracks in the inner/outer ring or rolling element.

■ Causes

- Excessive interference fit.
- Bearing seat has larger corner radius than bearing.
- Excess clearance during operation.
- Excess impact load.

■ Countermeasures

- Check fits. Finish shaft and sleeve to higher accuracy.
- Make shaft corner radius smaller than that of the bearing.
- Check fits and bearing clearance.
- Re-check load conditions.



(4) Brinelling

Brinelling, indentation and pear skin of bearing raceway and rolling element.

■ Causes

- Impact applied during mounting.
- Impact from dropped bearing
- Contamination
- Load applied to bearing at rest in excess of static load rating.

■ Countermeasures

- Carefully handle the bearing.
- Clean shaft and housing
- Improve the sealing
- Re-check load conditions.



(5) Fretting

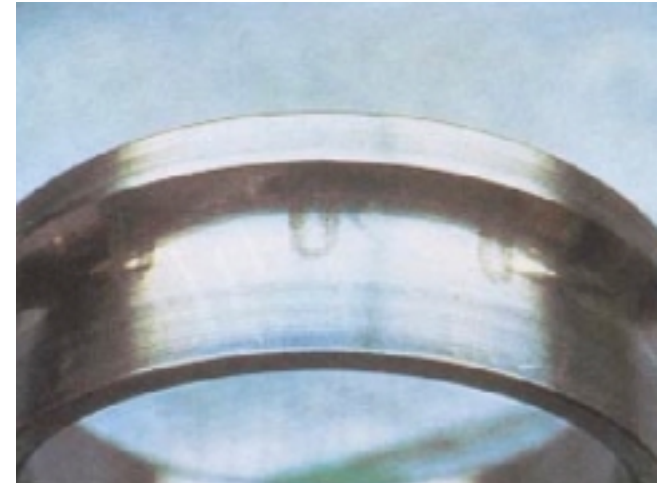
Occurred when a small relative motion is repeatedly caused in non rotating bearing. Fretting surface wear producing red colored particles at fitting surface.

■ Causes

- Vibration applied to bearing at rest (e. g. during shipment)
- swing with smaller amplitude.
- Minute clearance on fit surface.
- Slight sliding during operation as a result reduced interference under a load.

■ Countermeasures

- Fix the shaft and housing during shipment.
- Apply a preload. Use oil for lubrication.
- Increase the interference.
- Apply oil



(6) Smearing

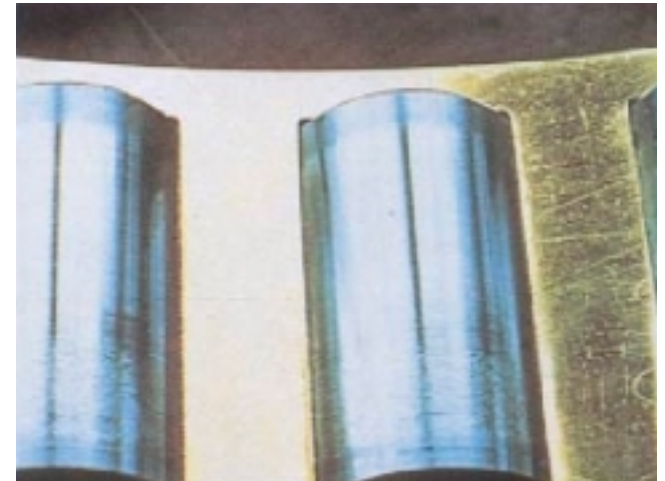
Metal to metal contact due to the destruction of oil film.
Sliding motion between outer/inner ring and rolling element.

■ Causes

- Excess axial load. Misalignment of bearing.
- Poor lubrication.
- Intrusion and galling of foreign matter.
- High acceleration on start-up.

■ Countermeasures

- Correct mounting errors.
- Review the load condition.
- Select a proper lubricant, and feed it in proper quantity.
- Improve the sealing.
- Clean shaft and housing.
- Avoid sharp acceleration.



(7) Excessive Wear

Abnormal wear of flange face, rolling element and retainer.

■ Causes

- Foreign matter and corrosion acting as lapping agent
- Insufficient or incorrect lubricant.

■ Countermeasures

- Improve sealing
- Clean shaft and housing
- Check lubricant for type and amount.



(8) Rusting, Corrosion

Rusting and corrosion of bearing ring and rolling element surface.

■ Causes

- Improper storage, cleaning.
- Improper washing oil.
- Poor rust prevention
- Corrosive gas, liquid or water.
- Handling with unprotected hand.
- Chemical action of lubricant.

■ Countermeasures

- Improve storage and handling.
- Re-check washing oil
- Review rust prevention.
- Improve sealing
- Correct handling.
- Check lubricant.



(9) Creep

Galling, wear, sliding and discoloration of fit face.

■ Causes

- Insufficient interference.
- Insufficient tightened sleeve.
- Insufficient surface pressure due to low rigidity and inaccurate shaft and housing.

■ Countermeasures

- Check fits.
- Tighten sleeve
- Redesign for greater rigidity.



Table 5.1.1 Tolerance Values of Inner Ring and of Outer Ring Width

(1/4)

Unit: μm

| Bearing bore diameter Nominal d (mm) | | Bearing with cylindrical bore | | | | | | | | | | | | | |
|---|-------|--|------|---------|-----|---------|-----|---------|-----|---------|------|---|-----|---------|------|
| | | Single plane mean bore diameter deviation Δd_{mp} | | | | | | | | | | Deviation of a single bore diameter (2) Δd_s | | | |
| | | | | | | | | | | | | | | | |
| | | Class 0 | | Class 6 | | Class 5 | | Class 4 | | Class 2 | | Class 4 | | Class 2 | |
| | | | | | | | | | | | | Diameter series 0,1,2,3,4 | | | |
| Over | Incl. | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low |
| 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 | 1000 | 0 | −100 | — | — | — | — | — | — | — | — | — | — | — | — |
| 1000 | 1250 | 0 | −125 | — | — | — | — | — | — | — | — | — | — | — | — |
| 1250 | 1600 | 0 | −160 | — | — | — | — | — | — | — | — | — | — | — | — |
| 1600 | 2000 | 0 | −200 | — | — | — | — | — | — | — | — | — | — | — | — |

- Notes: (1) This diameter is included in this group.
(2) Applies to bearings with cylindrical bore.
(3) Width deviation and variation of outer ring are the same with of inner ring. Outer ring width variation of classes 5, 4 and 2 are listed in Table 5.1.2.
(4) Applies to the rings of single bearings made for paired of stack mounting.
(5) Applies to radial ball bearings such as deep groove ball bearing, angular contact ball bearings.

Remarks: The high deviation of bearing cylindrical bore diameter specified in this table does not apply within a distance of $1.2 \times r$ (max) from the ring face.



Table 5.1.1 Tolerance Values of Inner Ring and of Outer Ring Width

(2/4)

Unit: μm

| Bearing bore diameter Nominal d (mm) | | Bearing with cylindrical bore | | | | | | | | | | | | | | | |
|---|-------|--|-----|-----------------|-------|-----|-----------------|-------|-----------|----------------------------------|-----------|---------|-----|---------|-----|---------|-----|
| | | Bore diameter variation in a single radial plane (2) | | | | | | | | Main bore diameter variation (2) | | | | | | | |
| | | V_{dp} | | | | | | | | V_{dmp} | | | | | | | |
| | | Class 0 | | Class 6 | | | Class 5 | | | Class 4 | | Class 2 | | Class 0 | | Class 6 | |
| | | Diameter series | | Diameter series | | | Diameter series | | | Diameter series | | Class 2 | | Class 0 | | Class 6 | |
| Over | Incl. | 7,8,9 | 0,1 | 2,3,4 | 7,8,9 | 0,1 | 2,3,4 | 7,8,9 | 0,1,2,3,4 | 7,8,9 | 0,1,2,3,4 | 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 | 1000 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 1000 | 1250 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 1250 | 1600 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 1600 | 2000 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |

Notes: (1) This diameter is included in this group.

(2) Applies to bearings with cylindrical bore.

(3) Width deviation and variation of outer ring are the same with of inner ring. Outer ring width variation of classes 5, 4 and 2 are listed in Table 5.1.2.

(4) Applies to the rings of single bearings made for paired of stack mounting.

(5) Applies to radial ball bearings such as deep groove ball bearing, angular contact ball bearings.

Remarks: The high deviation of bearing cylindrical bore diameter specified in this table does not apply within a distance of $1.2 \times r$ (max) from the ring face.

Table 5.1.1 Tolerance Values of Inner Ring and of Outer Ring Width

(3/4)

Unit: μm

| Bearing bore diameter Nominal d (mm) | | Deviation of a single inner ring width (or a single outer ring width) (2) ΔB_s (or ΔC_s) | | | | | | | | | | Inner (or outer) ring width variation V_{BS} (or V_{CS}) | | | | |
|---|-------|--|-------|--------------------|------|---------|------|-------------------------------------|------|--------------------|------|--|---------|---------|---------|---------|
| | | Single bearing | | | | | | Paired or stack mounted bearing (4) | | | | Inner ring (or outer ring) (3) | | | | |
| | | | | | | | | | | | | Inner ring | | | | |
| | | Class 0 Class 6 | | Class 5 Class 4 | | Class 2 | | Class 0 Class 6 | | Class 5 Class 4 | | Class 0 | Class 6 | Class 5 | Class 4 | Class 2 |
| Over | Incl. | 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 | 12 | 12 | 5 | 2.5 | 1.5 |
| 2.5 | 10 | 0 | – 120 | 0 | – 40 | 0 | – 40 | 0 | –250 | 0 | –250 | 15 | 15 | 5 | 2.5 | 1.5 |
| 10 | 18 | 0 | – 120 | 0 | – 80 | 0 | – 80 | 0 | –250 | 0 | –250 | 20 | 20 | 5 | 2.5 | 1.5 |
| 18 | 30 | 0 | – 120 | 0 | –120 | 0 | –120 | 0 | –250 | 0 | –250 | 20 | 20 | 5 | 2.5 | 1.5 |
| 30 | 50 | 0 | – 120 | 0 | –120 | 0 | –120 | 0 | –250 | 0 | –250 | 20 | 20 | 5 | 3 | 1.5 |
| 50 | 80 | 0 | – 150 | 0 | –150 | 0 | –150 | 0 | –380 | 0 | –250 | 25 | 25 | 6 | 4 | 1.5 |
| 80 | 120 | 0 | – 200 | 0 | –200 | 0 | –200 | 0 | –380 | 0 | –380 | 25 | 25 | 7 | 4 | 2.5 |
| 120 | 150 | 0 | – 250 | 0 | –250 | 0 | –250 | 0 | –500 | 0 | –380 | 30 | 30 | 8 | 5 | 2.5 |
| 150 | 180 | 0 | – 250 | 0 | –250 | 0 | –250 | 0 | –500 | 0 | –380 | 30 | 30 | 8 | 5 | 4 |
| 180 | 250 | 0 | – 300 | 0 | –300 | 0 | –300 | 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 | 1000 | 0 | –1000 | – | – | – | – | – | – | – | – | 80 | – | – | – | – |
| 1000 | 1250 | 0 | –1250 | – | – | – | – | – | – | – | – | 100 | – | – | – | – |
| 1250 | 1600 | 0 | –1600 | – | – | – | – | – | – | – | – | 120 | – | – | – | – |
| 1600 | 2000 | 0 | –2000 | – | – | – | – | – | – | – | – | 140 | – | – | – | – |

Notes: (1) This diameter is included in this group.

(2) Applies to bearings with cylindrical bore.

(3) Width deviation and variation of outer ring are the same with of inner ring. Outer ring width variation of classes 5, 4 and 2 are listed in Table 5.1.2.

(4) Applies to the rings of single bearings made for paired of stack mounting.

(5) Applies to radial ball bearings such as deep groove ball bearing, angular contact ball bearings.

Remarks: The high deviation of bearing cylindrical bore diameter specified in this table does not apply within a distance of $1.2 \times r$ (max) from the ring face.

Table 5.1.1 Tolerance Values of Inner Ring and of Outer Ring Width

(4/4)

Unit: μm 

| Bearing bore diameter Nominal d (mm) | | Radial runout of assembled bearing inner ring K_{ia} | | | | | Inner ring reference face runout with bore S_d | | | Assembled bearing inner ring face runout with raceway S_{ia} (5) | | |
|---|-------|---|---------|---------|---------|---------|---|---------|---------|---|---------|---------|
| | | Class 0 | Class 6 | Class 5 | Class 4 | Class 2 | Class 5 | Class 4 | Class 2 | Class 5 | Class 4 | Class 2 |
| | | Max | Max | Max | Max | Max | Max | Max | Max | Max | Max | Max |
| Over | Incl. | | | | | | | | | | | |
| 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 | 1000 | 90 | — | — | — | — | — | — | — | — | — | — |
| 1000 | 1250 | 100 | — | — | — | — | — | — | — | — | — | — |
| 1250 | 1600 | 120 | — | — | — | — | — | — | — | — | — | — |
| 1600 | 2000 | 140 | — | — | — | — | — | — | — | — | — | — |

Notes: (1) This diameter is included in this group.

(2) Applies to bearings with cylindrical bore.

(3) Width deviation and variation of outer ring are the same with of inner ring. Outer ring width variation of classes 5, 4 and 2 are listed in Table 5.1.2.

