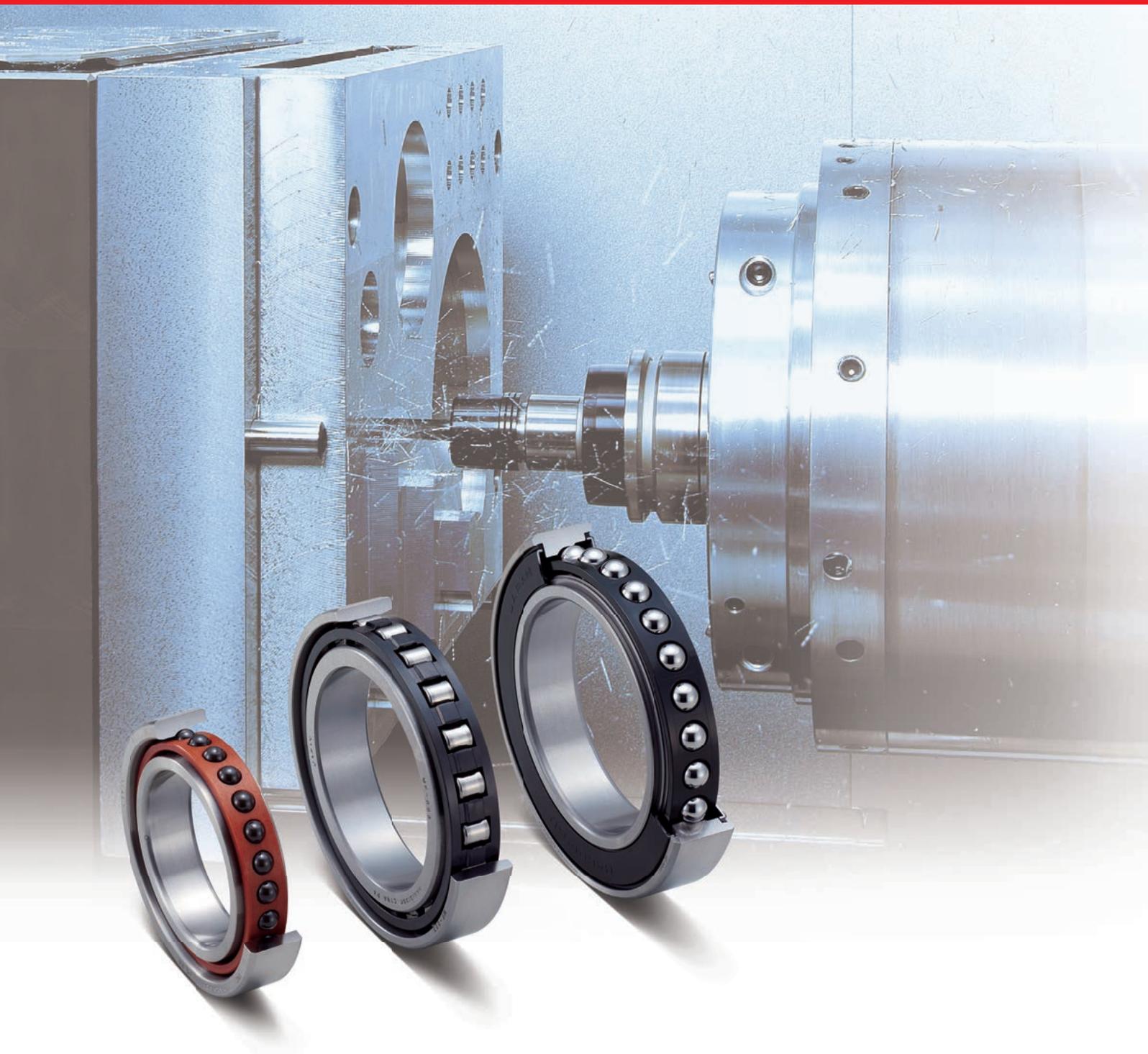
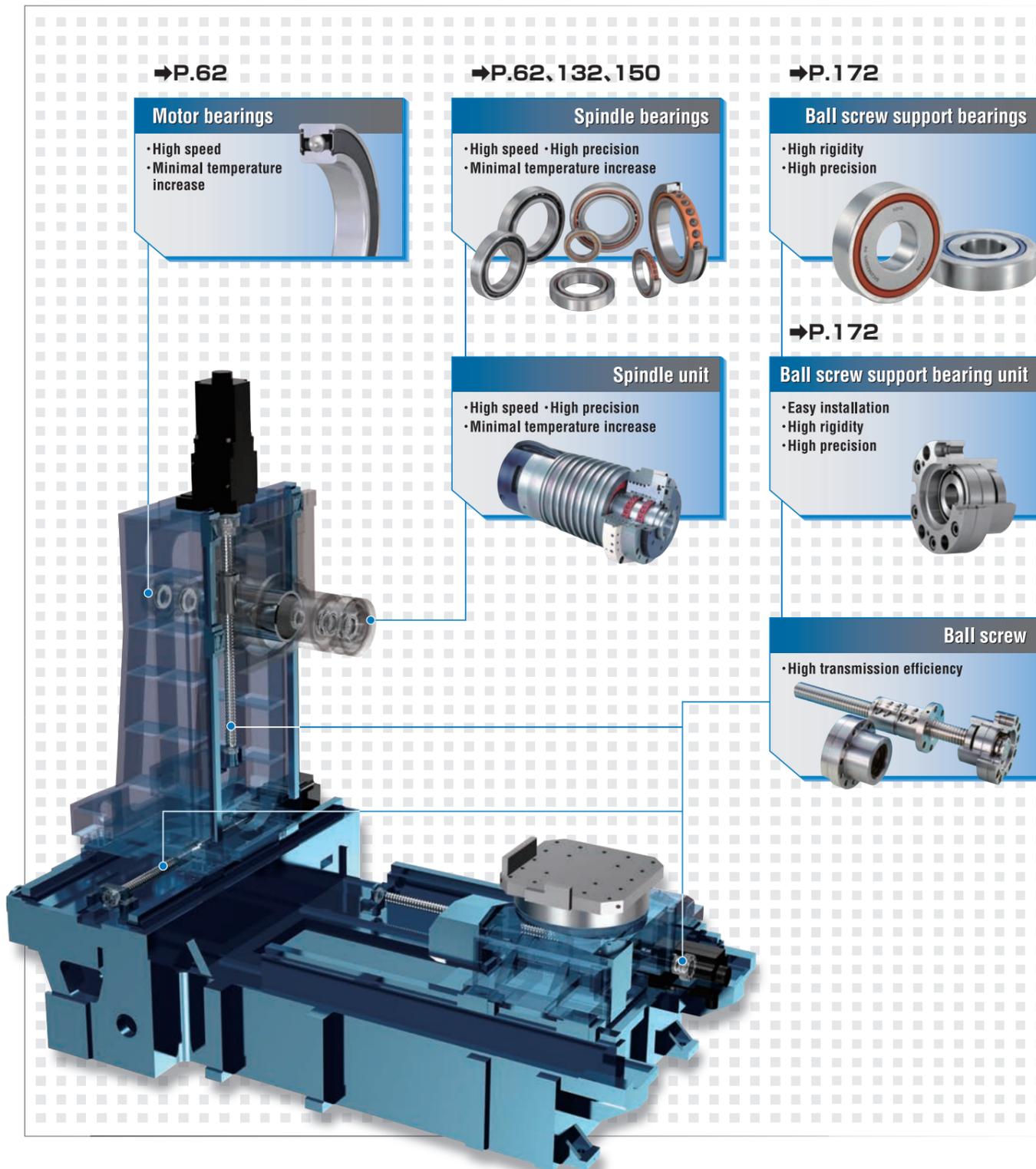


Precision Ball & Roller Bearings



Proposal of Various Products for Machine Tools

PRODUCT LINE-UP FOR MACHINING CENTERS



→P.62

Motor bearings

- High speed
- Minimal temperature increase

→P.62, 132, 150

Spindle bearings

- High speed · High precision
- Minimal temperature increase

Spindle unit

- High speed · High precision
- Minimal temperature increase

→P.172

Ball screw support bearings

- High rigidity
- High precision

→P.172

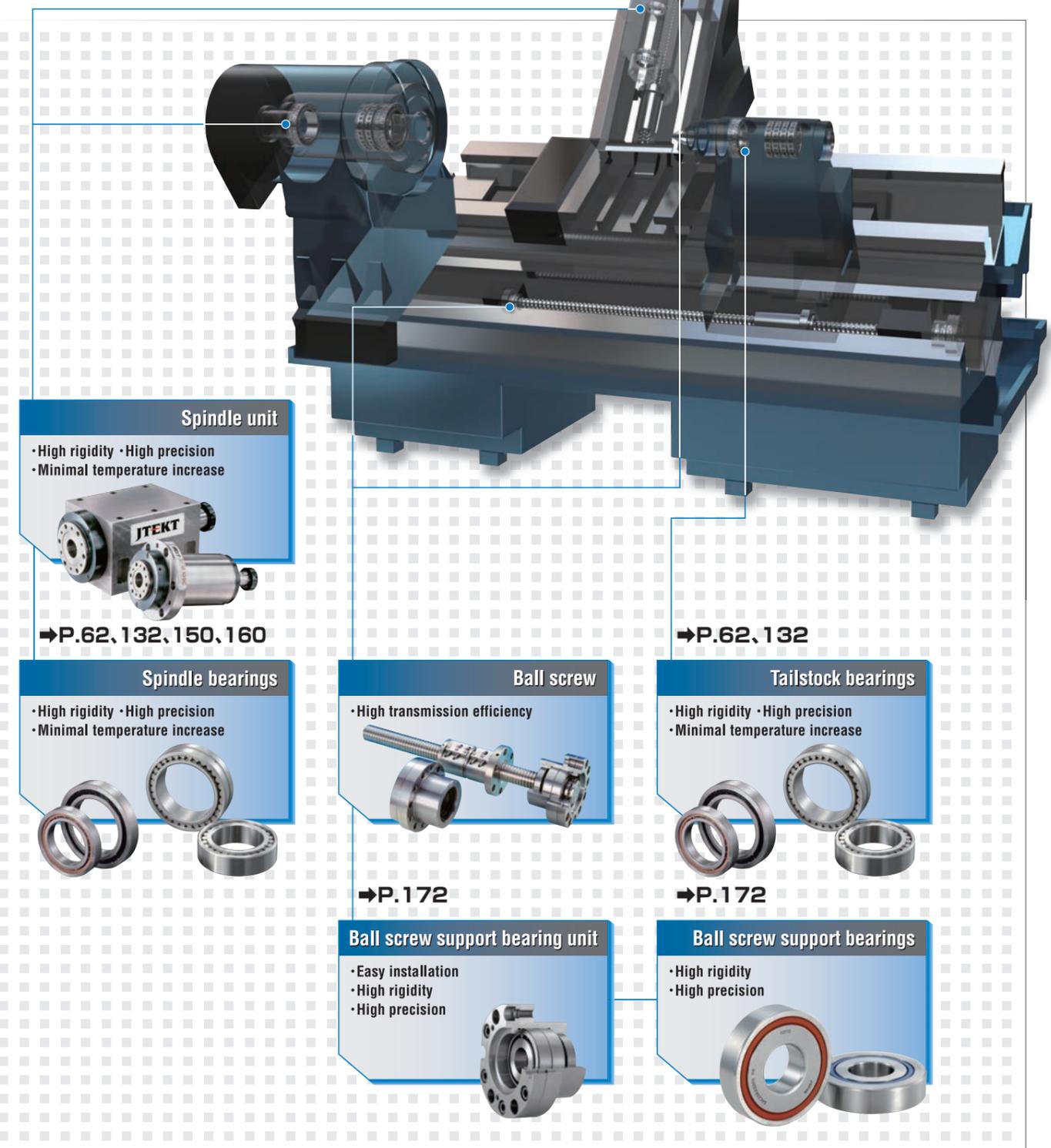
Ball screw support bearing unit

- Easy installation
- High rigidity
- High precision

Ball screw

- High transmission efficiency

PRODUCT LINE-UP FOR LATHES



Spindle unit

- High rigidity · High precision
- Minimal temperature increase

→P.62, 132, 150, 160

Spindle bearings

- High rigidity · High precision
- Minimal temperature increase

Ball screw

- High transmission efficiency

→P.172

Ball screw support bearing unit

- Easy installation
- High rigidity
- High precision

→P.62, 132

Tailstock bearings

- High rigidity · High precision
- Minimal temperature increase

→P.172

Ball screw support bearings

- High rigidity
- High precision

JTEKT

**Precision
Ball & Roller Bearings**



Catalog

Precision Ball & Roller Bearings Preface

Thank you for your valuable support of **JTEKT** products.

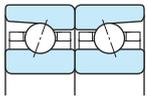
In recent years, the industrial sector has been called upon to achieve further advancements across all domains while addressing societal challenges such as climate change.

For this reason, further advancements are expected of precision ball & roller bearings, including miniaturization and weight reduction, extended service life, enhanced functionality, higher reliability, as well as a wide range of advanced technologies.

JTEKT continually offers the best technologies, quality, and services, through inspiration from the market and putting efforts into research and technical developments.

This catalog includes information on a variety of bearings and technical data to assist in selecting the optimal precision ball & roller bearing, and we are confident it will be of great use to you.

We hope that you will be as satisfied with our products and services as you have been in the past.

<p>I</p>	<p>Technical Descriptions</p>
<p>II</p>	<p>Bearing Dimension Tables</p> <hr/> <p>Angular Contact Ball Bearings </p> <hr/> <p>Cylindrical Roller Bearings </p> <hr/> <p>Angular Contact Ball Bearings for Axial Load </p> <hr/> <p>Tapered Roller Bearings </p> <hr/> <p>Support Bearings and Support Bearing Units for Precision Ball Screws </p>
<p>III</p>	<p>Handling of Bearings</p>
<p>IV</p>	<p>Examples of Bearing Failures</p>
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JTEKT

I . Technical Descriptions

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1. Types and structures of precision ball & roller bearings

Table 1. 1 Types and structures of precision ball & roller bearings (angular contact ball bearings)

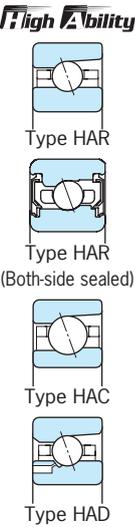
Bearing types	Cross-sections	Main applications	Product name	Bearing series	Rolling element material	Bearing ring material	Contact angles	Features and descriptions	Page No.		
 <p>Angular contact ball bearings</p>		High precision / long service life	Standard series	7900C	Bearing steel	Bearing steel	15°	<ul style="list-style-type: none"> Some bearing series support contact angle of 40° (B). Flush-ground G-type bearings are also available. 	P62		
				7000C							
				7200C							
				7000AC			25°				
				7200AC							
				7000							
				7200							
		High precision / ultra-high speed	High Ability	3NCHAR900C	Ceramics	Bearing steel	15°	<p>[Type HAR]</p> <ul style="list-style-type: none"> Improvements in high-speed performance are made through the use of balls that have a smaller diameter than standard bearing balls. Also, a large number of balls contributes to higher rigidity. There are two types of rolling elements: bearing steel and ceramic. Consult JTEKT, as the HAR000 series can correspond to the non-contact seal. <p>[Type HAC]</p> <ul style="list-style-type: none"> Large-diameter balls enable high load-carrying capacity. Ceramic balls realize excellent high-speed performance. <p>[Type HAD]</p> <ul style="list-style-type: none"> These bearings have holes for oil / air lubrication. They are suitable for ultrahigh-speed applications. Ceramic balls realize excellent high-speed performance. 			
				3NCHAC900C							
				3NCHAR000C							
				3NCHAC000C							
				3NCHAR900CA							
				3NCHAC900CA							
				3NCHAR000CA							
				3NCHAC000CA							
		3NCHAD000CA									
		High precision / high speed	High Ability	High Ability	HAR900C		Bearing steel			15°	
					HAR000C						
					HAR900CA						20°
					HAR000CA						
					HAR900						
HAR000	30°										

Table 1. 2 Types and structures of precision ball & roller bearings (cylindrical roller bearings) types

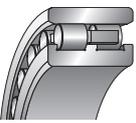
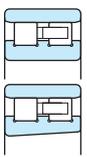
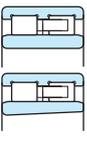
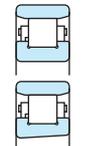
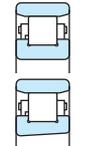
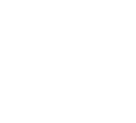
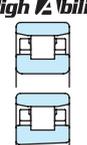
Bearing types	Cross-sections	Main applications	Product name	Bearing series	Rolling element material	Bearing ring material	Features and descriptions	Page No.
 NN-type double row cylindrical roller bearings		High precision / long service life	Standard series	NN3000 NN3000K	Bearing steel	Bearing steel	<ul style="list-style-type: none"> • Bearings with tapered bores (K) are also available for applications using tapered shafts. • For radial internal clearance values, use non-interchangeable bearings. • Bearings provided with a lubrication hole or groove on the outer ring are also available (W). 	P132
 NNU-type double row cylindrical roller bearings				NNU4900 NNU4900K				
 N-type single row cylindrical roller bearings				N1000 N1000K				
 N-type single row cylindrical roller bearings				3NCN1000 3NCN1000K				
 High Ability		High precision / ultra-high speed	High Ability	HAN1000 HAN1000B HAN1000K HAN1000BK	Bearing steel	Bearing steel	<ul style="list-style-type: none"> • This type of bearing produces less heat and has better high-speed performance than conventional single-row cylindrical roller bearings. 	

Table 1. 3 High-speed matched pair angular contact ball bearings and tapered roller bearings

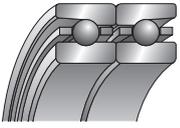
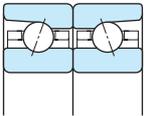
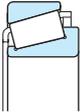
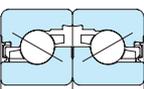
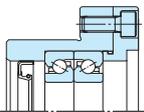
Bearing types	Cross-sections	Bearing series	Contact angles	Features and descriptions	Page No.
 High-speed pair-mounted angular contact ball bearings		ACT000DB	30°	<ul style="list-style-type: none"> They are placed on the small tapered-bore diameter side of NN30K. 	P150
		ACT000BDB	40°		
 Tapered roller bearings		32900JR 32000JR 30200JR 32200JR	Nominal contact angles: greater than 10° and equal to or less than 17°	<ul style="list-style-type: none"> Metric series single row tapered roller bearings complying with ISO standards. 	P160

Table 1. 4 Support bearings and support bearing units for precision ball screws

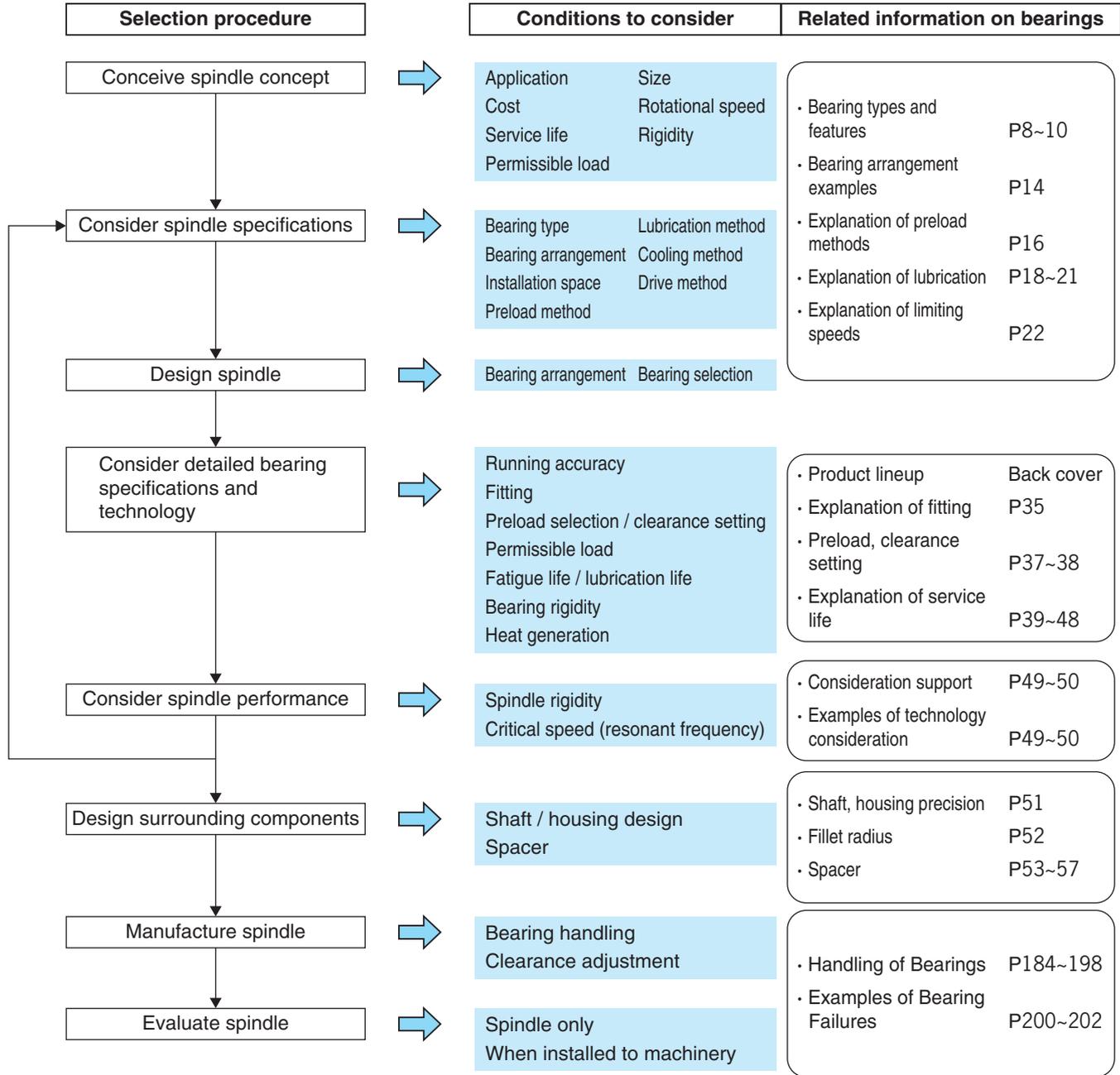
Bearing types	Cross-sections	Bearing series	Contact angles	Features and descriptions	Page No.
 Support bearings for precision ball screws	 Both-side sealed type	SAC0000B	60°	<ul style="list-style-type: none"> Standard preloads are specified, respectively, for 2-, 3-, and 4-row matched bearings. Flush-ground G-type bearings are also available. The support bearing for precision ball screws can correspond to the type with contact-seal. Consult JTEKT if desiring information about the type with seal and the matching method. 	P172
	 Matching example of one-side sealed type				
 Support bearing units for precision ball screws		BSU0000B	(60°)	<ul style="list-style-type: none"> Support bearing units consist of a support bearing for precision ball screws (SAC) and a precision housing. Fitting this bearing unit is very simple. 	

2. Selection of bearings

In order to select the optimum bearing to realize the intended design of a machine, it is necessary to consider specific operating conditions of the machine, bearing requirements, designs of parts around the bearing, marketability, and cost performance.

Table 2. 1 specifies the general procedure for selecting a bearing, and operating conditions to be taken into consideration. Note, however, that when selecting a bearing, priority should be given to meeting the most critical requirement rather than following a given procedure.

Table 2. 1 Procedure for selecting bearings and operating conditions to be taken into consideration



For more information about specifications, fill out the **Supplementary table 7 "Specification report of bearing for main shaft of machine tool"** on page 216, and contact **JTEKT**.

3. Selection of bearing types

When selecting a bearing type, it is of critical importance to fully understand the operating conditions of the bearing.

Table 3. 1 shows principal items to be considered and how to select a bearing type.

Table 3. 1 Selection of bearing types

Items to be considered	How to select a type
<p>① Installation space</p> <p>Bearing can be installed in target equipment</p>	<ul style="list-style-type: none"> When designing a shaft system, critical factors on the whole are shaft rigidity and strength, therefore, shaft diameter, namely, the bore diameter of the bearing is determined first. Select the bearing type and dimensional series according to the installation space.
<p>② Load</p> <p>Load magnitude, type and direction which applied</p> <p>The load capacity of the bearing is expressed in terms of the basic load rating, the value of which is given in the bearing dimension tables.</p>	<ul style="list-style-type: none"> Select the optimum bearing type taking into consideration the magnitude of the load applied to the bearing, whether the load is axial or radial, whether, in the case of axial load, the load is unidirectional or bidirectional, the level of vibration and shock, and other relevant factors. Radial load capacity varies as shown below with the bore diameter remaining the same. <p>(Small) $\xrightarrow{\hspace{10em}}$ (Large)</p> <p>Angular contact ball bearings Cylindrical roller bearings Tapered roller bearings</p>
<p>③ Rotational speeds</p> <p>Bearing types compatible with the machine's operating speed</p> <p>Standard values for rotational speed limits of bearings are expressed in limiting speed given in the bearing dimension tables.</p>	<ul style="list-style-type: none"> Limiting speeds of bearings largely depends not only on the bearing type, but also on other factors such as bearing size, running accuracy, type and materials of the cage, magnitude of load, and lubrication. Select a bearing taking these fully into consideration. In general, angular contact ball bearings and cylindrical roller bearings are used for high-speed applications.
<p>④ Running accuracy</p> <p>Bearing types meeting requirements for running accuracy</p> <p>Dimension and running accuracies are standardized by JIS and the like for each bearing type.</p>	<ul style="list-style-type: none"> The spindles of machine tools, which need to rotate with high accuracy, require precision bearings meeting tolerance class 5 or better. In general, angular contact ball bearings and cylindrical roller bearings are used.
<p>⑤ Rigidity</p> <p>Bearing types meeting the rigidity requirements for machine shaft systems</p> <p>When a load is applied to a bearing, elastic deformation occurs at the contacts between the raceway and rolling elements. The smaller the elastic deformation, the higher the rigidity.</p>	<ul style="list-style-type: none"> In order to improve the machining precision of a machine tool, the rigidity of bearings as well as the rigidity of the shaft should be improved. In general, roller bearings exhibit a high rigidity, while ball bearings exhibit low rigidity. Bearings of the same type and dimensions vary in rigidity with the number of rolling elements and contact angle. The rigidity of a bearing is increased by applying a preload to the bearing (to provide a clearance of a negative value). This method is suitable for angular contact ball bearings and tapered roller bearings.
<p>⑥ Mounting and dismounting</p> <p>Bearing types should be selected taking into consideration the frequency and method of mounting and dismounting on occasions such as periodic inspection</p>	<ul style="list-style-type: none"> If the bearing is to be mounted and dismounted frequently, cylindrical roller bearings and tapered roller bearings are advantageous, as the inner ring and outer ring are separable.

4. Spindle bearing arrangements

Fig. 4. 1 presents typical arrangements for spindle bearings for machine tools.

For high-speed spindles, the use of ceramic bearings enables higher speed.

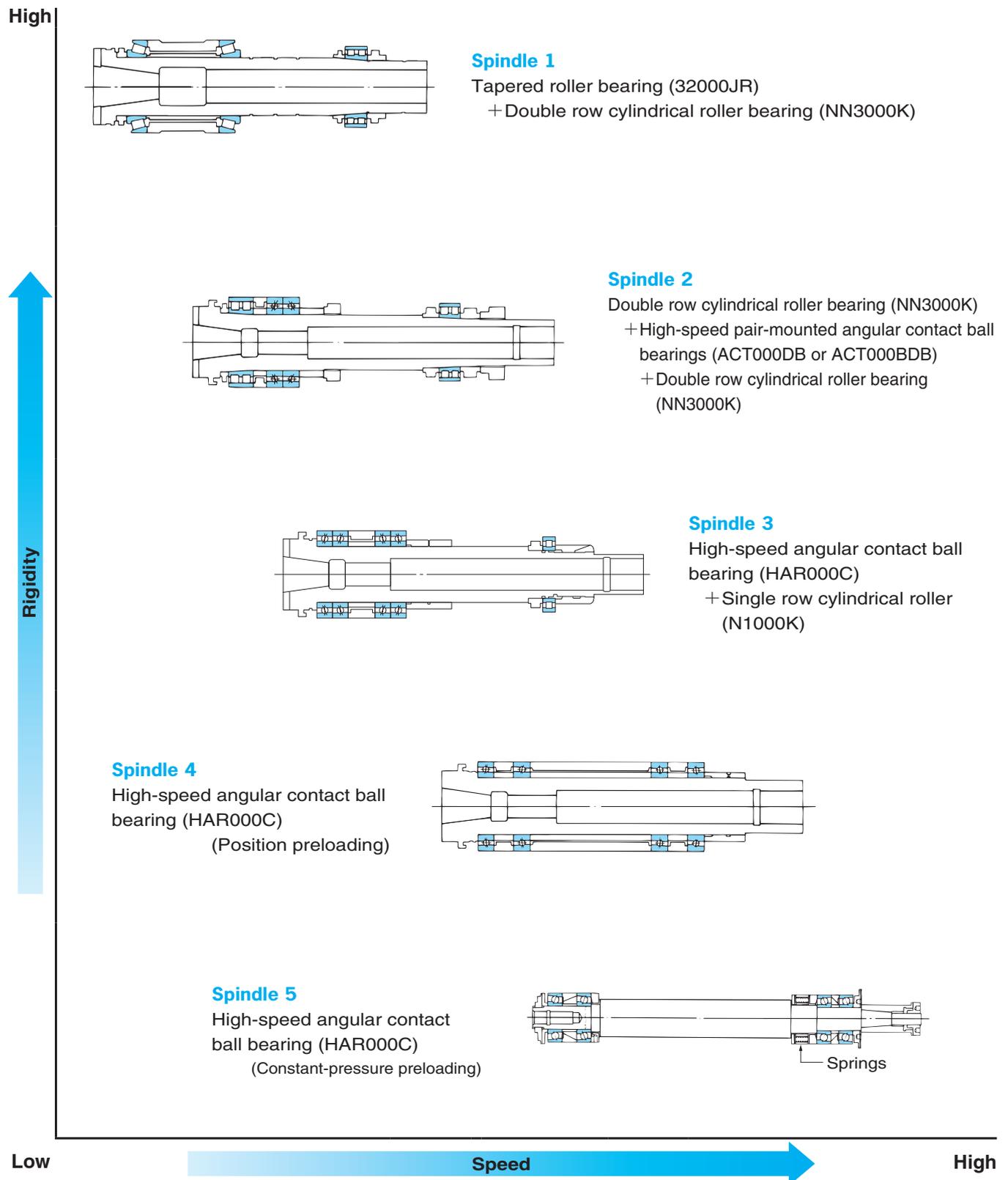


Fig. 4. 1 Examples of spindle bearing arrangements

Table 4. 1 Detailed examples of spindle bearing arrangements

(The $d_m n$ value represents the product of the pitch diameter of ball set d_m and the rotational speed n .)

Spindle	$d_m n$ Value	Features	Principal applications
1	Grease lubrication: 300,000	Both radial and axial loads are accepted by the tapered roller bearing. This arrangement produces high rigidity but is not suitable for high-speed operation.	Large lathes General-purpose lathes
2	Grease lubrication: 600,000	Radial loads are supported by double-row cylindrical roller bearings, and axial loads are supported by high-speed matched pair angular contact ball bearings.	CNC lathes Machining centers NC milling machine
3	Grease lubrication: 750,000 Oil / air lubrication: 1,050,000	Both radial and axial loads are accepted by the angular contact ball bearing. This arrangement is superior to Spindle 2 in high-speed performance, but inferior in radial and axial rigidity.	CNC lathes Machining centers NC milling machine
4	Grease lubrication: 1,100,000 Oil / air lubrication: 1,800,000	High-speed angular contact ball bearings are used in both the front and rear to provide greater high-speed performance. Factors such as thermal expansion should be taken into consideration for preload settings.	Boring machines Machining centers
5	Grease lubrication: 1,400,000 Oil / air lubrication: 2,300,000	Constant-pressure preloading is used to prevent increase in preload due to heat. This arrangement produces a lower rigidity than that produced by position preloading, but is superior in high-speed performance.	Grinding machines Machining centers

5. Rigidity and preload of bearings

5.1 Rigidity of bearings

The rigidity of a bearing has a considerable influence on the rigidity of the spindle of the machine tool. The rigidity of a bearing can be improved by the following methods.

- ① Roller bearings, in which line contact is made between the raceway surface and the rolling element, are used when a high radial rigidity is required.
- ② In the case where high axial rigidity is required, stack mounting angular contact ball bearings, are generally used.

Furthermore, bearings with a large contact angle are used.

- ③ For high-speed and high-rigidity requirements, it is effective to reduce the diameter and increase the number of rolling elements.

It is also possible to improve the rigidity of a bearing by using ceramics (silicon nitride) for the rolling elements which is superior in Young's modulus.

Bearings having ceramic rolling elements also offer improved high-speed performance since their density is lower than that of bearing steel, yielding a small centrifugal force even under high-speed rotation.

- ④ Apply a preload to the bearing.

5.2 Preload of bearings

Preloading means setting the inner clearance to be a negative value and loading the bearing after mounting it.

In case of the angular contact ball bearing and tapered roller bearing, an axial load is applied when preloading. And in case of the cylindrical roller bearing, a radial load is applied when preloading.

5.2.1 Objective of preload

- To improve rigidity
- To improve the positioning accuracy in the radial and axial directions, and to improve the running accuracy as well, by minimizing the runout of the shaft
- To reduce smearing by controlling whirl slip, orbital slip, and rotational slip of rolling elements in high-speed rotations
- To prevent noise caused by vibration and resonance

5.2.2 Methods for preloading

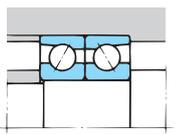
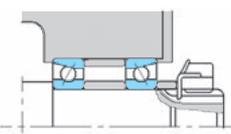
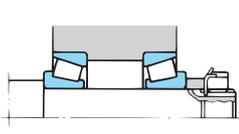
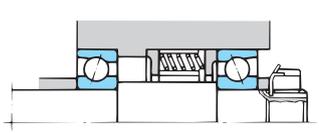
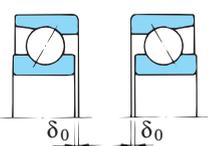
There are two major methods for preloading the angular contact ball bearing and tapered roller bearing; position preloading and constant-pressure preloading.

In the position preloading method, the bearing and spacer, whose dimensions are adjusted to the specified values beforehand, are used. In the constant-pressure preloading method, coil springs or disk springs are used to preload the bearing.

Usage examples and comparison of these methods are shown in Fig. 5. 1.

Also, these preloading methods can be switched over when rotating, and the amount of the preload (load) can be gradually changed in accordance with the speed of the rotation.

Table 5.1 Methods for preloading

Position preloading		Constant-pressure preloading	
<p>When applying the same preload, the displacement to load is smaller and the rigidity is higher than when using the constant-pressure preloading method.</p> <p>When rotating at high speed, the use of this method is limited because the preload amount varies depending on the mounting conditions, centrifugal force and temperature rise.</p>		<p>This method is applicable when rotating at high speed because there is less preload variation when rotating than when using the position preloading method, and almost constant preload can be maintained.</p> <p>However, the improvement of the rigidity of the shaft is not as good as when using the position preloading method.</p>	
 <p>① A method using matched pair bearings with the preload adjusted.</p>  <p>② A method using a spacer of preadjusted size.</p>	 <p>③ A method using a nut or bolt capable of adjusting the amount of preload in the axial direction.</p> <p>(In this case, confirm that the appropriate preload is applied while measuring the starting torque, etc. This method is not suitable for conditions which require high precision, because the bearing tends to tilt easily. In these conditions, methods 1) and 2) are recommended.)</p>	 <p>A method using coil springs or disk springs to apply preload.</p> <p>When using the coil springs, place them on the circumference at regular intervals so that the pressure is applied equally.</p>	
			

5. 2. 3 Preload and axial rigidity

Fig. 5. 1 shows the relationship between preload (position preload) and rigidity, namely, axial displacement of a back-to-back arrangement bearing.

Applying a preload P (by tightening the inner ring in the axial direction), as shown in **Fig. 5. 1**, results in bearings A and B respectively being displaced by δ_{a0} . The clearance between the inner rings $2\delta_{a0}$ will then become 0 (zero).

When an external axial load T is applied to these bearings, their resultant displacement as a pair-mounted bearing set can be obtained as δ_a .

- P : amount of preload
- T : external axial load
- T_A : axial load applied to bearing A
- T_B : axial load applied to bearing B
- δ_a : displacement of pair-mounted bearing set
- δ_{aA} : displacement of bearing A
- δ_{aB} : displacement of bearing B
- $2\delta_{a0}$: clearance between inner rings before applying preload

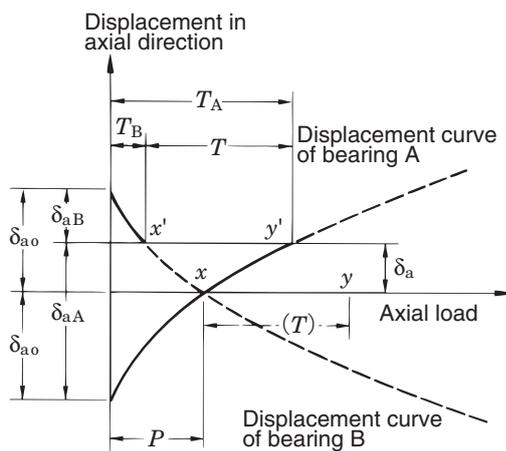
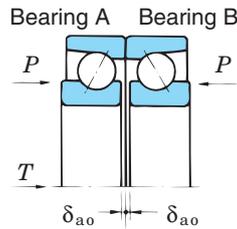


Fig. 5. 1 Preload diagram for position preloading

[Reference] How to determine δ_a in Fig. 5. 1

- ① Obtain the displacement curve of bearing A.
- ② Obtain the displacement curve of bearing B: this is the curve symmetrical with respect to the transverse axis and the intersection x at the preload P .
- ③ Assuming an external load T , obtain a line $x-y$ on the transverse axis passing through x . By parallel displacement of line $x-y$ along the displacement curve of bearing B, the intersection y' passing through the displacement curve of bearing A is obtained.
- ④ δ_a is determined as the distance between the lines $x'-y'$ and $x-y$.

Fig. 5. 2 shows the relationship between preload and rigidity when a constant-pressure preload is applied to the same pair-mounted bearing as shown in **Fig. 5. 1**.

Since the rigidity of the spring is negligible in this case, the rigidity of the bearing is approximately equal to that of a single bearing given a preload P .

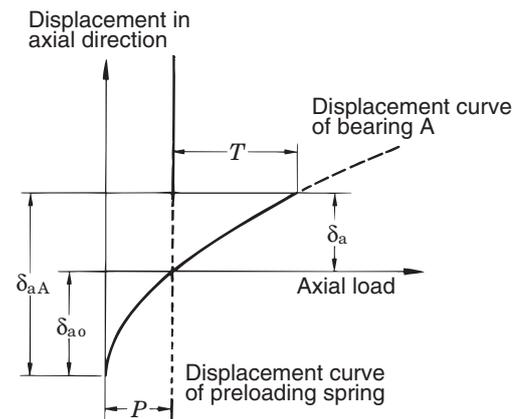


Fig. 5. 2 Preload diagram of constant-pressure preloading

Comparison of axial rigidity of the position preloading and the constant-pressure preloading is shown in **Fig. 5. 3**.

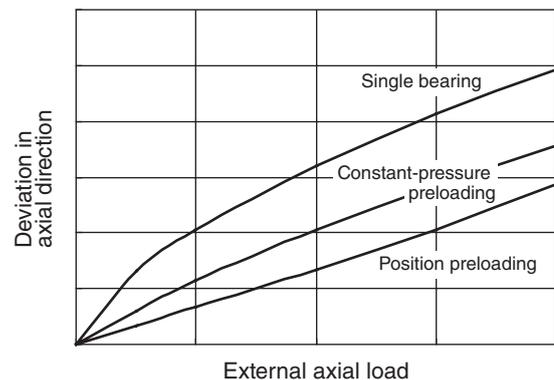


Fig. 5. 3 Comparison of axial rigidity

6. Lubrication of bearings

Lubrication is a crucial factor in bearing performance. The suitability of lubricants and lubrication methods significantly impacts bearing performance.

Lubrication plays the following roles.

- Prevents direct contact between bearing components, reducing wear and friction.
- Maintains the proper oil film on the bearing rolling contact surface at all times to prolong bearing fatigue life.
- Dissipates heat generated inside the bearing due to friction or other causes.
- Prevents bearings from rusting and foreign matter intrusion.

Lubrication is very important for spindle bearings of machine tools since such bearings require a low temperature increase under high-speed operation.

Relationships between the quantity of lubricant and power loss and between the quantity of lubricant and the temperature increase of the bearing are shown in **Fig. 6. 1**. Relationships between the viscosity of lubricant and power loss and between the viscosity of lubricant and the temperature increase of the bearing are shown in **Fig. 6. 2**.