(4) Applies to the rings of single bearings made for paired of stack mounting.

(5) Applies to radial ball bearings such as deep groove ball bearing, angular contact ball bearings.

Remarks: The high deviation of bearing cylindrical bore diameter specified in this table does not apply within a distance of $1.2 \times r$ (max) from the ring face.

Table 5.1.2 Tolerance Values of Outer Ring

(1/4)

Unit: μm

| Bearing outside diameter Nominal D (mm) | | Bearing outside diameter | | | | | | | | | | | | | |
|---|-------|--|-------|---------|------|---------|------|---------|------|---------------|-------|--|------|---------|-------|
| | | Single plane mean outside diameter deviation | | | | | | | | | | Deviation of a single outside diameter | | | |
| | | ΔD_{mp} | | | | | | | | | | ΔD_s | | | |
| | | Class 0 | | Class 6 | | Class 5 | | Class 4 | | Class 2 | | Class 4 | | | |
| | | | | | | | | | | | | Diameter series | | Class 2 | |
| | | | | | | | | | | 0, 1, 2, 3, 4 | | | | | |
| Over | Incl. | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low | High | Low |
| 2.5 ⁽¹⁾ | 6 | 0 | − 8 | 0 | − 7 | 0 | − 5 | 0 | − 4 | 0 | − 2.5 | 0 | − 4 | 0 | − 2.5 |
| 6 | 18 | 0 | − 8 | 0 | − 7 | 0 | − 5 | 0 | − 4 | 0 | − 2.5 | 0 | − 4 | 0 | − 2.5 |
| 18 | 30 | 0 | − 9 | 0 | − 8 | 0 | − 6 | 0 | − 5 | 0 | − 4 | 0 | − 5 | 0 | − 4 |
| 30 | 50 | 0 | − 11 | 0 | − 9 | 0 | − 7 | 0 | − 6 | 0 | − 4 | 0 | − 6 | 0 | − 4 |
| 50 | 80 | 0 | − 13 | 0 | − 11 | 0 | − 9 | 0 | − 7 | 0 | − 4 | 0 | − 7 | 0 | − 4 |
| 80 | 120 | 0 | − 15 | 0 | − 13 | 0 | − 10 | 0 | − 8 | 0 | − 5 | 0 | − 8 | 0 | − 5 |
| 120 | 150 | 0 | − 18 | 0 | − 15 | 0 | − 11 | 0 | − 9 | 0 | − 5 | 0 | − 9 | 0 | − 5 |
| 150 | 180 | 0 | − 25 | 0 | − 18 | 0 | − 13 | 0 | − 10 | 0 | − 7 | 0 | − 10 | 0 | − 7 |
| 180 | 250 | 0 | − 30 | 0 | − 20 | 0 | − 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 | 1000 | 0 | − 100 | 0 | − 60 | − | − | − | − | − | − | − | − | − | − |
| 1000 | 1250 | 0 | − 125 | − | − | − | − | − | − | − | − | − | − | − | − |
| 1250 | 1600 | 0 | − 160 | − | − | − | − | − | − | − | − | − | − | − | − |
| 1600 | 2000 | 0 | − 200 | − | − | − | − | − | − | − | − | − | − | − | − |
| 2000 | 2500 | 0 | − 250 | − | − | − | − | − | − | − | − | − | − | − | − |

Notes: (1) This diameter is included in this group.

(2) Applies before mounting and after removal of internal or external snap ring.

(3) Applies to radial ball bearings such as deep groove ball bearings, angular contact ball bearings.

(4) Outer ring width variation of class 0 and 6 are listed in Table 5.1.1.

(5) Applies to radial ball bearings such as deep groove ball bearing, angular contact ball bearings.

Remarks: The high deviation of bearing cylindrical bore diameter specified in this table does not apply within a distance of $1.2 \times r$ (max) from the ring face.

Table 5.1.2 Tolerance Values of Outer Ring

(2/4)

Unit: μm

| Bearing outside diameter Nominal D (mm) | | Bearing outside diameter | | | | | | | | | | | | |
|---|-------|---|-----|-----------------------|-------|-----------------|-----|-----------------------|-----------|-----------------|-----------|-----------------|-----------|--------------|
| | | Outside diameter variation in a single radial plane (2) | | | | | | | | | | | | |
| | | V_{Dp} | | | | | | | | | | | | |
| | | Class 0 | | | | Class 6 | | | | Class 5 | | Class 4 | | Class 2 |
| | | Open bearing | | Seal · shield bearing | | Open bearing | | Seal · shield bearing | | Open bearing | | Open bearing | | Open bearing |
| | | Diameter series | | Diameter series | | Diameter series | | Diameter series | | Diameter series | | Diameter series | | |
| Over | Incl. | 7,8,9 | 0,1 | 2,3,4 | 2,3,4 | 7,8,9 | 0,1 | 2,3,4 | 0,1,2,3,4 | 7,8,9 | 0,1,2,3,4 | 7,8,9 | 0,1,2,3,4 | Max |
| Max | Max | Max | Max | Max | 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 | 18 | 10 | 8 | 6 | 10 | 9 | 7 | 5 | 9 | 5 | 4 | 4 | 3 | 2.5 |
| 18 | 30 | 12 | 9 | 7 | 12 | 10 | 8 | 6 | 10 | 6 | 5 | 5 | 4 | 4 |
| 30 | 50 | 14 | 11 | 8 | 16 | 11 | 9 | 7 | 13 | 7 | 5 | 6 | 5 | 4 |
| 50 | 80 | 16 | 13 | 10 | 20 | 14 | 11 | 8 | 16 | 9 | 7 | 7 | 5 | 4 |
| 80 | 120 | 19 | 19 | 11 | 26 | 16 | 16 | 10 | 20 | 10 | 8 | 8 | 6 | 5 |
| 120 | 150 | 23 | 23 | 14 | 30 | 19 | 19 | 11 | 25 | 11 | 8 | 9 | 7 | 5 |
| 150 | 180 | 31 | 31 | 19 | 38 | 23 | 23 | 14 | 30 | 13 | 10 | 10 | 8 | 7 |
| 180 | 250 | 38 | 38 | 23 | — | 25 | 25 | 15 | — | 15 | 11 | 11 | 8 | 8 |
| 250 | 315 | 44 | 44 | 26 | — | 31 | 31 | 19 | — | 18 | 14 | 13 | 10 | 8 |
| 315 | 400 | 50 | 50 | 30 | — | 35 | 35 | 21 | — | 20 | 15 | 15 | 11 | 10 |
| 400 | 500 | 56 | 56 | 34 | — | 41 | 41 | 25 | — | 23 | 17 | — | — | — |
| 500 | 630 | 63 | 63 | 38 | — | 48 | 48 | 29 | — | 28 | 21 | — | — | — |
| 630 | 800 | 94 | 94 | 55 | — | 56 | 56 | 34 | — | 35 | 26 | — | — | — |
| 800 | 1000 | 125 | 125 | 75 | — | 75 | 75 | 45 | — | — | — | — | — | — |
| 1000 | 1250 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 1250 | 1600 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 1600 | 2000 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 2000 | 2500 | — | — | — | — | — | — | — | — | — | — | — | — | — |

Notes: (1) This diameter is included in this group.

(2) Applies before mounting and after removal of internal or external snap ring.

(3) Applies to radial ball bearings such as deep groove ball bearings, angular contact ball bearings.

(4) Outer ring width variation of class 0 and 6 are listed in Table 5.1.1.

(5) Applies to radial ball bearings such as deep groove ball bearing, angular contact ball bearings.

Remarks: The high deviation of bearing cylindrical bore diameter specified in this table does not apply within a distance of $1.2 \times r$ (max) from the ring face.

Table 5.1.2 Tolerance Values of Outer Ring

(3/4)

Unit: μm

| Bearing outside diameter Nominal D (mm) | | Bearing outside diameter | | | | | Radial runout of assembled bearing outer ring | | | | | Variation of bearing outside surface generatrix inclination with outer ring reference face | | |
|---|-------|-------------------------------------|---------|---------|---------|---------|---|---------|---------|---------|---------|--|---------|---------|
| | | Mean outside diameter variation (2) | | | | | Kea | | | | | SD | | |
| | | Class 0 | Class 6 | Class 5 | Class 4 | Class 2 | Class 0 | Class 6 | 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 | Max | Max |
| 2.5 ⁽¹⁾ | 6 | 6 | 5 | 3 | 2 | 1.5 | 15 | 8 | 5 | 3 | 1.5 | 8 | 4 | 1.5 |
| 6 | 18 | 6 | 5 | 3 | 2 | 1.5 | 15 | 8 | 5 | 3 | 1.5 | 8 | 4 | 1.5 |
| 18 | 30 | 7 | 6 | 3 | 2.5 | 2 | 15 | 9 | 6 | 4 | 2.5 | 8 | 4 | 1.5 |
| 30 | 50 | 8 | 7 | 4 | 3 | 2 | 20 | 10 | 7 | 5 | 2.5 | 8 | 4 | 1.5 |
| 50 | 80 | 10 | 8 | 5 | 3.5 | 2 | 25 | 13 | 8 | 5 | 4 | 8 | 4 | 1.5 |
| 80 | 120 | 11 | 10 | 5 | 4 | 2.5 | 35 | 18 | 10 | 6 | 5 | 9 | 5 | 2.5 |
| 120 | 150 | 14 | 11 | 6 | 5 | 2.5 | 40 | 20 | 11 | 7 | 5 | 10 | 5 | 2.5 |
| 150 | 180 | 19 | 14 | 7 | 5 | 3.5 | 45 | 23 | 13 | 8 | 5 | 10 | 5 | 2.5 |
| 180 | 250 | 23 | 15 | 8 | 6 | 4 | 50 | 25 | 15 | 10 | 7 | 11 | 7 | 4 |
| 250 | 315 | 26 | 19 | 9 | 7 | 4 | 60 | 30 | 18 | 11 | 7 | 13 | 8 | 5 |
| 315 | 400 | 30 | 21 | 10 | 8 | 5 | 70 | 35 | 20 | 13 | 8 | 13 | 10 | 7 |
| 400 | 500 | 34 | 25 | 12 | — | — | 80 | 40 | 23 | — | — | 15 | — | — |
| 500 | 630 | 38 | 29 | 14 | — | — | 100 | 50 | 25 | — | — | 18 | — | — |
| 630 | 800 | 55 | 34 | 18 | — | — | 120 | 60 | 30 | — | — | 20 | — | — |
| 800 | 1000 | 75 | 45 | — | — | — | 140 | 75 | — | — | — | — | — | — |
| 1000 | 1250 | — | — | — | — | — | 160 | — | — | — | — | — | — | — |
| 1250 | 1600 | — | — | — | — | — | 190 | — | — | — | — | — | — | — |
| 1600 | 2000 | — | — | — | — | — | 220 | — | — | — | — | — | — | — |
| 2000 | 2500 | — | — | — | — | — | 250 | — | — | — | — | — | — | — |

Notes: (1) This diameter is included in this group.

(2) Applies before mounting and after removal of internal or external snap ring.

(3) Applies to radial ball bearings such as deep groove ball bearings, angular contact ball bearings.

(4) Outer ring width variation of class 0 and 6 are listed in Table 5.1.1.

(5) Applies to radial ball bearings such as deep groove ball bearing, angular contact ball bearings.

Remarks: The high deviation of bearing cylindrical bore diameter specified in this table does not apply within a distance of $1.2 \times r$ (max) from the ring face.



Table 5.1.2 Tolerance Values of Outer Ring

(4/4)

| Bearing outside diameter Nominal D (mm) | | Assembled bearing outer ring face runout with raceway S_{ea} (3) | | | Outer ring width variation V_{Cs} (4) | | |
|---|-------|--|---------|---------|---|---------|---------|
| | | Class 5 | Class 4 | Class 2 | Class 5 | Class 4 | Class 2 |
| | | Max | Max | Max | Max | Max | Max |
| Over | Incl. | | | | | | |
| 2.5 ⁽¹⁾ | 6 | 8 | 5 | 1.5 | 5 | 2.5 | 1.5 |
| 6 | 18 | 8 | 5 | 1.5 | 5 | 2.5 | 1.5 |
| 18 | 30 | 8 | 5 | 2.5 | 5 | 2.5 | 1.5 |
| 30 | 50 | 8 | 5 | 2.5 | 5 | 2.5 | 1.5 |
| 50 | 80 | 10 | 5 | 4 | 6 | 3 | 1.5 |
| 80 | 120 | 11 | 6 | 5 | 8 | 4 | 2.5 |
| 120 | 150 | 13 | 7 | 5 | 8 | 5 | 2.5 |
| 150 | 180 | 14 | 8 | 5 | 8 | 5 | 2.5 |
| 180 | 250 | 15 | 10 | 7 | 10 | 7 | 4 |
| 250 | 315 | 18 | 10 | 7 | 11 | 7 | 5 |
| 315 | 400 | 20 | 13 | 8 | 13 | 8 | 7 |
| 400 | 500 | 23 | — | — | 15 | — | — |
| 500 | 630 | 25 | — | — | 18 | — | — |
| 630 | 800 | 30 | — | — | 20 | — | — |
| 800 | 1000 | — | — | — | — | — | — |
| 1000 | 1250 | — | — | — | — | — | — |
| 1250 | 1600 | — | — | — | — | — | — |
| 1600 | 2000 | — | — | — | — | — | — |
| 2000 | 2500 | — | — | — | — | — | — |

Notes: (1) This diameter is included in this group.