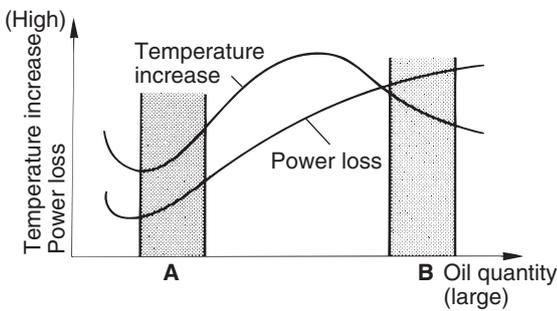


Fig. 6. 1 Relationships between lubricant quantity and power loss and between lubricant quantity and the temperature increase of the bearing

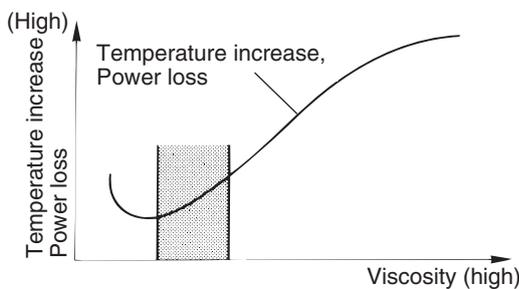


Fig. 6. 2 Relationships between viscosity of lubricant and power loss and between viscosity of lubricant and the temperature increase of the bearing

The quantity of lubricant needed to meet the low temperature increase requirement lies in zone A where the quantity of oil is small so the agitation loss is low, and zone B in which a large quantity of oil transfers heat from the bearing to the outside. Regarding the viscosity of lubricant, those which are of relatively low viscosity are suitable for meeting the above-mentioned requirement.

Note, however, that an excessively small quantity of oil or excessively low viscosity will not maintain a suitable lubricant film during operation, and further induce the chances of seizure.

For bearing lubrication methods, grease, oil / air, or oil mist lubrication is recommended in zone A in **Fig. 6. 1**, and jet lubrication, in zone B.

Table 6. 1 shows a comparison of features for various lubrication methods. It is important to select a lubrication method and a lubricant to best suit to the machine specifications.

Table 6. 1 Comparison of features of different lubrication methods

(○ : advantageous
 △ : somewhat disadvantageous
 × : disadvantageous)

Lubrication method	Grease lubrication	Oil / air lubrication	Oil mist lubrication	Jet lubrication
Total cost	○	△	△	×
Temperature increase of bearing	△	○	△	○
High-speed reliability	×	○	△	○
Power loss	○	○	○	×
Volume occupied by lubricator	○	△	△	×
Environmental contamination	○	△	×	△
Service life of lubricant	×	○	○	○

6. 1 Grease lubrication

Grease lubrication is most usually employed because it requires no special lubricator and the use of a relatively simple housing structure is sufficient.

However, to enable high-speed operation, low temperature increases, and long service life of sealed grease, the following should be taken into consideration.

6. 1. 1 Types of grease

In order to suppress temperature increases during high-speed operation, a grease low in base oil viscosity is suitable.

In general, grease NLGI 2 in consistency and approximately 10-30 mm²/s in base oil viscosity is often used for spindle bearings of machine tools. In cases where bearings are subjected to high loads, a grease with a base oil viscosity of approximately 100 mm²/s, and an extreme-pressure agent may be used to secure lubricant film during operation.

Table 6. 2 shows grease for spindle bearings of machine tools.

6. 1. 2 Sealing device

For spindle bearings of machine tools, it is important to use a reliable sealing device to prevent mixing of coolant, chips, wear particle of drive belt, gear lubricant, and so forth.

Where grease lubrication is adopted, foreign matter have a great influence on the service life of a bearing.

An example of sealing device for grease lubrication is shown in **Fig. 6. 3**.

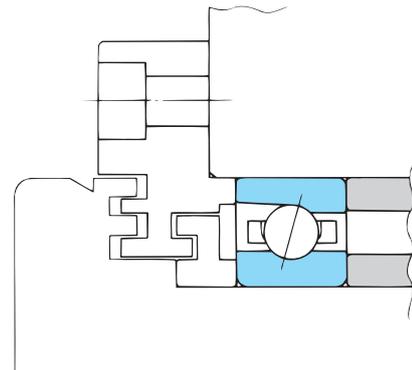


Fig. 6. 3 Example of sealing device for grease lubrication (labyrinth seal)

Table 6. 2 Grease for spindle bearings of machine tools (representative examples)

Grease name	Manufacturer	Thickener	Base oil	Base oil viscosity mm ² /s (40°C)	Application
Beacon 325	Exxon Mobil	Lithium	Diester	12	High-speed operation, low temperature
Maltemp PS 2	Kyodo oil	Lithium	Diester+mineral oil	14	
Isoflex NBU 15	NOK klüber	Barium complex	Ester	20	
Klüberspeed BF 72-22	NOK klüber	Urea	Ester	22	
Stabrag NBU 8 EP	NOK klüber	Barium complex	Mineral oil	95	High-load operation, wear resistance
Alvania No. 2	Showa shell sekiryu	Lithium	Mineral oil	130	

6.2 Oil lubrication

6.2.1 Oil / air lubrication

In this lubrication method, a small amount of oil of a specified quantity is supplied intermittently to each bearing by compressed air.

A schematic drawing of an oil / air lubrication system is shown in Fig. 6. 4.

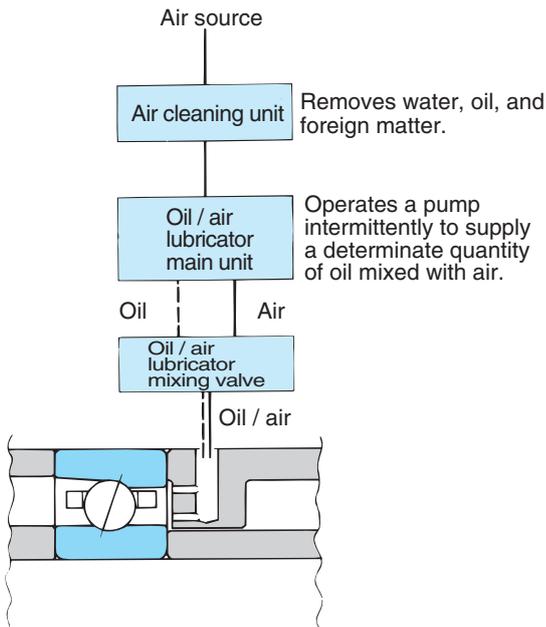


Fig. 6. 4 Oil / air lubrication system

Since oil / air lubrication has features as shown below, it has become popular in many high-speed spindle.

1. Compared with grease lubrication, oil / air lubrication allows bearings to meet the low temperature increase and high-speed operation requirements (see Fig. 6. 5).

This lubrication method eliminates concerns about the service life of lubricant as new oil is constantly supplied to the bearings. Furthermore, compressed air, which increases the pressure in the housing, is effective in preventing foreign matter from entering into the housing.

2. Compared with oil mist lubrication, oil / air lubrication is simple to adjust the quantity of oil with a high degree of accuracy. This leads to a high reliability for bearings during high-speed operation.

In addition, unlike oil mist lubrication, oil / air lubrication is free from environmental contamination and also reduces oil consumption.

3. Compared with jet lubrication, oil / air lubrication suppresses power losses of bearings (see Fig. 6. 6).

This feature saves space because a smaller drive motor and cooling unit can be used.

The structure of the main shaft can also be simple and compact.

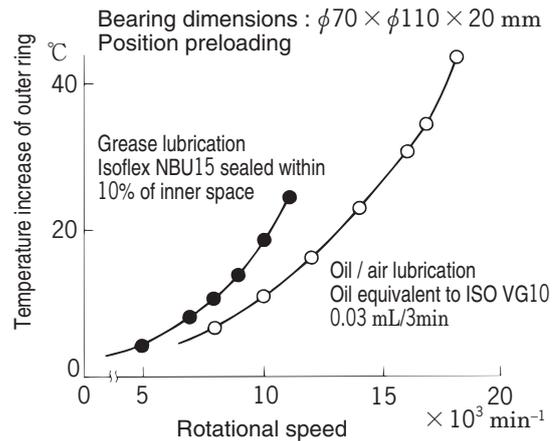


Fig. 6. 5 Comparison of the temperature increase between oil / air lubrication and grease lubrication

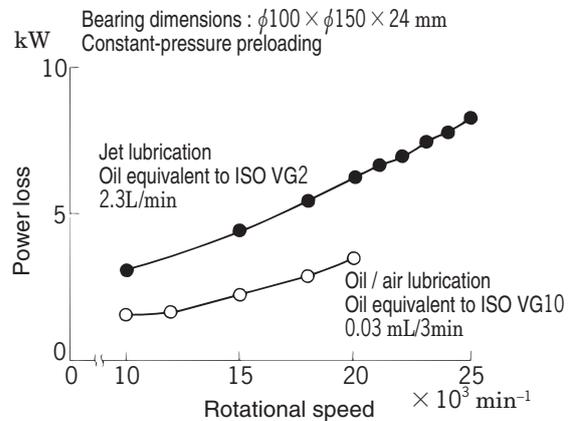


Fig. 6. 6 Comparison of power loss between oil / air lubrication and jet lubrication

Refer to Table 15. 4 on page 53 for information about the dimensions of the spacers for oil / air lubrication.

Refer to Supplementary table 6 on page 215 for information about the blow intervals of the oil / air.

6. 2. 2 Oil mist lubrication

Similar to oil / air lubrication, oil mist lubrication supplies a small quantity of oil to each bearing by compressed air.

Fig. 6. 7 shows an oil mist lubrication system.

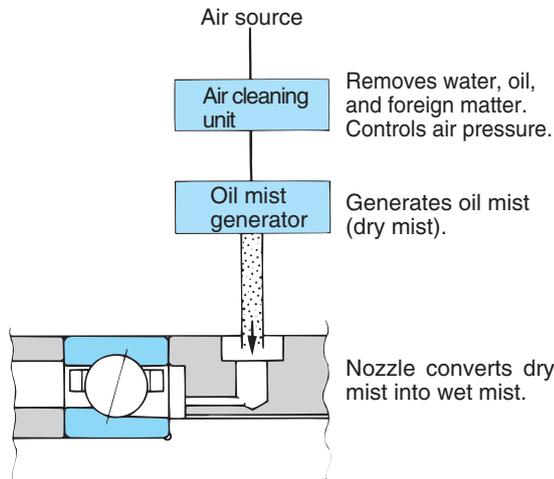


Fig. 6. 7 Oil mist lubrication system

The cost of oil mist lubrication is relatively low. The high-speed performance attained by this method is better than by grease lubrication.

To obtain maximum performance from this method, due consideration should be given to the following.

1. Oil quantity settings

The quantity of oil is set by the rate at which the oil mist generator produces oil drops. Since the rate of oil turned to mist depends on the type of oil, air pressure, flow rate, etc., it is important to determine the amount of oil drops required after the characteristics of the whole system have been sufficiently understood.

2. Distribution of mist to several bearings

In general, a single oil mist generator is used to distribute the mist to several bearings.

Each bearing should be checked to see if it is supplied with an adequate quantity of oil.

3. Installation of suitable nozzle(s)

The nozzle converts dry mist into wet mist suitable for lubrication of bearings and supplies mist to the inside of bearings.

For reliable operation, the nozzle design should be given sufficient consideration.

A well-designed nozzle reduces the quantity of oil so that contamination by oil mist will also be reduced.

6. 2. 3 Jet lubrication

Jet lubrication is a method in which a large quantity of lubricant is injected at a high velocities through the bearing side to lubricate and cool the bearing simultaneously.

Fig. 6. 8 shows a jet lubrication system.

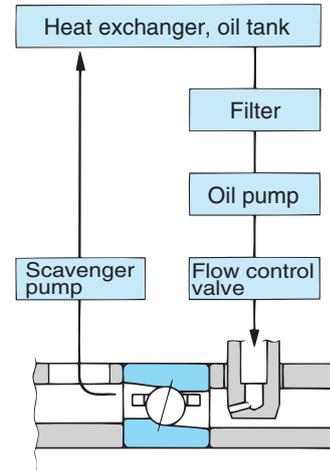


Fig. 6. 8 Jet lubrication system

Owing to its high reliability for high-speed operation, the jet lubrication is often applied to such bearings designed for high-speed and high-temperature operation, for example, gas turbine engines. Also, jet lubrication is sometimes employed for the high-speed spindles of machine tools. If this is the case, give due consideration to the following points.

1. Use oil of extremely low viscosity of approximately $2 \text{ mm}^2/\text{s}$ to restrain power loss and temperature increase.
2. To improve cooling efficiency, set the velocity of the lubricant ejected from the nozzle to at least 20% of the peripheral speed of the outer surface of the inner ring, thereby allowing more oil to pass through the bearing.
Installing several nozzles on the circumference for a larger quantity of oil is also effective to some degree.
3. A pump or similar device should be used to discharge oil smoothly. For this reason, the discharge port should be as large as possible to ensure a smooth discharge of oil.
After discharge, the lubricant should be cooled with a heat exchanger of adequate capacity in order to minimize temperature changes.
4. It is essential to maintain clean lubricant by installing an appropriate filter, ensuring an airtight oil tank, and so forth.

7. Limiting speeds of bearings

The rotational speed of a bearing is restricted chiefly by temperature increases caused by frictional heat generated within the bearing. When a speed limit is reached, it becomes impossible to continue operation due to seizure and the like.

The permissible rotational speed of a bearing represents the value of limiting speed at which the bearing can continue operation without causing seizure-generated temperatures.

Accordingly, the limiting speed differs with bearing types, dimensions, accuracy, lubrication methods, quality and quantity of lubricant, shape and material of cages, loading conditions (including amount of preload), etc.

The limiting speed for grease lubrication or oil (oil / air) lubrication of bearings are given in their dimension tables.

These values are the limiting speed that are applicable where a bearing of a standard design is operated under normal loading conditions ($C_r/P_r \geq 13$, $F_a/F_r \leq \text{approx. } 0.2$).

C_r : basic dynamic load rating
 P_r : dynamic equivalent load
 F_r : radial load
 F_a : axial load

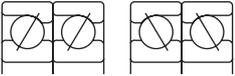
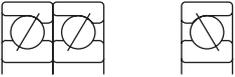
Spindle bearings for machine tools are commonly used in one of 2-, 3-, or 4-row combinations. The limiting speed of a stack mounting bearing is lower than that of a single row bearing.

The speed coefficients are shown in **Table 7. 1**. In this table, the correlations between the preload amounts and the matching methods of the bearings mounted to the shafts with position preloading are shown. Differences are made due to the heat radiation and the variation in the preload amount of each bearing.

Where a lubricant can efficiently remove the heat generated in the bearing, the limiting speed of a bearing will be greater than those given in the bearing dimension tables.

If the rotational speed of a bearing exceeds 80% of the value listed in the bearing dimension tables, careful consideration should be given to the amount of preload, lubrication method, lubricant, distance between the bearings, etc. Consult JTEKT.

Table 7. 1 Speed coefficients

Matching method	Prefix	Preload in mounting			
		Preload S	Preload L	Preload M	Preload H
	DB	0.85	0.80	0.65	0.55
	DBB	0.80	0.75	0.60	0.45
	DBD	0.75	0.70	0.55	0.40

* The speed coefficients vary depending on the distance between the bearings.

8. Material technology / heat treatment technology

JTEKT offers ceramic bearings made from ceramic materials that enhance bearing high-speed performance and rigidity, long-life bearings featuring proprietary heat treatment technology, as well as

8.1 Rolling elements

Compared with bearing steel, ceramics [silicon nitride (Si_3N_4)] has superior properties such as light weight and high elasticity.

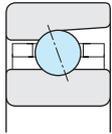
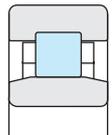
One of the advantages of ceramics when used as a material for bearings is a reduction in the slip of rolling elements caused by centrifugal force and gyroscopic moments under high-speed rotation. Ceramic material is highly effective for meeting the low temperature increase requirements of the bearing.

Other advantages include improved rigidity and improvements in seizure life and grease service life. Ceramic bearings, although varying depending on operating conditions, allow approximately 30% to 50% improvement in speed as compared with steel bearings.

8.1.1 Ceramic bearing structures and types

JTEKT offers precision ball & roller bearings with ceramic rolling elements.

Table 8.1 Ceramic bearing structures and types

	Codes, types, and structures of ceramic bearings
Code ¹⁾	3NC
Description	Rolling element : ceramics
Angular contact ball bearing	
Cylindrical roller bearing	

Note 1) A code is placed before a basic bearing number.

various cages that provide optimal performance depending on the application.

This section introduces JTEKT's heat treatment technology and material technology.

8.1.2 Properties of ceramics (silicon nitride: Si_3N_4)

Sintered in a high temperature and high-pressure gas atmospheric condition (HIP), ceramics (silicon nitride: Si_3N_4) has many superior properties such as heat resistance, light weight, low coefficient of linear expansion, and a high elastic modulus.

Table 8.2 shows a comparison of properties with ceramics (silicon nitride: Si_3N_4) and bearing steel.

Table 8.2 Comparison of properties with ceramics (silicon nitride: Si_3N_4) and bearing steel

Item	Unit	Ceramics (Si_3N_4)	Bearing steel (SUJ2)
Heat resistance (in the air)	°C	800	120
Density	g/cm^3	3.2	7.8
Coefficient of linear expansion	K^{-1}	3.2×10^{-6}	12.5×10^{-6}
Vickers' hardness	HV	1 300~2 000	700~800
Young's modulus	GPa	320	208
Poisson's ratio	—	0.29	0.3
Thermal conductivity	$\text{W}/(\text{m}\cdot\text{K})$	20	41.9~50.2
Corrosion resistance	—	Good	Not good
Magnetism	—	Non-magnetic material	Ferromagnetic material
Electrical conductivity	—	Not applicable (insulant)	Applicable (electric conductor)
Bonding form of material	—	Covalent bond	Metallic bond

8.1.3 Load ratings of ceramic bearings

JTEKT has adopted the following values as a standard for load ratings of ceramic bearings. These values are determined from a number of experiments and their results.

(1) Dynamic load rating :
Dynamic load rating of steel bearings (C) $\times 1.0$ or greater

(2) Static load rating :
Static load rating of steel bearings (C_0) $\times 1.0$

The load applied to a spindle bearing for a machine tool is generally very small as compared with bearing load ratings. Accordingly, it is rare that a bearing reaches its fatigue service life or brinelling occur in its raceway surfaces.

Sufficient care, however, should be taken to ensure that no impact load is applied to the bearing during handling and operation.

8. 1. 4 Sample test data of ceramic bearings

1) High-speed performance of bearings

Ceramic is superior to bearing steel in high-speed rotation performance because it has lower density and linear expansion coefficient.

■ Comparison with steel bearing (1)

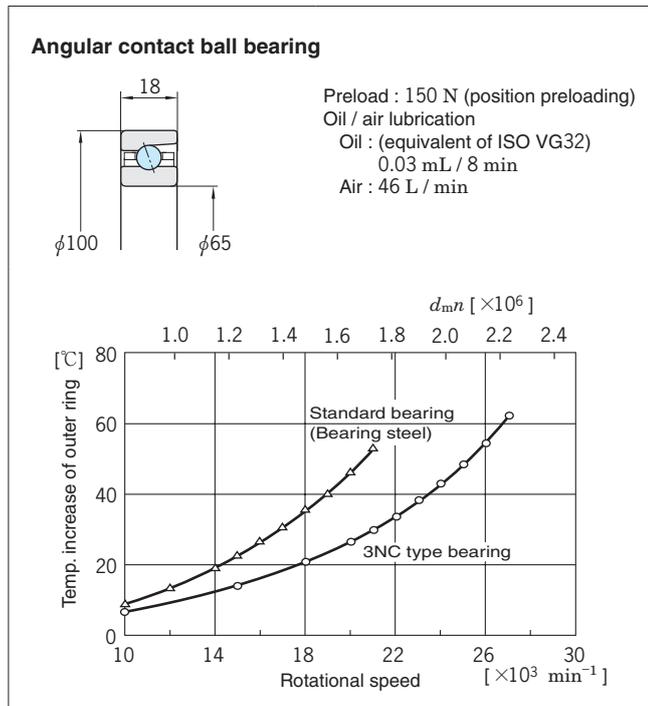


Fig. 8. 1 Comparison of Angular contact ball bearing

■ Comparison with steel bearing (2)

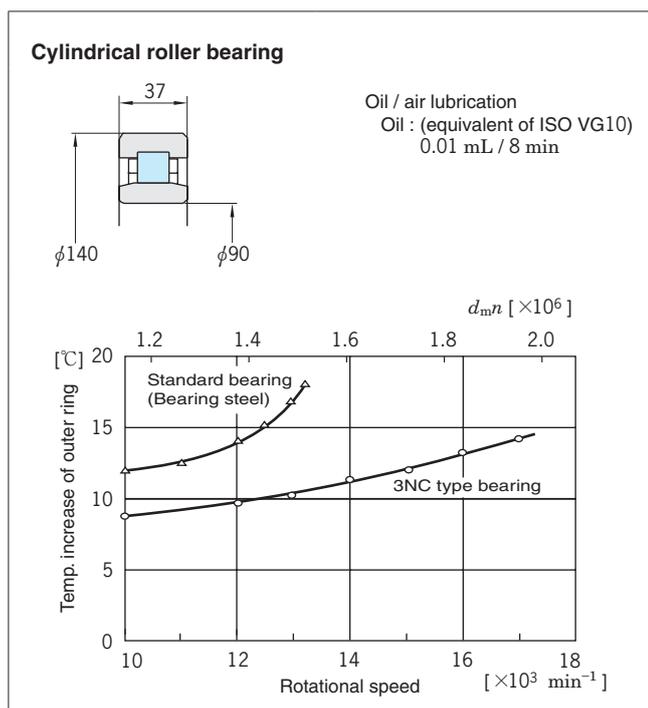


Fig. 8. 2 Comparison of cylindrical roller bearing

■ High-speed performance (1)

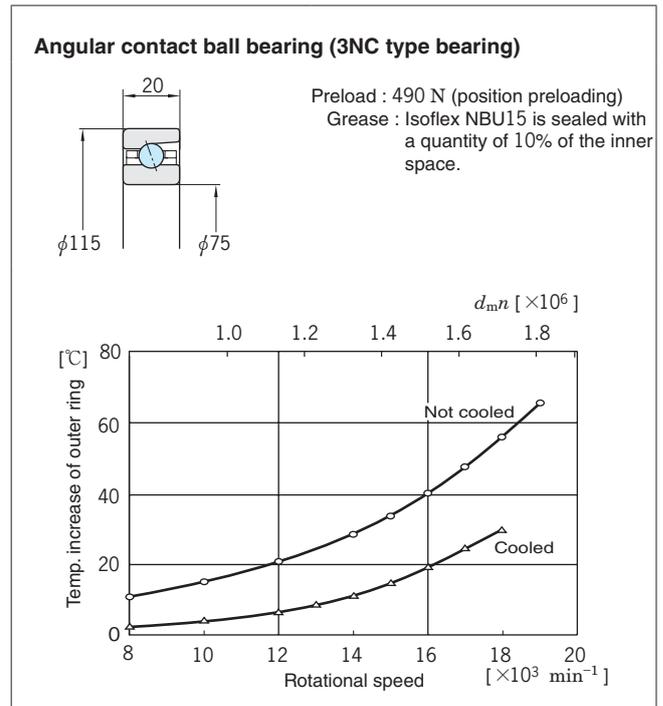


Fig. 8. 3 High speed performance with grease lub.

■ High-speed performance (2)

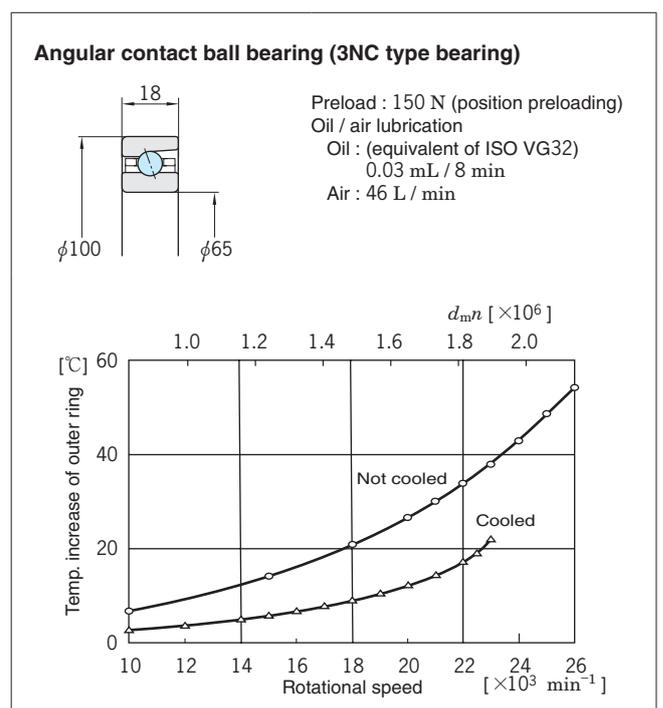


Fig. 8. 4 High speed performance with oil / air lub.

2) Rigidity of bearing

Since ceramics have a greater Young's modulus than bearing steel, the rigidity of a ceramic bearing is higher than that of a steel bearing.

■ Rigidity of bearing

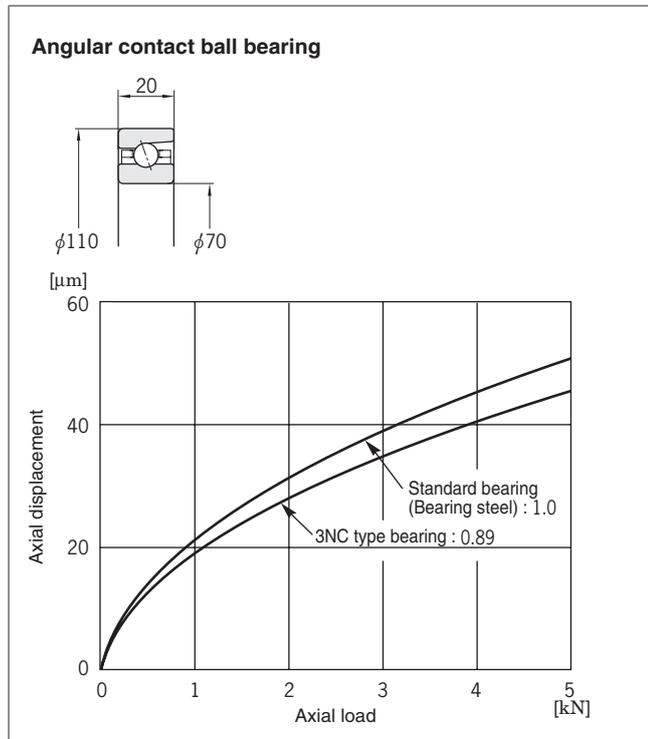


Fig. 8.5 Comparison of axial displacement

3) Changes in shaft dimensions

Compared with steel bearings, ceramic bearings have higher rigidity and lower temperature increase, thus reducing the risk of changes in shaft dimensions.

■ Changes in shaft dimensions

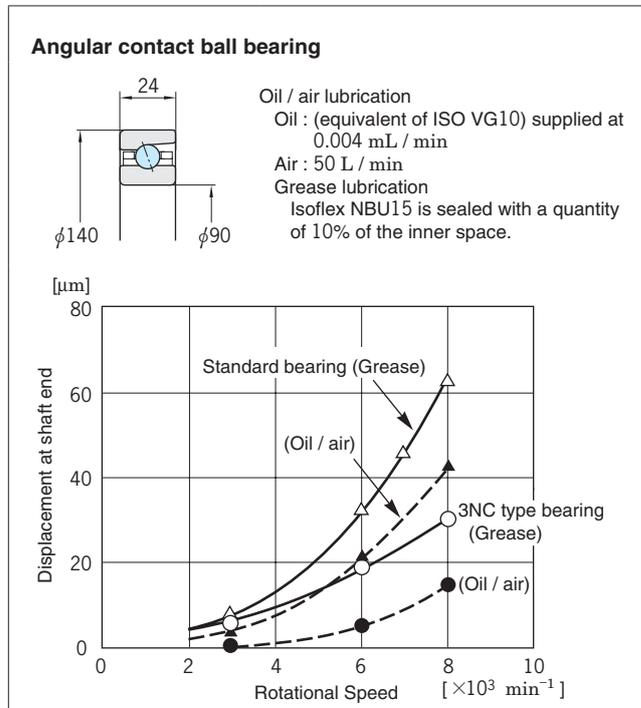


Fig. 8.6 Comparison of displacement at shaft end

4) Fatigue service life and seizure life of bearings

Ceramic bearings are superior to steel bearings in both seizure life and fatigue service life.

■ Seizure life test results (1)

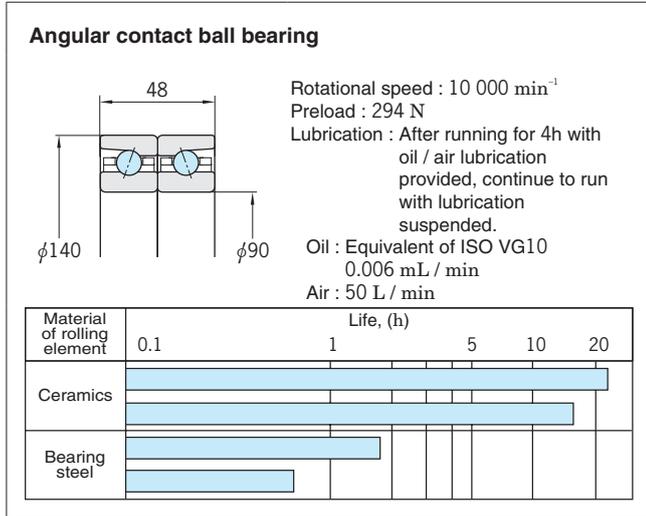


Fig. 8. 7 Seizure life test results of hybrid ceramic bearings and steel bearings

■ Seizure life test results (3)

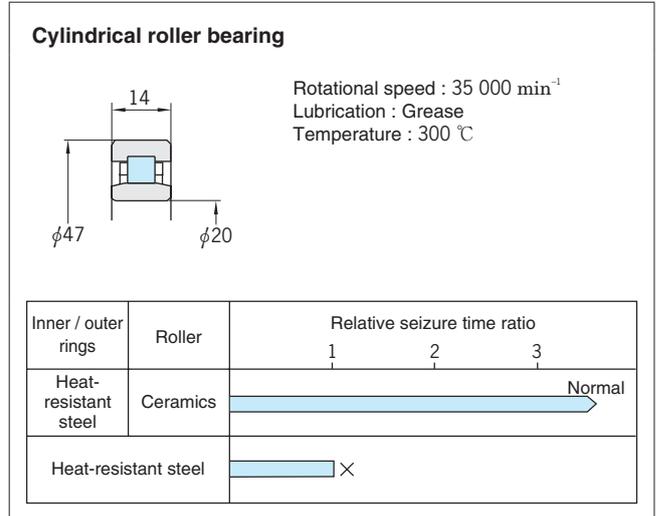


Fig. 8. 9 Seizure life test results of hybrid ceramic bearings and heat resisting steel bearings

■ Seizure life test results (2)

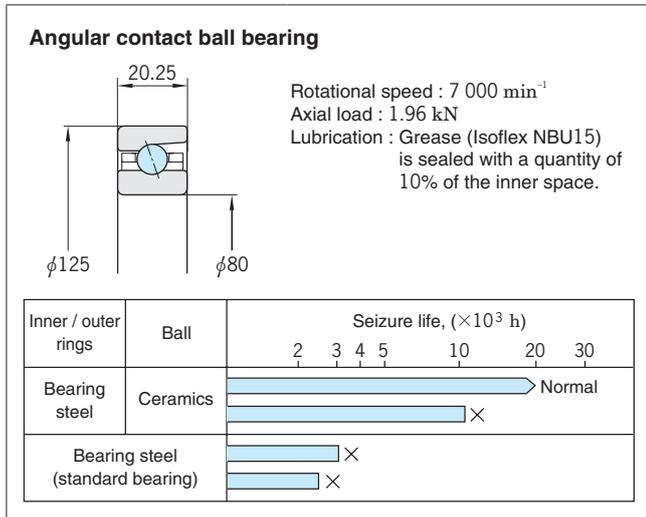


Fig. 8. 8 Seizure life test results of hybrid ceramic bearings and steel bearings

■ Fatigue service life test result

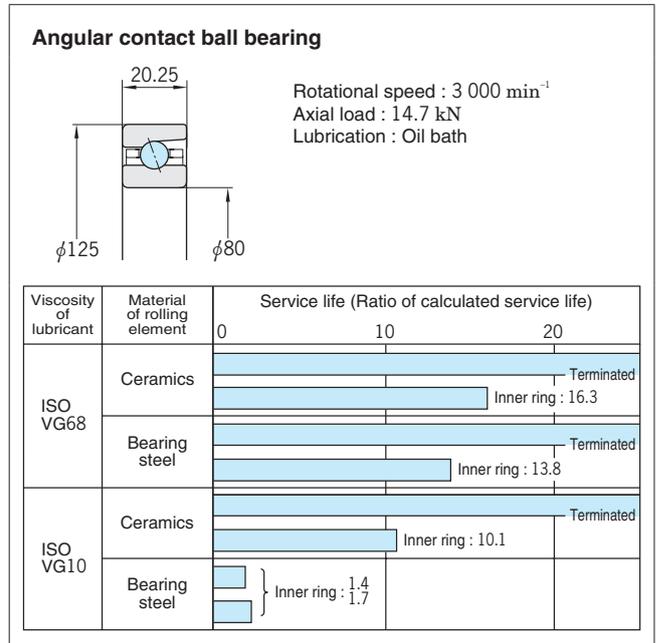


Fig. 8. 10 Life test results of hybrid ceramic bearings and steel bearings

8.2 Rings

The rings of precision ball & roller bearings, such as those used in machine tools, are generally made of bearing steel.

However, a special heat treatment (SH treatment) is also available as an option. Ceramic materials [silicon nitride (Si_3N_4)] can also be used.

8.2.1 SH bearing overview

SH bearings are bearings for which special heat treatment (SH treatment) has been applied to the inner and outer rings.

By forming a compressive residual stress layer on the ring surface (the goal of which is the improvement of the service life), we have improved the surface hardness. (See Fig. 8.11 and Fig. 8.12.)

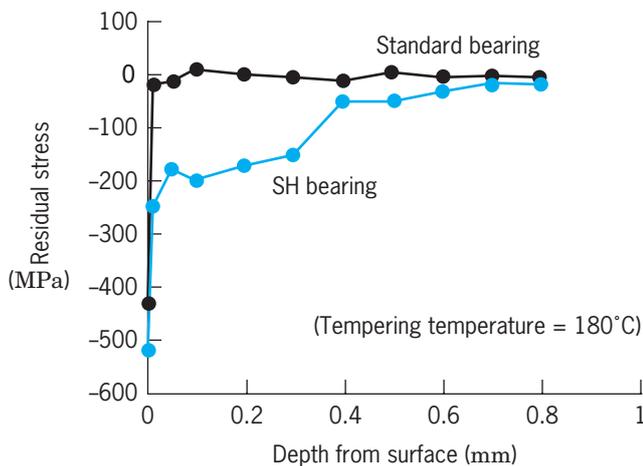


Fig. 8.11 Compressive residual stress layer

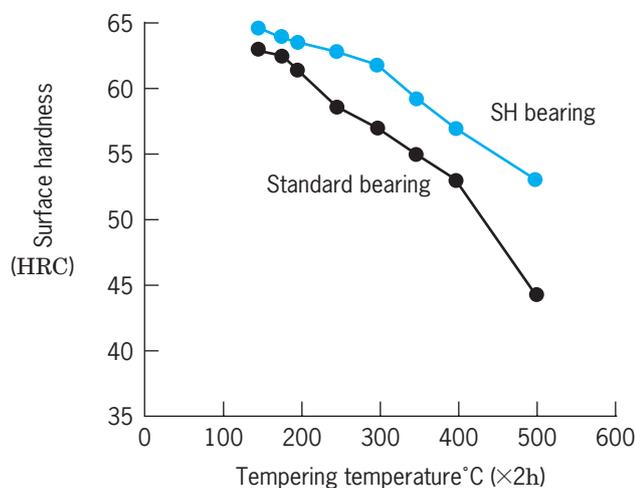


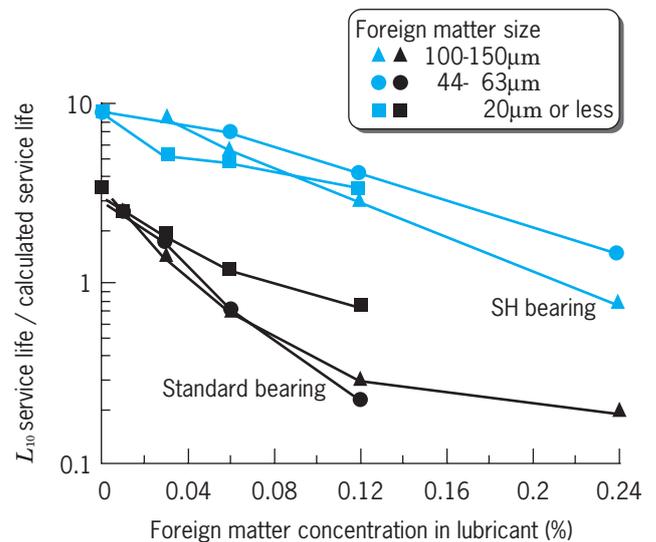
Fig. 8.12 Surface hardness

8.2.2 Performance

In clean oil, these bearings achieve a bearing rating life that is two or more times that of standard bearings.

(Also, in dirty oil, these bearings achieve a bearing rating life that is three or more times that of standard bearings.)

(See Fig. 8.13.)



Test bearing : Ball bearing 63/22 (equivalent)
 Tester : KS radial tester
 Lubricant : Oil bath with turbine oil #68
 Foreign matter : Bearing steel powder

Fig. 8.13 Relationship between lubricant cleanliness and bearing service life

8. 3 Cage

Compared to metal, engineering plastic is lighter and has better self-lubricating and wear resistance properties. When it is used in cages, it generates a

small amount of heat and causes little grease degradation due to wear. Therefore, engineering plastic is widely used in precision bearings for machine tool use.

8. 3. 1 Types and features of cage materials

Material	Cage code	Features
Brass	FW-FY	Excellent heat resistance and hardness
Polyamide resin	FG	A standard thermo plastic resin with low cost and excellent wear resistance and oil resistance
Phenolic resin	FT	A cloth base material impregnated with phenolic resin; excellent heat resistance, wear resistance, and oil resistance
PEEK resin	PG	The highest level of heat resistance among all thermo plastic resins and excellent properties such as wear resistance, creep resistance, and fatigue characteristics

8. 3. 2 Scope of cage materials

Material	Angular contact ball bearings	
	Oil / air lubrication	Grease lubrication
Polyamide resin	—	Ball guided ($\sim d_{mn}$ 1,500,000)
Phenolic resin	Outer ring guided ($\sim d_{mn}$ 3,000,000)	—
PEEK resin	Outer ring guided ($\sim d_{mn}$ 4,000,000)	—

Material	Cylindrical roller bearings	
	Oil / air lubrication	Grease lubrication
Brass	Roller guided	Roller guided
	Single row ($\sim d_{mn}$ 1,000,000)	Single row ($\sim d_{mn}$ 900,000)
	Double row ($\sim d_{mn}$ 800,000)	Double row ($\sim d_{mn}$ 700,000)
Polyamide resin	Roller guided	Roller guided
	Single row ($\sim d_{mn}$ 1,400,000)	Single row ($\sim d_{mn}$ 1,200,000)
PEEK resin	Outer ring guided	Outer ring guided
	Single row ($\sim d_{mn}$ 2,400,000)	Single row ($\sim d_{mn}$ 1,500,000)



Angular contact ball bearings
Outer ring guided
Phenolic resin cage



Angular contact ball bearings
Ball guided
Polyamide resin cage



Double row cylindrical roller bearings
Roller guided
Brass cage



Single row cylindrical roller bearings
Roller guided
Brass cage

8. 3. 3 Example evaluation of high-speed performance of cage materials

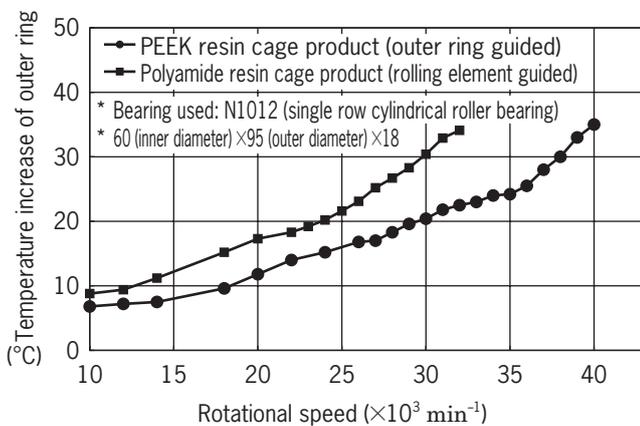


Fig. 8. 14 Example evaluation of the high-speed properties of a PEEK resin cage product and a polyamide resin cage product



Single row cylindrical roller bearings
Roller guided
Polyamide resin cage



Single row cylindrical roller bearings
Outer ring guided
PEEK resin cage

9. High Ability angular contact ball bearings



High Ability angular contact ball bearings are optimized for use on machine-tool spindles. They excel in high-speed performance and rapid acceleration / deceleration, and are especially superior

in ultrahigh-speed applications when used with oil / air lubrication. Even with grease lubrication, these bearings are superior to conventional products in high-speed applications.

9.1 Types and applications

High Ability angular contact bearings are available in the varieties listed in **Table 9.1**, all of which differ in structure and rolling-element material.

Select the type that is best suited for the application.
* High Ability is a registered trademark of **JTEKT**.