(2) Applies before mounting and after removal of internal or external snap ring.

(3) Applies to radial ball bearings such as deep groove ball bearings, angular contact ball bearings.

(4) Outer ring width variation of class 0 and 6 are listed in Table 5.1.1.

(5) Applies to radial ball bearings such as deep groove ball bearing, angular contact ball bearings.

Remarks: The high deviation of bearing cylindrical bore diameter specified in this table does not apply within a distance of $1.2 \times r$ (max) from the ring face.

Table 5.2.1 Tolerance Values of Inner Ring (1/2)

Unit: μm

| Bearing bore diameter Nominal d (mm) | | Bearing bore diameter | | | | | | | | | | | |
|--|-----|--|-----|--------------------|-----|---------|-----|---|-----|--|---------|---------|---------|
| | | Single plane mean bore diameter deviation Δd_{mp} | | | | | | Deviation of a single bore diameter Δd_s | | Bore diameter variation in a single radial plane Vd_p | | | |
| | | Class 0 Class 6X | | Class 6 Class 5 | | Class 4 | | Class 4 | | Class 0 Class 6X | Class 6 | Class 5 | Class 4 |
| | | High | Low | High | Low | High | Low | High | Low | Max | Max | Max | Max |
| 10 | 18 | 0 | -12 | 0 | -7 | 0 | -5 | 0 | -5 | 12 | 7 | 5 | 4 |
| 18 | 30 | 0 | -12 | 0 | -8 | 0 | -6 | 0 | -6 | 12 | 8 | 6 | 5 |
| 30 | 50 | 0 | -12 | 0 | -10 | 0 | -8 | 0 | -8 | 12 | 10 | 8 | 6 |
| 50 | 80 | 0 | -15 | 0 | -12 | 0 | -9 | 0 | -9 | 15 | 12 | 9 | 7 |
| 80 | 120 | 0 | -20 | 0 | -15 | 0 | -10 | 0 | -10 | 20 | 15 | 11 | 8 |
| 120 | 180 | 0 | -25 | 0 | -18 | 0 | -13 | 0 | -13 | 25 | 18 | 14 | 10 |
| 180 | 250 | 0 | -30 | 0 | -22 | 0 | -15 | 0 | -15 | 30 | 22 | 17 | 11 |
| 250 | 315 | 0 | -35 | - | - | - | - | - | - | 35 | - | - | - |
| 315 | 400 | 0 | -40 | - | - | - | - | - | - | 40 | - | - | - |
| 400 | 500 | 0 | -45 | - | - | - | - | - | - | - | - | - | - |
| 500 | 630 | 0 | -50 | - | - | - | - | - | - | - | - | - | - |
| 630 | 800 | 0 | -75 | - | - | - | - | - | - | - | - | - | - |

Remarks:

1. The high deviation of bearing bore diameter specified in this table does not apply within a distance of $1.2 \times r$ (max) from the ring face.
2. Some of these tolerances conform with the NACHI Standard.

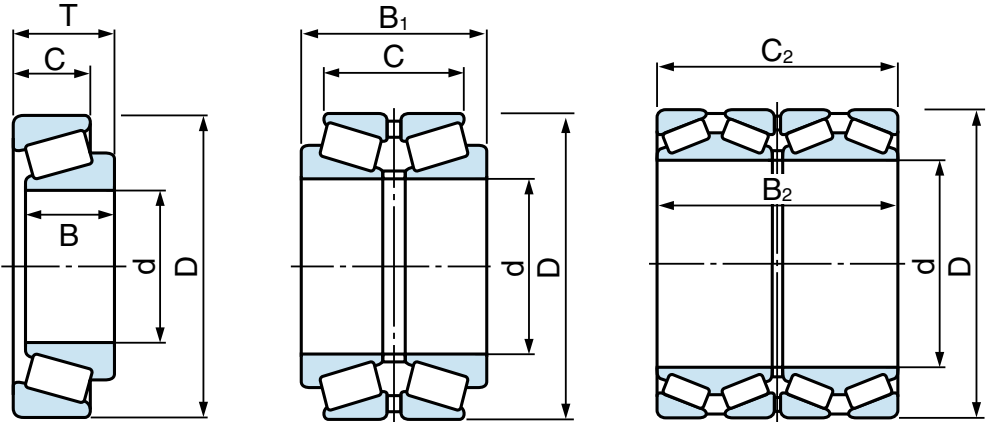


Table 5.2.1 Tolerance Values of Inner Ring (2/2)

Unit: μm

| Bearing bore diameter Nominal d (mm) | | Bearing bore diameter | | | | Radial runout of assembled bearing inner ring | | | | Inner ring reference face runout with bore | | Assembled bearing inner ring face runout with raceway |
|--------------------------------------|-------|--|---------|---------|---------|---|---------|---------|---------|--|---------|---|
| | | Mean bore diameter variation Vd_{mp} | | | | K_{ia} | | | | S_d | | |
| | | Class 0 Class 6X | Class 6 | Class 5 | Class 4 | Class 0 Class 6X | Class 6 | Class 5 | Class 4 | | | |
| | | | | | | | | | | | Class 5 | |
| Over | Incl. | Max | Max | Max | Max | Max | Max | Max | Max | Max | Max | Max |
| 10 | 18 | 9 | 5 | 5 | 4 | 15 | 7 | 5 | 3 | 7 | 3 | 3 |
| 18 | 30 | 9 | 6 | 5 | 4 | 18 | 8 | 5 | 3 | 8 | 4 | 4 |
| 30 | 50 | 9 | 8 | 5 | 5 | 20 | 10 | 6 | 4 | 8 | 4 | 4 |
| 50 | 80 | 11 | 9 | 6 | 5 | 25 | 10 | 7 | 4 | 8 | 5 | 4 |
| 80 | 120 | 15 | 11 | 8 | 5 | 30 | 13 | 8 | 5 | 9 | 5 | 5 |
| 120 | 180 | 19 | 14 | 9 | 7 | 35 | 18 | 11 | 6 | 10 | 6 | 7 |
| 180 | 250 | 23 | 16 | 11 | 8 | 50 | 20 | 13 | 8 | 11 | 7 | 8 |
| 250 | 315 | 26 | — | — | — | 60 | — | — | — | — | — | — |
| 315 | 400 | 30 | — | — | — | 70 | — | — | — | — | — | — |
| 400 | 500 | — | — | — | — | 70 | — | — | — | — | — | — |
| 500 | 630 | — | — | — | — | 85 | — | — | — | — | — | — |
| 630 | 800 | — | — | — | — | 100 | — | — | — | — | — | — |

Remarks:

1. The high deviation of bearing bore diameter specified in this table does not apply within a distance of $1.2 \times r$ (max) from the ring face.
2. Some of these tolerances conform with the NACHI Standard.

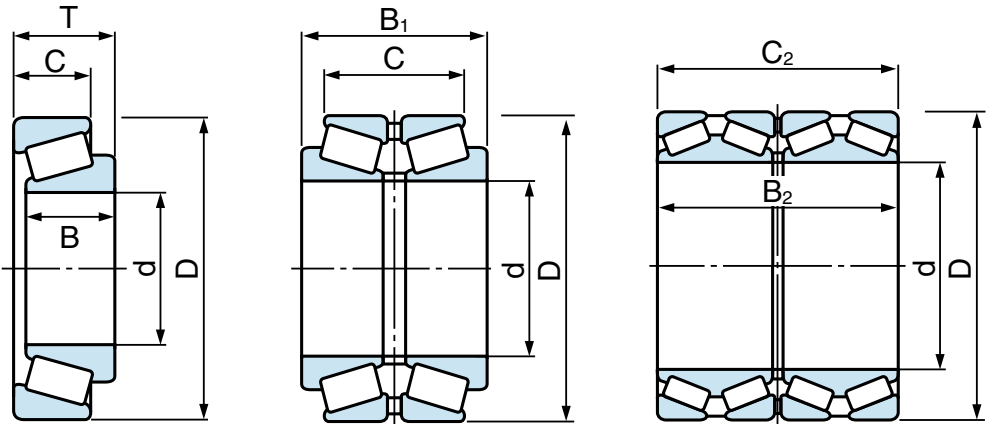


Table 5.2.2 Tolerance Values of Outer Ring
(1/2)
Unit: μm

| Bearing outside diameter Nominal D (mm) | | Bearing outside diameter | | | | | | | | | | | |
|---|------|--|------|--------------------|-----|---|-----|---------|-----|--|---------|---------|---------|
| | | Single plane mean outside diameter deviation ΔD_{mp} | | | | Deviation of a single outside diameter ΔD_s | | | | Outside diameter variation in a single radial plane V_{Dp} | | | |
| | | Class 0 Class 6X | | Class 6 Class 5 | | Class 4 | | Class 4 | | Class 0 Class 6X | Class 6 | Class 5 | Class 4 |
| | | High | Low | High | Low | High | Low | High | Low | Max | Max | Max | Max |
| 18 | 30 | 0 | -12 | 0 | -8 | 0 | -6 | 0 | -6 | 12 | 8 | 6 | 5 |
| 30 | 50 | 0 | -14 | 0 | -9 | 0 | -7 | 0 | -7 | 14 | 9 | 7 | 5 |
| 50 | 80 | 0 | -16 | 0 | -11 | 0 | -9 | 0 | -9 | 16 | 11 | 8 | 7 |
| 80 | 120 | 0 | -18 | 0 | -13 | 0 | -10 | 0 | -10 | 18 | 13 | 10 | 8 |
| 120 | 150 | 0 | -20 | 0 | -15 | 0 | -11 | 0 | -11 | 20 | 15 | 11 | 8 |
| 150 | 180 | 0 | -25 | 0 | -18 | 0 | -13 | 0 | -13 | 25 | 18 | 14 | 10 |
| 180 | 250 | 0 | -30 | 0 | -20 | 0 | -15 | 0 | -15 | 30 | 20 | 15 | 11 |
| 250 | 315 | 0 | -35 | 0 | -25 | 0 | -18 | 0 | -18 | 35 | 25 | 19 | 14 |
| 315 | 400 | 0 | -40 | 0 | -28 | 0 | -20 | 0 | -20 | 40 | 28 | 22 | 15 |
| 400 | 500 | 0 | -45 | — | — | — | — | — | — | 45 | — | — | — |
| 500 | 630 | 0 | -50 | — | — | — | — | — | — | 50 | — | — | — |
| 630 | 800 | 0 | -75 | — | — | — | — | — | — | — | — | — | — |
| 800 | 1000 | 0 | -100 | — | — | — | — | — | — | — | — | — | — |

- Remarks: 1. The low deviation of bearing outside diameter specified in this table does not apply within a distance of $1.2 \times r$ (max) from the ring face.
2. Some of these tolerances conform with the NACHI Standard.

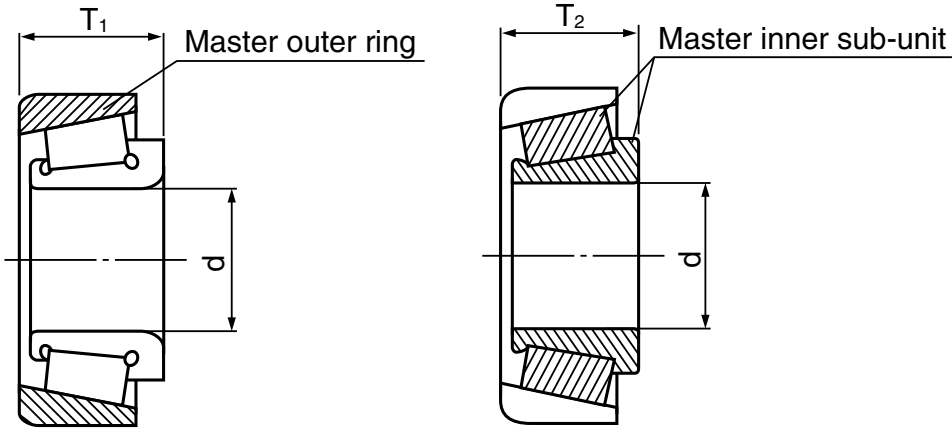


Table 5.2.2 Tolerance Values of Outer Ring

(2/2)

Unit: μm

| Bearing outside diameter Nominal D (mm) | | Bearing outside diameter | | | | Radial runout of assembled bearing outer ring | | | | Variation of bearing outside surface generatrix inclination with outer ring reference face S_D | | Assembled bearing outer ring face runout with raceway S_{ea} |
|---|-------|---|---------|---------|---------|---|---------|---------|---------|--|-----|--|
| | | Mean outside diameter variation V_{Dmp} | | | | | | | | | | |
| | | Class 0 | Class 6 | Class 5 | Class 4 | Class 0 | Class 6 | Class 5 | Class 4 | | | |
| | | Class 6X | | | | Class 6X | | | | | | |
| Over | Incl. | Max | Max | Max | Max | Max | Max | Max | Max | Max | Max | Max |
| 18 | 30 | 9 | 6 | 5 | 4 | 18 | 9 | 6 | 4 | 8 | 4 | 5 |
| 30 | 50 | 11 | 7 | 5 | 5 | 20 | 10 | 7 | 5 | 8 | 4 | 5 |
| 50 | 80 | 12 | 8 | 6 | 5 | 25 | 13 | 8 | 5 | 8 | 4 | 5 |
| 80 | 120 | 14 | 10 | 7 | 5 | 35 | 18 | 10 | 6 | 9 | 5 | 6 |
| 120 | 150 | 15 | 11 | 8 | 6 | 40 | 20 | 11 | 7 | 10 | 5 | 7 |
| 150 | 180 | 19 | 14 | 9 | 7 | 45 | 23 | 13 | 8 | 10 | 5 | 8 |
| 180 | 250 | 23 | 15 | 10 | 8 | 50 | 25 | 15 | 10 | 11 | 7 | 10 |
| 250 | 315 | 26 | 19 | 13 | 9 | 60 | 30 | 18 | 11 | 13 | 8 | 10 |
| 315 | 400 | 30 | 21 | 14 | 10 | 70 | 35 | 20 | 13 | 13 | 10 | 13 |
| 400 | 500 | 34 | — | — | — | 80 | — | — | — | — | — | — |
| 500 | 630 | 38 | — | — | — | 100 | — | — | — | — | — | — |
| 630 | 800 | — | — | — | — | 120 | — | — | — | — | — | — |
| 800 | 1000 | — | — | — | — | 120 | — | — | — | — | — | — |

Remarks: 1.

The low deviation of bearing outside diameter specified in this table does not apply within a distance of $1.2 \times r$ (max) from the ring face.

2.

Some of these tolerances conform with the NACHI Standard.

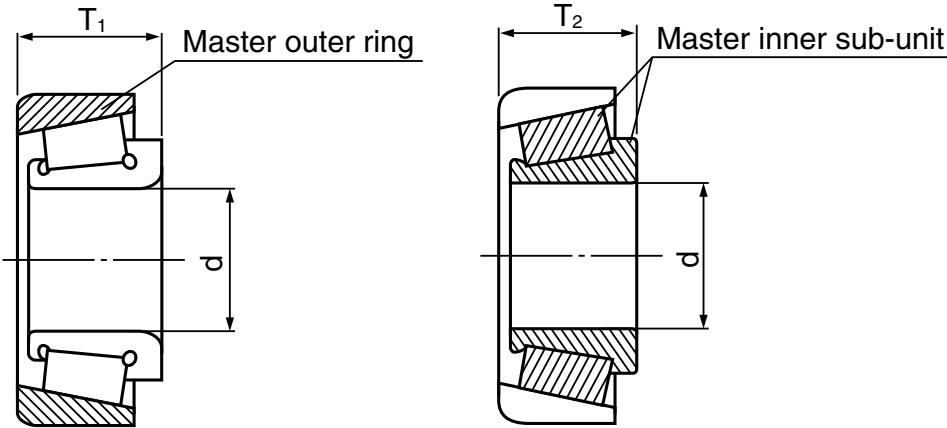


Table 5.2.3

Deviations of Single Ring Width,
Bearing Width and Duplex/Stack Mounted Bearing Width

(1/3)

Unit: μm

| Bearing bore diameter Nominal d (mm) | | Deviation of a single inner ring width ΔB_s | | | | | | Deviation of a single outer ring width ΔC_s | | | | | |
|---|-------|--|------|----------|-----|--------------------|------|--|------|----------|------|--------------------|------|
| | | Class 0 Class 6 | | Class 6X | | Class 5 Class 4 | | Class 0 Class 6 | | Class 6X | | Class 5 Class 4 | |
| Over | Incl. | 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 |
| 18 | 30 | 0 | -120 | 0 | -50 | 0 | -200 | 0 | -120 | 0 | -100 | 0 | -200 |
| 30 | 50 | 0 | -120 | 0 | -50 | 0 | -240 | 0 | -120 | 0 | -100 | 0 | -240 |
| 50 | 80 | 0 | -150 | 0 | -50 | 0 | -300 | 0 | -150 | 0 | -100 | 0 | -300 |
| 80 | 120 | 0 | -200 | 0 | -50 | 0 | -400 | 0 | -200 | 0 | -100 | 0 | -400 |
| 120 | 180 | 0 | -250 | 0 | -50 | 0 | -500 | 0 | -250 | 0 | -100 | 0 | -500 |
| 180 | 250 | 0 | -300 | 0 | -50 | 0 | -600 | 0 | -300 | 0 | -100 | 0 | -600 |
| 250 | 315 | 0 | -350 | 0 | -50 | — | — | 0 | -350 | 0 | -100 | — | — |
| 315 | 400 | 0 | -400 | 0 | -50 | — | — | 0 | -400 | 0 | -100 | — | — |
| 400 | 500 | 0 | -450 | — | — | — | — | 0 | -450 | — | — | — | — |
| 500 | 630 | 0 | -500 | — | — | — | — | 0 | -500 | — | — | — | — |
| 630 | 800 | 0 | -750 | — | — | — | — | 0 | -750 | — | — | — | — |

Remarks: Effective width of an inner sub-unit T₁ is the bearing width obtained when this sub-unit is mated with a master outer ring.
Effective width of an outer ring T₂ is the bearing width obtained when this ring is mated with a master inner sub-unit.



Table 5.2.3

Deviations of Single Ring Width,
Bearing Width and Duplex/Stack Mounted Bearing Width

(2/3)

Unit: μm

| Bearing bore diameter Nominal d (mm) | | Deviation of a actual bearing width ΔT_s | | | | | | Deviation of the actual effective width of inner sub-unit ΔT_{1s} | | | |
|---|-------|---|------|----------|-----|--------------------|------|--|------|----------|-----|
| | | Class 0 Class 6 | | Class 6X | | Class 5 Class 4 | | Class 0 | | Class 6X | |
| Over | Incl. | High | Low | High | Low | High | Low | High | Low | High | Low |
| 10 | 18 | +200 | 0 | +100 | 0 | +200 | -200 | +100 | 0 | + 50 | 0 |
| 18 | 30 | +200 | 0 | +100 | 0 | +200 | -200 | +100 | 0 | + 50 | 0 |
| 30 | 50 | +200 | 0 | +100 | 0 | +200 | -200 | +100 | 0 | + 50 | 0 |
| 50 | 80 | +200 | 0 | +100 | 0 | +200 | -200 | +100 | 0 | + 50 | 0 |
| 80 | 120 | +200 | -200 | +100 | 0 | +200 | -200 | +100 | -100 | + 50 | 0 |
| 120 | 180 | +350 | -250 | +150 | 0 | +350 | -250 | +150 | -150 | + 50 | 0 |
| 180 | 250 | +350 | -250 | +150 | 0 | +350 | -250 | +150 | -150 | + 50 | 0 |
| 250 | 315 | +350 | -250 | +200 | 0 | — | — | +150 | -150 | +100 | 0 |
| 315 | 400 | +400 | -400 | +200 | 0 | — | — | +200 | -200 | +100 | 0 |
| 400 | 500 | +400 | -400 | — | — | — | — | — | — | — | — |
| 500 | 630 | +500 | -500 | — | — | — | — | — | — | — | — |
| 630 | 800 | +600 | -600 | — | — | — | — | — | — | — | — |

Remarks: Effective width of an inner sub-unit T₁ is the bearing width obtained when this sub-unit is mated with a master outer ring.
Effective width of an outer ring T₂ is the bearing width obtained when this ring is mated with a master inner sub-unit.



Table 5.2.3 Deviations of Single Ring Width, Bearing Width and Duplex/Stack Mounted Bearing Width Unit: μm (3/3)

| Bearing bore diameter Nominal d (mm) | | Deviation of the actual effective width of outer sub-unit ΔT_{2S} | | | | Deviation of duplex/stack mounted bearing width | | | |
|---|-------|---|------|----------|-----|---|-------|---------------------------------------|-------|
| | | | | | | ΔB_{1S} | | $\Delta B_{2S} \bullet \Delta C_{2S}$ | |
| | | Class 0 | | Class 6X | | Duplex mounted bearing class 0 | | Four row bearing class 0 | |
| Over | Incl. | High | Low | High | Low | High | Low | High | Low |
| 10 | 18 | +100 | 0 | + 50 | 0 | + 200 | – 200 | – | – |
| 18 | 30 | +100 | 0 | + 50 | 0 | + 200 | – 200 | – | – |
| 30 | 50 | +100 | 0 | + 50 | 0 | + 240 | – 240 | – | – |
| 50 | 80 | +100 | 0 | + 50 | 0 | + 300 | – 300 | + 400 | – 400 |
| 80 | 120 | +100 | –100 | + 50 | 0 | + 400 | – 400 | + 500 | – 500 |
| 120 | 180 | +200 | –100 | +100 | 0 | + 500 | – 500 | + 600 | – 600 |
| 180 | 250 | +200 | –100 | +100 | 0 | + 600 | – 600 | + 750 | – 750 |
| 250 | 315 | +200 | –100 | +100 | 0 | + 700 | – 700 | + 900 | – 900 |
| 315 | 400 | +200 | –200 | +100 | 0 | + 800 | – 800 | +1000 | –1000 |
| 400 | 500 | – | – | – | – | + 900 | – 900 | +1200 | –1200 |
| 500 | 630 | – | – | – | – | +1000 | –1000 | +1200 | –1200 |
| 630 | 800 | – | – | – | – | +1500 | –1500 | +1500 | –1500 |

Remarks: Effective width of an inner sub-unit T_1 is the bearing width obtained when this sub-unit is mated with a master outer ring.
 Effective width of an outer ring T_2 is the bearing width obtained when this ring is mated with a master inner sub-unit.

Table 8.1 Fits vs. Load Characteristics

Table 8.2.1 Bearing Bore (1) Fits for Radial Bearings

Table 8.2.2 Bearing Outside Diameter (1) Fits for Radial Bearings

Table 8.3.1 Bearing Bore or Center Washer Bore (1) Fits for Thrust Bearings

Table 8.3.2 Bearing Outside Diameter (1) Fits for Thrust Bearings

Table 8.4 Shaft Tolerances (1) for Radial Bearings

Table 8.5 Shaft Tolerances for Thrust Bearings

Table 8.6 Housing Bore Tolerances (1) for Radial Bearings (Except Inch-series Tapered Roller Bearings)

Table 8.7 Housing Bore Tolerances for Thrust Bearings

Fits of Inch Series Tapered Roller Bearings with Shafts

Table 8.8.1 For Bearings with ABMA Classes 4 and 2

Table 8.8.2 For Bearings with ABMA Classes 3 and 0

Fits of Inch Series Tapered Roller Bearings with Housings

Table 8.9.1 For Bearings with ABMA Classes 4 and 2

Table 8.9.2 For Bearings with ABMA Classes 3 and 0

Amounts of Fits: Radial Bearings with Tolerance JIS Class 0 (ISO Normal Class)

Table 8.10.1 Inner Ring with Shaft

Table 8.10.2 Outer Ring with Housing

Amounts of Fits: Radial Bearings with Tolerance JIS (ISO) Class 6

Table 8.11.1 Inner Ring with Shaft

Table 8.11.2 Outer Ring with Housing

Amounts of Fits: Radial Bearings with Tolerance JIS (ISO) Class 5

Table 8.12.1 Inner Ring with Shaft

Table 8.12.2 Outer Ring with Housing

Amounts of Fits: Radial Bearings with Tolerance JIS (ISO) Class 4

Table 8.13.1 Inner Ring with Shaft

Table 8.13.2 Outer Ring with Housing

Amounts of Fits: Thrust Bearings with Tolerance JIS (ISO) Class 0

Table 8.14.1 Shaft Washer or Center Washer with Shaft

Table 8.14.2 Housing Washer with Housing

Table 8.1 Fits vs. Load Characteristics

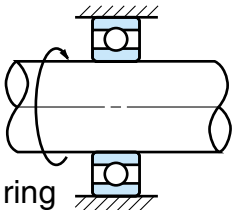
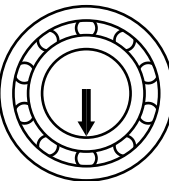
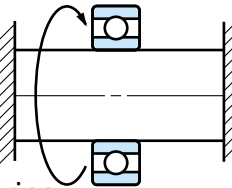
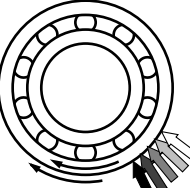
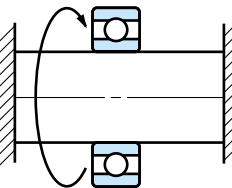
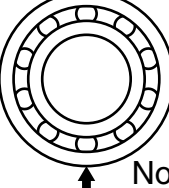
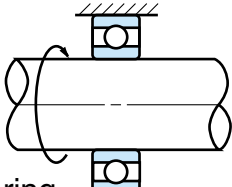
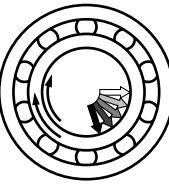
| Rotating condition | Type of load | Load conditions | Fit | |
|--|---|------------------------------|------------------|------------------|
| | | | Inner ring | Outer ring |
|  inner ring |  Non-rotating | Rotating inner ring load | Interference fit | Loose fit |
|  outer ring |  Rotating | Stationary outer ring load | | |
|  outer ring |  Non-rotating | Rotating outer ring load | Loose fit | Interference fit |
|  inner ring |  Rotating | Stationary inner ring load | | |
| Load direction not constant because of fluctuation unbalanced load | Rotating or Non-rotating | Indeterminate direction load | Interference fit | Interference fit |