Table 9.1 High Ability bearing types and principal applications

Principal applications	Type	Specification		
		Bearing dimension series	Contact angle	Material of rolling element
High-speed, high-rigidity type	 Type HAR	10	15°	Steel or ceramics
		19	20° 30°	
High-speed, high load-rating type	 Type HAC	10	15°	ceramics
		19	20°	
Ultrahigh-speed, low-noise type for oil / air lubrication	 Type HAD	10	20°	ceramics

9.2 Features

● **20 to 30% reduction in temperature increase (compared with JTEKT's conventional products)**

JTEKT has conducted various tests and analyses and developed elaborate machining techniques to improve the performance of bearings used with machining tool spindles. The result is a substantial reduction in frictional heat generated in bearings rotating at a high speed.

● **1.2- to 1.5-time increases in speed limits (compared with JTEKT's conventional products)**

Maximum rotational speed has been extended through redesigning for high-speed rotation and heat reduction. Also, the use of ceramic balls as rolling elements enables even higher speed rotation.

● **Improved high-speed performance achieved by position preloading**

Low increases in temperature during operation ensure reduced changes in preload. Preload can be given by position preloading even at high speeds, which has been hitherto unavailable with conventional systems. The result is high-precision machining with stability.

● **Conventional bearings easily replaced**

Because the boundary dimensions of High Ability bearings conform to ISO standards (excluding the chamfering of the Type HAD), replacement of conventional bearings with High Ability bearings requires no geometrical changes to the present spindle or housing.

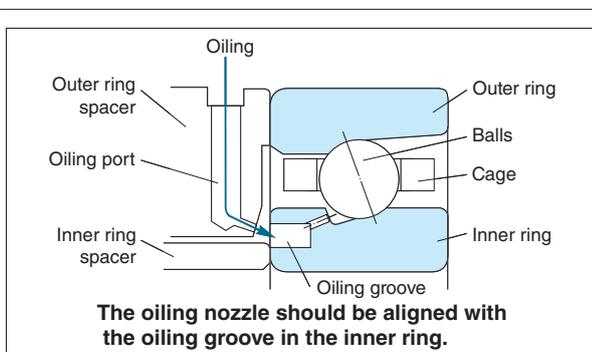


Fig. 9.1 Lubrication method for Type HAD

High Ability Type HAD bearings are designed for oil / air lubrication. Their inner rings have an oiling groove to ensure lubrication on the rolling contact surface for improved lubrication reliability.

9.3 Performance

High Ability bearings exhibit their maximum performance when used in pairs or when more than two units are combined and when preload is given by position preloading. Shown below is the operating performance of High Ability bearings with preload given by position preloading.

9.3.1 Performance of Types HAR and HAC

Fig. 9.2 compares relationships between rotational speed and increases in bearing temperature of Types R and C and conventional high-precision bearings.

High Ability bearings exhibit smaller temperature increases and higher speed limits than conventional bearings whether grease lubrication or oil / air lubrication is applied.

As shown in Fig. 9.3, this type has excellent anti-seizure characteristics with small quantity of lubricant oil in comparison with a conventional type. Thus, the quantity of the lubricant oil can be reduced.

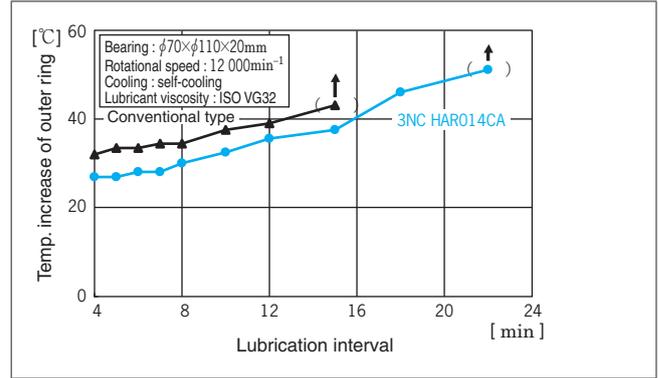


Fig. 9.3 Comparison of seizure limit oil quantity of Type HAR and conventional type

High Ability bearings also allow the possible change in lubrication of the spindle from oil / air to grease.

Fig. 9.4 shows an evaluation example.

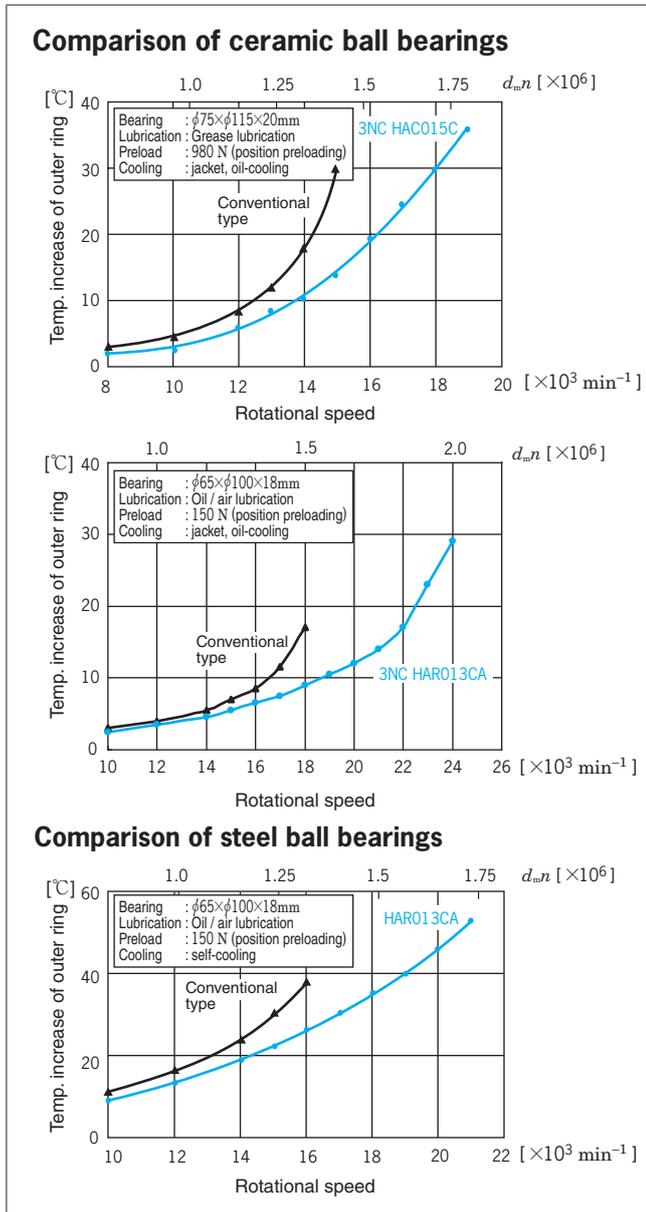
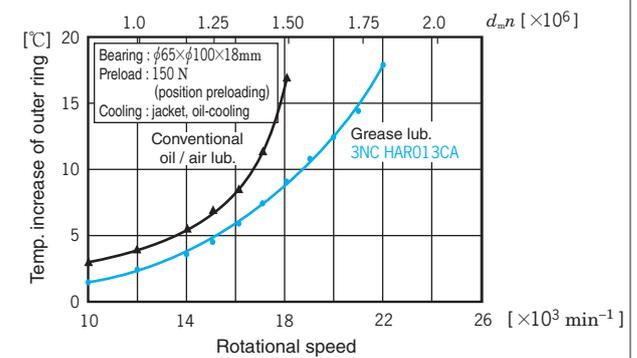
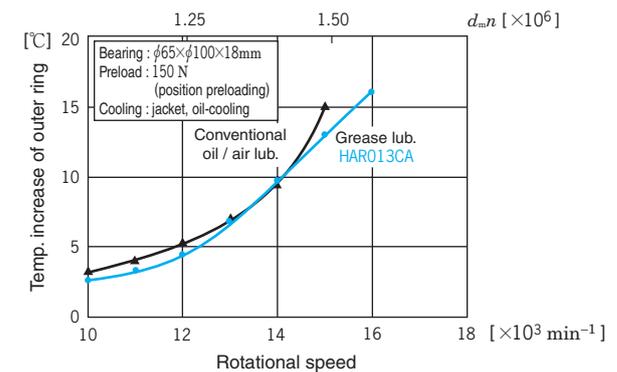


Fig. 9.2 Comparison of increases in bearing temp.

Comparison of ceramic ball bearings



Comparison of steel ball bearings



Results

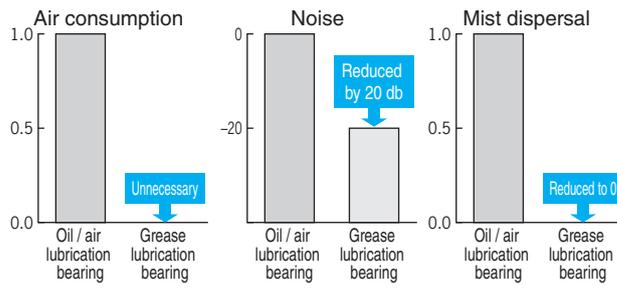


Fig. 9.4 Comparison of high-speed performance achieved by grease lubrication

9. 3. 2 Performance of Type HAD

Fig. 9. 5 compares the high-speed performance of Types HAD and HAR.

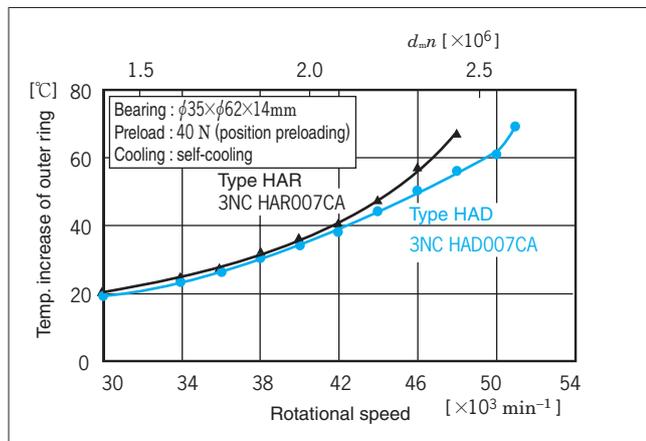


Fig. 9. 5 Comparison of increases in the bearing temp. of Types HAR and HAD

Also, Type HAD causes little wind roar when the bearing is rotating and is effective in reducing the spindle noise as well as air consumption. (Figs. 9. 6 and 9. 7)

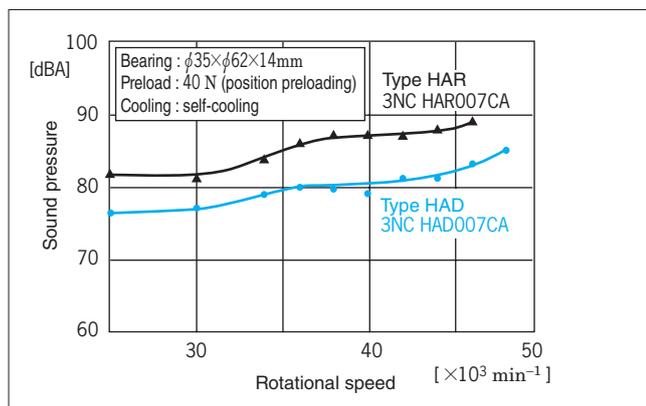


Fig. 9. 6 Comparison of noise by Types HAR and HAD

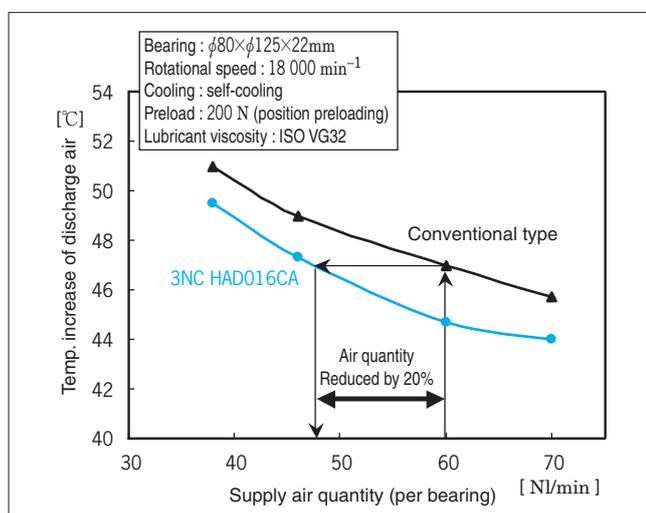


Fig. 9. 7 Comparison of air quantity of Type HAD and conventional type

10. PRECILENCE® angular contact ball bearings



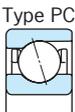
PRECILENCE angular contact ball bearings feature unprecedented ultra-high precision. Market demands for precision are becoming increasingly higher due to advancements in industry, contributing to

improvements in machining accuracy, machining efficiency, running accuracy repeatability, and even reductions in assembly time.

10.1 Types and applications

PRECILENCE angular contact ball bearings come in the bearing structure types shown in **Table 10. 1**. Please select the best bearing for your application or request **JTEKT** to make a selection for you.

Table 10. 1 Types of PRECILENCE angular contact ball bearings

Principal applications	Type	Specifications		
		Bearing dimension series	Contact angle	Rolling element material
High-speed / high-load type	 Type PC	10	15°	Ceramics
		19	20°	
High-speed / high-rigidity type	 Type PM	10	15° 20°	Ceramics

* PRECILENCE is a registered trademark of **JTEKT** and **JTEKT** Precision Bearing.

* Each is available in the low-NRRO H1 series.
NRRO: Non-Repeatable Run-Out

10.2 Features

● **Reduces rotational runout by 50% to 80% (in-house comparison)**

Rather than improving conventional products, **JTEKT**'s pursuit of the ideal bearing has enabled ultra-precise machining, improving raceway and ball precision while significantly reducing runout. The low-NRRO H1 series is also available.

● **Improves speed limits by 30% to 50% (in-house comparison)**

Thanks to an improved design and component precision suitable for high-speed rotation, heat generation is reduced for even higher rotational speeds.

● **Contributes to carbon neutrality**

Reducing heat generation for even higher rotational speeds enables oil / air lubrication to be switched to grease lubrication.

● **Conventional products can be easily switched to PRECILENCE**

Because the boundary dimensions of PRECILENCE bearings conform to ISO standards, replacement of conventional bearings with PRECILENCE bearings requires no geometrical changes to the present spindle or housing.

10.3 Performance

10.3.1 Basic performance of PRECILENCE

The performance of PRECILENCE bearings is evident on the workpiece surface.

When mounted on the spindle of a machine tool and used to process a workpiece with the following shape, the machined area on the side surface of the cutting tool is smoother than with other manufacturers' bearings, as shown in **Fig. 10.1**.

Measurements of the machined surface roughness show that it is approximately half that of other manufacturers. (**Fig. 10.1**)

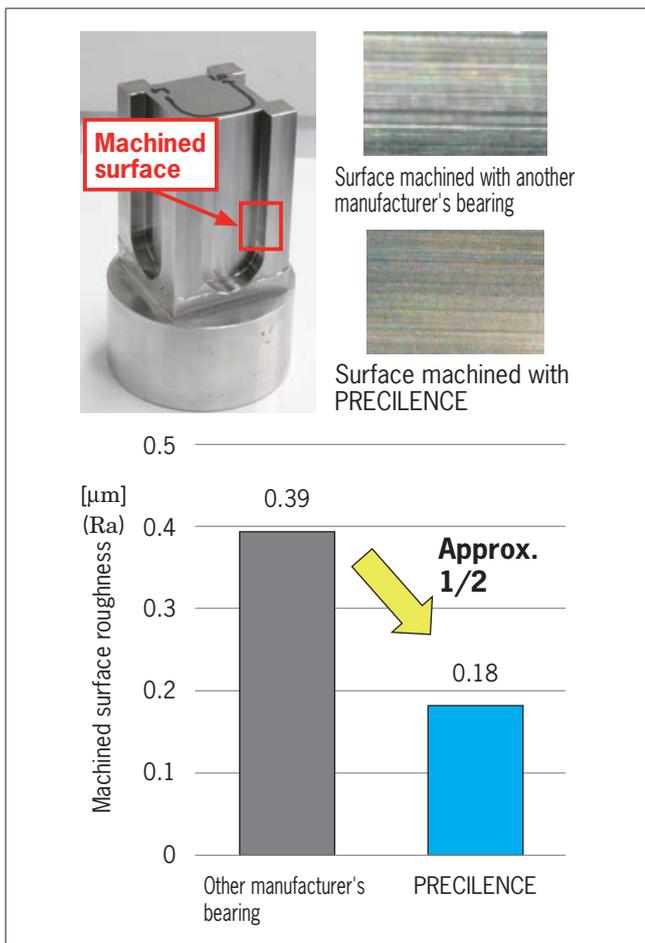


Fig. 10.1 Comparison of machined surface appearance and roughness

Also, when grease lubrication is used, there are less increases in temperature and higher maximum rotational speed than with conventional products. (**Fig. 10.2**)

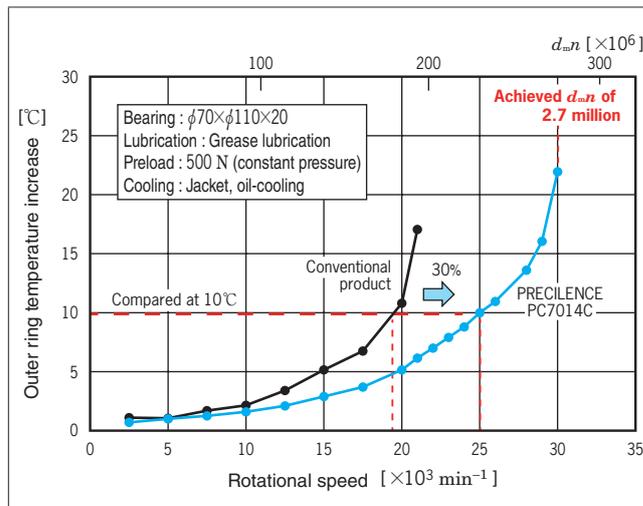


Fig. 10.2 Comparison of rotational speed and outer ring temperature increase

All PRECILENCE bearings are packed in a clean environment and can be used without being cleaned after opening.

Fig. 10.3 shows the relationship between size and quantity of debris in our packing environment.

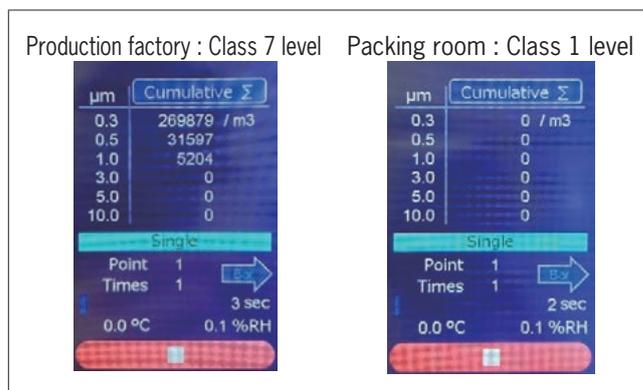


Fig. 10.3 Packing environment cleanliness

Reference : Cleanliness class

Industry	Required cleanliness	
	JIS / ISO	FED(209D)
Medical / Pharmaceutical / Laboratory / Film	Class 1-2	No standard
Semiconductor factory	Class 3-5	Class 1-100
Electronic component factory / Precision factory	Class 5-7	Class 100-10,000
Pharmaceutical factory / Food factory	Class 7-8	Class 100-100,000

10. 3. 2 Low-NRRO series performance

PRECILENCE is also available in a low-NRRO (Non-Repeatable Run-Out) series.

Measurement conditions

Measured with the bearing assembled to the spindle	
Bearing dimension	Front : $\phi 45 \times \phi 75 \times 16$
	Rear : $\phi 35 \times \phi 62 \times 14$
Lubrication	Oil / air
Cooling	Jacket, oil-cooling

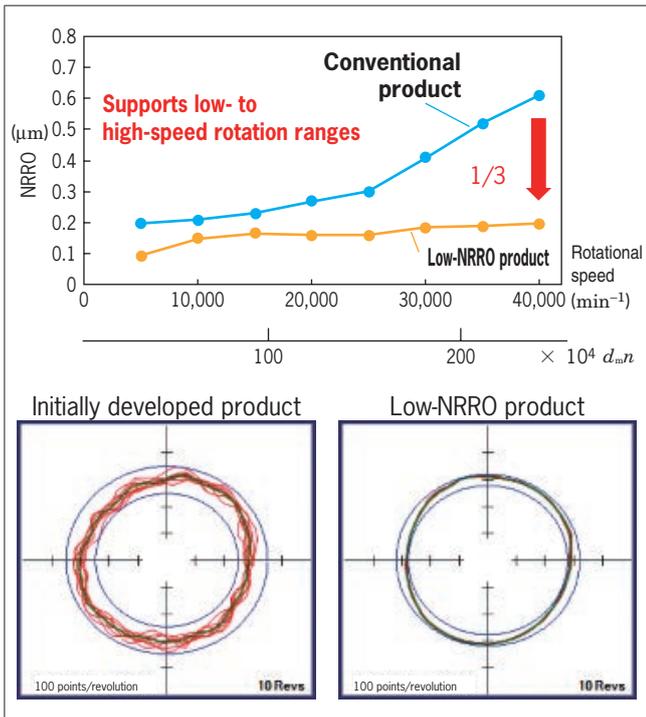


Fig. 10. 4 Rotational speed comparison with NRRO

Using the low-NRRO series to machine plastic molds reduced the surface roughness of the machined surface to approximately half that of conventional levels.



Fig. 10. 5 Machining example and comparison of machined surface appearance / roughness

Low-NRRO products are also effective in reducing temperature increases.

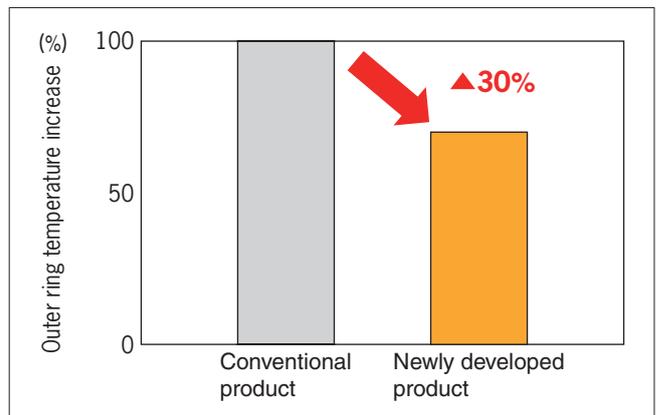


Fig. 10. 6 Outer ring temperature increase comparison between low-NRRO and generic products

11. Selecting a bearing fitting

11.1 Purpose of fitting

Fitting refer to the fitting surfaces between the inner ring and shaft, as well as the outer ring and housing, and are important for preventing harmful slippage (known as "creep") in the circumferential direction.

If this harmful slippage (creep) occurs, it can cause various issues such as abnormal heat generation, fitting surface wear, intrusion of wear debris into the bearing, and vibrations, which can prevent the bearing from functioning properly.

11.2 Selecting a fitting

Please refer to the fitting for spindle bearings under standard operating conditions shown in **Tables 11.1** and **11.2**.

Please consult JTEKT if the bearing is to be used under high-speed rotating conditions with a $d_m n$ value of 80×10^4 or higher, or under heavy load conditions where $C_r/P_r < 13$.

Table 11.1 Shaft fitting (in the case of a rotating inner ring)

Bearing type	Shaft diameter (mm) over up to		Tolerance class of bearing and fits				
			Class 5		Classes 4, 2		
			Tolerance class of shaft or dimensional tolerance of shaft diameter (μm)	Target fitting ¹⁾ (μm)	Tolerance class of shaft or dimensional tolerance of shaft diameter (μm)	Target fitting ¹⁾ (μm)	
Angular contact ball bearings	Amount of preload preset for matched pair bearings	General	All shaft diameter	js 5	—	js 4	—
			6 10	0 -4	0~2T	0 -2.5	0~2T
			10 18	+1 -4	0~2T	0 -3	0~2T
			18 30	+1 -5	0~2.5T	+1 -3	0~2.5T
			30 50	+1 -6	0~3.5T	+1 -4	0~3.5T
			50 80	+2 -6	0~4T	+1 -4	0~4T
			80 120	+3 -7	0~4.5T	+2 -4	0~4.5T
			120 180	+4 -8	0~5T	+2 -6	0~5T
			180 250	+5 -9	0~6T	+3 -6	0~6T
Cylindrical roller bearings (cylindrical bored in inner ring)	25 40	js 4	—	js 3	—		
	40 140	k 4	—	k 3	—		
	140 200	m 5	—	m 4	—		
	200 400	n 5	—	n 4	—		
High-speed matched pair angular contact ball bearings	All shaft diameter	h 5	—	h 4	—		
Support bearings for precision ball screws							
Tapered roller bearings (metric series)	25 40	js 5	—	—	—		
	40 140	k 5	—				
	140 200	m 5	—				

[Note] 1) The symbol "T" in the table indicates an interference fit.

[Remark] Consult JTEKT for specific operating conditions (high-speed rotation, rotating outer ring, heavy load, etc.).

Table 11. 2 Housing fitting (in the case of a rotating inner ring)

Bearing type	Housing bore diameter (mm) over up to	Bearing on fixed side				Bearing on free side				
		Tolerance class of bearing and fitting				Tolerance class of bearing and fitting				
		Class 5		Classes 4, 2		Class 5		Classes 4, 2		
		Tolerance class of housing bore	Target clearance (μm)	Tolerance class of housing bore	Target clearance (μm)	Tolerance class of housing bore	Target clearance (μm)	Tolerance class of housing bore	Target clearance (μm)	
Angular contact ball bearings	General	All housing bore diameter	JS 5	—	JS 4	—	H 5	—	H 4	—
		Amount of preload preset for matched pair bearings	Housing bore diameter (mm) over up to	(Bearing on fixed side)				(Bearing on free side)		
	(Tolerance class of bearing and fitting)				(Tolerance class of bearing and fitting)					
	Classes 5, 4, 2				Classes 5, 4, 2					
	Dimensional tolerance of housing bore (μm)		Target fitting ¹⁾ (μm)		Dimensional tolerance of housing bore (μm)		Target fitting ¹⁾ (μm)			
	18		30	±4.5	0~4L	+ 9 0	6~10L			
	30		50	±5.5	0~4L	+ 11 0	7~11L			
	50		80	±6.5	0~5L	+ 13 0	8~13L			
	80		120	±7.5	0~5L	+ 15 0	10~15L			
	120	180	±9	0~6L	+ 18 0	13~19L				
180	250	±10	0~7L	+ 20 0	17~24L					
250	315	±11.5	0~7L	+ 23 0	22~29L					
315	400	±12.5	0~8L	+ 25 0	26~33L					
(Bearing type)	Housing bore diameter (mm) over up to	Class 5		Classes 4, 2		Class 5		Classes 4, 2		
		Tolerance class of housing bore	Target clearance (μm)	Tolerance class of housing bore	Target clearance (μm)	Tolerance class of housing bore	Target clearance (μm)	Tolerance class of housing bore	Target clearance (μm)	
Cylindrical roller bearings	All housing bore diameter	K 5	0	K 4	0	—				
High-speed matched pair angular contact ball bearings		K 5	—	K 4	—	—				
Support bearings for precision ball screws		H 6	—	H 6	—	—				
Tapered roller bearings (metric series)		K 5	—	—		H 5	—	—		

[Note] 1) The symbol "L" in the table indicates a clearance fit.

[Remark] Consult JTEKT for specific operating conditions (high-speed rotation, outer ring rotation, heavy load, etc.).

12. Selecting a bearing preload

12.1 Amount of preload

If the amount of preload to the bearing is increased, the rigidity is improved.

However, as the load is applied to the bearing, the life may become shorter and abnormal heat may be generated, resulting in serious failure, including early damage, seizure, etc.

Also, in case of position preloading, the amount of preload varies depending on the mounting conditions, including fitting of the bearing, the centrifugal force generated during the operation and the temperature rise.

12.2 Variation of position preloading due to fitting and rotation

12.2.1 Preload in mounting the bearing

The angular contact ball bearing is shown as a model in **Fig. 12. 1a**.

In case of the bearing for the main shaft of a machine tool, for which the inner ring is usually rotated, the interference fit is employed for the inner ring, and the clearance fit is employed for the outer ring. However, the diameter of the inner ring raceway will expand due to interference, and the axial clearance changes as shown in **Fig. 12. 1b**, resulting in the increase in the amount of preload.

Furthermore, if the inner ring is tightened by the shaft nut, etc., the width of the inner ring and the spacer will shrink, resulting in increase in preload.

This is the preload generated when the bearing is mounted.

12.2.2 Change of preload during rotation

During rotation, the preload is changed by centrifugal force and temperature rise.

When rotating, the inner ring is affected by the centrifugal force and the raceway expands. Due to this expansion, the preload increases as shown in **Fig. 12. 1c**.

Influence of temperature rise is described below.

When rotating, the temperature of the bearing increases and the components expand because of rotation resistance, stirring resistance generated by the lubricant, and other external factors.

The temperature increase of the inner ring and the rolling elements is larger than that of the outer ring, which radiates heat easily. Therefore, the internal clearance changes because of the expansion as shown in **Fig. 12. 1d**, and the preload is increased.

Also, the temperature difference is generated between the outer ring and the housing, and the outer ring becomes hotter than the housing, reducing the clearance of the fitting surface of the outer ring. If the clearance of the fitting surface of the outer ring is too small, the fitting of the outer ring becomes interference fitting because of the temperature difference, and the internal clearance changes due to the shrinkage of the raceway of the outer ring, increasing the preload as shown in **Fig. 12. 1e**.

As a result, it is also important to take into consideration the case where the housing cools off excessively.

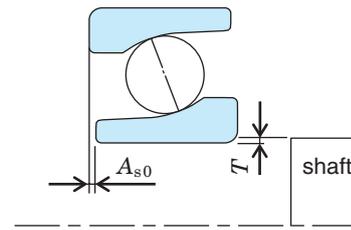


Fig. 12. 1a Bearing before mounting

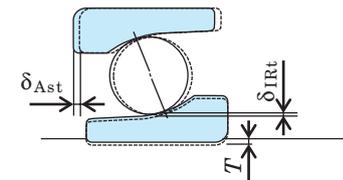


Fig. 12. 1b Change of dimension due to inner ring interference

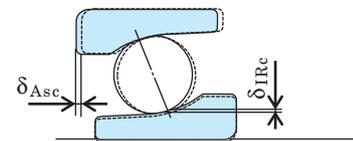


Fig. 12. 1c Change of dimension due to centrifugal expansion of inner ring raceway

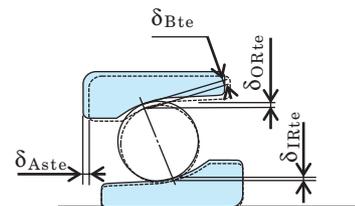


Fig. 12. 1d Change of dimension due to heat expansion

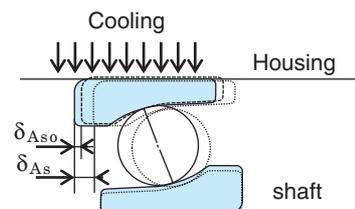


Fig. 12. 1e Change of dimension due to shrinkage of outer ring raceway

A_{s0}	: initial stand-out value (The sum of the stand-out value of a pair of bearings is the size of the clearance for which the preload is provided.)
T	: interference of inner ring
δ_{IRt}	: expansion of inner ring raceway due to inner ring interference
δ_{Ast}	: change of bearing stand-out value due to inner ring interference
δ_{IRc}	: centrifugal expansion of inner ring raceway
δ_{Asc}	: change of bearing stand-out value due to centrifugal expansion of inner ring raceway
δ_{IRte}	: heat expansion of inner ring raceway
δ_{ORte}	: heat expansion of outer ring raceway
δ_{Bte}	: heat expansion of rolling element
δ_{Aste}	: change of bearing stand-out value due to temperature rise of each component
δ_{Aso}	: change of bearing stand-out value due to shrinkage of outer ring raceway
δ_{As}	: total of change of stand-out value due to mounting conditions and rotation

12.3 Selecting preload

To maintain initial bearing performance over a long period while ensuring stable operation, it is necessary to carefully consider the operating conditions, select the optimal preloading method and preload amount, and thoroughly manage assembly conditions.

Especially when used under high-speed rotating conditions, it is necessary to select the appropriate preload by considering factors such as changes in preload, effects of centrifugal force on the contact surface pressure between the rolling elements and raceway, and the spin slide of angular contact ball bearings.

Standard preload amounts for each bearing are shown in bearing dimension tables.

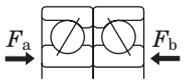
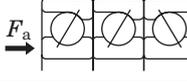
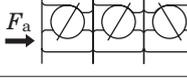
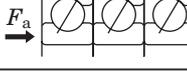
Please consult JTEKT if the bearing is to be used under high-speed rotating conditions with a $d_m n$ value of 80×10^4 or higher, or under heavy load conditions where $C_r/P_r < 13$.

12.4 Preload loss load

When an external axial load is applied to a combination bearing with preload P and results in a state where there is no load, it is referred to as "preload loss." If preload loss occurs, the rolling elements stop rotating, leading to sliding between the bearing ring and rolling elements, possibly causing abnormal heat generation and wear.

The external axial load that causes preload loss is called the "preload loss load" and its magnitude varies depending on the preload and combination method used, as shown in **Table 12.1**.

Table 12.1 Preload loss load

Combination method	Combination symbol	Preload loss load	
		F_a	F_b
	DB	$2.8 P$	$2.8 P$
	DBD	$4.2 P$	$2.1 P$
	DBB	$2.8 P$	$2.8 P$
	DBT	$5.4 P$	$1.8 P$

P : Preload

13. Service life of bearings

13.1 Rating life of bearings

When a bearing rotates under a load, the surfaces of the inner and outer ring raceways and the surfaces of the rolling elements are constantly subjected to repetitive loads. Even under proper operating conditions this results in scale-like damage (known as flaking) of the surfaces due to fatigue.

The total number of rotations before this damage occurs is known as "(fatigue) service life" of the bearing.

A substantial variation in "(fatigue) service life" occurs even if bearings of the same structure, dimensions, materials, machining method, etc. are operated under the same conditions.

This variation in fatigue, an intrinsic phenomenon to the material, should be examined statistically.

The total number of rotations at which 90% of the same type of bearings individually operated under the same conditions are free of damage caused by rolling fatigue (in other words, service life of 90% reliability), is referred to as "basic rating life of the bearing."

In some cases, however, bearings, when actually mounted and operated on a machine, may become inoperative due to causes other than damage by fatigue (wear, seizure, creep, fretting, brinelling, cracking, etc.).

By giving sufficient consideration to the selection of bearings, installation, lubrication, and the like, it is possible to avoid such causes.

13.2 Service life calculation of bearings

13.2.1 Basic dynamic load ratings

The strength of a bearing against rolling fatigue—that is, the basic dynamic load rating representing the bearing load capacity—is the net radial load (in the case of a radial bearing) or central axial load (in the case of a thrust bearing) such that its magnitude and direction are constant and the bearing can attain a basic rating life of 1 million rotations under the condition that the inner ring rotates while the outer ring is stationary (or vice versa).

These are called "basic dynamic radial load rating (C_r)" or "basic dynamic axial load rating (C_a)," respectively. Values for these items are given in the bearing dimension tables.

13.2.2 Basic rating life

The relationship among the basic dynamic load rating, the dynamic equivalent load, and the basic rating life is expressed by equation (13. 1).

If a bearing is to be operated at a constant rotational speed, its service life is conveniently expressed in hours as determined by equation (13. 2).

(Total number of rotations)

$$L_{10} = \left(\frac{C}{P}\right)^p \dots\dots\dots (13. 1)$$

(Hours)

$$L_{10h} = \frac{10^6}{60n} \left(\frac{C}{P}\right)^p \dots\dots\dots (13. 2)$$

where,

- L_{10} : basic rating life 10⁶ rotations
- L_{10h} : basic rating life h
- P : dynamic equivalent load N
- C : basic dynamic load rating N
- n : rotational speed min⁻¹
- p : $p=3$ for ball bearings
- $p=10/3$ for roller bearings

When a bearing is operated with a dynamic equivalent load of P and a rotational speed of n , the basic dynamic load rating C of the bearing, which is suitable for meeting the design service life, is given by equation (13. 3). Thus the bearing dimensions are determined by selecting a bearing from the bearing dimension tables, which meets requirement C .

$$C = P \left(L_{10h} \times \frac{60n}{10^6} \right)^{1/p} \dots\dots\dots (13. 3)$$

[Reference] A method for determining the rating life of a bearing in a simplified method

A formula for determining service life, in which a service life coefficient (f_h) and speed coefficient (f_n) are applied in equation (13. 2), is shown below.

$$L_{10h} = 500 f_h^p \dots\dots\dots (13. 4)$$

Service life coefficient :

$$f_h = f_n \frac{C}{P} \dots\dots\dots (13. 5)$$

Speed coefficient :

$$f_n = \left(\frac{10^6}{500 \times 60n} \right)^{1/p} = (0.03n)^{-1/p} \dots\dots\dots (13. 6)$$

13. 2. 3 Modified rating life L_{nm}

The life of rolling bearings was standardized as a basic rating life in the 1960s, but in actual applications, sometimes the actual life and the basic rating life have been quite different due to the lubrication status and the influence of the usage environment.

To make the calculated life closer to the actual life, a corrected rating life has been considered since the 1980s. In this corrected rating life, bearing characteristic factor a_2 (a correction factor for the case in which the characteristics related to the life are changed due to the bearing materials, manufacturing process, and design) and usage condition factor a_3 (a correction factor that takes into account usage conditions that have a direct influence on the bearing life, such as the lubrication) or factor a_{23} formed from the interdependence of these two factors, are considered with the basic rating life.

These factors were handled differently by each bearing manufacturer, but they have been standardized as a modified rating life in ISO 281 in 2007. In 2013, JIS B 1518 (dynamic load ratings and rating life) was amended to conform to the ISO.

The basic rating life (L_{10}) shown in equation (13. 1) is the (fatigue) life with a dependability of 90% under normal usage conditions for rolling bearings that have standard factors such as internal design, materials, and manufacturing quality.

JIS B 1518:2013 specifies a calculation method based on ISO 281:2007. To calculate accurate bearing life under a variety of operating conditions, it is necessary to consider elements such as the effect of changes in factors that can be anticipated when using different reliabilities and system approaches, and interactions between factors. Therefore, the specified calculation method considers additional stress due to the lubrication status, lubricant contamination, and fatigue load limit C_u (refer to 2) b) on the inside of the bearing. The life that uses this life modification factor a_{ISO} , which considers the above factors, is called modified rating life L_{nm} and is calculated with the following equation (13. 7).

$$L_{nm} = a_1 a_{ISO} L_{10} \dots\dots\dots (13. 7)$$

In this equation,

L_{nm} : Modified rating life 10^6 rotations

This rating life has been modified for one of or a combination of the following: reliability of 90% or higher, fatigue load limit, special bearing characteristics, lubrication contamination, and special operating conditions.

L_{10} : Basic rating life 10^6 rotations (reliability: 90%)

a_1 : Life modification factor for reliability
.....refer to section 1)

a_{ISO} : Life modification factor
.....refer to section 2)

[Remark] When bearing dimensions are to be selected given L_{nm} greater than 90% in reliability, the strength of shaft and housing must be considered.

1) Life modification factor for reliability a_1

The term "reliability" is defined as "for a group of apparently identical rolling bearings, operating under the same conditions, the percentage of the group that is expected to attain or exceed a specified life" in ISO 281:2007. Values of a_1 used to calculate a modified rating life with a reliability of 90% or higher (a failure probability of 10% or less) are shown in Table 13. 1.

Table 13. 1 Life modification factor for reliability a_1

Reliability, %	L_{nm}	a_1
90	L_{10m}	1
95	L_{5m}	0.64
96	L_{4m}	0.55
97	L_{3m}	0.47
98	L_{2m}	0.37
99	L_{1m}	0.25
99.2	$L_{0.8m}$	0.22
99.4	$L_{0.6m}$	0.19
99.6	$L_{0.4m}$	0.16
99.8	$L_{0.2m}$	0.12
99.9	$L_{0.1m}$	0.093
99.92	$L_{0.08m}$	0.087
99.94	$L_{0.06m}$	0.080
99.95	$L_{0.05m}$	0.077

(Table 13. 1 Citation from JIS B 1518:2013)

2) Life modification factor a_{ISO}

a) System approach

The various influences on bearing life are dependent on each other. The system approach of calculating the modified life has been evaluated as a practical method for determining life modification factor a_{ISO} (ref. Fig. 13. 1). Life modification factor a_{ISO} is calculated with the following equation. A diagram is available for each bearing type (radial ball bearings, radial roller bearings, thrust ball bearings, and thrust roller bearings). (Each diagram (Figs. 13. 2 to 13. 5) is a citation from JIS B 1518:2013.)