Table 8.2.1 Bearing Bore ⁽¹⁾ Fits for Radial Bearings

| Bearing tolerance class | Fit class vs. load type | | | | | | | | |
|-------------------------|---|-----|-----|------------|------------|--------------------|-----|------------------------------|------------|
| | For rotating inner ring load and indeterminate direction load | | | | | | | For rotating outer ring load | |
| Class 0, class 6 | r 6 | p 6 | n 6 | m 5 m 6 | k 5 k 6 | j 5 j 6 js 6 | h 5 | h 5 h 6 | g 5 g 6 |
| Class 5, class 4 | — | — | — | m 5 | k 4 | js 4 | h 4 | h 5 | — |

Table 8.2.2 Bearing Outside Diameter ⁽¹⁾ Fits for Radial Bearings

| Bearing tolerance class | Fit class vs. load type | | | | | | | | | |
|-------------------------|------------------------------|------------|------------|-----|----------------------------------|------------|------------|------------------------------|-----|-----|
| | For rotating inner ring load | | | | For indeterminate direction load | | | For rotating outer ring load | | |
| Class 0, class 6 | — | J 6 J 7 | H 6 H 7 | G 7 | M 7 | K 6 K 7 | J 6 J 7 | P 7 | N 7 | M 7 |
| Class 5, class 4 | K 5 | Js 5 | H 5 | — | — | — | — | — | — | M 5 |

Table 8.3.1 Bearing Bore or Center Washer Bore ⁽¹⁾ Fits for Thrust Bearings

| Bearing tolerance class | Fit class vs. load type | | | |
|-------------------------|-------------------------|--|-----|--------------------|
| | For centric axial load | For composite load (spherical roller thrust bearing) | | |
| Class 0 | j 6 js 6 | n 6 | m 6 | k 6 j 6 js 6 |

Table 8.3.2 Bearing Outside Diameter ⁽¹⁾ Fits for Thrust Bearings

| Bearing tolerance class | Fit class vs. load type | |
|-------------------------|-------------------------|--|
| | For centric axial load | For composite load (spherical roller thrust bearing) |
| Class 0 | — | M 7 H 7 |

Note: (1) These dimensional fits are based on JIS B 1514.

Table 8.4 Shaft Tolerances ⁽¹⁾ for Radial Bearings

| Operating conditions | | Shaft diameter (mm) | | Tolerance symbols | Remarks | Examples of application (Reference) |
|--------------------------------|---|-------------------------|--|-------------------|---|-------------------------------------|
| | | Bell bearings | Cylindrical roller bearings Tapered roller bearings | | | |
| Bearings with cylindrical bore | | | | | | |
| Rotating outer ring load | When the inner ring is required to move on the shaft easily | For all shaft diameters | | g6 | When high precision is required, adopt g5 and h5 respectively. For large bearings, f6 is adopted because of easy bearing movement in axial direction. | Driven wheel |
| | When the inner ring is required to move on the shaft easily | For all shaft diameters | | h6 | | Tension pully, rope sheave |

Note: (1) Shaft tolerances in this table are applied to solid steel shaft for bearings with tolerance class 0 and 6.
Remarks: Heavy load $P > 0.12Cr$, Normal Load $0.06Cr < P \leq 0.12Cr$, Light Load $P \leq 0.06Cr$ Cr: Basic Dynamic Load Rating





Table 8.4 Shaft Tolerances ⁽¹⁾ for Radial Bearings

(2/3)

| Operating conditions | | Shaft diameter (mm) | | | Tolerance symbols | Remarks | Examples of application (Reference) |
|--|--------------------------------|---------------------|--|---------------------------|-------------------|---|--|
| | | Bell bearings | Cylindrical roller bearings Tapered roller bearings | Spherical roller bearings | | | |
| Rotating inner ring load or indeterminate direction load | Light load or fluctuating load | 18 under and incl. | — | — | h5 | When high precision is required, adopt j5, k5 and m5 instead of j6, k5 and m6 respectively | Electrical appliance, machining tool, pump, blower, haulage car |
| | | 18 Over 100 Incl. | 40 under and incl. | — | j6 | | |
| | | 100 Over 200 Incl. | 40 Over 140 Incl. | — | k6 | | |
| | | — | 140 Over 200 Incl. | — | m6 | | |
| | Normal load or heavy load | 18 under and incl. | — | — | j5 | The tolerances of k6 and m6 instead of k5 and m5 can be used for single row tapered roller bearings and single row angular contact ball bearings. | Electric motor, turbine, pump, internal combustion engine, wood working machine, bearing application in general. |
| | | 18 Over 100 Incl. | 40 under and incl. | 40 under and incl. | k5 | | |
| | | 100 Over 200 Incl. | 40 Over 100 Incl. | 40 Over 65 Incl. | m5 | | |
| | | — | 100 Over 140 Incl. | 65 Over 100 Incl. | m6 | | |
| | | — | 140 Over 200 Incl. | 100 Over 140 Incl. | n6 | | |
| | | — | 200 Over 400 Incl. | 140 Over 200 Incl. | p6 | | |
| | | — | — | 280 Over | r6 | | |
| | Composite load | — | 50 Over 140 Incl. | 50 Over 100 Incl. | n6 | A bearing with an internal clearance larger than the normal clearance is required | Axles of locomotive and passenger train, traction motor |
| | | — | 140 Over 200 Incl. | 100 Over 140 Incl. | p6 | | |
| | | — | 200 Over | 140 Over | r6 | | |

Note: (1) Shaft tolerances in this table are applied to solid steel shaft for bearings with tolerance class 0 and 6.

Remarks: Heavy load $P > 0.12C_r$, Normal Load $0.06C_r < P \leq 0.12C_r$, Light Load $P \leq 0.06C_r$ C_r : Basic Dynamic Load Rating



**Table 8.4 Shaft Tolerances ⁽¹⁾ for Radial Bearings****(3/3)**

| Operating conditions | Shaft diameter (mm) | | | Tolerance symbols | Remarks | Examples of application (Reference) |
|---|-------------------------|--|---------------------------|-------------------|--|---|
| | Bell bearings | Cylindrical roller bearings Tapered roller bearings | Spherical roller bearings | | | |
| Centric axial load | 250 under and incl. | | | j6 | — | — |
| | 250 Over | | | js6, j6 | | |
| Bearing with tapered bore (with sleeve) | | | | | | |
| For all load condition | For all shaft condition | | | h9/IT5 | h10/IT7 instead of h9/IT5 can be used for power transmission shaft. IT5 and IT7 mean the form error (out of roundness, taper) should be limited within the tolerance ranges of IT5 and IT7 | Railroad car axle, bearing application in general |

Note: (1) Shaft tolerances in this table are applied to solid steel shaft for bearings with tolerance class 0 and 6.

Remarks: Heavy load $P > 0.12C_r$, Normal Load $0.06C_r < P \leq 0.12C_r$, Light Load $P \leq 0.06C_r$ C_r : Basic Dynamic Load Rating

Table 8.5 Shaft Tolerances for Thrust Bearings

| Operating conditions | | Shaft diameter (mm) | Tolerance symbols |
|---|---|---------------------|-------------------|
| Centric axial load (Thrust ball bearings and spherical roller thrust bearings) | | 250 under and incl. | j6 |
| | | 250 Over | js6, j6 |
| Composite load (Spherical roller thrust bearings) | Rotating outer ring load | 250 under and incl. | j6 |
| | | 250 Over | js6, j6 |
| | Rotation inner ring load or indeterminate direction load | 200 under and incl. | k6 |
| | | 200 Over 400 Incl. | m6 |
| | | 400 Over | n6 |

Table 8.7 Housing Bore Tolerances for Thrust Bearings

| Operating conditions | | Tolerance symbols | Remarks |
|--|---|-------------------|---|
| Centric axial load (All thrust bearings) | Thrust ball bearing | H8 | When high accuracy is not required, radial clearance will be provided between outer ring (housing washer)/aligning housing washer and housing |
| | Spherical roller thrust bearing; When housing is located in radial direction by another bearing. | — | 0.001D is recommended as a radial clearance between outer ring and housing. D: outside diameter of housing washer |
| Composite load (Spherical roller thrust bearings) | Stationary outer ring load or indeterminate direction load | H7 J7 | — |
| | Rotating outer ring load | K7 M7 | In case when the radial load is comparatively large, bearing application in general |

Table 8.6 Housing Bore Tolerances ⁽¹⁾ for Radial Bearings (Except Inch-series Tapered Roller Bearings) (1/2)

| Operating conditions | | | Tolerance symbols | Outer ring movement (2) | Examples of application (Reference) |
|--|---|---|---|---|---|
| Monoblock housing | Rotating outer ring load | When a heavy load is applied to a thin-walled housing or impact load | P7 | Outer ring can not be moved in axial direction. | Automotive wheel (roller bearing) |
| | | Normal load or heavy load | N7 | | Automotive wheel (ball bearing) |
| | | Light load or fluctuating load | M7 | | Conveyer roller, pulley, tension pulley |
| | Indeterminate direction load | Heavy impact load | | | Traction motor |
| | Indeterminate direction load | Heavy load or normal load; When the outer ring is not required to move in axial direction | K7 | Outer ring can not be moved in axial direction as a rule. | Electric motor, pump, crank shaft |
| | | Monoblock or split housing | Normal load or light load; When it is desirable that the outer ring can be moved in axial direction | J7 | Outer ring can be moved in axial direction. |
| Impact load; When no-load condition occurs instantaneously | Railroad car axle | | | | |
| Rotating inner ring load | All kinds of load | | H7 | Outer ring can be moved easily in axial direction. | Railroad car axle, bearing application in general |
| | Normal load or light load | | H8 | | Gear transmission |
| | When thermal conduction through the shaft is caused | | G7 | | Paper mill (Drying cylinder) |

Note: (1) The tolerances in this table are applied to cast iron or steel housing for bearings with tolerance class 0 and 6.
Tighter fit is adopted for light alloy housing.
(2) Outer ring of non-separable bearing



**Table 8.6 Housing Bore Tolerances ⁽¹⁾ for Radial Bearings (Except Inch-series Tapered Roller Bearings) (2/2)**

| Operating conditions | | | Tolerance symbols | Outer ring movement ⁽²⁾ | Examples of application (Reference) |
|----------------------|--|---|-------------------|---|--|
| Monoblock housing | When extremely high accuracy is required | Fluctuating load; When extremely accurate rotation and high rigidity are required | N6 | Outer ring can not be moved in axial direction. | Main shaft of machine tool (roller bearing, outside diameter is over 125 mm) |
| | | | M6 | | Main shaft of machine tool (roller bearing outside diameter is under and including 125 mm) |
| | | Indeterminate direction light load; When extremely accurate rotation is required. | K6 | Outer ring can not be moved in axial direction as a rule. | Main shaft of grinding machine, ball bearing on grinding wheel side High speed centrifugal compressor, clamping side bearing |
| | | When extremely accurate rotation is required and it is desirable that the outer ring can be moved in axial direction. | J6 | Outer ring can be moved in axial direction. | Main shaft of grinding machine, ball bearing on driving side High speed centrifugal compressor, floating side bearing |

Note: (1) The tolerances in this table are applied to cast iron or steel housing for bearings with tolerance class 0 and 6.

Tighter fit is adopted for light alloy housing.

(2) Outer ring of non-separable bearing

Table 4.2.1 Boundary Dimensions of Diameter Series 9, 0

(2/8)

Unit : mm



| | | | | | | | | | | | | | | | | | | | | | | | | |
|----------------------------------|-------------------------------|------------------|----------|-----|-----|------|----|----|-----|----------------------|----------|----|-------------------------------|------------------|----------|----|------|-----|----|-----|----------|----------------------|--|--|
| Single row, radial ball bearings | | | 69 79 | | | | | | | | | | | 160 | 60 70 | | | | | | | | | |
| Double row, radial ball bearings | | | | | | | | | | | | | | | | | | | | | | | | |
| Cylindrical roller bearings | | | | | | NN49 | | | | | | | | | N10 | | NN30 | | | | | | | |
| Spherical roller bearings | | | | | 239 | | | | | | | | | | | | 230 | 240 | | | | | | |
| Bearing bore diameter Nominal | Diameter series 9 | | | | | | | | | | | | Diameter series 0 | | | | | | | | | | | |
| | Bearing outside diameter D | Width series | | | | | | | | Chamfer dimension | | | Bearing outside diameter D | Width series | | | | | | | | Chamfer dimension | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 0 | | | | | 1 | 2 | 3 | 4 | 5 | 6 | | | | | |
| | | Dimension series | | | | | | | | | | | | Dimension series | | | | | | | | | | |
| | | 09 | 19 | 29 | 39 | 49 | 59 | 69 | 09 | 19 39 | 49 69 | 00 | | 10 | 20 | 30 | 40 | 50 | 60 | 00 | 10 60 | | | |
| Bore No. d | | Width B | | | | | | | | r _{min} | | | | Width B | | | | | | | | r _{min} | | |
| 00 10 | 22 | ñ | 6 | 8 | 10 | 13 | 16 | 22 | ñ | 0.3 | 0.3 | 26 | ñ | 8 | 10 | 12 | 16 | 21 | 29 | ñ | 0.3 | | | |
| 01 12 | 24 | ñ | 6 | 8 | 10 | 13 | 16 | 22 | ñ | 0.3 | 0.3 | 28 | 7 | 8 | 10 | 12 | 16 | 21 | 29 | 0.3 | 0.3 | | | |
| 02 15 | 28 | ñ | 7 | 8.5 | 10 | 13 | 18 | 23 | ñ | 0.3 | 0.3 | 32 | 8 | 9 | 11 | 13 | 17 | 23 | 30 | 0.3 | 0.3 | | | |
| 03 17 | 30 | ñ | 7 | 8.5 | 10 | 13 | 18 | 23 | ñ | 0.3 | 0.3 | 35 | 8 | 10 | 12 | 14 | 18 | 24 | 32 | 0.3 | 0.3 | | | |
| 04 20 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | | | |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. The chamfer dimensions given in this table do not necessarily apply to:

- (1) the groove side of bearing rings with snap ring groove
 (2) the flangeless side of thin cylindrical roller bearing rings

- (3) the front face side of angular contact bearing
 (4) inner rings of bearings with tapered bore



Table 4.2.1 Boundary Dimensions of Diameter Series 9, 0

(3/8)

Unit : mm



| | | | | | | | | | | | | | | | | | | | | | | | | | |
|----------------------------------|-------------------------------|------------------|----------|----|-----|------|----|----|-----|----------------------|----------|-----|-------------------|-------------------------------|------------------|----|------|-----|----|-----|----------|--|----------------------|--|--|
| Single row, radial ball bearings | | | 69 79 | | | | | | | | | | | 160 | 60 70 | | | | | | | | | | |
| Double row, radial ball bearings | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cylindrical roller bearings | | | | | | NN49 | | | | | | | | | N10 | | NN30 | | | | | | | | |
| Spherical roller bearings | | | | | 239 | | | | | | | | | | | | 230 | 240 | | | | | | | |
| Bearing bore diameter Nominal | Diameter series 9 | | | | | | | | | | | | Diameter series 0 | | | | | | | | | | | | |
| | Bearing outside diameter D | Width series | | | | | | | | Chamfer dimension | | | | Bearing outside diameter D | Width series | | | | | | | | Chamfer dimension | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 0 | | | | | | 1 | 2 | 3 | 4 | 5 | 6 | | | | | |
| | | Dimension series | | | | | | | | | | | | | Dimension series | | | | | | | | | | |
| | | 09 | 19 | 29 | 39 | 49 | 59 | 69 | 09 | 19 39 | 49 69 | 00 | 10 | | 20 | 30 | 40 | 50 | 60 | 00 | 10 60 | | | | |
| Bore No. d | | Width B | | | | | | | | r _{min} | | | | | Width B | | | | | | | | r _{min} | | |
| 09 45 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | | | | |

Remarks: 1. r_{min} is the smallest chamfer dimension.

2. The chamfer dimensions given in this table do not necessarily apply to:

- (1) the groove side of bearing rings with snap ring groove
 (2) the flangeless side of thin cylindrical roller bearing rings

- (3) the front face side of angular contact bearing
 (4) inner rings of bearings with tapered bore



Table 8.9 Fits of Inch Series Tapered Roller Bearings with Housings

Table 8.9.1 For Bearings with ABMA Classes 4 and 2 Unit: μm

| Operating conditions | | Bearing outside diameter Nominal D (mm) | | Bearing outside diameter deviation | | Housing bore diameter deviation | | Amounts ⁽¹⁾ | |
|-----------------------------------|--|--|-------|---------------------------------------|-----|------------------------------------|------|------------------------|------|
| | | Over | Incl. | High | Low | High | Low | Max | Min |
| Rotating inner ring load | Floating side or Clamping side | — | 76.2 | +25 | 0 | + 76 | + 50 | 25L | 76L |
| | | 76.2 | 127.0 | +25 | 0 | + 76 | + 50 | 25L | 76L |
| | | 127.0 | 304.8 | +25 | 0 | + 76 | + 50 | 25L | 76L |
| | | 304.8 | 609.6 | +51 | 0 | +152 | +102 | 51L | 152L |
| | | 609.6 | 914.4 | +76 | 0 | +229 | +152 | 76L | 229L |
| | Outer ring location in axial direction can be adjusted | — | 76.2 | +25 | 0 | + 25 | 0 | 25T | 25L |
| | | 76.2 | 127.0 | +25 | 0 | + 25 | 0 | 25T | 25L |
| | | 127.0 | 304.8 | +25 | 0 | + 51 | 0 | 25T | 51L |
| | | 304.8 | 609.6 | +51 | 0 | + 76 | + 26 | 25T | 76L |
| | | 609.6 | 914.4 | +76 | 0 | +127 | + 51 | 25T | 127L |
| | Outer ring location in axial direction can not be adjusted | — | 76.2 | +25 | 0 | — 13 | — 39 | 64T | 13T |
| | | 76.2 | 127.0 | +25 | 0 | — 25 | — 51 | 76T | 25T |
| | | 127.0 | 304.8 | +25 | 0 | — 25 | — 51 | 76T | 25T |
| | | 304.8 | 609.6 | +51 | 0 | — 25 | — 76 | 127T | 25T |
| | | 609.6 | 914.4 | +76 | 0 | — 25 | —102 | 178T | 25T |
| Rotating outer ring load | Outer ring location in axial direction can not be adjusted | — | 76.2 | +25 | 0 | — 13 | — 39 | 64T | 13T |
| | | 76.2 | 127.0 | +25 | 0 | — 25 | — 51 | 76T | 25T |
| | | 127.0 | 304.8 | +25 | 0 | — 25 | — 51 | 76T | 25T |
| | | 304.8 | 609.6 | +51 | 0 | — 25 | — 76 | 127T | 25T |
| | | 609.6 | 914.4 | +76 | 0 | — 25 | —102 | 178T | 25T |

Note: (1) T: Tight fit L: Loose fit

Table 8.9.2 For Bearings with ABMA Classes 3 and 0

 Unit: μm

| Operating conditions | | Bearing outside diameter Nominal D (mm) | | Bearing outside diameter deviation | | Housing bore diameter deviation | | Amounts ⁽¹⁾ | |
|-----------------------------------|--|--|-------|---------------------------------------|-----|------------------------------------|-----|------------------------|-----|
| | | Over | Incl. | High | Low | High | Low | Max | Min |
| Rotating inner ring load | Floating side | – | 152.4 | +13 | 0 | +38 | +26 | 13L | 38L |
| | | 152.4 | 304.8 | +13 | 0 | +38 | +26 | 13L | 38L |
| | | 304.8 | 609.6 | +25 | 0 | +64 | +38 | 13L | 64L |
| | | 609.6 | 914.4 | +38 | 0 | +89 | +51 | 13L | 89L |
| | Clamping side | – | 152.4 | +13 | 0 | +25 | +13 | 0 | 25L |
| | | 152.4 | 304.8 | +13 | 0 | +25 | +13 | 0 | 25L |
| | | 304.8 | 609.6 | +25 | 0 | +51 | +25 | 0 | 51L |
| | | 609.6 | 914.4 | +38 | 0 | +76 | +38 | 0 | 76L |
| | Outer ring location in axial direction can be adjusted | – | 152.4 | +13 | 0 | +13 | 0 | 13T | 13L |
| | | 152.4 | 304.8 | +13 | 0 | +25 | 0 | 13T | 25L |
| | | 304.8 | 609.6 | +25 | 0 | +25 | 0 | 25T | 25L |
| | | 609.6 | 914.4 | +38 | 0 | +38 | 0 | 38T | 38L |
| | Outer ring location in axial direction can not be adjusted | – | 152.4 | +13 | 0 | 0 | –12 | 25T | 0 |
| | | 152.4 | 304.8 | +13 | 0 | 0 | –25 | 38T | 0 |
| | | 304.8 | 609.6 | +25 | 0 | 0 | –26 | 51T | 0 |
| | | 609.6 | 914.4 | +38 | 0 | 0 | –38 | 76T | 0 |
| Rotating outer ring load | Normal load | – | 152.4 | +13 | 0 | –13 | –25 | 38T | 13T |
| | Outer ring location in axial direction can not be adjusted | 152.4 | 304.8 | +13 | 0 | –13 | –38 | 51T | 13T |
| | | 304.8 | 609.6 | +25 | 0 | –13 | –39 | 64T | 13T |
| | | 609.6 | 914.4 | +38 | 0 | –13 | –51 | 89T | 13T |

Note: (1) T: Tight fit L: Loose fit

(2) This tables is not applied to the bearing with tolerance class 0 whose bore diameter is over 304.8 mm.

Table 8.10 Amounts of Fits: Radial Bearings with Tolerance JIS Class 0 (ISO Normal Class)

Table 8.10.1 Inner Ring with Shaft

(1/2)

Unit: μm

| Nominal diameter (mm) | | Single plane mean bore diameter deviation of bearing Δd_{mp} | | Shaft with tolerance grade IT5 | | | | | | | | | |
|--------------------------|-------|--|-----|--------------------------------|-----|-------|-----|-------|-------|-------|-------|-------|-------|
| | | | | m5 | | k5 | | j5 | | h5 | | g5 | |
| | | | | Tight | | Tight | | Tight | Loose | Tight | Loose | Tight | Loose |
| | | | | Max | Min | Max | Min | Max | Max | Max | Max | Max | Max |
| Over | Incl. | High | Low | | | | | | | | | | |
| 3 | 6 | 0 | - 8 | - | - | - | - | 11 | 2 | 8 | 5 | 4 | 9 |
| 6 | 10 | 0 | - 8 | - | - | - | - | 12 | 2 | 8 | 6 | 3 | 11 |
| 10 | 18 | 0 | - 8 | - | - | 17 | 1 | 13 | 3 | 8 | 8 | 2 | 14 |
| 18 | 30 | 0 | -10 | - | - | 21 | 2 | 15 | 4 | 10 | 9 | 3 | 16 |
| 30 | 50 | 0 | -12 | 32 | 9 | 25 | 2 | 18 | 5 | 12 | 11 | 3 | 20 |
| 50 | 80 | 0 | -15 | 39 | 11 | 30 | 2 | 21 | 7 | 15 | 13 | 5 | 23 |
| 80 | 120 | 0 | -20 | 48 | 13 | 38 | 3 | 26 | 9 | 20 | 15 | 8 | 27 |
| 120 | 140 | | | | | | | | | | | | |
| 140 | 160 | 0 | -25 | 58 | 15 | 46 | 3 | - | - | 25 | 18 | 11 | 32 |
| 160 | 180 | | | | | | | | | | | | |
| 180 | 200 | | | | | | | | | | | | |
| 200 | 225 | 0 | -30 | 67 | 17 | 54 | 4 | - | - | 30 | 20 | 15 | 35 |
| 225 | 250 | | | | | | | | | | | | |
| 250 | 280 | | | | | | | | | | | | |
| 280 | 315 | 0 | -35 | - | - | - | - | - | - | 35 | 23 | 18 | 40 |
| 315 | 355 | | | | | | | | | | | | |
| 355 | 400 | 0 | -40 | - | - | - | - | - | - | 40 | 25 | 22 | 43 |
| 400 | 450 | | | | | | | | | | | | |
| 450 | 500 | 0 | -45 | - | - | - | - | - | - | 45 | 27 | 25 | 47 |





Table 8.10 Amounts of Fits: Radial Bearings with Tolerance JIS Class 0 (ISO Normal Class)

Table 8.10.1 Inner Ring with Shaft

(2/2)

Unit: μm

| Nominal diameter (mm) | | Shaft with tolerance grade IT6 | | | | | | | | | | | | | | | |
|-----------------------|-----|--------------------------------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-------|-------|-------|-------|-------|
| | | r6 | | p6 | | n6 | | m6 | | k6 | | j6 | | h6 | | g6 | |
| | | Tight | | Tight | | Tight | | Tight | | Tight | | Tight | Loose | Tight | Loose | Tight | Loose |
| | | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Max | Max | Max | Max | Max |
| 3 | 6 | — | — | — | — | — | — | — | — | — | — | 14 | 2 | 8 | 8 | 4 | 12 |
| 6 | 10 | — | — | — | — | — | — | — | — | — | — | 15 | 2 | 8 | 9 | 3 | 14 |
| 10 | 18 | — | — | — | — | — | — | — | — | 20 | 1 | 16 | 3 | 8 | 11 | 2 | 17 |
| 18 | 30 | — | — | — | — | — | — | — | — | 25 | 2 | 19 | 4 | 10 | 13 | 3 | 20 |
| 30 | 50 | — | — | — | — | 45 | 17 | 37 | 9 | 30 | 2 | 23 | 5 | 12 | 16 | 3 | 25 |
| 50 | 80 | — | — | — | — | 54 | 20 | 45 | 11 | 36 | 2 | 27 | 7 | 15 | 19 | 5 | 29 |
| 80 | 120 | — | — | 76 | 37 | 65 | 23 | 55 | 13 | 45 | 3 | 33 | 9 | 20 | 22 | 8 | 34 |
| 120 | 140 | 113 | 63 | 93 | 43 | 77 | 27 | 65 | 15 | 53 | 3 | 39 | 11 | 25 | 25 | 11 | 39 |
| 140 | 160 | 115 | 65 | | | | | | | | | | | | | | |
| 160 | 180 | 118 | 68 | | | | | | | | | | | | | | |
| 180 | 200 | 136 | 77 | 109 | 50 | 90 | 31 | 76 | 17 | 63 | 4 | 46 | 13 | 30 | 29 | 15 | 44 |
| 200 | 225 | 139 | 80 | | | | | | | | | | | | | | |
| 225 | 250 | 143 | 84 | | | | | | | | | | | | | | |
| 250 | 280 | 161 | 94 | 123 | 56 | — | — | — | — | — | — | 51 | 16 | 35 | 32 | 18 | 49 |
| 280 | 315 | 165 | 98 | | | | | | | | | | | | | | |
| 315 | 355 | 184 | 108 | | | | | | | | | | | | | | |
| 355 | 400 | 190 | 114 | 138 | 62 | — | — | — | — | — | — | 58 | 18 | 40 | 36 | 22 | 54 |
| 400 | 450 | 211 | 126 | — | — | — | — | — | — | — | — | 65 | 20 | 45 | 40 | 26 | 60 |
| 450 | 500 | 217 | 132 | | | | | | | | | | | | | | |

Table 8.10 Amounts of Fits: Radial Bearings with Tolerance JIS Class 0 (ISO Normal Class)

Table 8.10.2 Outer Ring with Housing

(1/2)

Unit: μm

| Nominal diameter (mm) | | Single plane mean outside diameter deviation of bearing ΔD_{mp} | | Housing with tolerance grade IT6 | | | | | |
|-----------------------------|-------|---|-----|----------------------------------|-------|-------|-------|-------|-------|
| | | | | K6 | | J6 | | H6 | |
| | | | | Tight | Loose | Tight | Loose | Tight | Loose |
| Over | Incl. | High | Low | Max | Max | Max | Max | Max | Max |
| 6 | 10 | 0 | − 8 | 7 | 10 | 4 | 13 | 0 | 17 |
| 10 | 18 | 0 | − 8 | 9 | 10 | 5 | 14 | 0 | 19 |
| 18 | 30 | 0 | − 8 | 11 | 11 | 5 | 17 | 0 | 22 |
| 30 | 50 | 0 | −11 | 13 | 14 | 6 | 21 | 0 | 27 |
| 50 | 80 | 0 | −13 | 15 | 17 | 6 | 26 | 0 | 32 |
| 80 | 120 | 0 | −15 | 18 | 19 | 6 | 31 | 0 | 37 |
| 120 | 150 | 0 | −18 | 21 | 22 | 7 | 36 | 0 | 43 |
| 150 | 180 | 0 | −25 | 21 | 29 | 7 | 43 | 0 | 50 |
| 180 | 250 | 0 | −30 | 24 | 35 | 7 | 52 | 0 | 59 |
| 250 | 315 | 0 | −35 | 27 | 40 | 7 | 60 | 0 | 67 |
| 315 | 400 | 0 | −40 | 29 | 47 | 7 | 69 | 0 | 76 |
| 400 | 500 | 0 | −45 | 32 | 53 | 7 | 78 | 0 | 85 |



Table 8.10 Amounts of Fits: Radial Bearings with Tolerance JIS Class 0 (ISO Normal Class)



Table 8.10.2 Outer Ring with Housing

(2/2)

Unit: μm

| Nominal diameter (mm) | | Housing with tolerance grade IT7 | | | | | | | | | | | | | |
|--------------------------|-------|----------------------------------|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-----|
| | | P7 | | N7 | | M7 | | K7 | | J7 | | H7 | | G7 | |
| | | Tight | | Tight | Loose | Tight | Loose | Tight | Loose | Tight | Loose | Tight | Loose | Loose | |
| Over | Incl. | Max | Min | Max | Max | Max | Max | Max | Max | Max | Max | Max | Max | Min | Max |
| 6 | 10 | 24 | 1 | 19 | 4 | 15 | 8 | 10 | 13 | 7 | 16 | 0 | 23 | 5 | 28 |
| 10 | 18 | 29 | 3 | 23 | 3 | 18 | 8 | 12 | 14 | 8 | 18 | 0 | 26 | 6 | 32 |
| 18 | 30 | 35 | 5 | 28 | 2 | 21 | 9 | 15 | 15 | 9 | 21 | 0 | 30 | 7 | 37 |
| 30 | 50 | 42 | 6 | 33 | 3 | 25 | 11 | 18 | 18 | 11 | 25 | 0 | 36 | 9 | 45 |
| 50 | 80 | 51 | 8 | 39 | 4 | 30 | 13 | 21 | 22 | 12 | 31 | 0 | 43 | 10 | 53 |
| 80 | 120 | 59 | 9 | 45 | 5 | 35 | 15 | 25 | 25 | 13 | 37 | 0 | 50 | 12 | 62 |
| 120 | 150 | 68 | 10 | 52 | 6 | 40 | 18 | 28 | 30 | 14 | 44 | 0 | 58 | 14 | 72 |
| 150 | 180 | 68 | 3 | 60 | 13 | 40 | 25 | 28 | 37 | 14 | 51 | 0 | 65 | 14 | 79 |
| 180 | 250 | 79 | 3 | 60 | 16 | 46 | 30 | 33 | 43 | 16 | 60 | 0 | 76 | 15 | 91 |
| 250 | 315 | 88 | 1 | 66 | 21 | 52 | 35 | 36 | 51 | 16 | 71 | 0 | 87 | 17 | 104 |
| 315 | 400 | 98 | 1 | 73 | 24 | 57 | 40 | 40 | 57 | 18 | 79 | 0 | 97 | 18 | 115 |
| 400 | 500 | 108 | 0 | 80 | 28 | 63 | 45 | 45 | 63 | 20 | 88 | 0 | 108 | 20 | 128 |

Table 8.11 Amounts of Fits: Radial Bearings with Tolerance JIS (ISO) Class 6

Table 8.11.1 Inner Ring with Shaft

(1/2)

Unit: μm

| Nominal diameter (mm) | | Single plane mean bore diameter deviation of bearing Δd_{mp} | | Shaft with tolerance grade IT5 | | | | | | | | | |
|--------------------------|-------|---|-----|--------------------------------|-----|-------|-----|-------|-------|-------|-------|-------|-------|
| | | | | m5 | | k5 | | j5 | | h5 | | g5 | |
| | | | | Tight | | Tight | | Tight | Loose | Tight | Loose | Tight | Loose |
| | | | | Max | Min | Max | Min | Max | Max | Max | Max | Max | Max |
| Over | Incl. | High | Low | | | | | | | | | | |
| 3 | 6 | 0 | - 7 | - | - | - | - | 10 | 2 | 7 | 5 | 3 | 9 |
| 6 | 10 | 0 | - 7 | - | - | - | - | 11 | 2 | 7 | 6 | 2 | 11 |
| 10 | 18 | 0 | - 7 | - | - | 16 | 1 | 12 | 3 | 7 | 8 | 1 | 14 |
| 18 | 30 | 0 | - 8 | - | - | 19 | 2 | 13 | 4 | 8 | 9 | 1 | 16 |
| 30 | 50 | 0 | -10 | 30 | 9 | 23 | 2 | 16 | 5 | 10 | 11 | 1 | 20 |
| 50 | 80 | 0 | -12 | 36 | 11 | 27 | 2 | 18 | 7 | 12 | 13 | 2 | 23 |
| 80 | 120 | 0 | -15 | 43 | 13 | 33 | 3 | 21 | 9 | 15 | 15 | 3 | 27 |
| 120 | 140 | 0 | -18 | 51 | 15 | 39 | 3 | - | - | 18 | 18 | 4 | 32 |
| 140 | 160 | | | | | | | | | | | | |
| 160 | 180 | | | | | | | | | | | | |
| 180 | 200 | 0 | -22 | 59 | 17 | 46 | 4 | - | - | 22 | 20 | 7 | 35 |
| 200 | 225 | | | | | | | | | | | | |
| 225 | 250 | | | | | | | | | | | | |





Table 8.11 Amounts of Fits: Radial Bearings with Tolerance JIS (ISO) Class 6

Table 8.11.1 Inner Ring with Shaft (2/2) Unit: μm

| Nominal diameter (mm) | | Shaft with tolerance grade IT6 | | | | | | | | | | | | | | | |
|-----------------------|-------|--------------------------------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-------|-------|-------|-------|-------|
| | | r6 | | p6 | | n6 | | m6 | | k6 | | j6 | | h6 | | g6 | |
| | | Tight | | Tight | | Tight | | Tight | | Tight | | Tight | Loose | Tight | Loose | Tight | Loose |
| Over | Incl. | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Max | Max | Max | Max | Max |
| 3 | 6 | — | — | — | — | — | — | — | — | — | — | 13 | 2 | 7 | 8 | 3 | 12 |
| 6 | 10 | — | — | — | — | — | — | — | — | — | — | 14 | 2 | 7 | 9 | 2 | 14 |
| 10 | 18 | — | — | — | — | — | — | — | — | 19 | 1 | 15 | 3 | 7 | 11 | 1 | 17 |
| 18 | 30 | — | — | — | — | — | — | — | — | 23 | 2 | 17 | 4 | 8 | 13 | 1 | 20 |
| 30 | 50 | — | — | — | — | 43 | 17 | 35 | 9 | 28 | 2 | 21 | 5 | 10 | 16 | 1 | 25 |
| 50 | 80 | — | — | — | — | 51 | 20 | 42 | 11 | 33 | 2 | 24 | 7 | 12 | 19 | 2 | 29 |
| 80 | 120 | — | — | 74 | 37 | 60 | 23 | 50 | 13 | 40 | 3 | 28 | 9 | 15 | 22 | 3 | 34 |
| 120 | 140 | 106 | 63 | 86 | 43 | 70 | 27 | 58 | 15 | 46 | 3 | 32 | 11 | 18 | 25 | 4 | 39 |
| 140 | 160 | 108 | 65 | | | | | | | | | | | | | | |
| 160 | 180 | 111 | 68 | | | | | | | | | | | | | | |
| 180 | 200 | 128 | 77 | 101 | 50 | 82 | 31 | 68 | 17 | 55 | 4 | 38 | 13 | 22 | 29 | 7 | 44 |
| 200 | 225 | 131 | 80 | | | | | | | | | | | | | | |
| 225 | 250 | 135 | 84 | | | | | | | | | | | | | | |

Table 8.11 Amounts of Fits: Radial Bearings with Tolerance JIS (ISO) Class 6

Table 8.11.2 Outer Ring with Housing (1/2) Unit: μm

| Nominal diameter (mm) | | Single plane mean outside diameter deviation of bearing ΔD_{mp} | | Housing with tolerance grade IT6 | | | | | |
|--------------------------|-------|---|-----|----------------------------------|-------|-------|-------|-------|-------|
| | | | | K6 | | J6 | | H6 | |
| | | | | Tight | Loose | Tight | Loose | Tight | Loose |
| | | | | Max | Max | Max | Max | Max | Max |
| Over | Incl. | High | Low | Max | Max | Max | Max | Max | Max |
| 6 | 10 | 0 | − 7 | 7 | 9 | 4 | 12 | 0 | 16 |
| 10 | 18 | 0 | − 7 | 9 | 9 | 5 | 13 | 0 | 18 |
| 18 | 30 | 0 | − 8 | 11 | 10 | 5 | 16 | 0 | 21 |
| 30 | 50 | 0 | − 9 | 13 | 12 | 6 | 19 | 0 | 25 |
| 50 | 80 | 0 | −11 | 15 | 15 | 6 | 24 | 0 | 30 |
| 80 | 120 | 0 | −13 | 18 | 17 | 6 | 29 | 0 | 35 |
| 120 | 150 | 0 | −15 | 21 | 19 | 7 | 33 | 0 | 40 |
| 150 | 180 | 0 | −18 | 21 | 22 | 7 | 36 | 0 | 43 |
| 180 | 250 | 0 | −20 | 24 | 25 | 7 | 42 | 0 | 49 |
| 250 | 315 | 0 | −25 | 27 | 30 | 7 | 50 | 0 | 57 |
| 315 | 400 | 0 | −28 | 29 | 35 | 7 | 57 | 0 | 64 |



Table 8.11 Amounts of Fits: Radial Bearings with Tolerance JIS (ISO) Class 6



Table 8.11.2 Outer Ring with Housing

(2/2)

Unit: μm

| Nominal diameter (mm) | | Housing with tolerance grade IT7 | | | | | | | | | | | | | |
|--------------------------|-------|----------------------------------|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-----|
| | | P7 | | N7 | | M7 | | K7 | | J7 | | H7 | | G7 | |
| | | Tight | | Tight | Loose | Tight | Loose | Tight | Loose | Tight | Loose | Tight | Loose | Loose | |
| Over | Incl. | Max | Min | Max | Max | Max | Max | Max | Max | Max | Max | Max | Max | Min | Max |
| 6 | 10 | 24 | 2 | 19 | 3 | 15 | 7 | 10 | 12 | 7 | 15 | 0 | 22 | 5 | 27 |
| 10 | 18 | 29 | 4 | 23 | 2 | 18 | 7 | 12 | 13 | 8 | 17 | 0 | 25 | 6 | 31 |
| 18 | 30 | 35 | 6 | 28 | 1 | 21 | 8 | 15 | 14 | 9 | 20 | 0 | 29 | 7 | 36 |
| 30 | 50 | 42 | 8 | 33 | 1 | 25 | 9 | 18 | 16 | 11 | 23 | 0 | 34 | 9 | 43 |
| 50 | 80 | 51 | 10 | 39 | 2 | 30 | 11 | 21 | 20 | 12 | 29 | 0 | 41 | 10 | 51 |
| 80 | 120 | 59 | 11 | 45 | 3 | 35 | 13 | 25 | 23 | 13 | 35 | 0 | 48 | 12 | 60 |
| 120 | 150 | 68 | 13 | 52 | 3 | 40 | 15 | 28 | 27 | 14 | 41 | 0 | 55 | 14 | 69 |
| 150 | 180 | 68 | 10 | 60 | 6 | 40 | 18 | 28 | 30 | 14 | 44 | 0 | 58 | 14 | 72 |
| 180 | 250 | 79 | 13 | 60 | 6 | 46 | 20 | 33 | 33 | 16 | 50 | 0 | 66 | 15 | 81 |
| 250 | 315 | 88 | 11 | 66 | 11 | 52 | 25 | 36 | 41 | 16 | 61 | 0 | 77 | 17 | 94 |
| 315 | 400 | 98 | 13 | 73 | 12 | 57 | 28 | 40 | 45 | 18 | 67 | 0 | 85 | 18 | 103 |