Note that in practical use, this is set so that life modification factor $a_{ISO} \leq 50$.

$$a_{ISO} = f \left(\frac{e_c C_u}{P}, \kappa \right) \dots\dots\dots (13. 8)$$

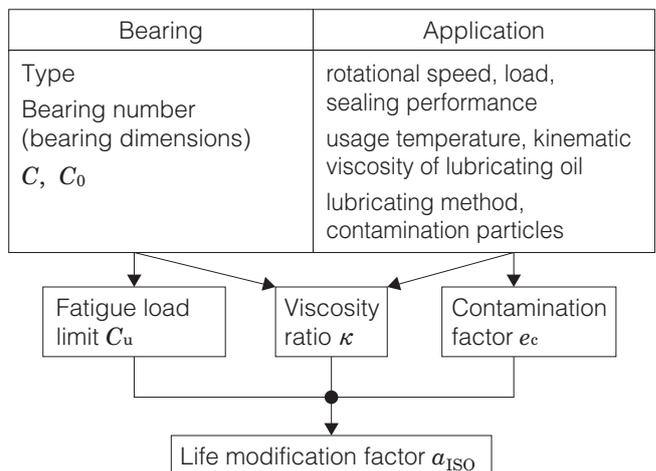
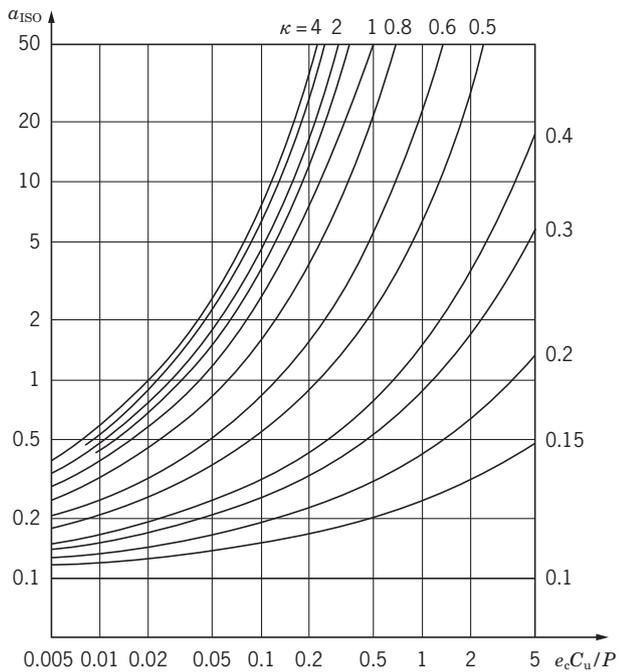
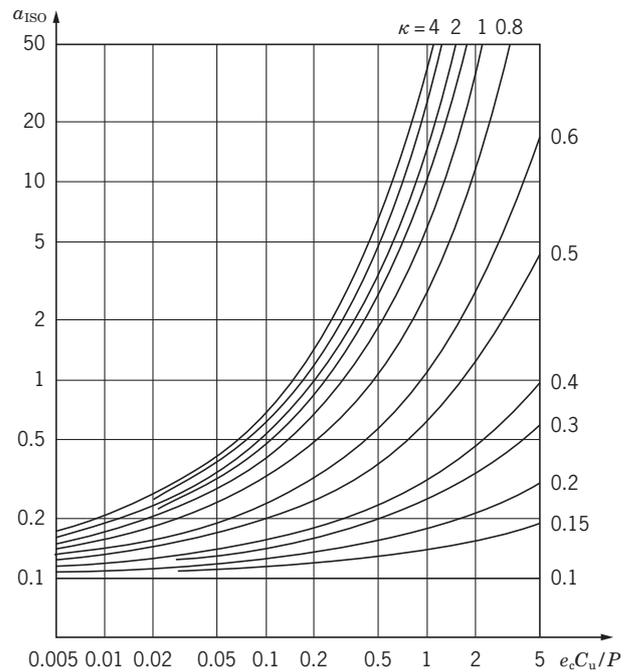


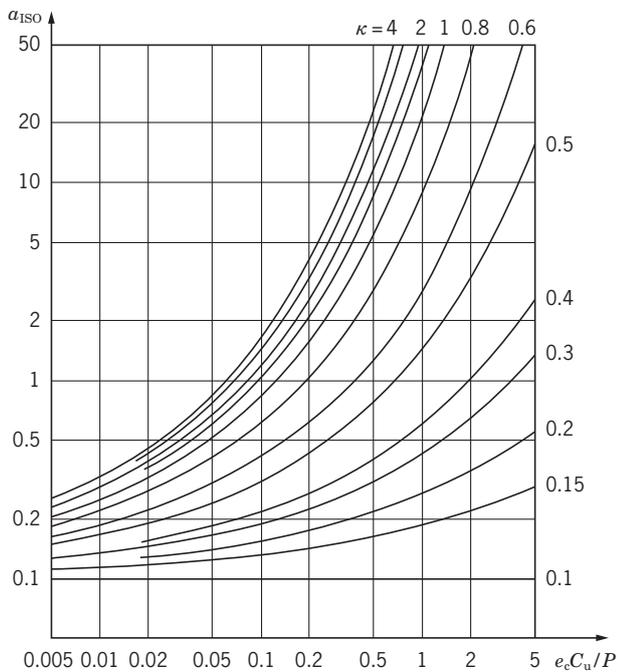
Fig. 13. 1 System approach



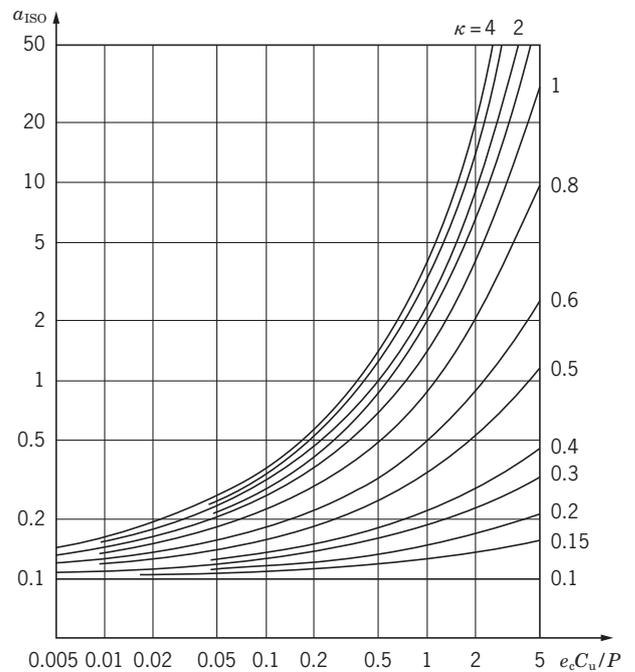
**Fig. 13. 2 Life modification factor a_{ISO}
(Radial ball bearings)**



**Fig. 13. 3 Life modification factor a_{ISO}
(Radial roller bearings)**



**Fig. 13. 4 Life modification factor a_{ISO}
(Thrust ball bearings)**



**Fig. 13. 5 Life modification factor a_{ISO}
(Thrust roller bearings)**
(Figs. 13. 2 to 13. 5 Citation from JIS B 1518:2013)

b) Fatigue load limit C_u

For regulated steel materials or alloy steel that has equivalent quality, the fatigue life is unlimited so long as the load condition does not exceed a certain value and so long as the lubrication conditions, lubrication cleanliness class, and other operating conditions are favorable. For general high-quality materials and bearings with high manufacturing quality, the fatigue stress limit is reached at a contact stress of approximately 1.5 GPa between the raceway and rolling elements. If one or both of the material quality and manufacturing quality are low, the fatigue stress limit will also be low.

The term "fatigue load limit" C_u is defined as "bearing load under which the fatigue stress limit is just reached in the most heavily loaded raceway contact" in ISO 281:2007. and is affected by factors such as the bearing type, size, and material.

For details on the fatigue load limits of special bearings and other bearings not listed in this catalog, contact JTEKT.

c) Contamination factor e_c

If solid particles in the contaminated lubricant are caught between the raceway and the rolling elements, indentations may form on one or both of the raceway and the rolling elements. These indentations will lead to localized increases in stress, which will decrease the life. This decrease in life attributable to the contamination of the lubricant can be calculated from the contamination level as contamination factor e_c .

D_{pw} shown in this table is the pitch diameter of ball / roller set, which is expressed simply as $D_{pw}=(D+d)/2$. (D : Outside diameter, d : Bore diameter)

For information such as details on special lubricating conditions or detailed investigations, contact JTEKT.

Table 13. 2 Values of contamination factor e_c

Contamination level	e_c	
	$D_{pw} < 100 \text{ mm}$	$D_{pw} \geq 100 \text{ mm}$
Extremely high cleanliness: The size of the particles is approximately equal to the thickness of the lubricant oil film, this is found in laboratory-level environments.	1	1
High cleanliness: The oil has been filtered by an extremely fine filter, this is found with standard grease-packed bearings and sealed bearings.	0.8 to 0.6	0.9 to 0.8
Standard cleanliness: The oil has been filtered by a fine filter, this is found with standard grease-packed bearings and shielded bearings.	0.6 to 0.5	0.8 to 0.6
Minimal contamination: The lubricant is slightly contaminated.	0.5 to 0.3	0.6 to 0.4
Normal contamination: This is found when no seal is used and a coarse filter is used in an environment in which wear debris and particles from the surrounding area penetrate into the lubricant.	0.3 to 0.1	0.4 to 0.2
High contamination: This is found when the surrounding environment is considerably contaminated and the bearing sealing is insufficient.	0.1 to 0	0.1 to 0
Extremely high contamination	0	0

(Table 13. 2 Citation from JIS B 1518:2013)

d) Viscosity ratio κ

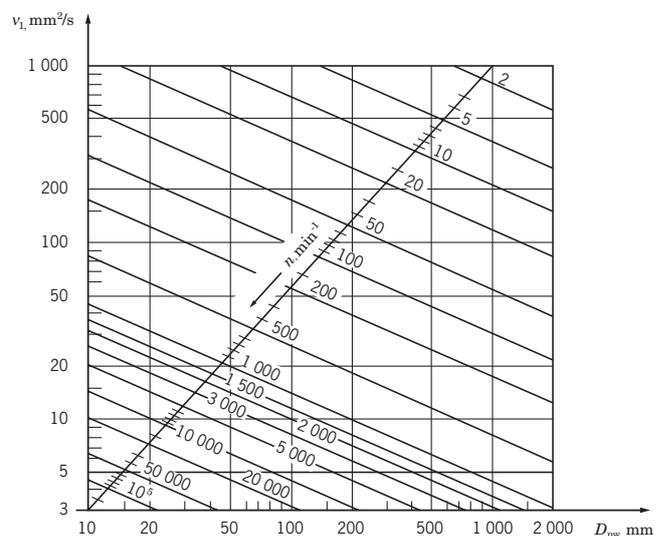
The lubricant forms an oil film on the roller contact surface, which separates the raceway and the rolling elements. The status of the lubricant oil film is expressed by viscosity ratio κ , the actual kinematic viscosity at the operating temperature ν divided by the reference kinematic viscosity ν_1 as shown in the following equation.

A κ greater than 4, equal to 4, or less than 0.1 is not applicable.

For details on lubricants such as grease and lubricants with extreme pressure additives, contact JTEKT.

$$\kappa = \frac{\nu}{\nu_1} \dots\dots\dots (13. 9)$$

- ν : Actual kinematic viscosity at the operating temperature; the viscosity of the lubricant at the operating temperature
- ν_1 : Reference kinematic viscosity; determined according to the speed and pitch diameter of ball / roller set D_{pw} of the bearing (ref. Fig. 13. 6)



(Fig. 13. 6 Citation from JIS B 1518:2013)

Fig. 13. 6 Reference kinematic viscosity ν_1

13. 2. 4 Service life of bearing system comprising two or more bearings

Even for systems which comprise two or more bearings, if one bearing is damaged, the entire system often malfunctions.

Where all bearings used in an application are regarded as one bearing system, the service life of the bearing system can be calculated using the following equation.

$$\frac{1}{L^e} = \frac{1}{L_1^e} + \frac{1}{L_2^e} + \frac{1}{L_3^e} + \dots \dots \dots (13. 10)$$

where :

L : rating life of system

$L_1, L_2, L_3 \dots$: rating life of each bearing

e : constant $\left\{ \begin{array}{l} e=10/9 \dots \dots \dots \text{ball bearing} \\ e= 9/8 \dots \dots \dots \text{roller bearing} \\ \text{The mean value is for a system} \\ \text{using both ball and roller bearings.} \end{array} \right.$

[Example]

When a shaft is supported by two roller bearings whose service lives are 50 000 hours and 30 000 hours respectively, the rating life of the bearing system supporting this shaft is calculated as follows, using equation (13. 10) :

$$\frac{1}{L^{9/8}} = \frac{1}{50\,000^{9/8}} + \frac{1}{30\,000^{9/8}}$$

$$L \doteq 20\,000 \text{ h}$$

The equation suggests that the rating life of these bearings as a system becomes shorter than that of the bearing with the shorter life.

This fact is very important in estimating bearing service life for applications using two or more bearings.

13.3 Dynamic equivalent loads

Bearings are used under different conditions. For example, they are often subjected to a resultant load consisting of radial and axial loads, the magnitudes of which may vary.

Consequently, it is not possible to directly compare the actual load that a bearing receives and the basic dynamic load rating.

In such a case, a calculation is carried out for comparison and examination, in which a load having a constant magnitude and direction, is applied to the bearing center such that it would make the service life of the bearing the same as that resulting from the actual load and rotational speed.

This theoretical load is known as the dynamic equivalent load (P).

13.3.1 Calculation of dynamic equivalent load

The dynamic equivalent loads of a radial bearing and a thrust bearing ($\alpha \neq 90^\circ$) receiving a resultant load constant in magnitude and direction is obtained as illustrated below.

$$P = XF_r + YF_a \dots\dots\dots(13.11)$$

where,

- P : dynamic equivalent load N
- | |
|---|
| For radial bearings, |
| "P _r : dynamic equivalent radial load" |
| and for thrust bearings, |
| "P _a : dynamic equivalent axial load," |
| respectively, are used. |
- F_r : radial load N
- F_a : axial load N
- X : radial load coefficient
- Y : axial load coefficient
- (Values of X and Y are noted in the bearing dimension tables.)

- 1) If $F_a/F_r \leq e$ for a single row radial bearing, $X=1$ and $Y=0$ are used. Hence, the dynamic equivalent load will be $P_r = F_r$.

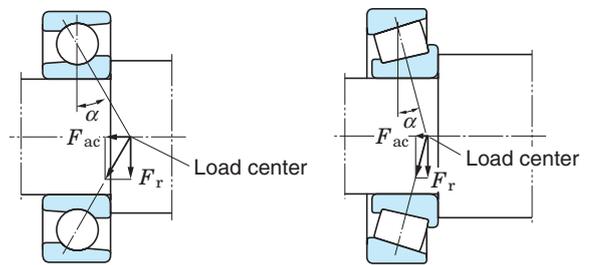
(e denotes the limit of F_a/F_r , whose values are listed in the bearing dimension tables.)

- 2) Application of a radial load to a single row angular contact ball bearing, or tapered roller bearing, produces a component of force (F_{ac}) in the axial direction (Fig. 13.7).

Therefore, a pair of bearings are usually used to arrange face-to-face or back-to-back.

The component of force in the axial direction is determined by the following equation.

$$F_{ac} = \frac{F_r}{2Y} \dots\dots\dots(13.12)$$



(Dimensions representing the position of load center are noted in the bearing dimension tables.)

Fig. 13.7 Components of force in axial direction

Table 13.3 (page 45) shows ways of determining the dynamic equivalent load where a radial load and external axial load (K_a) are applied to these bearings.

Table 13.3 Calculations of dynamic equivalent loads for two opposing single row angular contact ball bearings or tapered roller bearings

Bearing arrangement		Loading condition	Bearing	Axial load	Dynamic equivalent load
Back-to-back	Face-to-face				
		$\frac{F_{rB}}{2Y_B} + K_a \geq \frac{F_{rA}}{2Y_A}$	Bearing A	$\frac{F_{rB}}{2Y_B} + K_a$	$P_A = XF_{rA} + Y_A \left(\frac{F_{rB}}{2Y_B} + K_a \right)$ <p>Note that $P_A = F_{rA}$ if $P_A < F_{rA}$</p>
			Bearing B	—	$P_B = F_{rB}$
		$\frac{F_{rB}}{2Y_B} + K_a < \frac{F_{rA}}{2Y_A}$	Bearing A	—	$P_A = F_{rA}$
			Bearing B	$\frac{F_{rA}}{2Y_A} - K_a$	$P_B = XF_{rB} + Y_B \left(\frac{F_{rA}}{2Y_A} - K_a \right)$ <p>Note that $P_B = F_{rB}$ if $P_B < F_{rB}$</p>
		$\frac{F_{rB}}{2Y_B} \leq \frac{F_{rA}}{2Y_A} + K_a$	Bearing A	—	$P_A = F_{rA}$
			Bearing B	$\frac{F_{rA}}{2Y_A} + K_a$	$P_B = XF_{rB} + Y_B \left(\frac{F_{rA}}{2Y_A} + K_a \right)$ <p>Note that $P_B = F_{rB}$ if $P_B < F_{rB}$</p>
		$\frac{F_{rB}}{2Y_B} > \frac{F_{rA}}{2Y_A} + K_a$	Bearing A	$\frac{F_{rB}}{2Y_B} - K_a$	$P_A = XF_{rA} + Y_A \left(\frac{F_{rB}}{2Y_B} - K_a \right)$ <p>Note that $P_A = F_{rA}$ if $P_A < F_{rA}$</p>
			Bearing B	—	$P_B = F_{rB}$

[Remarks] 1. These calculations are applicable where during operation the internal clearance and preload are 0 (zero).
 2. Radial loads are assumed to be positive even if they are applied in the opposite direction of the arrows shown above.

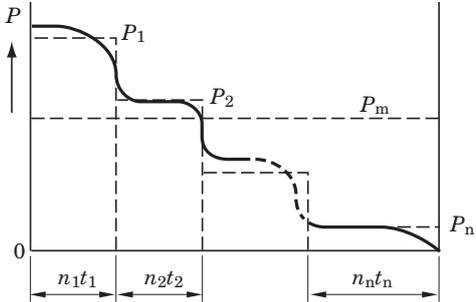
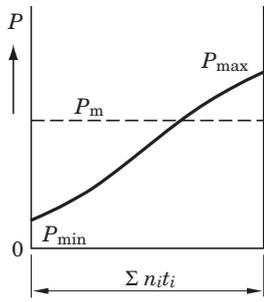
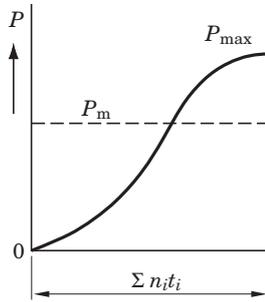
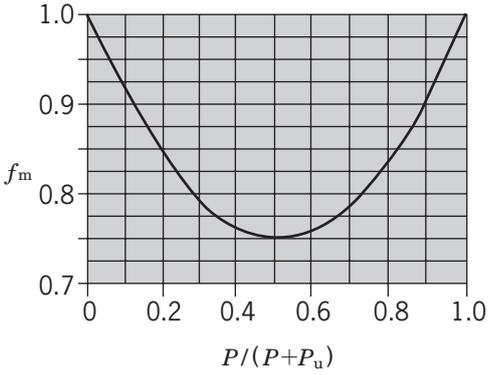
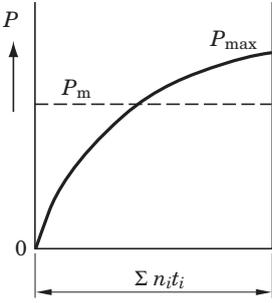
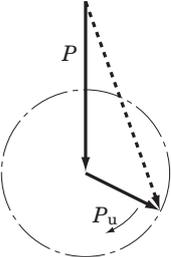
13. 3. 2 Mean dynamic equivalent loads for variable loads

When a load, applied to a bearing, varies in magnitude and direction, it is necessary to obtain a mean dynamic equivalent load that may result in the same service life as would result under actual variation conditions.

Ways of determining the mean dynamic equivalent load P_m suitable for different variation conditions are shown in **Table 13. 4, (1) to (4)**.

In the case when a stationary load and a rotational load are applied simultaneously, as shown in **(5)**, the mean dynamic equivalent load is given by equation (13. 17).

Table 13. 4 Ways of determining mean dynamic equivalent loads from variable loads

(1) Stepwise variation	(2) Simple variation	(3) Sine like curve variation
		
$P_m = \sqrt[p]{\frac{P_1^p n_1 t_1 + P_2^p n_2 t_2 + \dots + P_n^p n_n t_n}{n_1 t_1 + n_2 t_2 + \dots + n_n t_n}} \dots (13. 13)$	$P_m = \frac{P_{\min} + 2P_{\max}}{3} \dots (13. 14)$	$P_m = 0.68P_{\max} \dots (13. 15)$
<p>(4) Sine like curve variation (Upper portion of a sine curve)</p>	<p>(5) Stationary and rotational loads being applied at the same time</p>	
		<p>Fig. 13. 8 f_m Coefficient</p>
$P_m = 0.75P_{\max} \dots (13. 16)$	$P_m = f_m(P + P_u) \dots (13. 17)$	

13. 4. 3 Safety coefficient

The allowable static equivalent load for a bearing is determined by the basic static load rating of the bearing; however, bearing service life, which is affected by permanent deformation, differs in accordance with the performance required of the bearing and operating conditions.

Therefore, a safety coefficient is designated, based on empirical data, so as to ensure safety in relation to basic static load rating.

$$f_s = \frac{C_0}{P_0} \dots\dots\dots (13. 22)$$

where,

- f_s : safety coefficient (ref. **Table 13. 5**)
- C_0 : basic static load rating N
- P_0 : static equivalent load N

Table 13. 5 Values of safety coefficient f_s

Operating condition		f_s (min.)	
		Ball bearing	Roller bearing
With bearing rotation	When high accuracy is required	2	3
	Normal operation	1	1.5
	When impact load is applied	1.5	3
Without bearing rotation (occasional oscillation)	Normal operation	0.5	1
	When impact load or uneven distribution load is applied	1	2

[Remark] For spherical thrust roller bearings, $f_s \geq 4$.

13. 5 Service life of greases

Spindle bearings for machine tools, however, rarely have a problem of bearing service life caused by load.

When grease lubrication is used, ineffective lubrication may occasionally occur, resulting in bearing failures. It is therefore necessary to give sufficient consideration to selecting the brand and the amount of grease to be used, for given operating conditions.

Refer to "**6. Lubrication of bearings**" for grease lubrication.

13. 6 Permissible axial loads

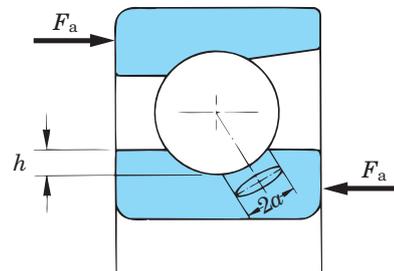
A large axial load may be applied to the bearings for main shafts of machine tools when, for example, tools are changed.

Application of a large axial load to an angular contact ball bearing may cause the contact ellipse formed between the ball and raceway surface to deviate beyond the raceway surface (see **Fig. 13. 9**).

Furthermore, if the stress becomes excessive, the rolling elements and raceway surface may sustain permanent deformation (nicks), possibly resulting in increased runout or vibration.

The smaller one of the following values is defined as the permissible axial load (static). And the permissible axial load (static) for each bearing is shown in the dimension list of the bearings.

- The load generated when the end of the contact ellipse formed between the ball and the raceway reaches the shoulder of the inner or outer ring.
- The load generated when the pressure of the contact surface between the ball and the raceway reaches the standard value calculated based on the actual results.



where,

- h : bearing shoulder height
- a : half length of the contact ellipses' major axis
- F_a : axial load

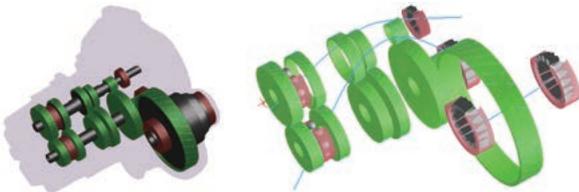
Fig. 13. 9 Contact ellipse

14. Examples of consideration at JTEKT

14.1 Shaft system analysis program

Accurately understanding the internal load conditions of the bearing is essential for predicting ball & roller bearing characteristics such as internal stress distribution, frictional torque, and fatigue life.

It is often not enough to just analyze the bearing itself, particularly in the case of the compact and lightweight designs of recent years. Instead, analysis must be performed under load conditions that include both the bearing and its surrounding components. JTEKT has developed an in-house shaft system analysis program capable of accurately determining bearing internal load conditions and of providing various analysis results under actual operating conditions in a short amount of time.



14.1.1 Features

- Simplified modeling of various components

Bearings	Shafts	Shaft boxes	Gears	Belts / chains

Available bearing types

Ball bearings	Cylindrical roller bearings	Needle roller bearings	Tapered roller bearings	Spherical roller bearings

* Thrust bearings are also available for all bearing types.

- Parameter studies are possible
- Simultaneous analysis of multiple load conditions is possible

14.1.2 Introduction to analysis functions

This program consists of basic calculation functions centered on analyzing the static rigidity of multi-axis shaft systems and determining service life based on **ISO 281** and **JIS B 1518**. Optional calculation functions are also available, including bearing life calculations based on **ISO / TS 16281** and bearing mechanism analysis, which enable versatile use according to objectives.

Program content

[Basic calculation]

Shaft system power flow calculation
(Confirmation of bearing rotational speed, gear load, etc.)

Analysis of shaft system (incl. shaft box) static rigidity
(Confirmation of shaft system bearing internal load, service life, shaft deformation, etc.)

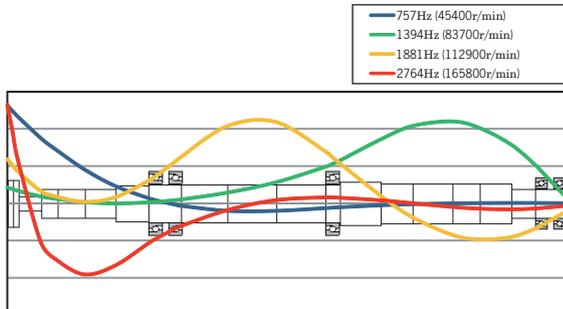
Calculation of bearing service life and life modification factor (considering lubrication conditions)
(Calculation of bearing life according to objectives)

- Service life based on ISO 281 and JIS B 1518
- Service life based on the Lundberg-Palmgren equation
- Service life based on ISO / TS 16281
- Life modification factor considering lubrication conditions (factor aISO)

[Optional calculations]

- Calculation of contact stress distribution between rollers and raceways
Outputs contact stress distribution considering crowning shape, load, and misalignment

- Analysis of shaft system natural vibration
Outputs the natural frequency and natural vibration modes of the shaft considering bearing support rigidity



Natural vibration mode

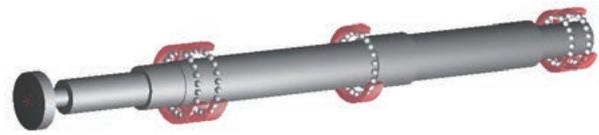
- Calculation of bearing frictional torque considering EHL
Analysis of bearing torque characteristics based on the EHL (elastohydrodynamic lubrication) theory and analysis of torque generation causes
- Static rigidity analysis considering bearing ring deformation
Analysis of impact to bearing internal load by deformation of shaft box and ring
- Mechanical analysis of ball & roller bearings
Analysis of bearing behavior under unsteady conditions
- Calculation of effective ball & roller bearing clearance
(Considering fitting, temperature increases, and centrifugal expansion)
- Calculation of rib area PV values for tapered roller bearings

14. 1. 3 Application examples

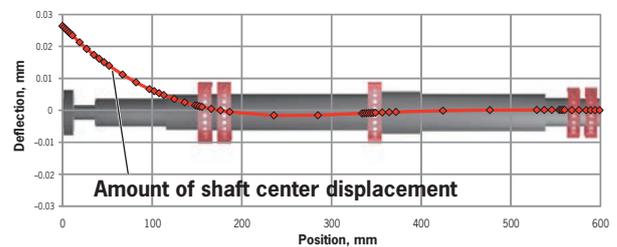
Analysis of machine tool spindle rigidity

Example of analyzing the deformation of a spindle supported by a high-speed rotating ball bearing when radial load is applied at the spindle tip

- * Assists in bearing selection by analyzing spindle rigidity



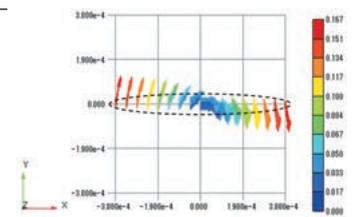
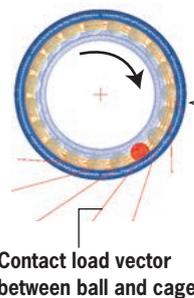
Radial load applied



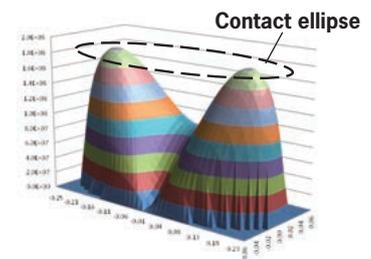
Mechanical analysis of angular contact ball bearing for machine tools

Example of analyzing the time-history variation of contact force between the cage and balls of a high-speed rotating angular contact ball bearing for machine tools, as well as the slip behavior within the contact ellipse caused by the contact between the balls and outer ring raceway

- * Used to achieve the optimal design for the bearing interior



Slip velocity distribution within the contact ellipse



PV value distribution within the contact ellipse

15. Designing peripheral parts of bearings

15.1 Tolerances of shafts and housings

When the inner and outer rings of a bearing are mounted on a shaft and a housing with a certain interference, the shapes of the shaft and housing tend to influence the raceway surface of the bearing leading to a change in running accuracy.

Therefore, shafts and housings need to be finished

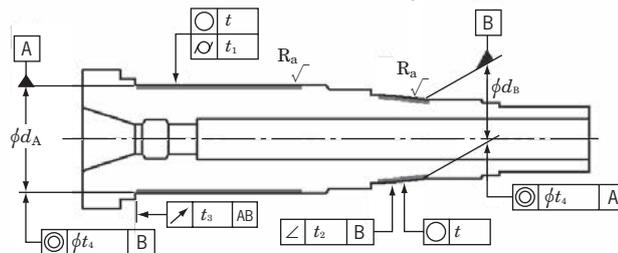
to maximum possible precision.

Recommended values for tolerances and surface roughness of shafts and housings are shown in

Tables 15.1 and 15.2.

Refer to "III. Handling of Bearings" for details about handling and mounting of the bearings.

Table 15.1 Tolerances and surface roughness of shafts

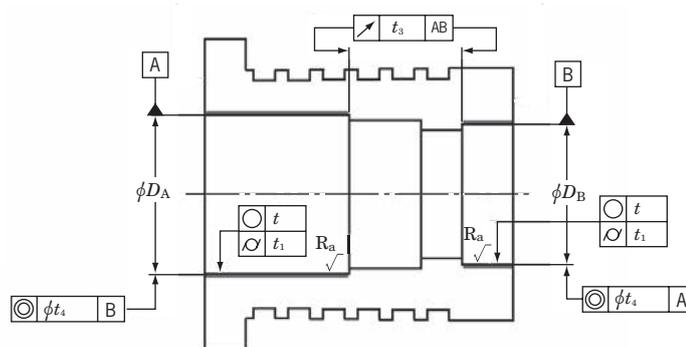


Unit : μm

Shaft diameter (mm)		Roundness(\circ)		Cylindricity(\odot)		Inclination(\sphericalangle)		Deflection(\nearrow)		Coaxiality(\odot)		Roughness	
		t		t_1		t_2		t_3		t_4		R_a	
over	up to	Tolerance class of bearing		Tolerance class of bearing		Tolerance class of bearing		Tolerance class of bearing		Tolerance class of bearing		Tolerance class of bearing	
		Class 5	Classes 4, 2	Class 5	Classes 4, 2	Classes 4, 2		Class 5	Classes 4, 2	Class 5	Classes 4, 2	Class 5	Classes 4, 2
18	30	2	1.2	2	1.2	2		4		9	6	0.2	0.1
30	50	2	1.2	2	1.2	2		4		11	7	0.2	0.1
50	80	2.5	1.5	2.5	1.5	2.5		5		13	8	0.2	0.1
80	120	3	2	3	2	3		6		15	10	0.4	0.2
120	180	4	2.5	4	2.5	4		8		18	12	0.4	0.2
180	250	5	3.5	5	3.5	5		10		20	14	0.4	0.2
250	315	6	4	6	4	6		12		23	16	0.4	0.2
315	400	6.5	4.5	6.5	4.5	6.5		13		25	18	0.4	0.2

- [Remarks]
1. Tolerances, symbols, and reference planes for shafts comply with ISO1101.
 2. When determining the tolerance in relation to the permissible accuracy of shapes, the shaft diameters d_A and d_B are used as reference dimensions.

Table 15.2 Tolerances and surface roughness of housings

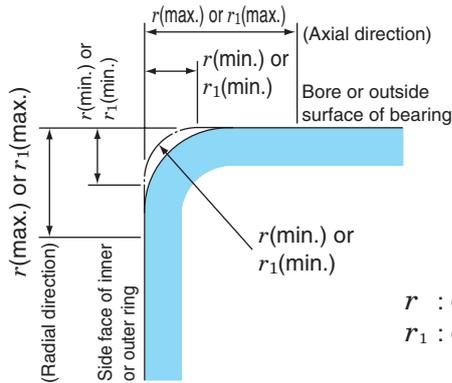


Unit : μm

Housing bore diameter (mm)		Roundness(\circ)		Cylindricity(\odot)		Deflection(\nearrow)		Coaxiality(\odot)		Roughness	
		t		t_1		t_3		t_4		R_a	
over	up to	Tolerance class of bearing									
		Class 5	Classes 4, 2								
18	30	2	1.2	2	1.2	4		9	6	0.3	0.1
30	50	2	1.2	2	1.2	4		11	7	0.3	0.1
50	80	2.5	1.5	2.5	1.5	5		13	8	0.4	0.2
80	120	3	2	3	2	6		15	10	0.8	0.4
120	180	4	2.5	4	2.5	8		18	12	0.8	0.4
180	250	5	3.5	5	3.5	10		20	14	0.8	0.4
250	315	6	4	6	4	12		23	16	1.6	0.8
315	400	6.5	4.5	6.5	4.5	13		25	18	1.6	0.8
400	500	7.5	5	7.5	5	15		27	20	1.6	0.8
500	630	8	5.5	8	5.5	16		30	22	1.6	0.8

- [Remarks]
1. Tolerances, symbols, and reference planes for housings comply with ISO1101.
 2. When determining the tolerance in relation to the permissible accuracy of shapes, the housing bore diameters D_A and D_B are used as reference dimensions.

15.2 Limits of chamfer dimensions and fillet radii of shafts and housings



[Remark]

An imaginary arc with a radius of r (min) is defined as being tangent to both the side face of the inner ring and the bore surface of the bearing; or to both the side face of outer ring and the outside surface of the bearing. Although an exact shape is not specified for chamfered surfaces, the outline in the axial plane shall not extend beyond the imaginary arc.

r : dimension for chamfering inner and outer rings

r_1 : dimension for chamfering the front and the likes of the inner and outer rings

Table 15.3 Limits of chamfer dimensions and fillet radii of shafts and housings

(1) Radial bearings (not applicable to tapered roller bearings)

Unit : mm

r (min.) or r_1 (min.)	Nominal bore diameter d (mm)		r (max.) or r_1 (max.)		(Refer.) Fillet radius of shaft or housing r_a
	over	up to	Radial direction	Axial direction ¹⁾	max.
0.05	—	—	0.1	0.2	0.05
0.08	—	—	0.16	0.3	0.08
0.1	—	—	0.2	0.4	0.1
0.15	—	—	0.3	0.6	0.15
0.2	—	—	0.5	0.8	0.2
0.3	— 40	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
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

[Note] 1) For bearings 2mm or less in nominal width, the value of r (max.) in the axial direction shall be the same as that in the radial direction.

(2) Metric tapered roller bearings

Unit : mm

r (min.) or r_1 (min.) ²⁾	Nominal bore ¹⁾ or nominal outside diameter d or D (mm)		r (max.) or r_1 (max.)		(Refer.) Fillet radius of shaft or housing r_a
	over	up to	Radial direction	Axial direction	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
7.5	—	—	12.5	17	6
9.5	—	—	15	19	8

[Notes] 1) Inner rings are classified by d , outer rings, by D .
2) Values in italics comply with JTEKT standards.

15.3 Spacers for oil / air lubrication

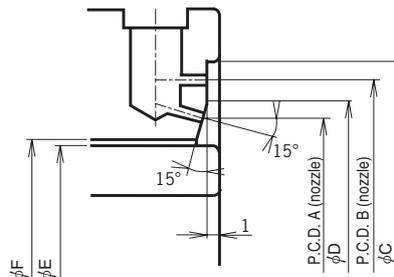
The dimensions of the spacers for oil / air lubrication are shown in **Table 15. 4**.

Table 15. 4(1) Dimensions of the spacers for oil / air lubrication Angular contact ball bearings

7000 series

7200 series

7900 series



* Commonly used in contact angles of 15° and 30°.

** Cage: Outer ring guided

Arrangement: These are the recommended dimensions for a back-to-back (DB) arrangement.

Nozzle diameter

7000, 7200 series		7900 series	
Bore dia. No.	Nozzle diameter (φ)	Bore dia. No.	Nozzle diameter (φ)
00-09	0.8	00-10	0.8
10-40	1.0	11-40	1.0

Unit : mm

Bore dia. No.	Nominal bore dia.	7000 series						7200 series						7900 series					
		A	B	C	D	E	F	A	B	C	D	E	F	A	B	C	D	E	F
00	10	15.2	20.7	23.5	18.0	11.5	12.5	18.2	23.5	26.3	20.9	14.5	15.5	14.7	18.1	20.9	16.4	11.0	12.0
01	12	18.4	23.8	26.6	21.1	14.7	15.7	19.0	25.9	28.7	22.5	15.3	16.3	16.7	20.1	22.9	18.4	13.0	14.0
02	15	21.3	26.7	29.5	24.0	17.6	18.6	22.8	29.4	32.2	26.1	19.1	20.1	19.7	24.0	26.8	21.9	16.0	17.0
03	17	24.6	29.8	32.6	27.2	20.9	21.9	25.8	33.4	36.2	29.6	22.1	23.1	21.7	26.0	28.8	23.9	18.0	19.0
04	20	28.5	35.8	38.6	32.2	24.8	25.8	30.5	39.6	42.4	35.1	26.8	27.8	26.2	31.8	34.6	29.0	22.5	23.5
05	25	33.0	40.2	43.0	36.6	29.3	30.3	35.3	44.1	46.9	39.7	31.6	32.6	32.0	37.3	40.1	34.7	28.3	29.3
06	30	39.0	47.1	49.9	43.1	35.3	36.3	41.7	52.7	55.5	47.2	38.0	39.0	36.3	41.7	44.5	39.0	32.6	33.6
07	35	45.0	54.0	56.8	49.5	41.3	42.3	48.3	61.3	64.1	54.8	44.6	45.6	41.7	48.4	51.2	45.1	38.0	39.0
08	40	50.5	59.3	62.1	54.9	46.8	47.8	53.2	67.0	69.8	60.1	49.5	50.5	47.9	54.8	57.6	51.4	44.2	45.2
09	45	55.4	65.4	68.2	60.4	51.7	52.7	56.8	71.7	74.5	64.3	53.1	54.1	53.2	60.9	63.7	57.1	49.5	50.5
10	50	60.9	70.9	73.9	65.9	57.0	58.0	63.5	78.1	81.1	70.8	59.6	60.6	57.7	65.3	68.1	61.5	54.0	55.0
11	55	66.8	78.7	81.7	72.8	62.9	63.9	70.7	87.6	90.6	79.2	66.8	67.8	64.1	72.1	74.9	68.1	60.2	61.2
12	60	71.9	83.9	86.9	77.9	68.0	69.0	77.7	96.6	99.6	87.2	73.8	74.8	68.8	77.5	80.5	73.2	64.9	65.9
13	65	77.2	89.0	92.0	83.1	73.3	74.3	82.4	102.5	105.5	92.5	78.5	79.5	73.8	82.1	85.1	78.0	69.9	70.9
14	70	83.3	97.2	100.2	90.3	79.4	80.4	87.2	108.0	111.0	97.6	83.3	84.3	80.8	90.4	93.4	85.6	76.9	77.9
15	75	88.3	102.1	105.1	95.2	84.4	85.4	91.7	113.5	116.5	102.6	87.8	88.8	85.6	95.0	98.0	90.3	81.7	82.7
16	80	94.7	110.5	113.5	102.6	90.8	91.8	98.7	121.5	124.5	110.1	94.8	95.8	92.3	100.3	103.3	96.3	88.4	89.4
17	85	100.8	116.5	119.5	108.7	96.9	97.9	105.2	130.0	133.0	117.6	101.3	102.3	101.1	108.7	111.7	104.9	97.2	98.2
18	90	106.1	123.8	126.8	115.0	102.2	103.2	111.7	138.5	141.5	125.1	107.8	108.8	104.2	113.7	116.7	109.0	100.3	101.3
19	95	119.6	130.7	133.7	125.2	115.7	116.7	118.3	146.9	149.9	132.6	114.4	115.4	107.0	118.4	121.4	112.7	103.1	104.1
20	100	121.0	132.4	135.4	126.7	117.1	118.1	125.8	156.4	159.4	141.1	121.9	122.9	112.9	127.3	130.3	120.1	109.0	110.0
21	105	125.1	144.2	147.2	134.7	121.2	122.2	144.6	165.4	168.4	155.0	140.7	141.7	120.7	132.4	135.4	126.6	116.8	117.8
22	110	129.7	151.0	154.0	140.4	125.8	126.8	150.7	171.8	174.6	161.3	146.8	147.8	123.2	137.3	140.3	130.3	119.3	120.3
24	120	138.5	161.0	164.0	149.8	134.6	135.6	163.3	186.7	189.7	175.0	159.4	160.4	137.5	150.7	153.7	144.1	133.6	134.6
26	130	153.5	177.0	180.0	165.3	149.6	150.6	174.7	199.4	202.4	187.1	170.8	171.8	149.4	164.2	167.2	156.8	145.5	146.5
28	140	171.7	187.1	190.1	179.4	167.8	168.8	178.1	214.7	217.7	196.4	174.2	175.2	159.4	174.2	177.2	166.8	155.5	156.5
30	150	174.8	200.5	203.5	187.7	170.9	171.9	191.4	231.7	234.7	211.6	187.5	188.5	170.6	191.2	194.2	180.9	166.7	167.7
32	160	188.2	213.7	216.7	201.0	184.3	185.3	207.4	245.7	248.7	226.6	203.5	204.5	180.7	201.2	204.2	191.0	176.8	177.8
34	170	201.7	231.0	234.0	216.4	197.8	198.8	220.8	262.6	265.6	241.7	216.9	217.9	190.7	211.2	214.2	201.0	186.8	187.8
36	180	215.0	247.8	250.8	231.4	211.1	212.1	229.0	274.5	277.5	251.8	225.1	226.1	204.1	228.1	231.1	216.1	200.2	201.2
38	190	225.1	257.9	260.9	241.5	221.2	222.2	244.1	289.5	292.5	266.8	240.2	241.2	214.1	238.1	241.1	226.1	210.2	211.2
40	200	238.5	274.8	277.8	256.7	234.6	235.6	257.3	306.3	309.3	281.8	253.4	254.4	227.5	255.0	258.0	241.3	223.6	224.6

Table 15. 4(2) Dimensions of the spacers for oil / air lubrication

High Ability

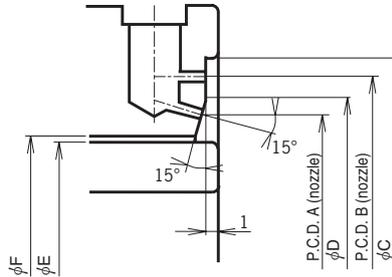
Angular contact ball bearings

HAR000 series

HAR900 series

3NCHAR000 series

3NCHAR900 series



Nozzle diameter

HAR000, 3NCHAR000 series		HAR900, 3NCHAR900 series	
Bore dia. No.	Nozzle diameter (ϕ)	Bore dia. No.	Nozzle diameter (ϕ)
06-10	0.8	08-10	0.8
11-34	1.0	11-34	1.0

* Commonly used in contact angles of 15°, 20° and 30°.

** Cage: Outer ring guided

Arrangement: These are the recommended dimensions for a back-to-back (DB) arrangement.

Unit : mm

Bore dia. No.	Nominal bore dia.	HAR000, 3NCHAR000 series						HAR900, 3NCHAR900 series					
		A	B	C	D	E	F	A	B	C	D	E	F
06	30	39.7	45.9	48.7	42.8	36.0	37.0	—	—	—	—	—	—
07	35	45.6	51.9	54.7	48.8	41.9	42.9	—	—	—	—	—	—
08	40	51.4	57.4	60.2	54.4	47.7	48.7	49.1	53.7	56.5	51.4	45.4	46.4
09	45	57.0	63.6	66.4	60.3	53.3	54.3	54.6	59.2	62.0	56.9	50.9	51.9
10	50	62.5	68.6	71.6	65.6	58.6	59.6	58.8	64.1	66.9	61.5	55.1	56.1
11	55	69.7	76.6	79.6	73.2	65.8	66.8	65.3	70.6	73.6	68.0	61.4	62.4
12	60	74.7	81.6	84.6	78.2	70.8	71.8	70.3	75.6	78.6	73.0	66.4	67.4
13	65	79.4	86.6	89.6	83.0	75.5	76.5	75.1	80.9	83.9	78.0	71.2	72.2
14	70	86.2	95.0	98.0	90.6	82.3	83.3	82.6	88.6	91.6	85.6	78.7	79.7
15	75	91.2	99.9	102.9	95.6	87.3	88.3	88.5	93.6	96.6	91.1	84.6	85.6
16	80	98.1	107.9	110.9	103.0	94.2	95.2	93.5	98.6	101.6	96.1	89.6	90.6
17	85	104.0	112.9	115.9	108.5	100.1	101.1	100.7	106.5	109.5	103.6	96.8	97.8
18	90	110.7	121.4	124.4	116.1	106.8	107.8	104.7	111.5	114.5	108.1	100.8	101.8
19	95	115.7	126.4	129.4	121.1	111.8	112.8	110.7	116.5	119.5	113.6	106.8	107.8
20	100	119.4	131.3	134.3	125.4	115.5	116.5	116.4	124.9	127.9	120.7	112.5	113.5
21	105	127.6	139.1	142.1	133.4	123.7	124.7	122.6	129.9	132.9	126.3	118.7	119.7
22	110	136.5	147.3	150.3	141.9	132.6	133.6	127.6	134.9	137.9	131.3	123.7	124.7
24	120	146.5	157.3	160.3	151.9	142.6	143.6	139.9	147.9	150.9	143.9	136.0	137.0
26	130	160.7	173.7	176.7	167.2	156.8	157.8	152.2	160.9	163.9	156.6	148.3	149.3
28	140	170.7	183.7	186.7	177.2	166.8	167.8	162.2	170.9	173.9	166.6	158.3	159.3
30	150	182.7	197.2	200.2	190.0	178.8	179.8	176.5	187.3	190.3	181.9	172.6	173.6
32	160	195.1	210.2	213.2	202.7	191.2	192.2	186.5	197.3	200.3	191.9	182.6	183.6
34	170	209.6	226.1	229.1	217.9	205.7	206.7	196.5	207.3	210.3	201.9	192.6	193.6

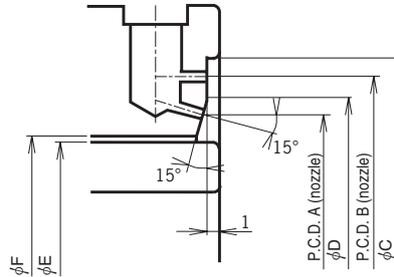
Table 15. 4(3) Dimensions of the spacers for oil / air lubrication

High Ability

Angular contact ball bearings

3NCHAC000 series

3NCHAC900 series



* Commonly used in contact angles of 15° and 20°.

** Cage: Outer ring guided

Arrangement: These are the recommended dimensions for a back-to-back (DB) arrangement.

Nozzle diameter

3NCHAC000 series		3NCHAC900 series	
Bore dia. No.	Nozzle diameter (ϕ)	Bore dia. No.	Nozzle diameter (ϕ)
00-09	0.8	00-10	0.8
10-34	1.0	11-34	1.0

Unit : mm

Bore dia. No.	Nominal bore dia.	3NCHAC000 series						3NCHAC900 series					
		A	B	C	D	E	F	A	B	C	D	E	F
00	10	15.7	20.7	23.5	18.2	12.0	13.0	15.0	18.1	20.9	16.6	11.3	12.3
01	12	18.8	23.8	26.6	21.3	15.1	16.1	16.7	20.1	22.9	18.4	13.0	14.0
02	15	21.8	26.7	29.5	24.3	18.1	19.1	20.0	24.0	26.8	22.0	16.3	17.3
03	17	25.1	29.8	32.6	27.5	21.4	22.4	22.3	26.0	28.8	24.2	18.6	19.6
04	20	29.1	35.8	38.6	32.5	25.4	26.4	26.6	31.8	34.6	29.2	22.9	23.9
05	25	33.6	40.2	43.0	36.9	29.9	30.9	32.4	37.3	40.1	34.9	28.7	29.7
06	30	39.7	47.1	49.9	43.4	36.0	37.0	36.8	41.7	44.5	39.3	33.1	34.1
07	35	45.8	54.0	56.8	49.9	42.1	43.1	42.2	48.4	51.2	45.3	38.5	39.5
08	40	51.2	59.3	62.1	55.3	47.5	48.5	48.5	54.8	57.6	51.7	44.8	45.8
09	45	56.2	65.4	68.2	60.8	52.5	53.5	53.8	60.9	63.7	57.4	50.1	51.1
10	50	61.7	70.9	73.9	66.3	57.8	58.8	58.2	65.3	68.1	61.8	54.5	55.5
11	55	67.7	78.7	81.7	73.2	63.8	64.8	64.7	72.1	74.9	68.4	61.0	62.0
12	60	72.8	83.9	86.9	78.4	68.9	69.9	69.5	77.5	80.5	73.5	65.6	66.6
13	65	78.1	89.0	92.0	83.6	74.2	75.2	74.1	82.1	85.1	78.1	70.2	71.2
14	70	84.4	97.2	100.2	90.8	80.5	81.5	81.6	90.4	93.4	86.0	77.7	78.7
15	75	89.4	102.1	105.1	95.8	85.5	86.5	86.4	95.0	98.0	90.7	82.5	83.5
16	80	96.0	110.5	113.5	103.3	92.1	93.1	91.5	100.3	103.3	95.9	87.6	88.6
17	85	102.0	116.5	119.5	109.3	98.1	99.1	98.2	108.7	111.7	103.5	94.3	95.3
18	90	107.5	123.8	126.8	115.7	103.6	104.6	103.2	113.7	116.7	108.5	99.3	100.3
19	95	119.6	130.7	133.7	125.2	115.7	116.7	107.9	118.4	121.4	113.2	104.0	105.0
20	100	117.8	134.0	137.0	125.9	113.9	114.9	114.0	127.3	130.3	120.7	110.1	111.1
21	105	126.7	144.2	147.2	135.5	122.8	123.8	121.8	132.3	135.3	127.1	117.9	118.9
22	110	131.4	151.0	154.0	141.2	127.5	128.5	124.3	137.3	140.3	130.8	120.4	121.4
24	120	140.2	161.0	164.0	150.6	136.3	137.3	138.9	150.8	153.8	144.9	135.0	136.0
26	130	155.4	177.0	180.0	166.2	151.5	152.5	151.2	164.5	167.5	157.9	147.3	148.3
28	140	169.7	187.1	190.1	178.4	165.8	166.8	157.8	174.3	177.3	166.1	153.9	154.9
30	150	177.5	200.5	203.5	189.0	173.6	174.6	171.8	191.2	194.2	181.5	167.9	168.9
32	160	193.8	214.0	217.0	203.9	189.9	190.9	185.0	201.2	204.2	193.1	181.1	182.1
34	170	207.8	230.7	233.7	219.3	203.9	204.9	195.0	211.2	214.2	203.1	191.1	192.1

Table 15. 4(4) Dimensions of the spacers for oil / air lubrication

High Ability

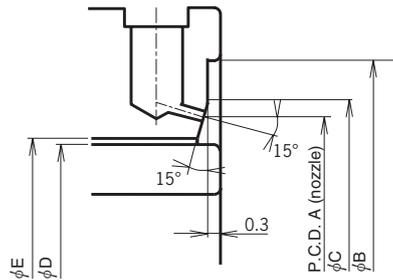
Angular contact ball bearings

3NCHAD000 series

* These are the recommended dimensions for a back-to-back (DB) arrangement.

Unit : mm

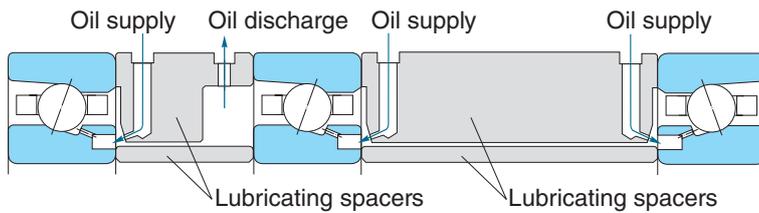
Bore dia. No.	Nominal bore dia.	3NCHAD000 series				
		A	B	C	D	E
07	35	41.3	54.7	43.3	39.1	39.7
08	40	46.4	60.2	48.6	44.2	44.8
09	45	52.2	66.4	54.4	49.6	50.2
10	50	57.2	71.6	59.4	54.6	55.2
11	55	63.8	79.6	66.3	61.0	61.6
12	60	68.8	84.6	71.3	66.0	66.6
13	65	73.8	89.6	76.3	71.0	71.6
14	70	79.6	98.0	82.4	76.8	77.4
15	75	84.6	102.9	87.4	81.8	82.4
16	80	91.7	110.9	94.4	87.9	89.5
17	85	96.7	115.9	99.4	92.9	94.5
18	90	101.9	124.4	105.2	98.1	99.7
19	95	106.9	129.4	110.2	103.1	104.7
20	100	112.7	134.3	115.6	107.5	109.7
21	105	119.3	142.1	122.4	114.1	116.3
22	110	125.6	150.3	129.0	120.4	122.6
24	120	135.6	160.3	139.0	130.4	132.6
26	130	148.4	176.7	152.1	141.6	145.4



Nozzle diameter

3NCHAD000 series	
Bore dia. No.	Nozzle diameter (ϕ)
07-10	0.8
11-26	1.0

These bearings are useful only with oil / air lubrication. Please use with lubricating spacers as shown below.



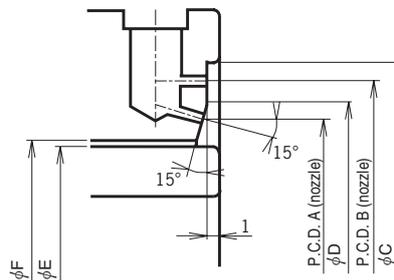
* Please consult JTEKT regarding the dimensions of the oil / air lubrication spacer for PRECILENCE.

**Table 15. 4(5) Dimensions of the spacers for oil / air lubrication
Cylindrical Roller bearings**

NN3000 series

N1000 series

3NCN1000 series



Nozzle diameter

NN3000 series		N1000, 3NCN1000 series	
Bore dia. No.	Nozzle diameter (φ)	Bore dia. No.	Nozzle diameter (φ)
05-09	0.8	06-10	0.8
10-40	1.0	11-32	1.0

Unit : mm

Bore dia. No.	Nominal bore dia.	NN3000 series						N1000, 3NCN1000 series					
		A	B	C	D	E	F	A	B	C	D	E	F
05	25	34.9	40.7	41.9	37.7	31.9	32.9	—	—	—	—	—	—
06	30	40.6	47.4	48.6	43.4	37.5	38.5	40.7	47.3	48.6	43.5	37.5	38.5
07	35	47.4	53.9	55.1	50.1	44.0	45.0	47.0	53.7	55.2	49.8	44.0	45.0
08	40	53.6	60.0	61.2	56.4	50.0	51.0	54.0	60.0	61.4	56.8	50.0	51.0
09	45	58.5	66.2	67.4	61.3	54.5	55.5	58.1	67.2	68.8	60.9	53.5	54.5
10	50	63.4	71.1	72.3	66.2	59.5	60.5	62.1	71.2	72.8	64.9	57.5	58.5
11	55	70.5	79.5	80.8	73.3	66.0	67.0	71.1	79.7	81.6	73.9	66.0	67.0
12	60	75.5	84.5	85.9	78.3	71.1	72.1	76.2	84.8	86.6	79.0	71.1	72.1
13	65	80.5	89.5	91.0	83.3	76.0	77.0	80.5	89.2	91.1	83.3	75.5	76.5
14	70	88.2	98.2	100.0	91.2	83.0	84.0	88.6	98.5	100.8	91.4	83.0	84.0
15	75	93.2	103.3	105.0	96.2	88.0	89.0	93.8	103.5	105.8	96.8	88.0	89.0
16	80	100.0	110.8	113.0	103.0	94.0	95.0	100.7	111.4	113.9	103.7	94.0	95.0
17	85	105.0	115.8	118.0	108.0	99.0	100.0	105.4	116.4	118.8	108.4	99.0	100.0
18	90	112.6	124.5	127.0	115.6	106.0	107.0	112.7	125.2	128.1	115.7	106.0	107.0
19	95	117.5	129.5	132.0	120.5	111.0	112.0	117.7	130.2	132.8	120.7	111.0	112.0
20	100	122.5	134.5	137.0	125.5	116.0	117.0	120.1	135.5	139.8	123.1	114.0	115.0
21	105	128.3	143.0	146.4	131.3	121.4	122.4	125.8	142.5	147.5	128.8	119.9	120.9
22	110	136.4	152.0	155.2	139.4	128.4	129.4	135.8	151.5	156.0	138.8	128.4	129.4
24	120	146.4	162.0	165.2	149.4	138.4	139.4	143.3	162.3	167.8	146.3	136.4	137.4
26	130	160.4	178.5	182.6	163.4	151.4	152.4	159.8	179.3	183.8	162.8	149.4	150.4
28	140	170.5	188.5	192.8	173.5	161.4	162.4	167.7	187.0	193.8	170.7	159.4	160.4
30	150	183.2	202.4	206.8	186.2	173.4	174.4	179.9	202.0	209.3	182.9	170.9	171.9
32	160	192.9	214.0	219.8	195.9	182.4	183.4	191.0	218.5	223.8	194.0	181.4	182.4
34	170	207.2	230.0	237.0	210.2	195.4	196.4	—	—	—	—	—	—
36	180	221.6	248.3	256.2	224.6	208.4	209.4	—	—	—	—	—	—
38	190	229.5	259.0	266.2	232.5	216.4	217.4	—	—	—	—	—	—
40	200	248.0	276.0	283.4	251.0	233.4	234.4	—	—	—	—	—	—



II. Bearing Dimension Tables

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1. Angular Contact Ball Bearings

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1. Angular contact ball bearings

The angular contact ball bearing can receive a radial load, unidirectional axial load, or a combination of the above loads.

There are four different contact angles to choose from when angular contact ball bearings are considered: 15° (contact angle symbol: C), 20° (CA), 30° (A: to be omitted), and 40° (B).

Of these types, the 15° (contact angle symbol: C), 20° (CA) and 30° (A) bearings are usually used for spindle of machine tools (see Fig. 1. 1).

The greater the contact angle, the higher the axial rigidity, and the smaller the contact angle, the more advantageous for high-speed rotations.

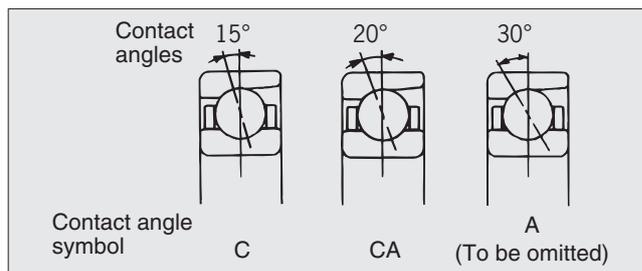


Fig. 1. 1 Contact angles of angular contact ball bearings

1. 1 Types and features of angular contact ball bearings

Standard angular contact ball bearings

7900C 7000C
7000AC 7000
7200C 7200AC
7200

High Ability angular contact ball bearings

HAR900C HAC900C HAD000CA
HAR900CA HAC900CA
HAR900 HAC000C
HAR000C HAC000CA
HAR000CA HAR000

*Consult JTEKT, as the HAR000 series can correspond to the non-contact seal.

PRECILENCE angular contact ball bearings

PC7000C PM7000C
PC7900CA PM7000CA
PC7000CA

Fig. 1. 2 Types and series of angular contact ball bearings

1) Standard angular contact ball bearings

7900C
7000C, 7000AC, 7000 series
7200C, 7200AC, 7200

The standard cage is of the ball-guided type and is made from polyamide resin.

2) High Ability angular contact ball bearings

HAR900C, HAR900CA, HAR900	High-rigidity type
HAR000C, HAR000CA, HAR000	
HAC000C, HAC000CA, HAC900C	High-load type
HAC900CA	
HAD000CA	Ultra-high-speed type

- The High Ability angular contact ball bearings are optimized for use on high-speed machine tool spindles. They are available in three types: high-rigidity type, High-load type, and ultrahigh-speed type. (The ultrahigh-speed type is used with oil / air lubrication.)
- The standard contact angle of these bearings is 20°. The high-rigidity type products are also available with a contact angle of 15° and 30°. The High-load type products are also available with a contact angle of 15°.
- These bearings have ceramic balls and an outer ring-guided cage made from reinforced phenol resin as standard components. Steel-ball products and ball-guided cage products are also available to suit your needs.

3) PRECILENCE angular contact ball bearings

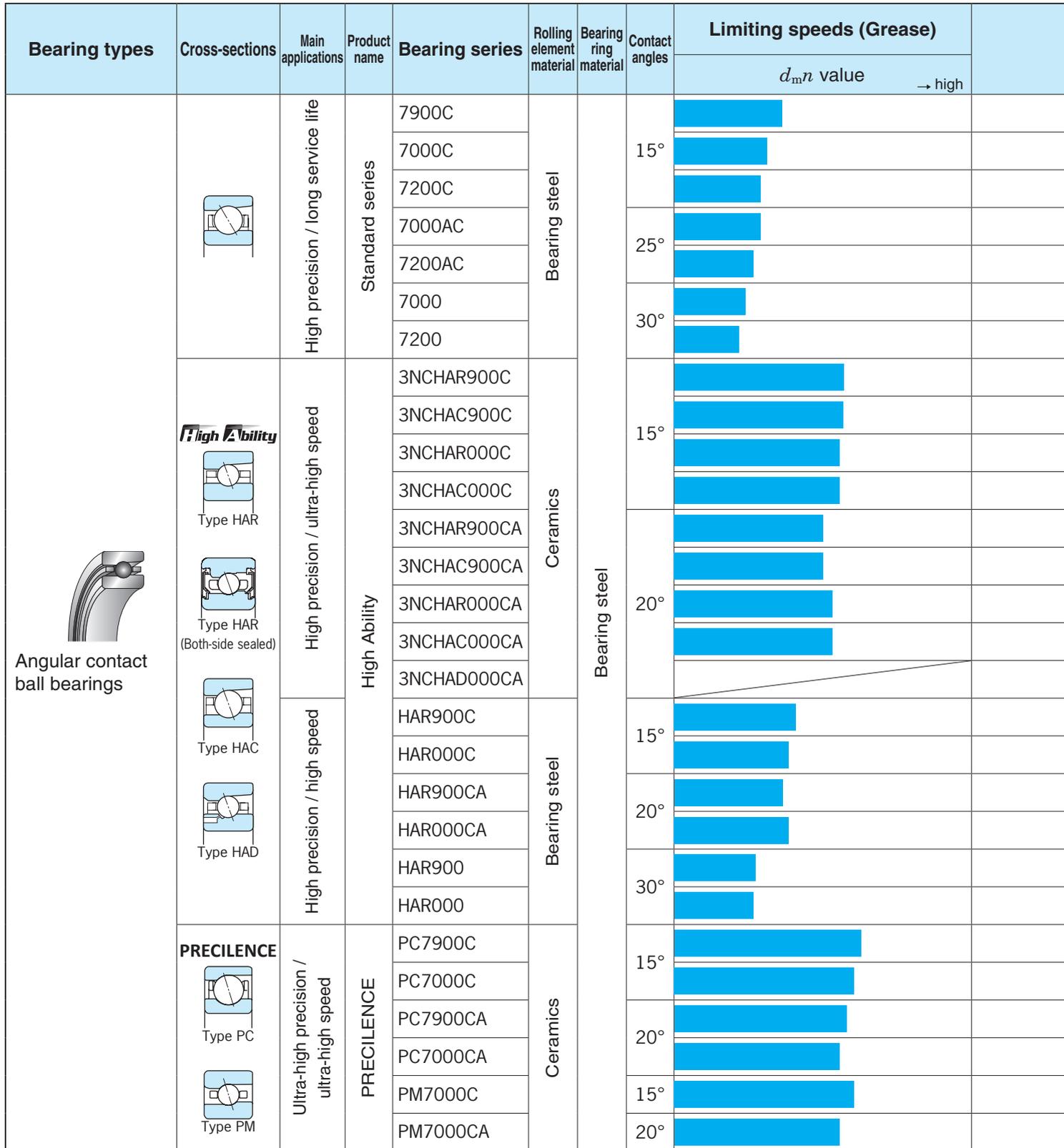
PC7900C, PC7900CA	High-speed / high-load type
PC7000C, PC7000CA	
PM7000C, PM7000CA	High-speed / high-rigidity type

- PRECILENCE angular contact ball bearings are an ultra-high precision series available in both high-load and high-rigidity types capable of high-speed operation.
- The standard contact angle of these bearings is 15° and 20°. This type of bearing has ceramic balls and an outer ring-guided cage made from PEEK resin. Depending on the application, steel balls and phenolic resin or polyamide resin cages are also available.

1. Angular contact ball bearings

3) Performance comparison of angular contact ball bearings

Fig. 1. 3 Performance comparison of angular contact ball bearings



Note 1) P5 and P4 are manufactured to JIS standards, while PRECILENCE P4S and P2 are manufactured to JTEKT proprietary standards.

	Limiting speeds (Oil / Air)	Basic load ratings		Permissible axial load → high	Rotational speeds ¹⁾				Page No.
	d_{mn} value → high	C_r → high	C_{0r} → high		P5	P4	P4S	P2	
					●	●			P80
					●	●			
					●	●			
					●	●			
					●	●			
					●	●			
					●	●			
					●	●			P80
					●	●			
					●	●			
					●	●			
					●	●			
					●	●			
					●	●			
					●	●			
					●	●			
					●	●			
					●	●			
					●	●			
					●	●			
					●	●			
					●	●			
							●	●	P118
							●	●	
							●	●	
							●	●	
							●	●	
							●	●	

4) Rigidity comparison of angular contact ball bearings

Fig. 1. 4 shows a comparison of moment rigidity for each bearing series when the maximum preload setting is applied at respective rotational speed.

JTEKT offers a lineup of series tailored to various applications, ranging from the standard series suited for low-speed / high-rigidity applications to the High Ability series with ceramic balls designed for high-speed rotation.

The best product for your operating conditions can be selected by referencing the specifications shown on pages 64 and 65.

Moment rigidity can be calculated using the shaft system analysis program (pages 49 and 50). Please feel free to inquire for assistance in selecting a product.

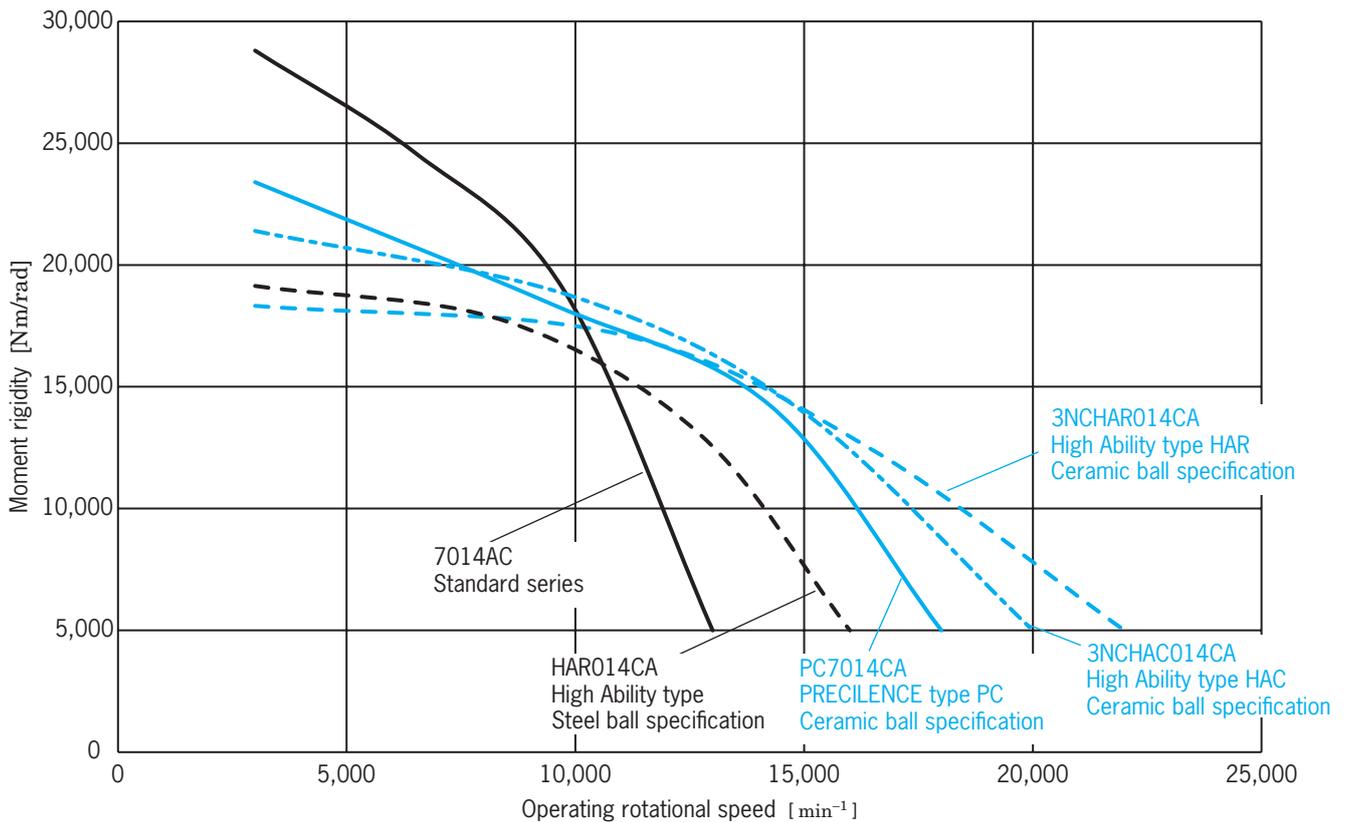


Fig. 1. 4 Moment rigidity comparison of angular contact ball bearings ($\phi 70$ size)

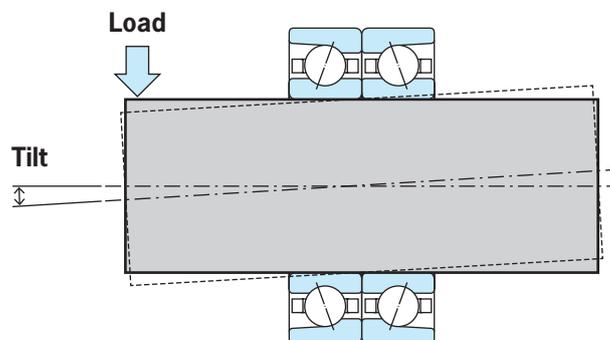


Fig. 1. 5 Moment rigidity

1. 2 Matched pair angular contact ball bearings

Matched pair or stack bearings

Angular contact ball bearings are used in matched pair, or in combinations of more than two bearings. **Table 1. 1** shows combination types and symbols for angular contact ball bearings.

Matched pair angular contact ball bearings are adjusted to a preset amount of preload and axial clearance.

The standard preloads are divided into 4 classes : slight preload (symbol : S), light preload (L), medium preload (M), and heavy preload (H). The dimension tables show amounts of standard preloads.

Type G bearings

The type G bearing has both sides machined (flush-ground) to obtain the same stand-out between the inner and outer rings, enabling the specified preload to be obtained with any combination.

This makes it possible to select any desired combination(s) from **Table 1. 1**.

Each bearing housing includes not only the measured dimensional differences for the inner diameter (d) and outer diameter (D), but also the face width difference (f) and back width difference (b). (See **Fig. 1. 6**)

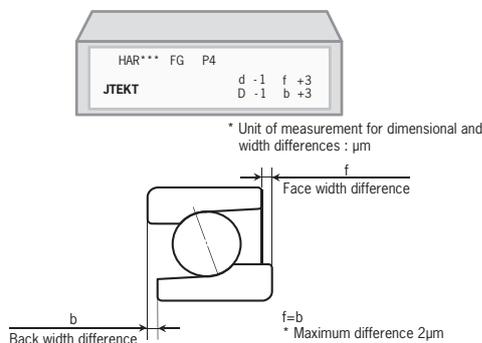


Fig. 1. 6 Type G bearing (flush-ground)

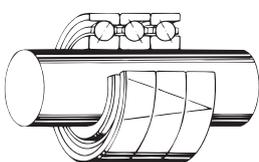
- Examples of identification numbers of type G bearings
7010GL : Adjustment is made so that any combination of two or more bearings presents light preload (preload symbol : L).
7010GL×2 : Adjustment is made so that any combination of this set of two bearings presents light preload (preload symbol : L).

Table 1. 1 Combination types and symbols for angular contact ball bearings

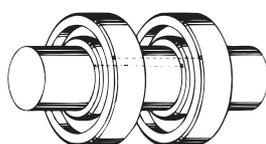
Combination of two			
	DB	DF	DT
Matched pair or stack bearings			
Single-row type G			
Combination of three			
	DBD	DFD	DTD
Matched pair or stack bearings			
Single-row type G			
Combination of four			
	DBB	DFF	
Matched pair or stack bearings			
Single-row type G			
	DBT	DFT	
Matched pair or stack bearings			
Single-row type G			

[Remark] ----- indicates the direction of the "V" mark.

Cautions for assembly



(Combination mark)



(Mark indicating position of maximum eccentricity)

- ① A "V" mark is put on the outside surfaces of the outer rings of matched pair or matched stack angular contact ball bearings, to indicate their combination mode. Combine them in such a way that the marks on the outer ring form a "V".
- ② Chamfered edges of the inner and outer rings are marked with a circle "○", which shows the position of maximum eccentricity.

Mount bearings so that the "○" marks on the inner and outer rings are opposite (180°) to the position of maximum eccentricity of the shaft or housing. By doing so, maximum running accuracy is obtained.

1.3 Composition of bearing numbers

● Standard angular contact ball bearings, *High Ability* angular contact ball bearings

7018C-5K5DBL /27A FTP5
3NCHAC018C-5K5DBCS5/27A FGP4

Ceramic bearing

Bearing type symbols

7 : angular contact ball bearing

HAR } *High Ability*

HAC } angular contact ball

HAD } bearings

Dimension series symbols

9 : dimension series 19

0 : dimension series 10

2 : dimension series 02

Bore diameter number

18 : nominal bore diameter : 90 mm
 (bore diameter number × 5 equals nominal bore diameter.)

Contact angle symbols

A : nominal contact angle : 30° (A is to be omitted.)

C : nominal contact angle : 15°

CA : nominal contact angle : 20°

AC : nominal contact angle : 25°

Cage guiding system symbols

No specified : outer ring-guiding

-5 : ball-guiding

Special permissible dimensional deviation symbols

K5 : JTEKT's special permissible dimensional deviations are used for the bore diameter of the inner ring and the outside diameter of the outer ring.

No specified : If standard permissible dimensional deviations are used.

Tolerance class symbols

P5 : JIS class 5

P4 : JIS class 4

P2 : JIS class 2

Cage symbols

FG : molded cage made of polyamide resin

FT : machined cage made of reinforced phenolic

FY : machined cage made of copper alloy

PG : PEEK resin cage

Spacer number / symbols

No specified : If no spacer is provided.

/27 : spacer with lubrication hole, 27 mm in nominal width

A : spacer not provided with lubrication hole (symbol A is not used if the spacer has a lubrication hole.)

Preload symbol* or clearance symbols

(*In some cases, a symbol denoting the specific preload is used.)

S : slight preload

CS : clearance

L : light preload

CY : negative clearance (preload)

M : medium preload

(CS5 : The mean value of the clearance is 5µm.)

H : heavy preload

(For amount of preload, see the dimension tables.)

Matched pair or stack symbols

DB : back-to-back

DF : face-to-face

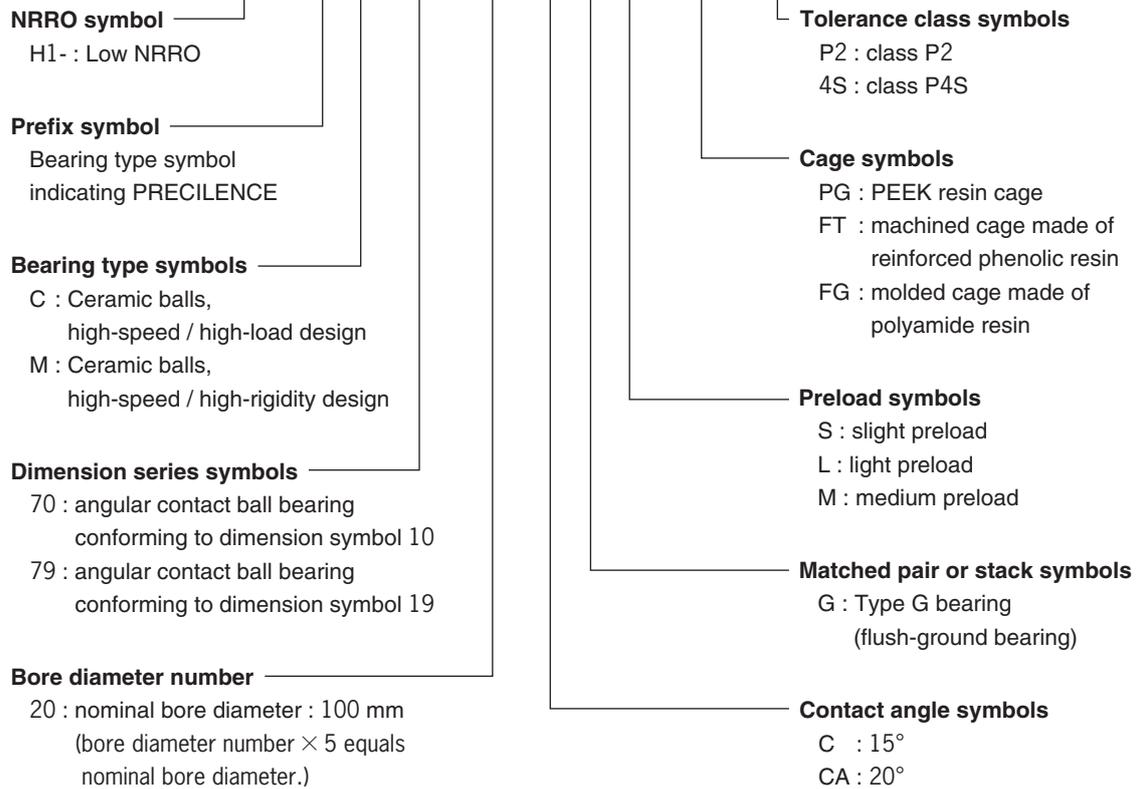
DT : tandem

For suffixes that denote bearings which consist of three or four bearings, see **Table 1.1** (page 67).

G : Type G bearing (flush-ground bearing)

● **PRECILENCE** angular contact ball bearings

H1 - PC7006CGS PG4S



1. Angular contact ball bearings

1.4 Tolerance of bearings

The tolerance of the precision angular contact ball bearing is compliant with permissible dimensional deviations and limits of classes 5, 4, and 2 as specified in JIS B 1514 for radial bearings (tapered roller bearings not included).

Permissible dimensional deviations and limits of radial bearings are shown in **Table 1. 2**.

Table 1. 3 (page 71) shows **JTEKT's** special permissible dimensional deviations (K5) used to facilitate multi-row combinations (K5 is used for the bore diameter of the inner ring and the outside diameter of the outer ring).

Also, ultra-high precision PRECILENCE angular contact ball bearings are manufactured to **JTEKT** proprietary standards. **Fig. 1. 7** shows running accuracy and dimensional precision, while **Table 1. 4** (page 72) shows permissible dimensional deviations and limits.

Table 1. 2(1) Permissible dimensional deviations and limits of angular contact ball and cylindrical roller bearings

(1) Inner ring

Unit : μm

Nominal bore diameter d (mm)		Single plane mean bore diameter deviation Δ_{dmp}						Single bore diameter deviation $\Delta_{ds}^{(1)}$				Single plane bore diameter variation V_{dsp}			Mean bore diameter variation V_{dmp}					
		Class 5		Class 4		Class 2		Class 4		Class 2		Diameter series 7, 8, 9		Diameter series 0, 1, 2, 3, 4		Class 2	Class 5		Class 4	Class 2
		upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	max.	max.	max.	max.	max.	max.	max.	max.	
over	up to																			
10	18	0	-5	0	-4	0	-2.5	0	-4	0	-2.5	5	4	4	3	2.5	3	2	1.5	
18	30	0	-6	0	-5	0	-2.5	0	-5	0	-2.5	6	5	5	4	2.5	3	2.5	1.5	
30	50	0	-8	0	-6	0	-2.5	0	-6	0	-2.5	8	6	6	5	2.5	4	3	1.5	
50	80	0	-9	0	-7	0	-4	0	-7	0	-4	9	7	7	5	4	5	3.5	2	
80	120	0	-10	0	-8	0	-5	0	-8	0	-5	10	8	8	6	5	5	4	2.5	
120	150	0	-13	0	-10	0	-7	0	-10	0	-7	13	10	10	8	7	7	5	3.5	
150	180	0	-13	0	-10	0	-7	0	-10	0	-7	13	10	10	8	7	7	5	3.5	
180	250	0	-15	0	-12	0	-8	0	-12	0	-8	15	12	12	9	8	8	6	4	
250	315	0	-18	0	-15	-	-	0	-15	-	-	18	15	14	11	-	9	8	-	
315	400	0	-23	0	-18	-	-	0	-18	-	-	23	18	18	14	-	12	9	-	

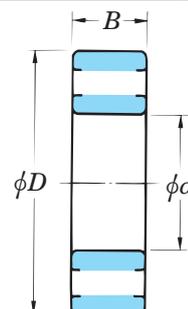
Nominal bore diameter d (mm)		Radial runout of assembled bearing inner ring K_{ia}			S_d			$S_{ia}^{(2)}$			Single inner ring width deviation Δ_{Bs}				Single inner ring width deviation $\Delta_{Bs}^{(3)}$		Inner ring width variation V_{Bs}		
		Class 5	Class 4	Class 2	Class 5	Class 4	Class 2	Class 5	Class 4	Class 2	Classes 5, 4		Class 2		Classes 5, 4		Class 5	Class 4	Class 2
over	up to	max.			max.			max.			upper	lower	upper	lower	upper	lower	max.		
10	18	4	2.5	1.5	7	3	1.5	7	3	1.5	0	-80	0	-80	0	-250	5	2.5	1.5
18	30	4	3	2.5	8	4	1.5	8	4	2.5	0	-120	0	-120	0	-250	5	2.5	1.5
30	50	5	4	2.5	8	4	1.5	8	4	2.5	0	-120	0	-120	0	-250	5	3	1.5
50	80	5	4	2.5	8	5	1.5	8	5	2.5	0	-150	0	-150	0	-250	6	4	1.5
80	120	6	5	2.5	9	5	2.5	9	5	2.5	0	-200	0	-200	0	-380	7	4	2.5
120	150	8	6	2.5	10	6	2.5	10	7	2.5	0	-250	0	-250	0	-380	8	5	2.5
150	180	8	6	5	10	6	4	10	7	5	0	-250	0	-250	0	-380	8	5	4
180	250	10	8	5	11	7	5	13	8	5	0	-300	0	-300	0	-500	10	6	5
250	315	13	10	-	13	8	-	15	9	-	0	-350 ⁽⁴⁾	-	-	0	-500 ⁽⁴⁾	13	8	-
315	400	15	13	-	15	9	-	20	12	-	0	-400 ⁽⁴⁾	-	-	0	-630 ⁽⁴⁾	15	9	-

S_d : Perpendicularity of inner ring face with respect to the bore

S_{ia} : Axial runout of assembled bearing inner ring

- [Notes] 1) Tolerance class 4 is applied to bearings of diameter series 0, 1, 2, 3, and 4.
 2) Applied to angular contact ball bearings.
 3) Applied to individual bearing rings manufactured for matched pair or stack bearings.
 4) Class 5 tolerance complies with JIS; class 4 tolerance is **JTEKT** standard.