Table 8.12 Amounts of Fits: Radial Bearings with Tolerance JIS (ISO) Class 5

Table 8.12.1 Inner Ring with Shaft

Unit: μm

| Nominal diameter (mm) | | Single plane mean bore diameter deviation of bearing Δd_{mp} | | Shaft with tolerance grade IT4 | | | | | | | | Shaft with tolerance grade IT5 | | | |
|-----------------------|-------|---|-----|--------------------------------|-----|-------|-----|-------|-------|-------|-------|--------------------------------|-----|-------|-------|
| | | | | m4 | | k4 | | js4 | | h4 | | m5 | | h5 | |
| | | | | Tight | | Tight | | Tight | Loose | Tight | Loose | Tight | | Tight | Loose |
| Over | Incl. | High | Low | Max | Min | Max | Min | Max | Max | Max | Max | Max | Min | Max | Max |
| 3 | 6 | 0 | − 5 | 13 | 4 | 10 | 1 | 7 | 2 | 5 | 4 | 14 | 4 | 5 | 5 |
| 6 | 10 | 0 | − 5 | 15 | 6 | 10 | 1 | 7 | 2 | 5 | 4 | 17 | 6 | 5 | 6 |
| 10 | 18 | 0 | − 5 | 17 | 7 | 11 | 1 | 7.5 | 2.5 | 5 | 5 | 20 | 7 | 5 | 8 |
| 18 | 30 | 0 | − 6 | 20 | 8 | 14 | 2 | 9 | 3 | 6 | 6 | 23 | 8 | 6 | 9 |
| 30 | 50 | 0 | − 8 | 24 | 9 | 17 | 2 | 11.5 | 3.5 | 8 | 7 | 28 | 9 | 8 | 11 |
| 50 | 80 | 0 | − 9 | 28 | 11 | 19 | 2 | 13 | 4 | 9 | 8 | 33 | 11 | 9 | 13 |
| 80 | 120 | 0 | −10 | 33 | 13 | 23 | 3 | 15 | 5 | 10 | 10 | 38 | 13 | 10 | 15 |
| 120 | 180 | 0 | −13 | 40 | 15 | 28 | 3 | 19 | 6 | 13 | 12 | 46 | 15 | 13 | 18 |
| 180 | 250 | 0 | −15 | 46 | 17 | 33 | 4 | 22 | 7 | 15 | 14 | 52 | 17 | 15 | 20 |

Table 8.12 Amounts of Fits: Radial Bearings with Tolerance JIS (ISO) Class 5

Table 8.12.2 Outer Ring with Housing

Unit: μm

| Nominal diameter (mm) | | Single plane mean outside diameter deviation of bearing ΔD_{mp} | | Housing with tolerance grade IT5 | | | | | | | |
|-----------------------|-------|---|-----|----------------------------------|-------|-------|-------|-------|-------|-------|-------|
| | | | | M5 | | K5 | | Js5 | | H5 | |
| | | | | Tight | Loose | Tight | Loose | Tight | Loose | Tight | Loose |
| Over | Incl. | High | Low | Max | Max | Max | Max | Max | Max | Max | Max |
| 6 | 10 | 0 | − 5 | 10 | 1 | 5 | 6 | 3 | 8 | 0 | 11 |
| 10 | 18 | 0 | − 5 | 12 | 1 | 6 | 7 | 4 | 9 | 0 | 13 |
| 18 | 30 | 0 | − 6 | 14 | 1 | 8 | 7 | 4.5 | 10.5 | 0 | 15 |
| 30 | 50 | 0 | − 7 | 16 | 2 | 9 | 9 | 5.5 | 12.5 | 0 | 18 |
| 50 | 80 | 0 | − 9 | 19 | 3 | 10 | 12 | 6.5 | 15.5 | 0 | 22 |
| 80 | 120 | 0 | −10 | 23 | 2 | 13 | 12 | 7.5 | 17.5 | 0 | 25 |
| 120 | 150 | 0 | −11 | 27 | 2 | 15 | 14 | 9 | 20 | 0 | 29 |
| 150 | 180 | 0 | −13 | 27 | 4 | 15 | 16 | 9 | 22 | 0 | 31 |
| 180 | 250 | 0 | −15 | 31 | 4 | 18 | 17 | 10 | 25 | 0 | 35 |
| 250 | 315 | 0 | −18 | 36 | 5 | 20 | 21 | 11.5 | 29.5 | 0 | 41 |
| 315 | 400 | 0 | −20 | 39 | 6 | 22 | 23 | 12.5 | 32.5 | 0 | 45 |

Table 8.13 Amounts of Fits: Radial Bearings with Tolerance JIS (ISO) Class 4

Table 8.13.1 Inner Ring with Shaft

Unit: μm

| Nominal diameter (mm) | | Single plane mean bore diameter deviation of bearing Δd_{mp} | | Shaft with tolerance grade IT4 | | | | | | | | Shaft with tolerance grade IT5 | | | |
|-----------------------|-------|--|-----|--------------------------------|-----|-------|-----|-------|-------|-------|-------|--------------------------------|-----|-------|-------|
| | | | | m4 | | k4 | | js4 | | h4 | | m5 | | h5 | |
| | | | | Tight | | Tight | | Tight | Loose | Tight | Loose | Tight | | Tight | Loose |
| Over | Incl. | High | Low | Max | Min | Max | Min | Max | Max | Max | Max | Max | Min | Max | Max |
| 3 | 6 | 0 | - 4 | 12 | 4 | 9 | 1 | 6 | 2 | 4 | 4 | 13 | 4 | 4 | 5 |
| 6 | 10 | 0 | - 4 | 14 | 6 | 9 | 1 | 6 | 2 | 4 | 4 | 16 | 6 | 4 | 6 |
| 10 | 18 | 0 | - 4 | 16 | 7 | 10 | 1 | 6.5 | 2.5 | 4 | 5 | 19 | 7 | 4 | 8 |
| 18 | 30 | 0 | - 5 | 19 | 8 | 13 | 2 | 8 | 3 | 5 | 6 | 22 | 8 | 5 | 9 |
| 30 | 50 | 0 | - 6 | 22 | 9 | 15 | 2 | 9.5 | 3.5 | 6 | 7 | 26 | 9 | 6 | 11 |
| 50 | 80 | 0 | - 7 | 26 | 11 | 17 | 2 | 11 | 4 | 7 | 8 | 31 | 11 | 7 | 13 |
| 80 | 120 | 0 | - 8 | 31 | 13 | 21 | 3 | 13 | 5 | 8 | 10 | 36 | 13 | 8 | 15 |
| 120 | 180 | 0 | 10 | 37 | 15 | 25 | 3 | 16 | 6 | 10 | 12 | 43 | 15 | 10 | 18 |
| 180 | 250 | 0 | -12 | 43 | 17 | 30 | 4 | 19 | 7 | 12 | 14 | 49 | 17 | 12 | 20 |

Table 8.13 Amounts of Fits: Radial Bearings with Tolerance JIS (ISO) Class 4

Table 8.13.2 Outer Ring with Housing

Unit: μm

| Nominal diameter (mm) | | Single plane mean outside diameter deviation of bearing ΔD_{mp} | | Housing with tolerance grade IT5 | | | | | | | |
|-----------------------|-------|---|-----|----------------------------------|-------|-------|-------|-------|-------|-------|-------|
| | | | | M5 | | K5 | | Js5 | | H5 | |
| | | | | Tight | Loose | Tight | Loose | Tight | Loose | Tight | Loose |
| | | | | Max | Max | Max | Max | Max | Max | Max | Max |
| Over | Incl. | High | Low | Max | Max | Max | Max | Max | Max | Max | Max |
| 6 | 10 | 0 | − 4 | 10 | 0 | 5 | 5 | 3 | 7 | 0 | 10 |
| 10 | 18 | 0 | − 4 | 12 | 0 | 6 | 6 | 4 | 8 | 0 | 12 |
| 18 | 30 | 0 | − 5 | 14 | 0 | 8 | 6 | 4.5 | 9.5 | 0 | 14 |
| 30 | 50 | 0 | − 6 | 16 | 1 | 9 | 8 | 5.5 | 11.5 | 0 | 17 |
| 50 | 80 | 0 | − 7 | 19 | 1 | 10 | 10 | 6.5 | 13.5 | 0 | 20 |
| 80 | 120 | 0 | − 8 | 23 | 0 | 13 | 10 | 7.5 | 15.5 | 0 | 23 |
| 120 | 150 | 0 | − 9 | 27 | 0 | 15 | 12 | 9 | 18 | 0 | 27 |
| 150 | 180 | 0 | −10 | 27 | 1 | 15 | 13 | 9 | 19 | 0 | 28 |
| 180 | 250 | 0 | −11 | 31 | 0 | 18 | 13 | 10 | 21 | 0 | 31 |
| 250 | 315 | 0 | −13 | 36 | 0 | 20 | 16 | 11.5 | 24.5 | 0 | 36 |
| 315 | 400 | 0 | −15 | 39 | 1 | 22 | 18 | 12.5 | 27.5 | 0 | 40 |

Table 8.14 Amounts of Fits: Thrust Bearings with Tolerance JIS (ISO) Class 0

Table 8.14.1 Shaft Washer or Center Washer with Shaft

Unit: μm

| Nominal diameter (mm) | | Single plane mean bore diameter deviation of bearing Δd_{mp} | | Shaft with tolerance grade IT6 | | | | | | | |
|-----------------------|-------|--|-----|--------------------------------|-----|-------|-----|-------|-----|-------|-------|
| | | | | n6 | | m6 | | k6 | | j6 | |
| | | | | Tight | | Tight | | Tight | | Tight | Loose |
| | | | | Max | Min | Max | Min | Max | Min | Max | Max |
| Over | Incl. | High | Low | | | | | | | | |
| 6 | 10 | 0 | − 8 | − | − | − | − | 18 | 1 | 15 | 2 |
| 10 | 18 | 0 | − 8 | − | − | − | − | 20 | 1 | 16 | 3 |
| 18 | 30 | 0 | −10 | − | − | − | − | 25 | 2 | 19 | 4 |
| 30 | 50 | 0 | −12 | − | − | − | − | 30 | 2 | 23 | 5 |
| 50 | 80 | 0 | −15 | − | − | − | − | 36 | 2 | 27 | 7 |
| 80 | 120 | 0 | −20 | − | − | − | − | 45 | 3 | 33 | 9 |
| 120 | 180 | 0 | −25 | − | − | − | − | 53 | 3 | 39 | 11 |
| 180 | 250 | 0 | −30 | − | − | 76 | 17 | 63 | 4 | 46 | 13 |
| 250 | 315 | 0 | −35 | − | − | 87 | 20 | − | − | 51 | 16 |
| 315 | 400 | 0 | −40 | − | − | 97 | 21 | − | − | 58 | 18 |
| 400 | 500 | 0 | −45 | 125 | 40 | − | − | − | − | 65 | 20 |

Table 8.14 Amounts of Fits: Thrust Bearings with Tolerance JIS (ISO) Class 0

Table 8.14.2 Housing Washer with Housing

Unit: μm

| Nominal diameter (mm) | | Single plane mean outside diameter deviation of bearing ΔD_{mp} | | Housing with tolerance grade IT7 | | | |
|--------------------------|-------|--|-----|----------------------------------|-------|-------|-------|
| | | | | M7 | | H7 | |
| | | | | Tight | Loose | Tight | Loose |
| Over | Incl. | High | Low | Max | Max | Max | Max |
| 10 | 18 | 0 | -11 | 18 | 11 | 0 | 29 |
| 18 | 30 | 0 | -13 | 21 | 13 | 0 | 34 |
| 30 | 50 | 0 | -16 | 25 | 16 | 0 | 41 |
| 50 | 80 | 0 | -19 | 30 | 19 | 0 | 49 |
| 80 | 120 | 0 | -22 | 35 | 22 | 0 | 57 |
| 120 | 180 | 0 | -25 | 40 | 25 | 0 | 65 |
| 180 | 250 | 0 | -30 | 46 | 30 | 0 | 76 |
| 250 | 315 | 0 | -35 | 52 | 35 | 0 | 87 |
| 315 | 400 | 0 | -40 | 57 | 40 | 0 | 97 |
| 400 | 500 | 0 | -45 | 63 | 45 | 0 | 108 |