[Remark] Values in italics comply with **JTEKT** standards.



d : nominal bore diameter
 D : nominal outside diameter
 B : nominal bearing width

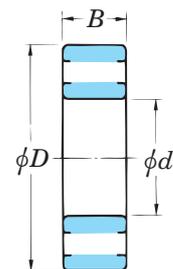
Table 1. 2(2) Permissible dimensional deviations and limits of angular contact ball and cylindrical roller bearings

(2) Outer ring

Unit : μm

Nominal outside diameter D (mm)		Single plane mean outside diameter deviation Δ_{Dmp}						Single outside diameter deviation $\Delta_{Ds}^{1)}$				Single plane outside diameter variation V_{Dsp}				Mean outside diameter variation V_{Dmp}			
		Class 5		Class 4		Class 2		Class 4		Class 2		Diameter series 7, 8, 9		Diameter series 0, 1, 2, 3, 4		-	Class 5, 4, 2		
		upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	max.	max.	max.	max.	max.	max.	max.	max.
18	30	0	-6	0	-5	0	-4	0	-5	0	-4	6	5	5	4	4	3	2.5	2
30	50	0	-7	0	-6	0	-4	0	-6	0	-4	7	6	5	5	4	4	3	2
50	80	0	-9	0	-7	0	-4	0	-7	0	-4	9	7	7	5	4	5	3.5	2
80	120	0	-10	0	-8	0	-5	0	-8	0	-5	10	8	8	6	5	5	4	2.5
120	150	0	-11	0	-9	0	-5	0	-9	0	-5	11	9	8	7	5	6	5	2.5
150	180	0	-13	0	-10	0	-7	0	-10	0	-7	13	10	10	8	7	7	5	3.5
180	250	0	-15	0	-11	0	-8	0	-11	0	-8	15	11	11	8	8	8	6	4
250	315	0	-18	0	-13	0	-8	0	-13	0	-8	18	13	14	10	8	9	7	4
315	400	0	-20	0	-15	0	-10	0	-15	0	-10	20	15	15	11	10	10	8	5
400	500	0	-23	0	-17	-	-	0	-17	-	-	23	17	17	13	-	12	9	-
500	630	0	-28	0	-20	-	-	0	-20	-	-	28	20	21	15	-	14	10	-

Nominal outside diameter D (mm)		Radial runout of assembled bearing outer ring K_{ea}			Perpendicularity of outer ring outside surface with respect to the face S_D			Axial runout of assembled bearing outer ring $S_{ea}^{2)}$			Deviation of a single outer ring width Δ_{Cs}		Ring width variation V_{Cs}		
		Class 5	Class 4	Class 2	Class 5	Class 4	Class 2	Class 5	Class 4	Class 2	Class 5, 4, 2	Class 5	Class 4	Class 2	
over	up to	max.			max.			max.			upper	lower	max.		
18	30	6	4	2.5	8	4	1.5	8	5	2.5	Same as tolerance Δ_{Bs}, d being that of the same bearing.	5	2.5	1.5	
30	50	7	5	2.5	8	4	1.5	8	5	2.5		5	2.5	1.5	
50	80	8	5	4	8	4	1.5	10	5	4		6	3	1.5	
80	120	10	6	5	9	5	2.5	11	6	5		8	4	2.5	
120	150	11	7	5	10	5	2.5	13	7	5		8	5	2.5	
150	180	13	8	5	10	5	2.5	14	8	5		8	5	2.5	
180	250	15	10	7	11	7	4	15	10	7		10	7	4	
250	315	18	11	7	13	8	5	18	10	7		11	7	5	
315	400	20	13	8	13	10	7	20	13	8		13	8	7	
400	500	23	15	-	15	12	-	23	15	-		15	9	-	
500	630	25	18	-	18	13	-	25	18	-	18	11	-		



d : nominal bore diameter
 D : nominal outside diameter
 B : nominal bearing width

[Notes] 1) Tolerance class 4 is applied to bearings of diameter series 0, 1, 2, 3, and 4.

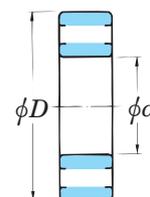
2) Applied to angular contact ball bearings.

[Remark] Values in italics comply with JTEKT standards.

Table 1. 3 JTEKT's specific tolerances of angular contact ball bearings (K5)¹⁾

Unit : μm

Nominal bore diameter d (mm)		Single plane mean bore or outside diameter deviation $\Delta_{dmp}, \Delta_{Dmp}$			
		Class 5		Class 4	
over	up to	upper	lower	upper	lower
-	50	-1	-4	-1	-3
50	80	-1	-5	-1	-4
80	120	-1	-5	-1	-4
120	150	-1	-5	-1	-4
150	180	-1	-5	-1	-4
180	250	-1	-5	-1	-4



d : nominal bore diameter
 D : nominal outside diameter

[Note] 1) K5 denotes specially formulated JTEKT standards for the purpose of minimizing individual differences in performance, which may occur as a result of fitting stack-mounted to bearings.

1. Angular contact ball bearings

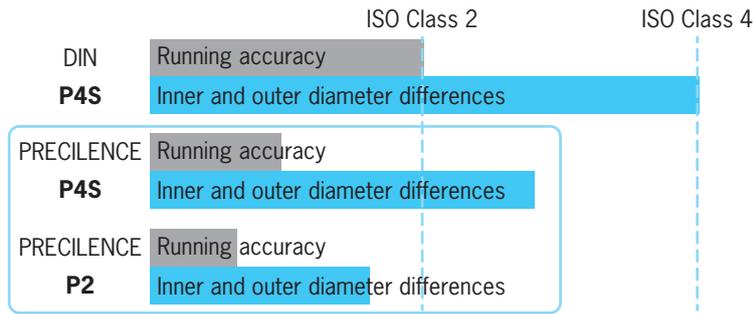


Fig. 1. 7 Running accuracy and main dimensions

Table 1. 4(1) Permissible dimensional deviations and limits of PRECILENCE angular contact ball bearings¹⁾

(1) Inner ring

Unit : μm

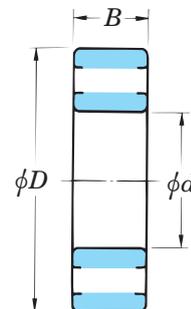
Nominal bore diameter d (mm)		Single plane mean bore diameter deviation Δ_{dmp}				Single bore diameter deviation Δ_{ds}				Single plane bore diameter variation V_{dsp}		Mean bore diameter variation V_{dmp}	
		Class P4S		Class P2		Class P4S		Class P2		Class P4S	Class P2	Class P4S	Class P2
over	up to	upper	lower	upper	lower	upper	lower	upper	lower	max.		max.	
18	30	-0.5	-3.5	-0.5	-2.5	-0.5	-3.5	-0.5	-2.5	0.5	0.4	0.5	0.4
30	50	-0.5	-3.5	-0.5	-2.5	-0.5	-3.5	-0.5	-2.5	0.8	0.6	0.8	0.6
50	80	-1	-4	-1	-3	-1	-4	-1	-3	0.8	0.6	0.8	0.6
80	120	-1	-5	-1	-3	-1	-5	-1	-3	1	0.8	1	0.8

Nominal bore diameter d (mm)		Radial runout of assembled bearing inner ring K_{ia}		S_d		S_{ia}	Single inner ring width deviation Δ_{Bs}		Inner ring width variation V_{Bs}
		Class P4S	Class P2	Class P4S	Class P2	Classes P4S, P2	Classes P4S, P2	Classes P4S, P2	
over	up to	max.		max.		max.	upper	lower	max.
18	30	0.8	0.5	1	0.8	0.8	-20	-80	0.4
30	50	0.8	0.5	1	0.8	1.2	-20	-80	0.4
50	80	0.8	0.5	1	0.8	1.2	-20	-80	0.4
80	120	1.2	0.8	1.5	1.2	1.6	-20	-80	0.8

S_d : Perpendicularity of inner ring face with respect to the bore

S_{ia} : Axial runout of assembled bearing inner ring

[Notes] 1) PRECILENCE precision and dimensional standards are based on JTEKT proprietary standards.



d : nominal bore diameter
 D : nominal outside diameter
 B : nominal bearing width

Table 1. 4(2) Permissible dimensional deviations and limits of PRECILENCE angular contact ball bearings¹⁾

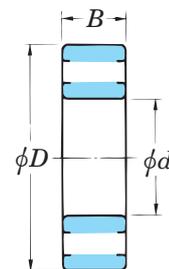
(2) Outer ring

Unit : μm

Nominal outside diameter D (mm)		Single plane mean outside diameter deviation Δ_{Dmp}				Single outside diameter deviation Δ_{Ds}				Single plane bore diameter variation V_{dsp} Diameter series 9, 0		Mean outside diameter variation V_{Dmp}	
		Class P4S		Class P2		Class P4S		Class P2		Class P4S	Class P2	Class P4S	Class P2
over	up to	upper	lower	upper	lower	upper	lower	upper	lower	max.		max.	
30	50	-1	-5	-1	-3	-1	-5	-1	-3	0.5	0.4	0.5	0.4
50	80	-1	-5	-1	-3	-1	-5	-1	-3	1	0.8	1	0.8
80	120	-1	-5	-1	-3	-1	-5	-1	-3	1	0.8	1	0.8
120	150	-1	-6	-1	-3	-1	-6	-1	-3	1	0.8	1	0.8
150	180	-1	-6	-1	-4	-1	-6	-1	-4	1	0.8	1	0.8

Nominal outside diameter D (mm)		Radial runout of assembled bearing outer ring K_{ea}		Perpendicularity of outer ring outside surface with respect to the face S_D		Axial runout of assembled bearing outer ring S_{ea}	Deviation of a single outer ring width Δ_{Cs}		Ring width variation V_{Cs}
		Class P4S	Class P2	Class P4S	Class P2	Classes P4S, P2	upper	lower	Classes P4S, P2
over	up to	max.		max.		max.			max.
30	50	0.8	0.5	1	0.8	1.2	upper	lower	0.8
50	80	0.8	0.5	1	0.8	1.6	Same as tolerance Δ_{Bs} , d being that of the same bearing.		0.8
80	120	0.8	0.5	1	0.8	1.6			0.8
120	150	1.6	1	1.5	1.2	2			0.8
150	180	1.6	1	1.5	1.2	2			0.8

[Notes] 1) PRECILENCE precision and dimensional standards are based on JTEKT proprietary standards.



d : nominal bore diameter
 D : nominal outside diameter
 B : nominal bearing width

1.5 Standard preloads for matched pair angular contact ball bearings

Back-to-back and face-to-face matched pair bearings are often used under a preload. By applying a preload to a bearing, the following effects are realized.

- 1) The rigidity of a bearing can be improved.
- 2) Running accuracy is improved.
- 3) Abnormal noise caused by vibration and resonance is prevented.

A greater preload results in higher bearing rigidity. However, such preload also influences other parameters of the bearing : service life, temperature, frictional torque, etc.

Therefore, it is important to select an adequate preload, taking into consideration the rotational speed and lubrication conditions.

JTEKT offers 4 types of preset preloads, slight preload (S), light preload (L), medium preload (M), and heavy preload (H). This will enable the user to select any desired preload suitable for individual applications.

Standard preloads for each bearing are shown in dimension tables.

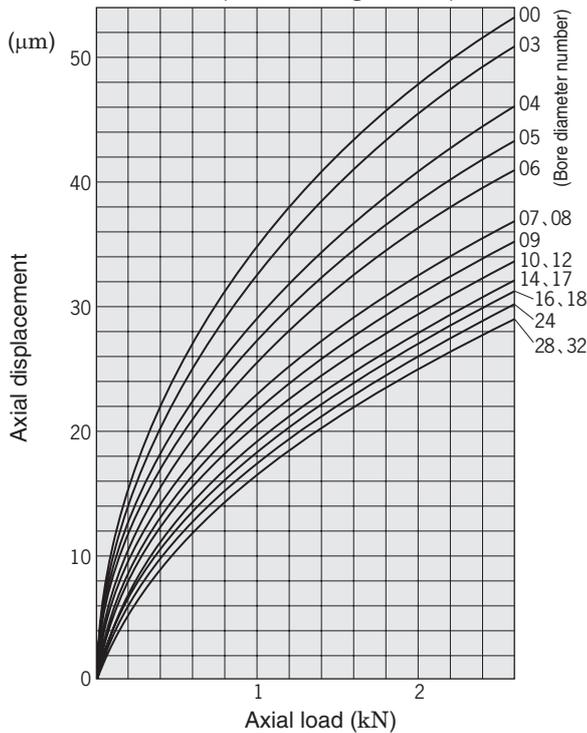
As a guide for selecting the preload, light or medium preload is used for spindles of grinding machines, while medium or heavy preloads are used for spindle of lathes and milling machines.

1. 6 Axial load and displacement (angular contact ball bearings)

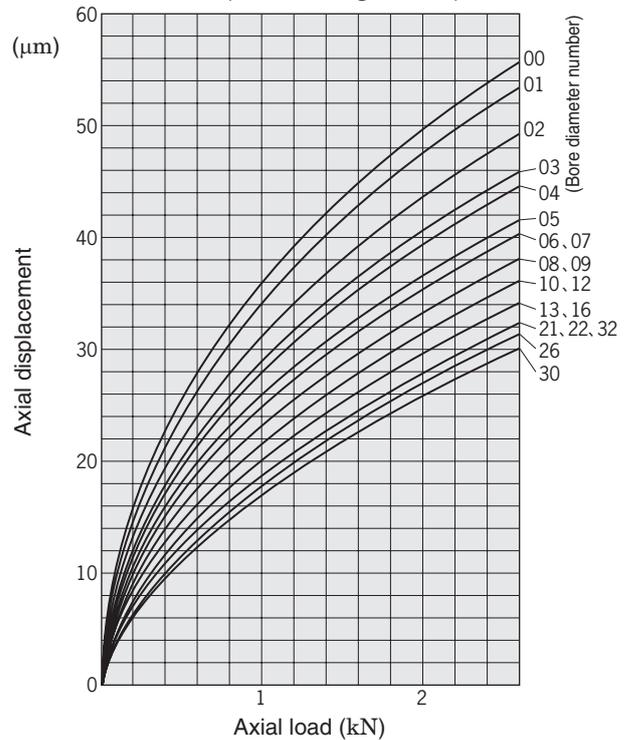
Fig. 1. 8 shows relationships between axial load and displacement of angular contact ball bearings. The graphs indicate that the greater the contact angle of a bearing, the smaller the axial displacement (high rigidity).

The displacement curve of duplex bearings under a given preload is determined by the method shown in Fig. 5. 1 on page 17.

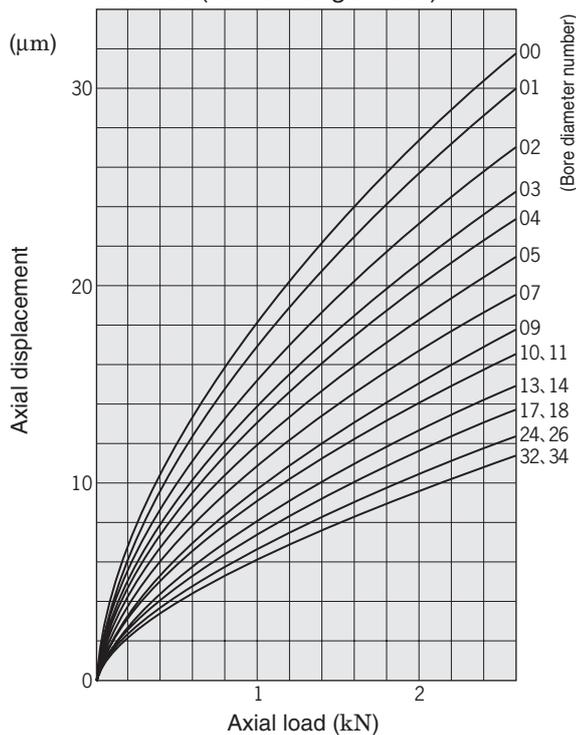
(1) 7900C series (contact angle : 15°)



(2) 7000C series (contact angle : 15°)



(3) 7000 series (contact angle : 30°)



(4) 7200C series (contact angle : 15°)

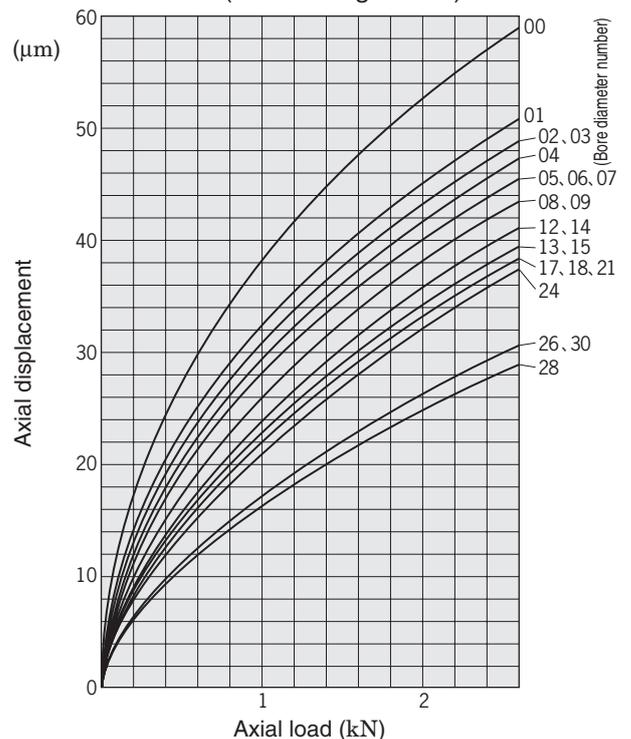
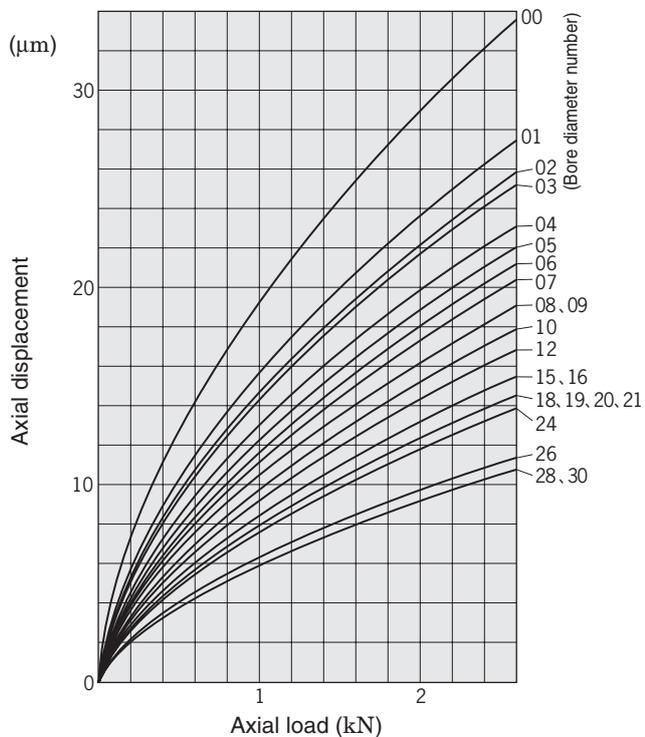


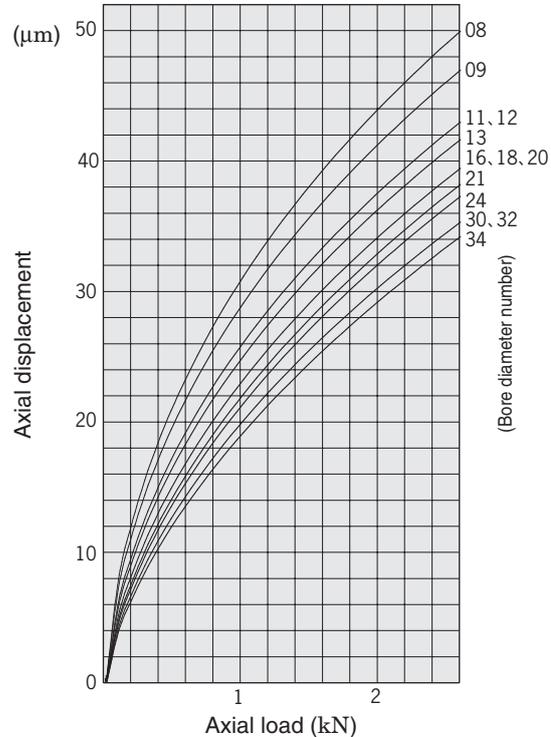
Fig. 1. 8 (1) Relationships between axial load and displacement (angular contact ball bearings)

*The axial displacements shown above are values of the single-row bearings not preloaded.

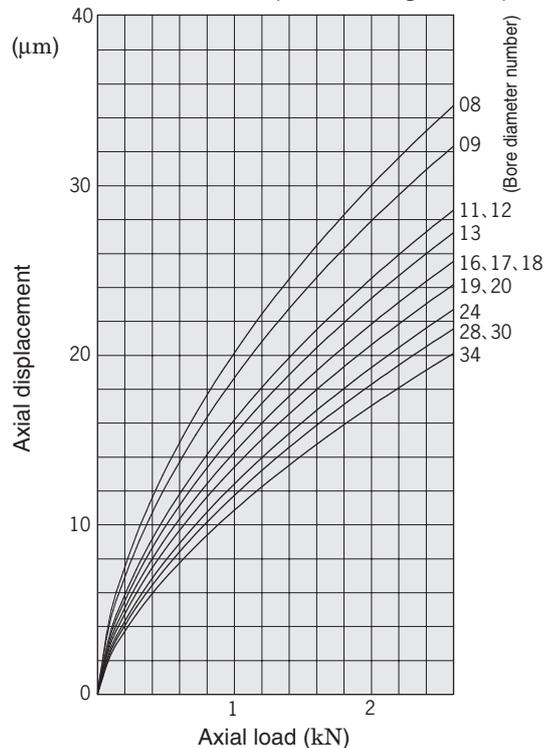
(5) 7200 series (contact angle : 30°)



(6) HAR900C series (contact angle : 15°)



(7) HAR900CA series (contact angle : 20°)



(8) HAR900 series (contact angle : 30°)

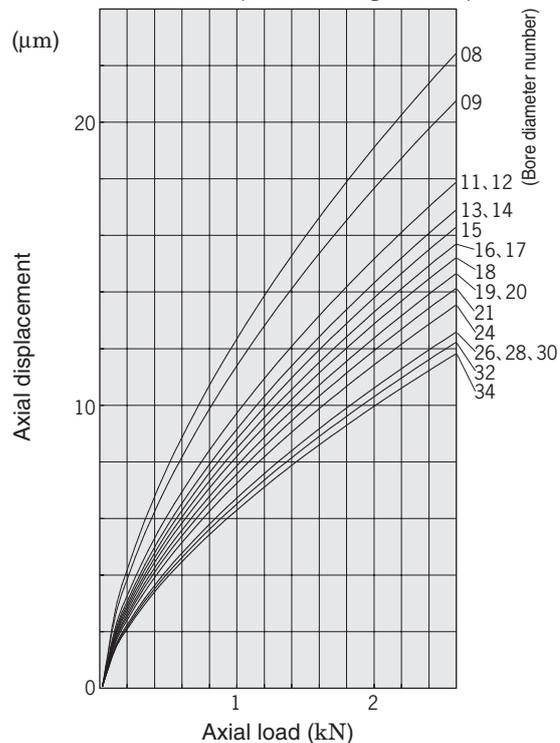


Fig. 1. 8 (2) Relationships between axial load and displacement (angular contact ball bearings)

*The axial displacements shown above are values of the single-row bearings not preloaded.

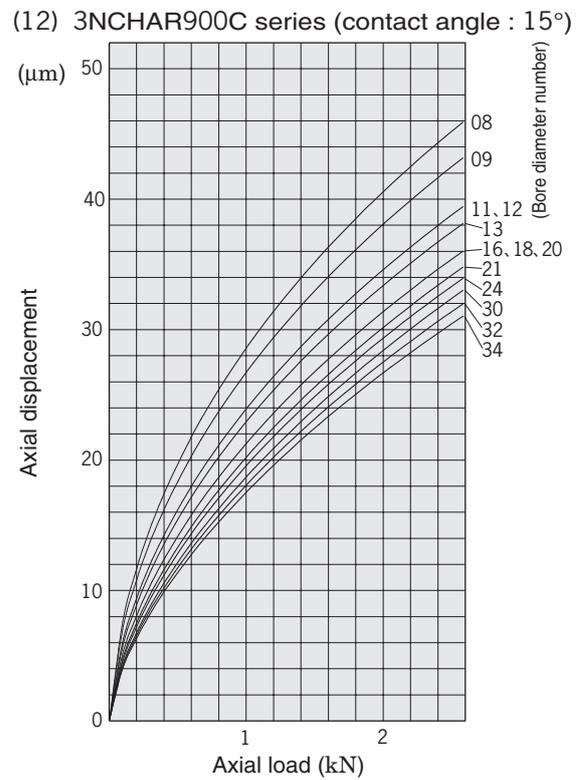
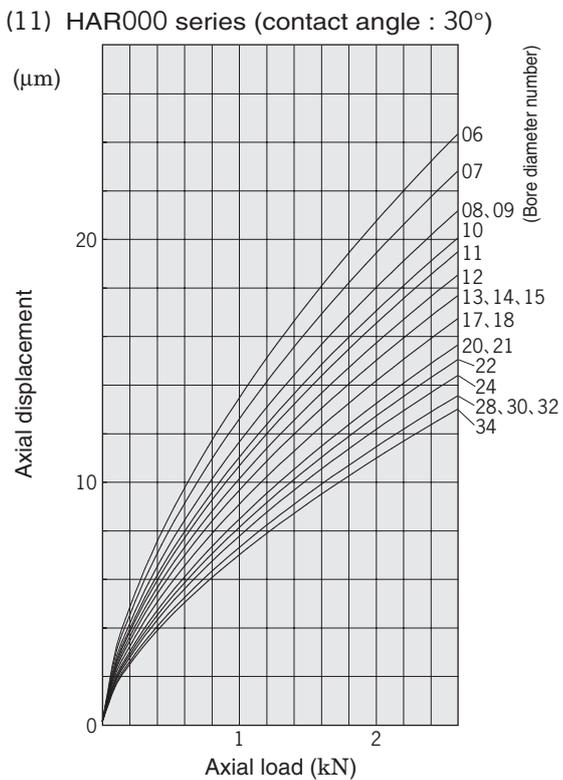
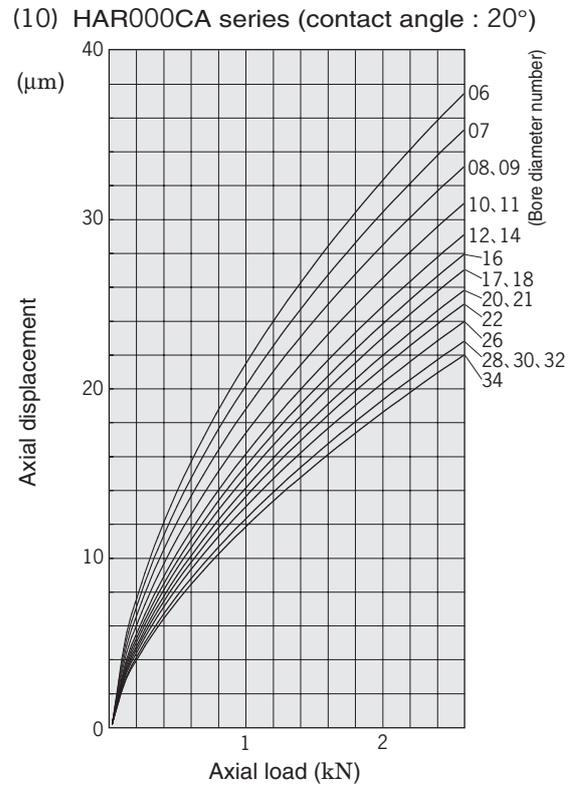
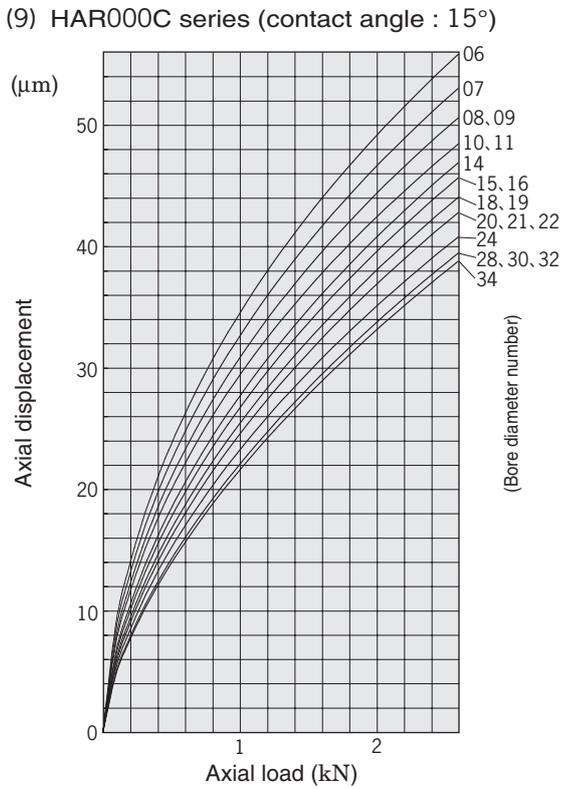
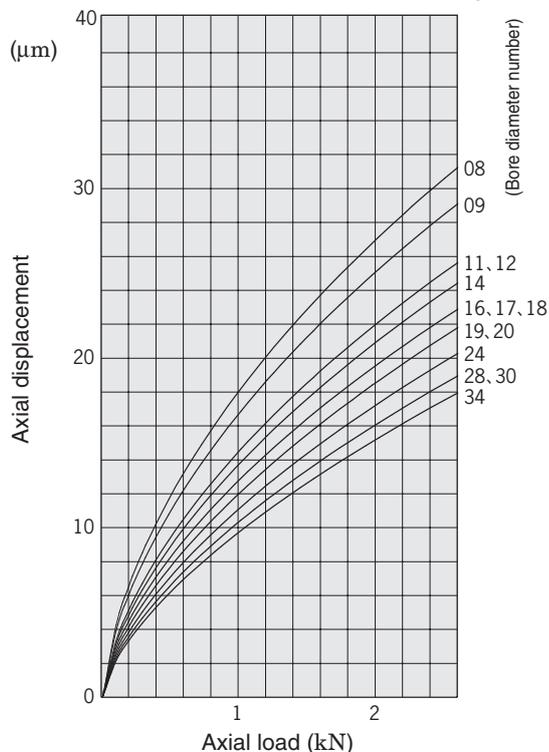


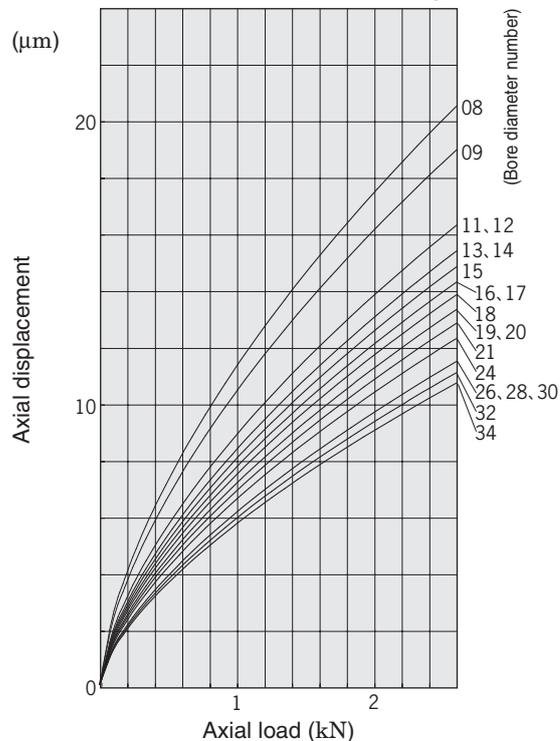
Fig. 1. 8 (3) Relationships between axial load and displacement (angular contact ball bearings)

*The axial displacements shown above are values of the single-row bearings not preloaded.

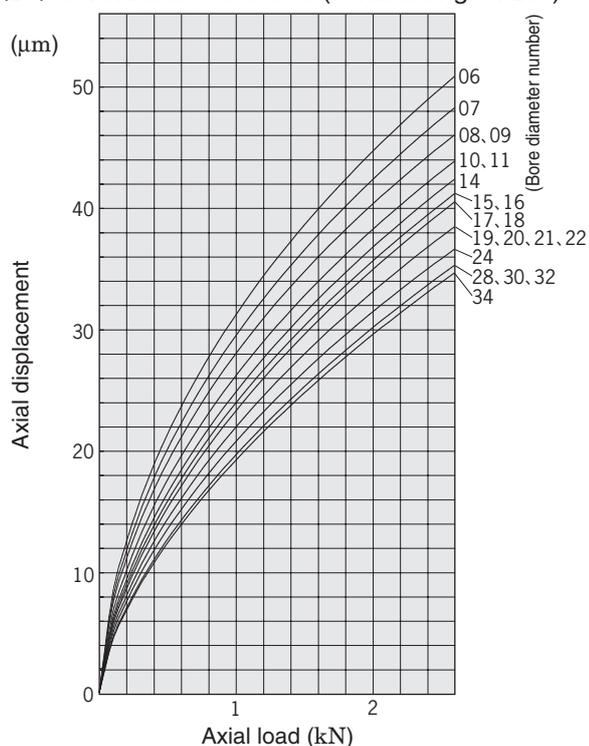
(13) 3NCHAR900CA series (contact angle : 20°)



(14) 3NCHAR900 series (contact angle : 30°)



(15) 3NCHAR000C series (contact angle : 15°)



(16) 3NCHAR000CA series (contact angle : 20°)

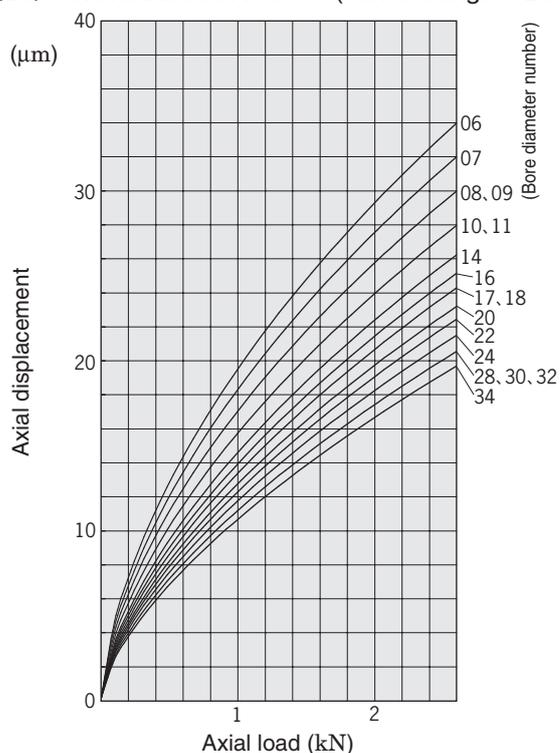
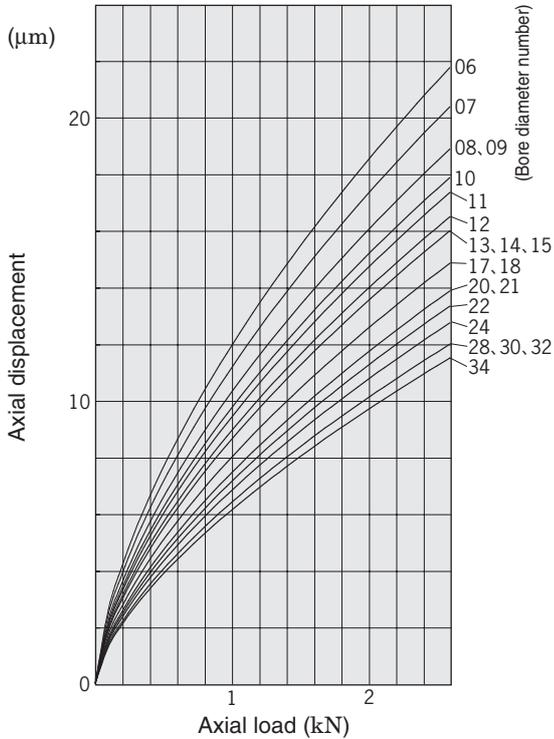


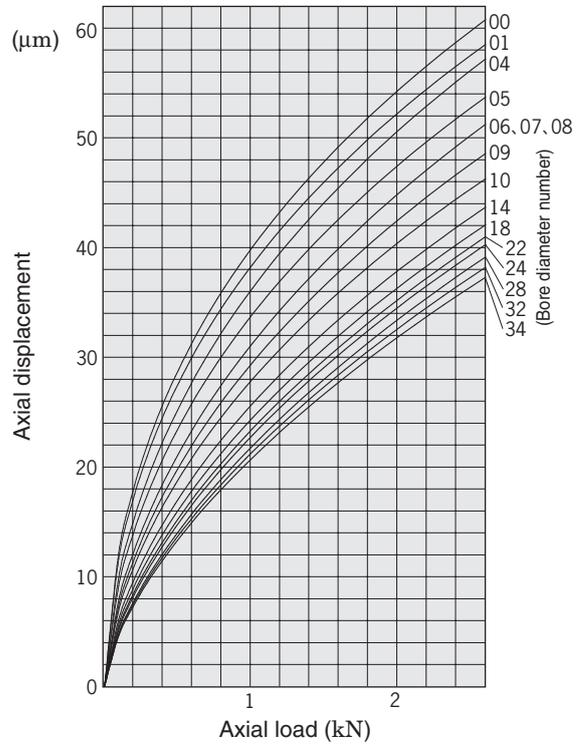
Fig. 1. 8 (4) Relationships between axial load and displacement (angular contact ball bearings)

*The axial displacements shown above are values of the single-row bearings not preloaded.

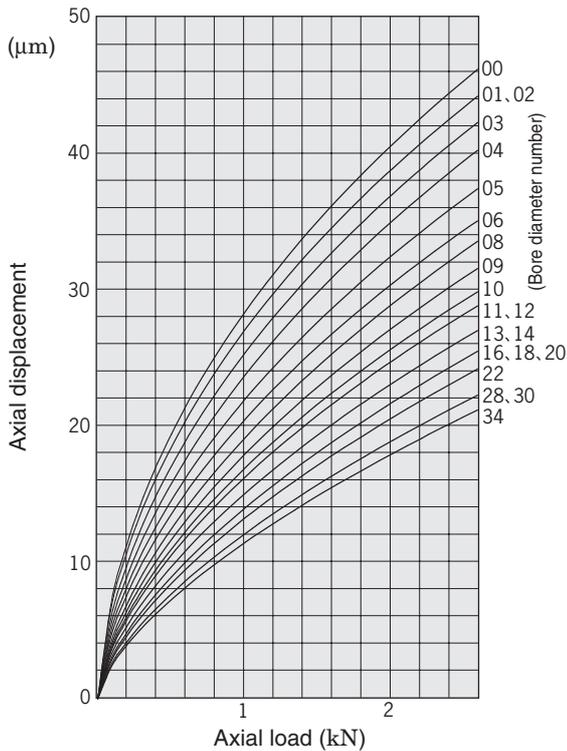
(17) 3NCHAR000 series (contact angle : 30°)



(18) 3NCHAC900C series (contact angle : 15°)



(19) 3NCHAC900CA series (contact angle : 20°)



(20) 3NCHAC000C series (contact angle : 15°)

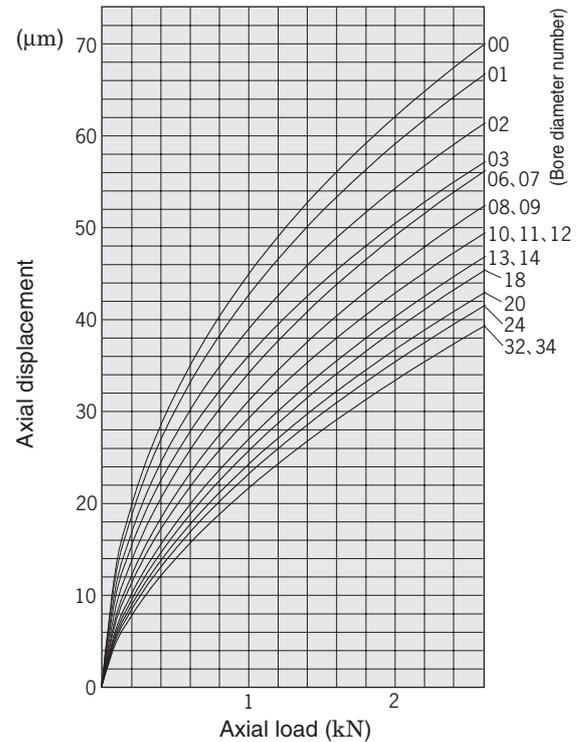
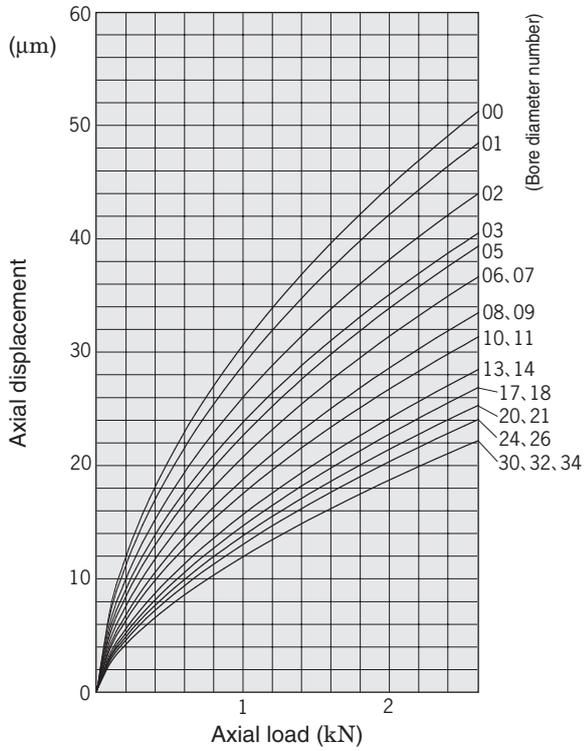


Fig. 1. 8 (5) Relationships between axial load and displacement (angular contact ball bearings)

*The axial displacements shown above are values of the single-row bearings not preloaded.

(21) 3NCHAC000CA series (contact angle : 20°)



(22) 3NCHAD000CA series (contact angle : 20°)

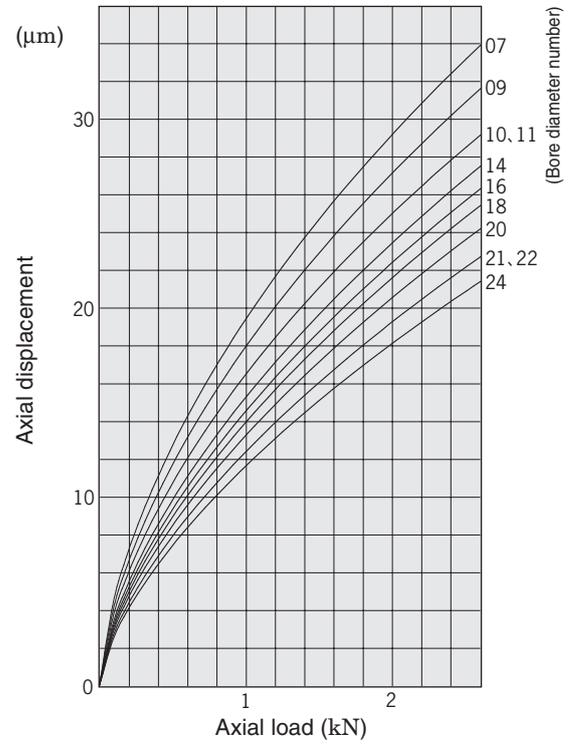
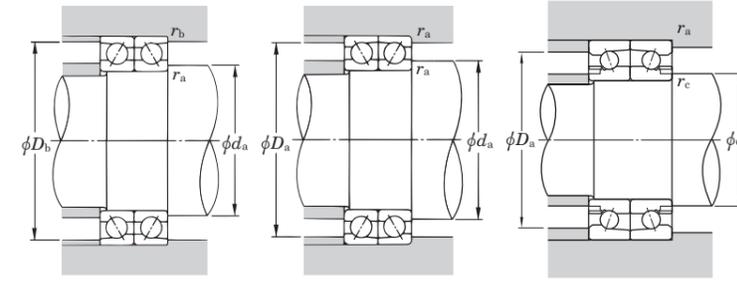
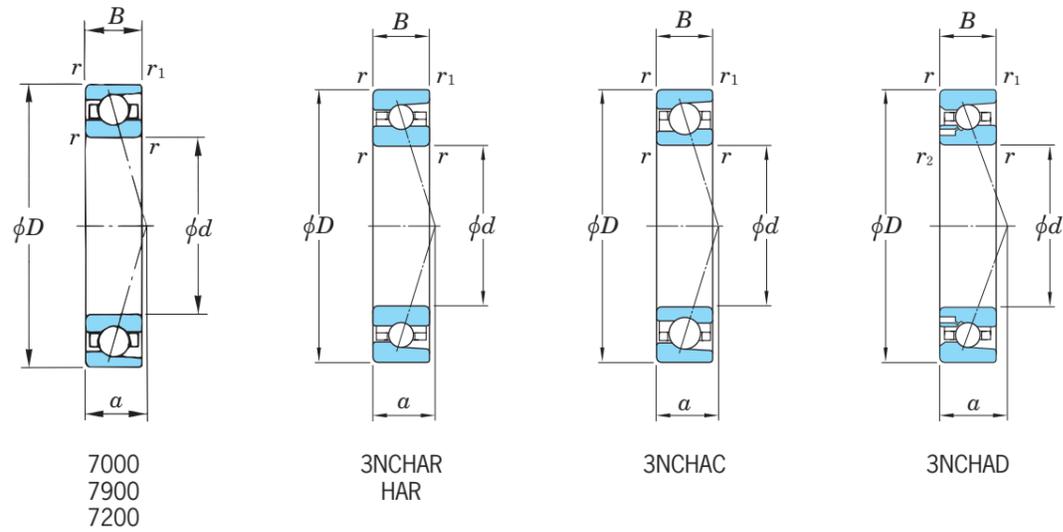


Fig. 1. 8 (6) Relationships between axial load and displacement (angular contact ball bearings)

*The axial displacements shown above are values of the single-row bearings not preloaded.



We recommend that recesses be added at r_a , r_b , and r_c .

Static equivalent load $P_0 = X_0 F_r + Y_0 F_a$

Contact angle	Single row/Tandem		Back-to-back/Face-to-face	
	X_0	Y_0	X_0	Y_0
15°	0.5	0.46	1	0.92
20°	0.5	0.42	1	0.84
30°	0.5	0.33	1	0.66

Note that in the case of single row or tandem, assume $P_0 = F_r$ if $P_0 < F_r$.

Dynamic equivalent load $P = X F_r + Y F_a$

Contact angle	$\frac{i_0 F_a}{C_{0r}}$	e	Single row/Tandem				Back-to-back/Face-to-face			
			$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
			X	Y	X	Y	X	Y	X	Y
15°	0.178	0.38			1.47			1.65		2.39
	0.357	0.40			1.40			1.57		2.28
	0.714	0.43			1.30			1.46		2.11
	1.07	0.46			1.23			1.38		2.00
	1.43	0.47	1	0	1.19	1	0.72	1.34	0.72	1.93
	2.14	0.50			1.12			1.26		1.82
	3.57	0.55			1.02			1.14		1.66
	5.35	0.56			1.00			1.12		1.63
7.14	0.56			1.00			1.12		1.63	
20°		0.57	1	0	0.43	1	1	1.09	0.70	1.63
30°		0.80	1	0	0.39	0.76	1	0.78	0.63	1.24

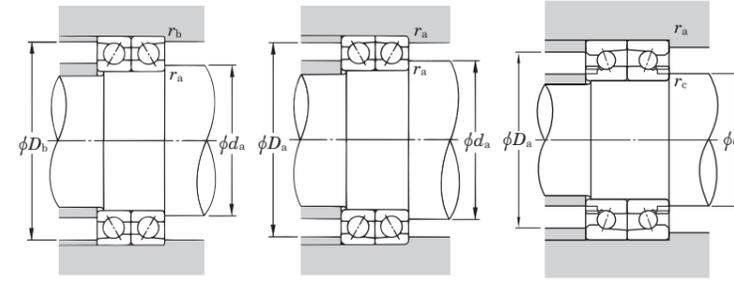
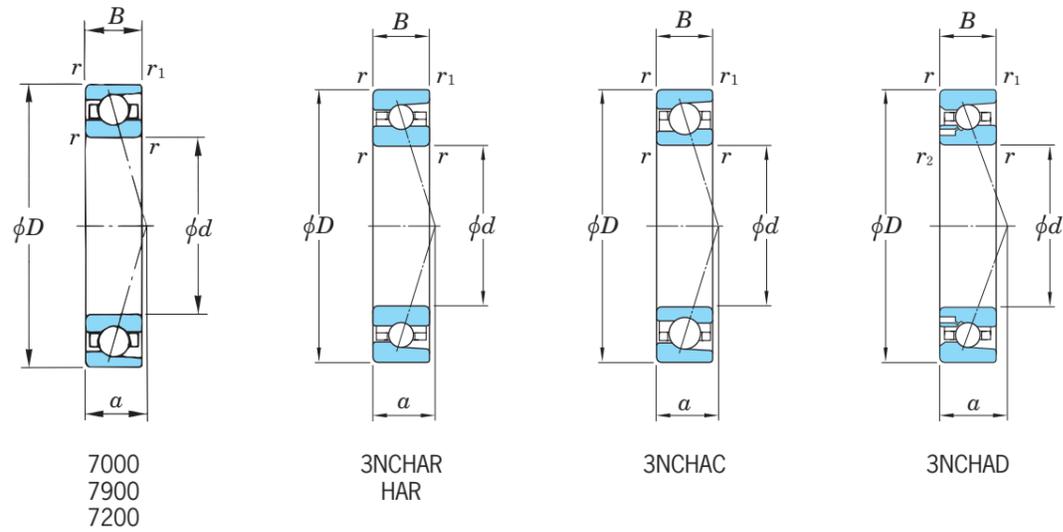
1) For i , use 2 for DB & DF and 1 for single & DT.

d 10 ~ (15)

d	Boundary dimensions (mm)					Bearing No.	Basic load ratings (kN)		Fatigue load limit (kN) C_u	Factor f_0	Limiting speeds (min ⁻¹)		Load center (mm) a	Interspace volume (cm ³ /row)	(Refer.) Mass (kg/row)	Permissible axial load (kN) (static)	Mounting dimensions (mm)						Nut axial tension (N)	Interference of retaining plate (mm)	Preload (Combination of DB and DF) (N)				Axial rigidity (Combination of DB and DF) (N/μm)				
	D	B	r min.	r ₁ min.	r ₂ min.		C_r	C_{0r}			Grease lub.	Oil lub.					d_a min.	d_b min.	D_a max.	D_b max.	r_a max.	r_b max.			r_c max.	S	L	M	H	S	L	M	H
10	22	6	0.3	0.15	—	7900C-5	3.75	1.50	0.060	14.2	78 000	120 000	5.1	0.44	0.008	1.10	12.5	—	19.5	20.8	0.3	0.15	—	1 500	0.01~0.02	5	15	30	—	7.4	12	16	—
	22	6	0.3	0.15	—	3NCHAC900C	2.55	0.75	0.040	7.20	130 000	210 000	5.1	0.43	0.008	0.62	12.5	—	19.5	20.8	0.3	0.15	—	1 500	0.01~0.02	5	15	30	—	7.7	12	16	—
	22	6	0.3	0.15	—	3NCHAC900CA	2.50	0.75	0.040	—	120 000	200 000	5.9	0.43	0.008	0.76	12.5	—	19.5	20.8	0.3	0.15	—	1 500	0.01~0.02	7	21	42	—	16	23	31	—
	26	8	0.3	0.15	—	7000C-5	6.60	2.45	0.13	12.5	67 000	100 000	6.4	0.89	0.021	1.90	12.5	—	23.5	24.8	0.3	0.15	—	2 000	0.01~0.02	6	20	50	100	8.3	13	20	29
	26	8	0.3	0.15	—	7000AC-5	6.40	2.40	0.12	—	59 000	84 000	8.1	0.86	0.021	1.77	12.5	—	23.5	24.8	0.3	0.15	—	2 000	0.01~0.02	—	30	80	145	—	32	48	60
	26	8	0.3	0.15	—	7000-5	6.25	2.35	0.12	—	51 000	67 000	9.1	0.86	0.021	0.70	12.5	—	23.5	24.8	0.3	0.15	—	2 000	0.01~0.02	—	30	80	145	—	43	62	77
	26	8	0.3	0.15	—	3NCHAC000C	4.40	1.25	0.070	6.40	110 000	190 000	6.4	0.92	0.016	0.99	12.5	—	23.5	24.8	0.3	0.15	—	2 000	0.01~0.02	7	21	42	—	8.5	13	17	—
	26	8	0.3	0.15	—	3NCHAC000CA	4.35	1.25	0.060	—	110 000	180 000	7.2	0.92	0.016	1.24	12.5	—	23.5	24.8	0.3	0.15	—	2 000	0.01~0.02	11	33	66	—	18	27	35	—
	30	9	0.6	0.3	—	7200C-5	6.25	2.35	0.12	13.4	57 000	92 000	7.2	1.3	0.031	2.22	14.5	—	25.5	27.5	0.6	0.3	—	2 000	0.01~0.02	10	30	80	145	9.3	15	24	33
	30	9	0.6	0.3	—	7200AC-5	6.00	2.25	0.12	—	51 000	75 000	9.3	1.3	0.031	1.71	14.5	—	25.5	27.5	0.6	0.3	—	3 000	0.01~0.02	—	50	145	245	—	37	57	71
30	9	0.6	0.3	—	7200-5	5.85	2.20	0.11	—	44 000	57 000	10.4	1.3	0.031	1.00	14.5	—	25.5	27.5	0.6	0.3	—	3 000	0.01~0.02	—	50	145	245	—	49	72	88	
12	24	6	0.3	0.15	—	7901C-5	4.00	1.70	0.070	14.7	70 000	100 000	5.4	0.49	0.010	1.20	14.5	—	21.5	22.8	0.3	0.15	—	2 000	0.01~0.02	7	20	40	—	9.0	14	19	—
	24	6	0.3	0.15	—	3NCHAC901C	2.70	0.85	0.050	7.10	110 000	190 000	5.4	0.48	0.009	0.70	14.5	—	21.5	22.8	0.3	0.15	—	2 000	0.01~0.02	5	15	30	—	8.3	13	17	—
	24	6	0.3	0.15	—	3NCHAC901CA	2.65	0.85	0.040	—	100 000	180 000	6.3	0.48	0.009	0.86	14.5	—	21.5	22.8	0.3	0.15	—	2 000	0.01~0.02	7	21	42	—	18	25	32	—
	28	8	0.3	0.15	—	7001C-5	7.25	2.95	0.15	13.4	57 000	92 000	6.7	1.1	0.024	1.97	14.5	—	25.5	26.8	0.3	0.15	—	2 000	0.01~0.02	6	20	50	100	8.9	14	22	30
	28	8	0.3	0.15	—	7001AC-5	6.95	2.80	0.15	—	51 000	75 000	8.8	1.1	0.024	1.06	14.5	—	25.5	26.8	0.3	0.15	—	2 000	0.01~0.02	—	30	80	145	—	35	51	64
	28	8	0.3	0.15	—	7001-5	6.75	2.75	0.14	—	44 000	57 000	9.9	1.1	0.024	0.74	14.5	—	25.5	26.8	0.3	0.15	—	2 000	0.01~0.02	—	30	80	145	—	46	67	83
	28	8	0.3	0.15	—	3NCHAC001C	4.85	1.50	0.080	6.80	100 000	170 000	6.7	1.1	0.017	1.18	14.5	—	25.5	26.8	0.3	0.15	—	2 000	0.01~0.02	9	27	54	—	10	15	21	—
	28	8	0.3	0.15	—	3NCHAC001CA	4.80	1.45	0.080	—	95 000	160 000	7.7	1.1	0.017	1.46	14.5	—	25.5	26.8	0.3	0.15	—	2 000	0.01~0.02	13	39	78	—	21	31	40	—
	32	10	0.6	0.3	—	7201C-5	9.90	3.85	0.30	12.5	54 000	85 000	7.9	1.7	0.038	2.28	16.5	—	27.5	29.5	0.6	0.3	—	3 000	0.01~0.02	15	40	100	195	13	21	32	46
	32	10	0.6	0.3	—	7201AC-5	9.55	3.70	0.29	—	48 000	70 000	10.1	1.7	0.038	1.87	16.5	—	27.5	29.5	0.6	0.3	—	3 000	0.01~0.02	—	60	145	295	—	49	70	94
32	10	0.6	0.3	—	7201-5	9.30	3.65	0.28	—	42 000	54 000	11.4	1.7	0.038	1.05	16.5	—	27.5	29.5	0.6	0.3	—	3 000	0.01~0.02	—	60	145	295	—	63	89	118	
15	28	7	0.3	0.15	—	7902C-5	5.15	2.65	0.11	14.5	58 000	91 000	6.4	0.68	0.015	2.86	17.5	—	25.5	26.8	0.3	0.15	—	2 000	0.01~0.02	8	25	50	—	10	16	22	—
	28	7	0.3	0.15	—	3NCHAC902C	4.05	1.35	0.070	7.40	98 000	160 000	6.4	0.65	0.014	1.07	17.5	—	25.5	26.8	0.3	0.15	—	2 000	0.01~0.02	7	21	42	—	10	15	20	—
	28	7	0.3	0.15	—	3NCHAC902CA	3.95	1.30	0.070	—	91 000	150 000	7.4	0.65	0.014	1.32	17.5	—	25.5	26.8	0.3	0.15	—	2 000	0.01~0.02	10	30	60	—	20	30	39	—
	32	9	0.3	0.15	—	7002C-5	8.25	3.70	0.19	14.1	50 000	79 000	7.6	1.3	0.035	2.84	17.5	—	29.5	30.8	0.3	0.15	—	3 000	0.01~0.02	10	30	80	145	12	19	30	40
	32	9	0.3	0.15	—	7002AC-5	7.90	3.55	0.18	—	45 000	65 000	10.0	1.3	0.035	1.68	17.5	—	29.5	30.8	0.3	0.15	—	3 000	0.01~0.02	—	50	145	245	—	48	72	89
	32	9	0.3	0.15	—	7002-5	7.65	3.45	0.18	—	39 000	50 000	11.3	1.3	0.035	1.00	17.5	—	29.5	30.8	0.3	0.15	—	3 000	0.01~0.02	—	50	145	245	—	61	92	113
	32	9	0.3	0.15	—	3NCHAC002C	5.55	1.90	0.10	7.20	89 000	140 000	7.6	1.4	0.026	1.50	17.5	—	29.5	30.8	0.3	0.15	—	3 000	0.01~0.02	11	33	66	—	12	19	25	—
	32	9	0.3	0.15	—	3NCHAC002CA	5.50	1.85	0.10	—	84 000	140 000	8.8	1.4	0.026	1.85	17.5	—	29.5	30.8	0.3	0.15	—	3 000	0.01~0.02	17	51	102	—	26	38	50	—

- [Remarks] 1. For the dimensions of the spacers for oil / air lubrication, refer to Table 15.4 on page 53 to 57.
 2.

1. Angular contact ball bearings



We recommend that recesses be added at r_a , r_b , and r_c .

Static equivalent load $P_0 = X_0 F_r + Y_0 F_a$

Contact angle	Single row/Tandem		Back-to-back/Face-to-face	
	X_0	Y_0	X_0	Y_0
15°	0.5	0.46	1	0.92
20°	0.5	0.42	1	0.84
30°	0.5	0.33	1	0.66

Note that in the case of single row or tandem, assume $P_0 = F_r$ if $P_0 < F_r$.

Dynamic equivalent load $P = X F_r + Y F_a$

Contact angle	$\frac{i_0 F_a}{C_{0r}}$	e	Single row/Tandem				Back-to-back/Face-to-face			
			$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
			X	Y	X	Y	X	Y	X	Y
15°	0.178	0.38			1.47		1.65		2.39	
	0.357	0.40			1.40		1.57		2.28	
	0.714	0.43			1.30		1.46		2.11	
	1.07	0.46			1.23		1.38		2.00	
	1.43	0.47	1	0	1.19	1	1.34	0.72	1.93	
	2.14	0.50			1.12		1.26		1.82	
	3.57	0.55			1.02		1.14		1.66	
	5.35	0.56			1.00		1.12		1.63	
7.14	0.56			1.00		1.12		1.63		
20°		0.57	1	0	0.43	1	1.09	0.70	1.63	
30°		0.80	1	0	0.39	0.76	1	0.78	0.63	1.24

1) For i , use 2 for DB & DF and 1 for single & DT.

d (15) ~ (25)

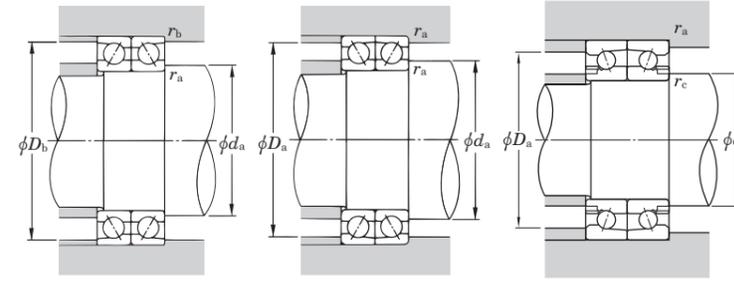
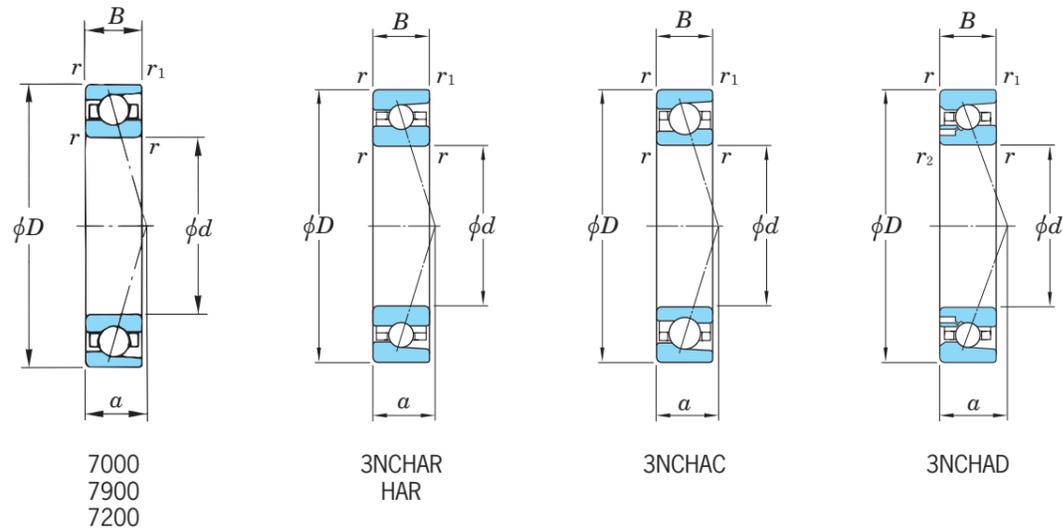
d	Boundary dimensions (mm)					Bearing No.	Basic load ratings (kN)		Fatigue load limit (kN) C_u	Factor f_0	Limiting speeds (min ⁻¹)		Load center (mm) a	Interspace volume (cm ³ /row)	(Refer.) Mass (kg/row)	Permissible axial load (kN) (static)	Mounting dimensions (mm)						Nut axial tension (N)	Interference of retaining plate (mm)	Preload (Combination of DB and DF) (N)				Axial rigidity (Combination of DB and DF) (N/μm)				
	D	B	r min.	r ₁ min.	r ₂ min.		C_r	C_{0r}			Grease lub.	Oil lub.					d_a min.	d_b min.	D_a max.	D_b max.	r_a max.	r_b max.			r_c max.	S	L	M	H	S	L	M	H
15	35	11	0.6	0.3	—	7202C-5	10.8	4.55	0.34	13.3	46 000	74 000	8.9	2.3	0.048	2.33	19.5	—	30.5	32.5	0.6	0.3	—	5 000	0.01~0.02	15	50	145	245	14	24	41	54
	35	11	0.6	0.3	—	7202AC-5	10.1	4.25	0.32	—	41 000	60 000	11.4	2.3	0.048	1.44	19.5	—	30.5	32.5	0.6	0.3	—	5 000	0.01~0.02	—	80	245	390	—	58	92	113
	35	11	0.6	0.3	—	7202-5	10.1	4.25	0.30	—	35 000	46 000	12.9	2.3	0.048	1.10	19.5	—	30.5	32.5	0.6	0.3	—	5 000	0.01~0.02	—	80	245	390	—	76	115	141
17	30	7	0.3	0.15	—	7903C-5	6.25	2.95	0.12	14.9	51 000	81 000	6.7	0.68	0.016	2.86	19.5	—	27.5	28.8	0.3	0.15	—	3 000	0.01~0.02	8	25	50	—	11	17	23	—
	30	7	0.3	0.15	—	3NCHAC903C	4.25	1.50	0.080	7.60	88 000	140 000	6.7	0.88	0.014	1.20	19.5	—	27.5	28.8	0.3	0.15	—	3 000	0.01~0.02	7	21	42	—	10	16	21	—
	30	7	0.3	0.15	—	3NCHAC903CA	4.15	1.45	0.080	—	81 000	130 000	7.9	0.88	0.014	1.47	19.5	—	27.5	28.8	0.3	0.15	—	3 000	0.01~0.02	10	30	60	—	22	32	41	—
	35	10	0.3	0.15	—	7003C-5	9.15	4.45	0.23	14.6	44 000	71 000	8.6	1.8	0.045	2.90	19.5	—	32.5	33.8	0.3	0.15	—	3 000	0.01~0.02	15	40	100	195	15	23	35	50
	35	10	0.3	0.15	—	7003AC-5	8.71	4.25	0.22	—	40 000	58 000	11.2	1.6	0.045	1.56	19.5	—	32.5	33.8	0.3	0.15	—	3 000	0.01~0.02	—	60	145	295	—	56	79	105
	35	10	0.3	0.15	—	7003-5	8.40	4.15	0.21	—	35 000	44 000	12.7	1.6	0.045	1.03	19.5	—	32.5	33.8	0.3	0.15	—	3 000	0.01~0.02	—	60	145	295	—	73	102	133
	35	10	0.3	0.15	—	3NCHAC003C	6.20	2.30	0.12	7.40	79 000	130 000	8.6	1.7	0.035	1.82	19.5	—	32.5	33.8	0.3	0.15	—	3 000	0.01~0.02	13	39	78	—	14	22	29	—
	35	10	0.3	0.15	—	3NCHAC003CA	6.10	2.25	0.12	—	74 000	120 000	9.8	1.7	0.035	2.14	19.5	—	32.5	33.8	0.3	0.15	—	3 000	0.01~0.02	20	60	120	—	30	45	59	—
	40	12	0.6	0.3	—	7203C-5	13.6	5.90	0.44	13.4	40 000	65 000	9.9	3.2	0.070	3.60	21.5	—	35.5	37.5	0.6	0.3	—	5 000	0.01~0.02	25	70	145	345	18	29	41	65
	40	12	0.6	0.3	—	7203AC-5	13.1	5.65	0.41	—	35 000	53 000	12.8	3.1	0.070	2.35	21.5	—	35.5	37.5	0.6	0.3	—	5 000	0.01~0.02	—	100	245	540	—	66	94	132
	40	12	0.6	0.3	—	7203-5	12.7	5.50	0.38	—	30 000	40 000	14.4	3.1	0.070	1.86	21.5	—	35.5	37.5	0.6	0.3	—	5 000	0.01~0.02	—	100	245	540	—	87	120	164
	20	37	9	0.3	0.15	—	7904C-5	9.10	4.55	0.24	14.9	44 000	68 000	8.3	1.5	0.035	2.90	22.5	—	34.5	35.8	0.3	0.15	—	3 000	0.01~0.02	15	40	80	—	15	23	32
37		9	0.3	0.15	—	3NCHAC904C	6.20	2.35	0.12	7.60	74 000	120 000	8.3	1.7	0.031	1.86	22.5	—	34.5	35.8	0.3	0.15	—	3 000	0.01~0.02	12	36	72	—	14	21	29	—
37		9	0.3	0.15	—	3NCHAC904CA	6.10	2.30	0.12	—	68 000	110 000	9.7	1.7	0.031	2.14	22.5	—	34.5	35.8	0.3	0.15	—	3 000	0.01~0.02	17	51	102	—	28	42	54	—
42		12	0.6	0.3	—	7004C-5	13.9	6.60	0.45	14.1	37 000	60 000	10.2	3.2	0.079	3.40	24.5	—	37.5	39.5	0.6	0.3	—	5 000	0.01~0.02	15	40	100	245	16	24	37	59
42		12	0.6	0.3	—	7004AC-5	13.3	6.30	0.42	—	33 000	49 000	13.3	3.2	0.079	2.13	24.5	—	37.5	39.5	0.6	0.3	—	5 000	0.01~0.02	—	60	145	295	—	59	84	111
42		12	0.6	0.3	—	7004-5	12.9	6.10	0.39	—	29 000	37 000	15.1	3.2	0.079	1.65	24.5	—	37.5	39.5	0.6	0.3	—	5 000	0.01~0.02	—	60	145	295	—	80	109	142
42		12	0.6	0.3	—	3NCHAC004C	9.35	3.35	0.17	7.20	67 000	110 000	10.2	3.4	0.056	2.67	24.5	—	37.5	39.5	0.6	0.3	—	5 000	0.01~0.02	15	45	90	—	15	22	30	—
42		12	0.6	0.3	—	3NCHAC004CA	9.20	3.30	0.17	—	61 000	100 000	11.7	3.4	0.056	3.29	24.5	—	37.5	39.5	0.6	0.3	—	5 000	0.01~0.02	30	90	180	—	34	51	67	—
47		14	1	0.6	—	7204C-5	19.4	9.00	0.67	13.4	35 000	54 000	11.6	5.3	0.112	4.80	25.5	—	41.5	42.5	1	0.6	—	5 000	0.01~0.02	25	80	195	390	20	32	50	71
47		14	1	0.6	—	7204AC-5	18.7	8.65	0.62	—	31 000	45 000	15.0	5.2	0.112	3.02	25.5	—	41.5	42.5	1	0.6	—	5 000	0.01~0.02	—	145	295	635	—	83	110	152
47		14	1	0.6	—	7204-5	18.1	8.40	0.58	—	26 000	35 000	17.0	5.2	0.112	2.34	25.5	—	41.5	42.5	1	0.6	—	5 000	0.01~0.02	—	145	295	635	—	109	142	190
25		42	9	0.3	0.15	—	7905C-5	9.75	5.45	0.28	15.5	36 000	57 000	9.1	1.9	0.041	3.00	27.5	—	39.5	40.8	0.3	0.15	—	3 000	0.01~0.02	15	50	100	—	17	28	38
	42	9	0.3	0.15	—	3NCHAC905C	6.75	2.75	0.14	7.90	61 000	100 000	9.1	1.9	0.037	2.23	27.5	—	39.5	40.8	0.3	0.15	—	3 000	0.01~0.02	15	45	90	—	17	25	34	—
	42	9	0.3	0.15	—	3NCHAC905CA	6.60	2.70	0.14	—	57 000	96 000	10.7	1.9	0.037	2.72	27.5	—	39.5	40.8	0.3	0.15	—	3 000	0.01~0.02	20	60	120	—	32	49	63	—
	47	12	0.6	0.3	—	7005C-5	15.4	8.00	0.51	14.7	33 000	51 000	10.8	3.6	0.091	3.98	29.5	—	42.5	44.5	0.6	0.3	—	5 000	0.01~0.02	20	60	145	295	20	32	48	69

- [Remarks] 1. For the dimensions of the spacers for oil / air lubrication, refer to Table 15.4 on page 53 to 57.
 2. For the discharge intervals of the oil / air, refer to Supplementary table 6 on page 215.
 3. C, CA, and no character string in the bearing number indicate nominal contact angles of 15°, 20°, and 30°, respectively.

Basic load ratings in case of multiple-row combination bearing

	Basic dynamic load ratings	Basic static load ratings
2-row	$C_r \times 1.62$	$C_{0r} \times 2$
3-row	$C_r \times 2.16$	$C_{0r} \times 3$
4-row	$C_r \times 2.64$	$C_{0r} \times$

1. Angular contact ball bearings



We recommend that recesses be added at r_a , r_b , and r_c .

Static equivalent load $P_0 = X_0 F_r + Y_0 F_a$

Contact angle	Single row/Tandem		Back-to-back/Face-to-face	
	X_0	Y_0	X_0	Y_0
15°	0.5	0.46	1	0.92
20°	0.5	0.42	1	0.84
30°	0.5	0.33	1	0.66

Note that in the case of single row or tandem, assume $P_0 = F_r$ if $P_0 < F_r$.

Dynamic equivalent load $P = X F_r + Y F_a$

Contact angle	$\frac{i_0 F_a}{C_{0r}}$	e	Single row/Tandem				Back-to-back/Face-to-face			
			$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
			X	Y	X	Y	X	Y	X	Y
15°	0.178	0.38			1.47			1.65		2.39
	0.357	0.40			1.40			1.57		2.28
	0.714	0.43			1.30			1.46		2.11
	1.07	0.46			1.23			1.38		2.00
	1.43	0.47	1	0	1.19	1	0.72	1.34	0.72	1.93
	2.14	0.50			1.12			1.26		1.82
	3.57	0.55			1.02			1.14		1.66
	5.35	0.56			1.00			1.12		1.63
7.14	0.56			1.00			1.12		1.63	
20°		0.57	1	0	0.43	1	1	1.09	0.70	1.63
30°		0.80	1	0	0.39	0.76	1	0.78	0.63	1.24

1) For i , use 2 for DB & DF and 1 for single & DT.

d (25) ~ (35)

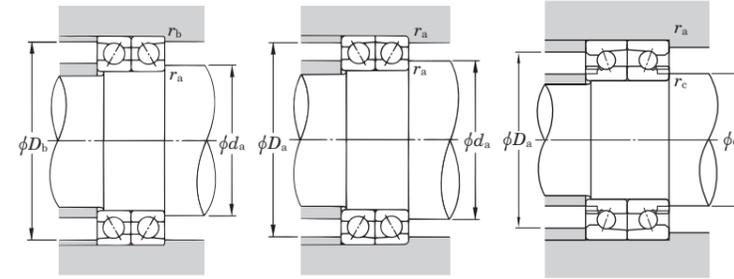
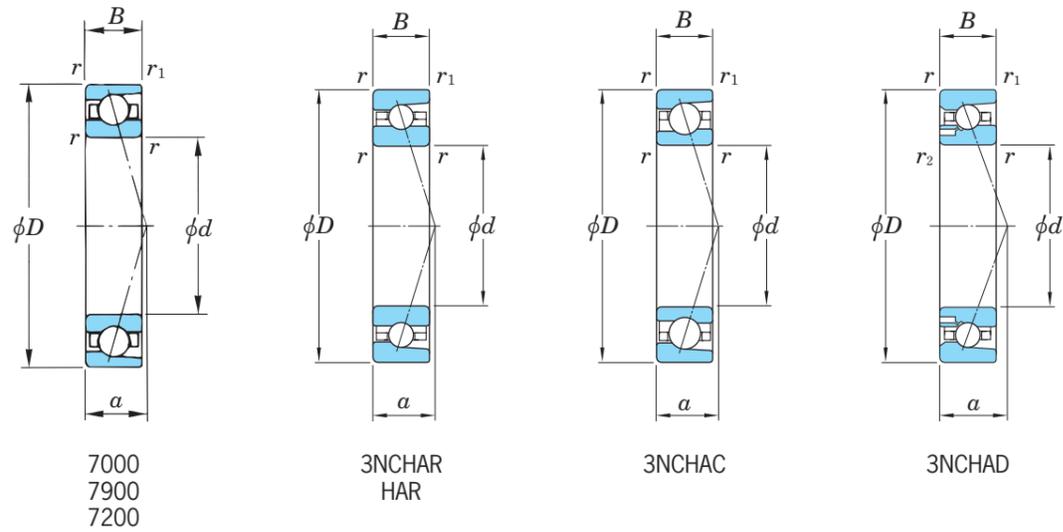
d	Boundary dimensions (mm)					Bearing No.	Basic load ratings (kN)		Fatigue load limit (kN) C_u	Factor f_0	Limiting speeds (min ⁻¹)		Load center (mm) a	Interspace volume (cm ³ /row)	(Refer.) Mass (kg/row)	Permissible axial load (kN) (static)	Mounting dimensions (mm)						Nut axial tension (N)	Interference of retaining plate (mm)	Preload (Combination of DB and DF) (N)				Axial rigidity (Combination of DB and DF) (N/μm)				
	D	B	r min.	r ₁ min.	r ₂ min.		C_r	C_{0r}			Grease lub.	Oil lub.					d_a min.	d_b min.	D_a max.	D_b max.	r_a max.	r_b max.			r_c max.	S	L	M	H	S	L	M	H
25	47	12	0.6	0.3	—	7005AC-5	14.6	7.65	0.47	—	29 000	42 000	14.4	3.6	0.091	2.50	29.5	—	42.5	44.5	0.6	0.3	—	5 000	0.01~0.02	—	100	245	490	—	80	113	151
	47	12	0.6	0.3	—	7005-5	14.1	7.40	0.45	—	25 000	33 000	16.4	3.6	0.091	1.94	29.5	—	42.5	44.5	0.6	0.3	—	5 000	0.01~0.02	—	100	245	490	—	103	144	190
	47	12	0.6	0.3	—	3NCHAC005C	10.4	4.10	0.21	7.50	58 000	96 000	10.8	3.8	0.066	3.26	29.5	—	42.5	44.5	0.6	0.3	—	5 000	0.01~0.02	25	75	150	—	20	30	41	—
	47	12	0.6	0.3	—	3NCHAC005CA	10.2	4.00	0.21	—	54 000	91 000	12.6	3.8	0.066	4.00	29.5	—	42.5	44.5	0.6	0.3	—	5 000	0.01~0.02	35	105	210	—	40	60	77	—
	52	15	1	0.6	—	7205C-5	20.7	10.2	0.71	14.0	30 000	49 000	12.7	6.6	0.135	5.26	30.5	—	46.5	47.5	1	0.6	—	8 000	0.01~0.02	35	100	245	490	24	37	58	84
	52	15	1	0.6	—	7205AC-5	19.8	9.80	0.65	—	27 000	40 000	16.6	6.5	0.135	3.30	30.5	—	46.5	47.5	1	0.6	—	8 000	0.01~0.02	—	145	390	780	—	88	131	174
	52	15	1	0.6	—	7205-5	19.2	9.50	0.62	—	23 000	30 000	18.8	6.5	0.135	2.56	30.5	—	46.5	47.5	1	0.6	—	8 000	0.01~0.02	—	145	390	780	—	116	166	218
	30	47	9	0.3	0.15	—	7906C-5	10.4	6.25	0.32	15.9	32 000	50 000	9.7	2.2	0.046	3.04	32.5	—	44.5	45.8	0.3	0.15	—	5 000	0.01~0.02	15	50	100	—	18	29	40
47		9	0.3	0.15	—	3NCHAC906C	7.20	3.20	0.16	8.10	54 000	91 000	9.7	2.3	0.041	2.57	32.5	—	44.5	45.8	0.3	0.15	—	5 000	0.01~0.02	35	105	210	—	25	39	54	—
47		9	0.3	0.15	—	3NCHAC906CA	7.05	3.10	0.16	—	50 000	85 000	11.5	2.3	0.041	3.13	32.5	—	44.5	45.8	0.3	0.15	—	5 000	0.01~0.02	45	135	270	—	47	72	94	—
55		13	1	0.6	—	7006C-5	19.8	11.0	0.69	14.9	28 000	44 000	12.2	4.9	0.133	5.34	35.5	—	49.5	50.5	1	0.6	—	5 000	0.01~0.02	25	80	195	390	23	38	58	83
55		13	1	0.6	—	7006AC-5	18.8	10.5	0.64	—	25 000	36 000	16.4	4.9	0.133	3.36	35.5	—	49.5	50.5	1	0.6	—	5 000	0.01~0.02	—	145	295	635	—	98	130	179
55		13	1	0.6	—	7006-5	18.2	10.1	0.61	—	21 000	28 000	18.8	4.9	0.133	2.60	35.5	—	49.5	50.5	1	0.6	—	5 000	0.01~0.02	—	145	295	635	—	129	166	225
55		13	1	0.6	—	HAR006C	10.9	4.85	0.25	7.90	36 000	56 000	12.2	4.4	0.116	6.14	35.5	—	49.5	50.5	1	0.6	—	5 000	0.01~0.02	40	120	240	—	25	38	53	—
55		13	1	0.6	—	3NCHAR006C	10.9	4.85	0.18	7.90	49 000	82 000	12.2	4.4	0.106	3.91	35.5	—	49.5	50.5	1	0.6	—	5 000	0.01~0.02	45	135	270	—	29	45	61	—
55		13	1	0.6	—	HAR006CA	10.7	4.75	0.25	—	35 000	53 000	14.2	4.4	0.116	7.25	35.5	—	49.5	50.5	1	0.6	—	5 000	0.01~0.02	40	120	240	—	42	64	85	—
55		13	1	0.6	—	3NCHAR006CA	10.7	4.75	0.17	—	46 000	77 000	14.2	4.4	0.106	4.78	35.5	—	49.5	50.5	1	0.6	—	5 000	0.01~0.02	45	135	270	—	51	75	98	—
55		13	1	0.6	—	HAR006	10.0	4.45	0.23	—	25 000	33 000	18.8	4.4	0.116	6.37	35.5	—	49.5	50.5	1	0.6	—	5 000	0.01~0.02	50	130	260	—	80	111	141	—
55		13	1	0.6	—	3NCHAC006C	13.5	5.60	0.29	7.60	49 000	82 000	12.2	5.4	0.097	4.48	35.5	—	49.5	50.5	1	0.6	—	5 000	0.01~0.02	45	135	270	—	26	41	56	—
55		13	1	0.6	—	3NCHAC006CA	13.2	5.50	0.28	—	46 000	77 000	14.2	5.4	0.097	5.49	35.5	—	49.5	50.5	1	0.6	—	5 000	0.01~0.02	45	135	270	—	47	70	91	—
62		16	1	0.6	—	7206C-5	28.8	14.7	1.00	14.0	25 000	40 000	14.3	9.3	0.208	7.61	35.5	—	56.5	57.5	1	0.6	—	8 000	0.01~0.02	35	100	295	590	25	38	64	91
62		16	1	0.6	—	7206AC-5	27.6	14.1	0.94	—	22 000	33 000	18.8	9.3	0.208	4.78	35.5	—	56.5	57.5	1	0.6	—	8 000	0.01~0.02	—	145	590	930	—	92	158	194
62		16	1	0.6	—	7206-5	26.7	13.7	0.89	—	19 000	25 000	21.5	9.3	0.208	3.70	35.5	—	56.5	57.5	1	0.6	—	8 000	0.01~0.02	—	145	590	930	—	121	203	242
35	55	10	0.6	0.3	—	7907C-5	15.7	9.70	0.55	15.7	28 000	43 000	11.0	3.0	0.074	5.20	39.5	—	50.5	52.5	0.6	0.3	—	5 000	0.01~0.02	25	70	135	—	25	39	53	—
	55	10	0.6	0.3	—	3NCHAC907C	10.8	4.90	0.25	8.00	46 000	78 000	11.0	3.5	0.063	3.96	39.5	—	50.5	52.5	0.6	0.3	—	5 000	0.01~0.02	35	105	210	—	25	40	54	—
	55	10	0.6	0.3	—	3NCHAC907CA	10.6	4.80	0.25	—	43 000	72 000	13.2	3.5	0.063	4.83	39.5	—	50.5	52.5	0.6	0.3	—	5 000	0.01~0.02	50	150	300	—	51	78	103	—
	62	14	1	0.6	—	7007C-5	23.9	13.7	0.84	15.0	23 000	39 000	13.5	7.0	0.170	6.63	40.5	—	56.5	57.5	1	0.6	—	8 000	0.01~0.02	35	100	245	490	27	42	64	93
	62	14	1	0.6	—	7007AC-5	22.7	13.1	0.78	—	21 000	31 000	18.4	6.9	0.170	4.16	40.5	—	56.5	57.5	1	0.6	—	8 000	0.01~0.02	—	145	390	785	—	100	149	199
	62	14	1	0.6	—	7007-5	21.9	12.6	0.74	—	18 000	23 000	21.2	6.9	0.170	3.22	40.5	—	56.5	57.5	1	0.6	—	8 000	0.01~0.02	—	145	390	785	—	132	190	249

- [Remarks] 1. For the dimensions of the spacers for oil / air lubrication, refer to Table 15. 4 on page 53 to 57.
 2. For the discharge intervals of the oil / air, refer to Supplementary table 6 on page 215.
 3. C, CA, and no character string in the bearing number indicate nominal contact angles of 15°, 20°, and 30°, respectively.

Basic load ratings in case of multiple-row combination bearing

	Basic dynamic load ratings	Basic static load ratings
2-row	$C_r \times 1.62$	$C_{0r} \times 2$
3-row	$C_r \times 2.16$	$C_{0r} \times 3$
4-row	$C_r \times 2.64$	

1. Angular contact ball bearings



We recommend that recesses be added at r_a , r_b , and r_c .

Static equivalent load $P_0 = X_0 F_r + Y_0 F_a$

Contact angle	Single row/Tandem		Back-to-back/Face-to-face	
	X_0	Y_0	X_0	Y_0
15°	0.5	0.46	1	0.92
20°	0.5	0.42	1	0.84
30°	0.5	0.33	1	0.66

Note that in the case of single row or tandem, assume $P_0 = F_r$ if $P_0 < F_r$.

Dynamic equivalent load $P = X F_r + Y F_a$

Contact angle	$\frac{i f_0 F_a}{C_{0r}}$	e	Single row/Tandem				Back-to-back/Face-to-face			
			$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
			X	Y	X	Y	X	Y	X	Y
15°	0.178	0.38			1.47			1.65		2.39
	0.357	0.40			1.40			1.57		2.28
	0.714	0.43			1.30			1.46		2.11
	1.07	0.46			1.23			1.38		2.00
	1.43	0.47	1	0	1.19	1	0.72	1.34	0.72	1.93
	2.14	0.50			1.12			1.26		1.82
	3.57	0.55			1.02			1.14		1.66
	5.35	0.56			1.00			1.12		1.63
7.14	0.56			1.00			1.12		1.63	
20°		0.57	1	0	0.43	1	1	1.09	0.70	1.63
30°		0.80	1	0	0.39	0.76	1	0.78	0.63	1.24

1) For i , use 2 for DB & DF and 1 for single & DT.

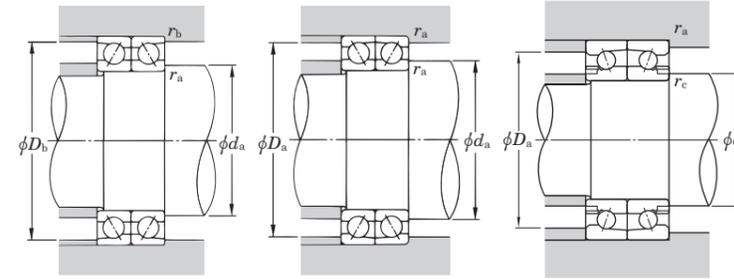
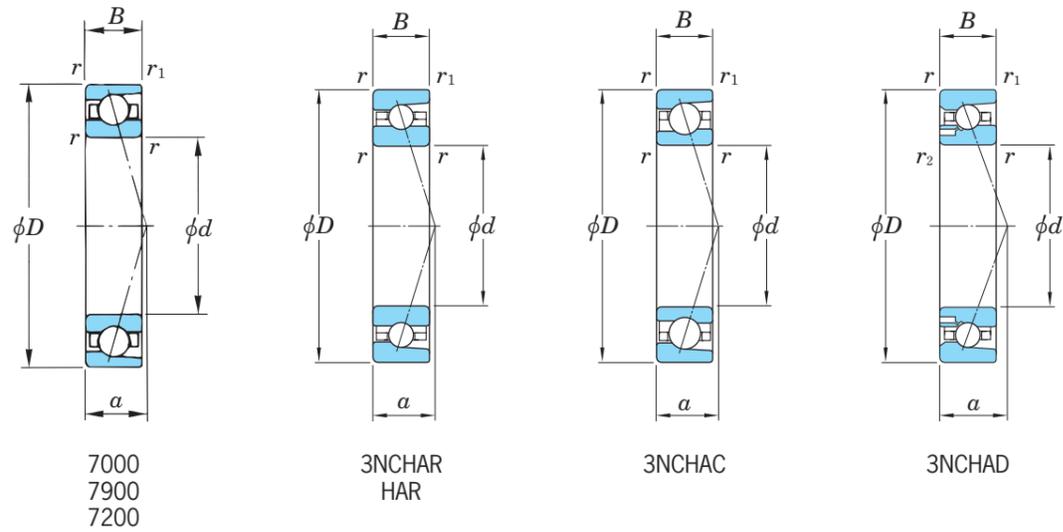
d (35) ~ (40)

d	Boundary dimensions (mm)					Bearing No.	Basic load ratings (kN)		Fatigue load limit (kN) C_u	Factor f_0	Limiting speeds (min ⁻¹)		Load center (mm) a	Interspace volume (cm ³ /row)	(Refer.) Mass (kg/row)	Permissible axial load (kN) (static)	Mounting dimensions (mm)						Nut axial tension (N)	Interference of retaining plate (mm)	Preload (Combination of DB and DF) (N)				Axial rigidity (Combination of DB and DF) (N/μm)				
	D	B	r min.	r ₁ min.	r ₂ min.		C_r	C_{0r}			Grease lub.	Oil lub.					d_a min.	d_b min.	D_a max.	D_b max.	r_a max.	r_b max.			r_c max.	S	L	M	H	S	L	M	H
35	62	14	1	0.6	—	HAR007C	11.6	5.55	0.29	8.10	32 000	49 000	13.5	5.5	0.158	7.02	40.5	—	56.5	57.5	1	0.6	—	8 000	0.01~0.02	40	120	240	—	26	41	55	—
	62	14	1	0.6	—	3NCHAR007C	11.6	5.55	0.20	8.10	43 000	71 000	13.5	5.5	0.148	4.47	40.5	—	56.5	57.5	1	0.6	—	8 000	0.01~0.02	45	135	270	—	30	47	65	—
	62	14	1	0.6	—	HAR007CA	11.3	5.40	0.28	—	30 000	46 000	15.8	5.5	0.158	7.44	40.5	—	56.5	57.5	1	0.6	—	8 000	0.01~0.02	45	135	270	—	49	72	94	—
	62	14	1	0.6	—	3NCHAR007CA	11.3	5.40	0.20	—	40 000	67 000	15.8	5.5	0.148	4.90	40.5	—	56.5	57.5	1	0.6	—	8 000	0.01~0.02	50	150	300	—	56	83	109	—
	62	14	1	0.6	—	HAR007	10.6	5.05	0.26	—	21 000	29 000	21.0	5.5	0.158	6.58	40.5	—	56.5	57.5	1	0.6	—	8 000	0.01~0.02	60	180	360	—	92	133	169	—
	62	14	1	0.6	—	3NCHAC007C	16.3	7.00	0.36	7.60	43 000	71 000	13.6	7.1	0.129	5.59	40.5	—	56.5	57.5	1	0.6	—	8 000	0.01~0.02	45	135	270	—	27	42	57	—
	62	14	1	0.6	—	3NCHAC007CA	16.0	6.85	0.35	—	40 000	67 000	15.9	7.1	0.129	6.85	40.5	—	56.5	57.5	1	0.6	—	8 000	0.01~0.02	50	150	300	—	50	75	98	—
	62	14	1	0.6	0.3	3NCHAD007CA	10.5	4.90	0.25	—	—	72 000	15.8	—	0.157	4.90	40.5	—	56.5	57.5	1	0.6	0.3	8 000	0.01~0.02	50	150	300	—	51	78	103	—
	72	17	1.1	0.6	—	7207C-5	38.0	20.1	1.40	14.0	22 000	35 000	15.8	13	0.295	10.8	42	—	65	67.5	1	0.6	—	8 000	0.01~0.02	50	145	390	780	29	46	73	105
	72	17	1.1	0.6	—	7207AC-5	36.3	19.2	1.30	—	19 000	29 000	21.2	13	0.295	6.94	42	—	65	67.5	1	0.6	—	8 000	0.01~0.02	—	245	780	1 270	—	117	185	226
	72	17	1.1	0.6	—	7207-5	35.2	18.6	1.20	—	16 000	22 000	24.2	13	0.295	5.43	42	—	65	67.5	1	0.6	—	8 000	0.01~0.02	—	245	780	1 270	—	153	234	282
	40	62	12	0.6	0.3	—	7908C-5	19.7	12.4	0.71	15.7	25 000	37 000	12.8	5.2	0.107	6.59	44.5	—	57.5	59.5	0.6	0.3	—	5 000	0.01~0.02	25	80	145	—	26	42	55
62		12	0.6	0.3	—	HAR908C	7.95	4.05	0.21	8.40	30 000	46 000	12.8	4.1	0.115	5.18	44.5	—	57.5	59.5	0.6	0.3	—	5 000	0.01~0.02	35	110	220	—	25	40	56	—
62		12	0.6	0.3	—	3NCHAR908C	7.95	4.05	0.15	8.40	40 000	68 000	12.8	4.1	0.109	3.30	44.5	—	57.5	59.5	0.6	0.3	—	5 000	0.01~0.02	40	120	240	—	29	46	64	—
62		12	0.6	0.3	—	HAR908CA	7.75	3.95	0.21	—	29 000	43 000	15.3	4.1	0.115	6.08	44.5	—	57.5	59.5	0.6	0.3	—	5 000	0.01~0.02	50	160	320	—	50	77	102	—
62		12	0.6	0.3	—	3NCHAR908CA	7.75	3.95	0.14	—	37 000	64 000	15.3	4.1	0.109	4.00	44.5	—	57.5	59.5	0.6	0.3	—	5 000	0.01~0.02	55	165	330	—	58	88	115	—
62		12	0.6	0.3	—	HAR908	7.20	3.70	0.19	—	21 000	28 000	20.7	4.1	0.115	4.79	44.5	—	57.5	59.5	0.6	0.3	—	5 000	0.01~0.02	65	205	410	—	93	139	178	—
62		12	0.6	0.3	—	3NCHAC908C	13.6	6.30	0.33	8.00	40 000	68 000	12.8	5.4	0.093	5.10	44.5	—	57.5	59.5	0.6	0.3	—	5 000	0.01~0.02	40	120	240	—	28	43	59	—
62		12	0.6	0.3	—	3NCHAC908CA	13.3	6.20	0.32	—	37 000	64 000	15.3	5.4	0.093	6.22	44.5	—	57.5	59.5	0.6	0.3	—	5 000	0.01~0.02	55	165	330	—	56	84	109	—
68		15	1	0.6	—	7008C-5	25.7	15.9	0.94	15.4	22 000	35 000	14.8	8.8	0.210	7.53	45.5	—	62.5	63.5	1	0.6	—	8 000	0.01~0.02	35	100	295	590	29	45	76	109
68		15	1	0.6	—	7008AC-5	24.3	15.1	0.87	—	19 000	29 000	20.1	8.7	0.210	4.73	45.5	—	62.5	63.5	1	0.6	—	8 000	0.01~0.02	—	145	390	780	—	109	159	212
68		15	1	0.6	—	7008-5	23.4	14.6	0.83	—	16 000	22 000	23.2	8.7	0.210	3.66	45.5	—	62.5	63.5	1	0.6	—	8 000	0.01~0.02	—	145	390	780	—	141	205	269
68		15	1	0.6	—	HAR008C	12.2	6.20	0.32	8.20	28 000	43 000	14.7	6.6	0.200	7.88	45.5	—	62.5	63.5	1	0.6	—	8 000	0.01~0.02	45	135	270	—	29	45	62	—
68		15	1	0.6	—	3NCHAR008C	12.2	6.20	0.23	8.20	39 000	64 000	14.7	6.6	0.189	5.02	45.5	—	62.5	63.5	1	0.6	—	8 000	0.01~0.02	50	150	300	—	33	53	71	—
68		15	1	0.6	—	HAR008CA	11.9	6.05	0.31	—	26 000	42 000	17.3	6.6	0.200	9.27	45.5	—	62.5	63.5	1	0.6	—	8 000	0.01~0.02	50	150	300	—	54	80	104	—
68		15	1	0.6	—	3NCHAR008CA	11.9	6.05	0.22	—	36 000	61 000	17.3	6.6	0.189	6.10	45.5	—	62.5	63.5	1	0.6	—	8 000	0.01~0.02	55	165	330	—	61	92	120	—
68		15	1	0.6	—	HAR008	11.1	5.65	0.29	—	19 000	26 000	23.1	6.6	0.200	7.75	45.5	—	62.5	63.5	1	0.6	—	8 000	0.01~0.02	70	210	420	—	100	150	191	—
68		15	1	0.6	—	3NCHAC008C	17.7	8.10	0.42	7.80	39 000	64 000	14.7	8.7	0.161	6.50	45.5	—	62.5	63.5	1	0.6	—	8 000	0.01~0.02	50	150	300	—	30	47	63	—
68		15	1	0.6	—	3NCHAC008CA	17.3	7.90	0.41	—	36 000	61 000	17.3	8.7	0.161	7.95	45.5	—	62.5	63.5	1	0.6	—	8 000	0.01~0.02	55	165	330	—	56	85	109	—
68		15	1	0.6	0.3	3NCHAD008CA	11.1	5.50	0.28	—	—	64 000	17.3	—	0.197	5.55	45.5	—	62.5	63.5	1	0.6	0.3	8 000	0.01~0.02	55	165	330	—	58	87	113	—

- [Remarks] 1. For the dimensions of the spacers for oil / air lubrication, refer to Table 15.4 on page 53 to 57.
 2. For the discharge intervals of the oil / air, refer to Supplementary table 6 on page 215.
 3. C, CA, and no character string in the bearing number indicate nominal contact angles of 15°, 20°, and 30°, respectively.

Basic load ratings in case of multiple-row combination bearing

1. Angular contact ball bearings



We recommend that recesses be added at r_a , r_b , and r_c .

Static equivalent load $P_0 = X_0 F_r + Y_0 F_a$

Contact angle	Single row/Tandem		Back-to-back/Face-to-face	
	X_0	Y_0	X_0	Y_0
15°	0.5	0.46	1	0.92
20°	0.5	0.42	1	0.84
30°	0.5	0.33	1	0.66

Note that in the case of single row or tandem, assume $P_0 = F_r$ if $P_0 < F_r$.

Dynamic equivalent load $P = X F_r + Y F_a$

Contact angle	$\frac{i_0 F_a}{C_{0r}}$	e	Single row/Tandem				Back-to-back/Face-to-face				
			$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		
			X	Y	X	Y	X	Y	X	Y	
15°	0.178	0.38					1.47		1.65		2.39
	0.357	0.40					1.40		1.57		2.28
	0.714	0.43					1.30		1.46		2.11
	1.07	0.46					1.23		1.38		2.00
	1.43	0.47	1	0	0.44	1.19	1	1.34	0.72	1.93	1.93
	2.14	0.50				1.12		1.26		1.82	
	3.57	0.55				1.02		1.14		1.66	
	5.35	0.56				1.00		1.12		1.63	
7.14	0.56				1.00		1.12		1.63		
20°		0.57	1	0	0.43	1	1	1.09	0.70	1.63	
30°		0.80	1	0	0.39	0.76	1	0.78	0.63	1.24	

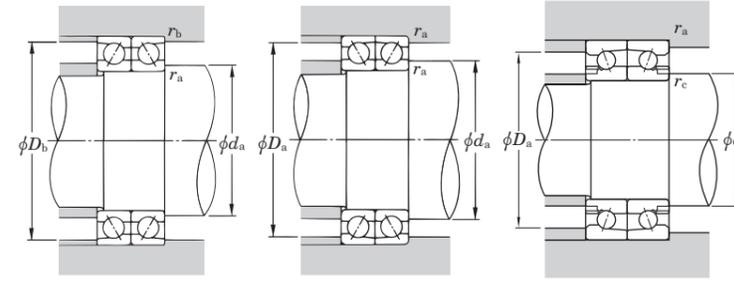
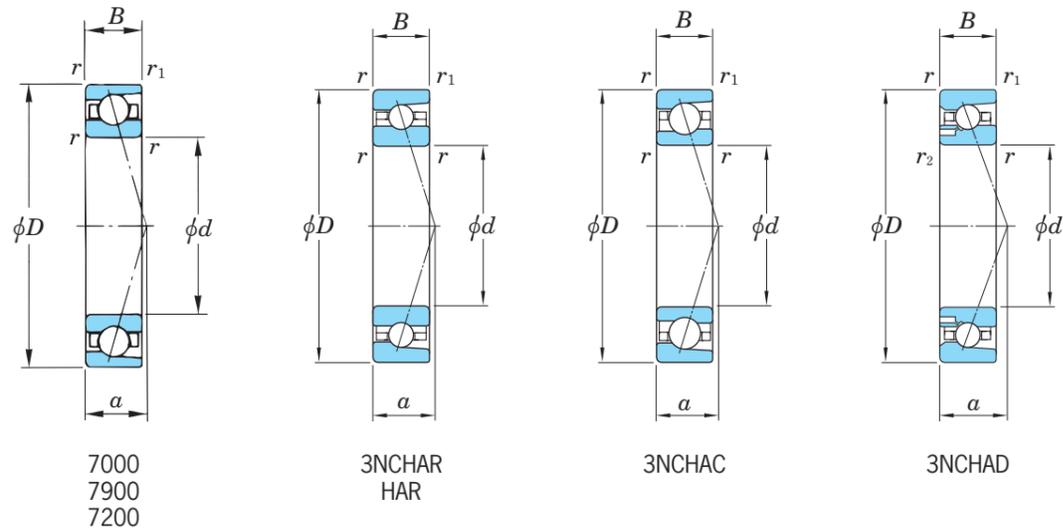
1) For i , use 2 for DB & DF and 1 for single & DT.

d (40) ~ (50)

d	Boundary dimensions (mm)					Bearing No.	Basic load ratings (kN)		Fatigue load limit (kN) C_u	Factor f_0	Limiting speeds (min ⁻¹)		Load center (mm) a	Interspace volume (cm ³ /row)	(Refer.) Mass (kg/row)	Permissible axial load (kN) (static)	Mounting dimensions (mm)							Nut axial tension (N)	Interference of retaining plate (mm)	Preload (Combination of DB and DF) (N)				Axial rigidity (Combination of DB and DF) (N/μm)			
	D	B	r min.	r ₁ min.	r ₂ min.		C_r	C_{0r}			Grease lub.	Oil lub.					d_a min.	d_b min.	D_a max.	D_b max.	r_a max.	r_b max.	r_c max.			S	L	M	H	S	L	M	H
40	80	18	1.1	0.6	—	7208C-5	45.4	25.2	1.70	14.2	19 000	30 000	17.0	15	0.382	15.5	47	—	73	75.5	1	0.6	—	10 000	0.01~0.02	65	195	440	880	35	55	81	116
	80	18	1.1	0.6	—	7208AC-5	43.4	24.1	1.60	—	17 000	25 000	23.0	15	0.382	10.4	47	—	73	75.5	1	0.6	—	10 000	0.01~0.02	—	390	880	1 570	—	147	205	262
	80	18	1.1	0.6	—	7208-5	42.0	23.3	1.50	—	15 000	19 000	26.3	15	0.382	8.31	47	—	73	75.5	1	0.6	—	10 000	0.01~0.02	—	390	880	1 570	—	193	261	329
45	68	12	0.6	0.3	—	7909C-5	20.8	14.1	0.77	16.0	22 000	35 000	13.6	5.7	0.127	6.84	49.5	—	63.5	65.5	0.6	0.3	—	6 000	0.01~0.02	35	100	195	—	31	49	67	—
	68	12	0.6	0.3	—	HAR909C	8.50	4.70	0.24	8.50	26 000	42 000	13.6	4.6	0.136	5.97	49.5	—	63.5	65.5	0.6	0.3	—	6 000	0.01~0.02	35	110	220	—	27	43	59	—
	68	12	0.6	0.3	—	3NCHAR909C	8.50	4.70	0.17	8.50	37 000	61 000	13.6	4.6	0.129	3.80	49.5	—	63.5	65.5	0.6	0.3	—	6 000	0.01~0.02	40	120	240	—	31	50	68	—
	68	12	0.6	0.3	—	HAR909CA	8.30	4.55	0.24	—	26 000	39 000	16.3	4.6	0.136	7.00	49.5	—	63.5	65.5	0.6	0.3	—	6 000	0.01~0.02	55	165	330	—	56	85	112	—
	68	12	0.6	0.3	—	3NCHAR909CA	8.30	4.55	0.17	—	35 000	58 000	16.3	4.6	0.129	4.61	49.5	—	63.5	65.5	0.6	0.3	—	6 000	0.01~0.02	60	180	360	—	65	97	129	—
	68	12	0.6	0.3	—	HAR909	7.70	4.25	0.22	—	18 000	25 000	22.3	4.6	0.136	5.14	49.5	—	63.5	65.5	0.6	0.3	—	6 000	0.01~0.02	75	225	450	—	107	155	202	—
	68	12	0.6	0.3	—	3NCHAC909C	14.4	7.15	0.37	8.10	37 000	61 000	13.6	6.2	0.109	5.78	49.5	—	63.5	65.5	0.6	0.3	—	6 000	0.01~0.02	40	120	240	—	30	46	62	—
	68	12	0.6	0.3	—	3NCHAC909CA	14.1	7.00	0.36	—	35 000	58 000	16.3	6.2	0.109	7.04	49.5	—	63.5	65.5	0.6	0.3	—	6 000	0.01~0.02	60	180	360	—	65	97	129	—
	75	16	1	0.6	—	7009C-5	30.5	19.3	1.15	15.4	19 000	30 000	16.0	11	0.260	9.14	50.5	—	69.5	70.5	1	0.6	—	10 000	0.01~0.02	50	145	345	635	34	54	82	112
	75	16	1	0.6	—	7009AC-5	28.9	18.3	1.05	—	17 000	25 000	22.0	11	0.260	5.74	50.5	—	69.5	70.5	1	0.6	—	10 000	0.01~0.02	—	245	540	980	—	136	186	239
	75	16	1	0.6	—	7009-5	27.8	17.7	1.00	—	15 000	19 000	25.3	11	0.260	4.44	50.5	—	69.5	70.5	1	0.6	—	10 000	0.01~0.02	—	245	540	980	—	178	237	302
	75	16	1	0.6	—	HAR009C	13.6	7.10	0.37	8.30	25 000	39 000	16.0	8.4	0.251	9.03	50.5	—	69.5	70.5	1	0.6	—	10 000	0.01~0.02	50	150	300	—	30	48	65	—
	75	16	1	0.6	—	3NCHAR009C	13.6	7.10	0.26	8.30	35 000	58 000	16.0	8.4	0.237	5.76	50.5	—	69.5	70.5	1	0.6	—	10 000	0.01~0.02	55	165	330	—	35	55	75	—
	75	16	1	0.6	—	HAR009CA	13.3	6.95	0.36	—	25 000	37 000	18.9	8.4	0.251	10.6	50.5	—	69.5	70.5	1	0.6	—	10 000	0.01~0.02	60	180	360	—	59	87	113	—
	75	16	1	0.6	—	3NCHAR009CA	13.3	6.95	0.25	—	32 000	54 000	18.9	8.4	0.237	7.00	50.5	—	69.5	70.5	1	0.6	—	10 000	0.01~0.02	65	195	390	—	67	100	130	—
	75	16	1	0.6	—	HAR009	12.4	6.45	0.33	—	18 000	23 000	25.3	8.4	0.251	9.56	50.5	—	69.5	70.5	1	0.6	—	10 000	0.01~0.02	80	240	480	—	107	160	204	—
	75	16	1	0.6	—	3NCHAC009C	20.9	9.80	0.51	7.80	35 000	58 000	16.0	11	0.205	7.89	50.5	—	69.5	70.5	1	0.6	—	10 000	0.01~0.02	55	165	330	—	32	50	67	—
	75	16	1	0.6	—	3NCHAC009CA	20.5	9.60	0.50	—	32 000	54 000	18.9	11	0.205	9.64	50.5	—	69.5	70.5	1	0.6	—	10 000	0.01~0.02	65	195	390	—	62	92	119	—
	75	16	1	0.6	0.3	3NCHAD009CA	12.4	6.30	0.33	—	—	58 000	18.9	—	0.249	6.36	50.5	—	69.5	70.5	1	0.6	0.3	10 000	0.01~0.02	65	195	390	—	63	94	123	—
	85	19	1.1	0.6	—	7209C-5	51.0	28.7	1.95	14.2	18 000	29 000	18.1	18	0.430	16.8	52	—	78	80.5	1	0.6	—	10 000	0.01~0.02	85	245	540	1 080	39	62	90	129
	85	19	1.1	0.6	—	7209AC-5	48.8	27.4	1.80	—	16 000	24 000	24.4	18	0.430	11.0	52	—	78	80.5	1	0.6	—	10 000	0.01~0.02	85	490	1 080	1 770	85	165	225	278
85	19	1.1	0.6	—	7209-5	47.2	26.6	1.70	—	14 000	18 000	28.0	18	0.430	8.74	52	—	78	80.5	1	0.6	—	10 000	0.01~0.02	—	490	1 080	1 770	—	213	288	349	
50	72	12	0.6	0.3	—	7910C-5	21.8	15.7	0.84	16.2	21 000	32 000	14.2	6.2	0.128	7.42	54.5	—	67.5	69.5	0.6	0.3	—	6 000	0.01~0.02	35	100	195	—	33	52	70	—
	72	12	0.6	0.3	—	HAR910C	11.4	6.30	0.33	8.50	25 000	39 000	14.2	5.6	0.131	8.06	54.5	—	67.5	69.5	0.6	0.3	—	6 000	0.01~0.02	40	120	240	—	29	46	62	—
	72	12	0.6	0.3	—	3NCHAR910C	11.4	6.30	0.23	8.50	35 000	57 000	14.2	5.6	0.121	5.13	54.5	—	67.5	69.5	0.6	0.3	—	6 000	0.01~0.02	45	135	270	—	35	53	72	—
	72	12	0.6	0.3	—	HAR910CA	11.1	6.15	0.32	—	23 000	36 000	17.1	5.6	0.131	9.13	54.5	—	67.5	69.5	0.6	0.3	—	6 000	0.01~0.02	60	180	360	—	60	90	119	—
	72	12	0.6	0.3	—	3NCHAR910CA	11.1	6.15	0.22	—	32 000	54 000	17.1	5.6	0.121	6.22	54.5	—	67.5	69.5	0.6	0.3	—	6 000	0.01~0.02	65	195	390	—	70	105	137	—

- [Remarks] 1. For the dimensions of the spacers for oil / air lubrication, refer to Table 15.4 on page 53 to 57.
 2. For the discharge intervals of the oil / air,

1. Angular contact ball bearings



We recommend that recesses be added at r_a , r_b , and r_c .

Static equivalent load $P_0 = X_0 F_r + Y_0 F_a$

Contact angle	Single row/Tandem		Back-to-back/Face-to-face	
	X_0	Y_0	X_0	Y_0
15°	0.5	0.46	1	0.92
20°	0.5	0.42	1	0.84
30°	0.5	0.33	1	0.66

Note that in the case of single row or tandem, assume $P_0 = F_r$ if $P_0 < F_r$.

Dynamic equivalent load $P = X F_r + Y F_a$

Contact angle	$\frac{i_0 F_a}{C_{0r}}$	e	Single row/Tandem				Back-to-back/Face-to-face				
			$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		
			X	Y	X	Y	X	Y	X	Y	
15°	0.178	0.38					1.47		1.65		2.39
	0.357	0.40					1.40		1.57		2.28
	0.714	0.43					1.30		1.46		2.11
	1.07	0.46					1.23		1.38		2.00
	1.43	0.47	1	0	0.44	1.19	1	1.34	0.72	1.93	
	2.14	0.50					1.12		1.26		1.82
	3.57	0.55					1.02		1.14		1.66
	5.35	0.56					1.00		1.12		1.63
7.14	0.56					1.00		1.12		1.63	
20°		0.57	1	0	0.43	1	1	1.09	0.70	1.63	
30°		0.80	1	0	0.39	0.76	1	0.78	0.63	1.24	

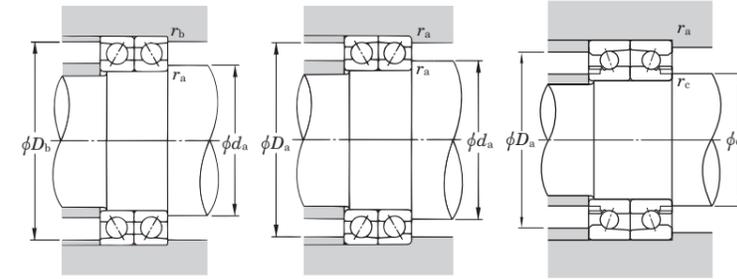
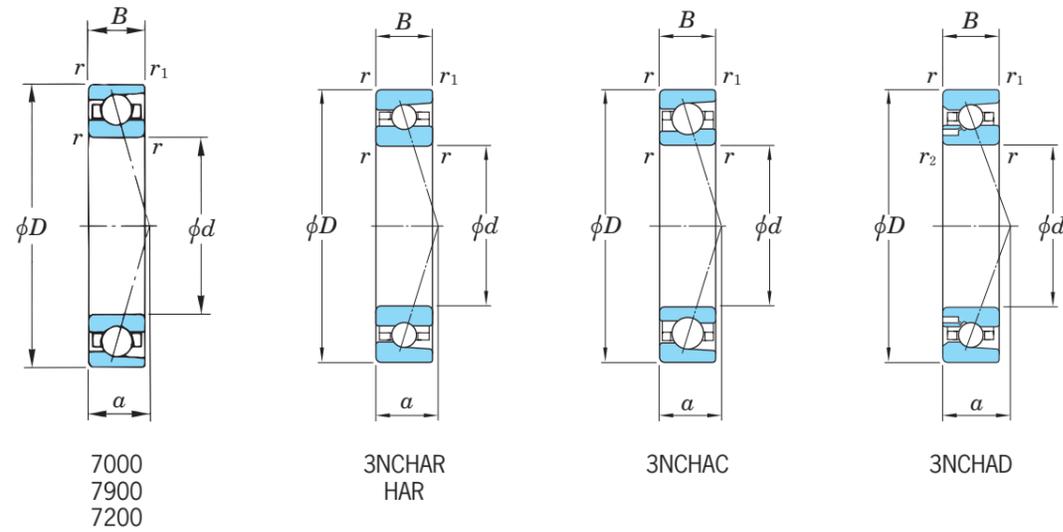
1) For i , use 2 for DB & DF and 1 for single & DT.

d (50) ~ (55)

d	Boundary dimensions (mm)					Bearing No.	Basic load ratings (kN)		Fatigue load limit (kN) C_u	Factor f_0	Limiting speeds (min ⁻¹)		Load center (mm) a	Interspace volume (cm ³ /row)	(Refer.) Mass (kg/row)	Permissible axial load (kN) (static)	Mounting dimensions (mm)						Nut axial tension (N)	Interference of retaining plate (mm)	Preload (Combination of DB and DF) (N)				Axial rigidity (Combination of DB and DF) (N/μm)				
	D	B	r min.	r ₁ min.	r ₂ min.		C_r	C_{0r}			Grease lub.	Oil lub.					d_a min.	d_b min.	D_a max.	D_b max.	r_a max.	r_b max.			r_c max.	S	L	M	H	S	L	M	H
50	72	12	0.6	0.3	—	HAR910	10.3	5.75	0.30	—	16 000	22 000	23.6	5.6	0.131	5.16	54.5	—	67.5	69.5	0.6	0.3	—	6 000	0.01~0.02	85	255	510	—	113	170	219	—
	72	12	0.6	0.3	—	3NCHAC910C	15.2	7.95	0.41	8.20	35 000	57 000	14.2	6.5	0.109	6.45	54.5	—	67.5	69.5	0.6	0.3	—	6 000	0.01~0.02	45	135	270	—	30	46	62	—
	72	12	0.6	0.3	—	3NCHAC910CA	14.9	7.95	0.40	—	32 000	54 000	17.1	6.5	0.109	7.85	54.5	—	67.5	69.5	0.6	0.3	—	6 000	0.01~0.02	65	195	390	—	67	101	132	—
	80	16	1	0.6	—	7010C-5	32.5	21.9	1.25	15.7	18 000	29 000	16.8	12	0.290	10.2	55.5	—	74.5	75.5	1	0.6	—	10 000	0.01~0.02	50	145	390	735	36	57	92	128
	80	16	1	0.6	—	7010AC-5	30.7	20.8	1.15	—	16 000	24 000	23.3	12	0.290	6.43	55.5	—	74.5	75.5	1	0.6	—	10 000	0.01~0.02	—	245	635	1 180	—	146	212	274
	80	16	1	0.6	—	7010-5	29.5	20.1	1.10	—	13 000	18 000	26.9	12	0.290	4.97	55.5	—	74.5	75.5	1	0.6	—	10 000	0.01~0.02	—	245	635	1 180	—	192	270	345
	80	16	1	0.6	—	HAR010C	14.2	7.85	0.41	8.40	23 000	36 000	16.7	10	0.273	9.98	55.5	—	74.5	75.5	1	0.6	—	10 000	0.01~0.02	55	165	330	—	33	52	72	—
	80	16	1	0.6	—	3NCHAR010C	14.2	7.85	0.29	8.40	32 000	53 000	16.7	10	0.258	6.36	55.5	—	74.5	75.5	1	0.6	—	10 000	0.01~0.02	60	180	360	—	39	60	82	—
	80	16	1	0.6	—	HAR010CA	13.9	7.65	0.40	—	22 000	35 000	19.8	10	0.273	11.7	55.5	—	74.5	75.5	1	0.6	—	10 000	0.01~0.02	65	195	390	—	63	94	123	—
	80	16	1	0.6	—	3NCHAR010CA	13.9	7.65	0.28	—	29 000	50 000	19.8	10	0.258	7.72	55.5	—	74.5	75.5	1	0.6	—	10 000	0.01~0.02	70	210	420	—	72	109	141	—
	80	16	1	0.6	—	HAR010	12.9	7.15	0.37	—	16 000	21 000	26.8	10	0.273	10.4	55.5	—	74.5	75.5	1	0.6	—	10 000	0.01~0.02	90	270	540	—	120	177	227	—
	80	16	1	0.6	—	3NCHAC010C	22.4	11.2	0.58	8.00	32 000	53 000	16.8	12	0.219	9.00	55.5	—	74.5	75.5	1	0.6	—	10 000	0.01~0.02	60	180	360	—	36	55	74	—
	80	16	1	0.6	—	3NCHAC010CA	21.9	10.9	0.56	—	29 000	50 000	19.9	12	0.219	10.9	55.5	—	74.5	75.5	1	0.6	—	10 000	0.01~0.02	70	210	420	—	68	101	131	—
	80	16	1	0.6	0.3	3NCHAD010CA	13.5	7.35	0.38	—	—	53 000	19.8	—	0.269	7.40	55.5	—	74.5	75.5	1	0.6	0.3	10 000	0.01~0.02	70	210	420	—	70	105	138	—
	90	20	1.1	0.6	—	7210C-5	53.5	31.8	2.05	14.6	16 000	26 000	19.4	23	0.485	18.1	57	—	83	85.5	1	0.6	—	12 000	0.01~0.02	85	245	590	1 180	41	64	97	140
	90	20	1.1	0.6	—	7210AC-5	51.0	30.4	1.90	—	14 000	21 000	26.4	22	0.485	11.8	57	—	83	85.5	1	0.6	—	12 000	0.01~0.02	—	540	1 180	2 060	—	179	243	310
90	20	1.1	0.6	—	7210-5	49.2	29.4	1.80	—	12 000	16 000	30.4	22	0.485	9.44	57	—	83	85.5	1	0.6	—	12 000	0.01~0.02	—	540	1 180	2 060	—	232	311	387	
55	80	13	1	0.6	—	7911C-5	24.6	18.5	0.98	16.3	18 000	29 000	15.5	8.1	0.178	8.27	60.5	—	74.5	75.5	1	0.6	—	6 000	0.01~0.02	40	115	235	—	36	57	78	—
	80	13	1	0.6	—	HAR911C	12.6	7.65	0.40	8.60	22 000	35 000	15.5	6.5	0.189	9.80	60.5	—	74.5	75.5	1	0.6	—	6 000	0.01~0.02	45	135	270	—	35	54	72	—
	80	13	1	0.6	—	3NCHAR911C	12.6	7.65	0.28	8.60	30 000	51 000	15.5	6.5	0.176	6.24	60.5	—	74.5	75.5	1	0.6	—	6 000	0.01~0.02	50	150	300	—	40	62	84	—
	80	13	1	0.6	—	HAR911CA	12.3	7.50	0.39	—	22 000	33 000	18.8	6.5	0.189	10.7	60.5	—	74.5	75.5	1	0.6	—	6 000	0.01~0.02	65	195	390	—	70	104	138	—
	80	13	1	0.6	—	3NCHAR911CA	12.3	7.50	0.27	—	29 000	49 000	18.8	6.5	0.176	7.06	60.5	—	74.5	75.5	1	0.6	—	6 000	0.01~0.02	70	210	420	—	80	120	157	—
	80	13	1	0.6	—	HAR911	11.4	6.95	0.36	—	15 000	21 000	26.0	6.5	0.189	8.84	60.5	—	74.5	75.5	1	0.6	—	6 000	0.01~0.02	90	270	540	—	133	193	251	—
	80	13	1	0.6	—	3NCHAC911C	17.3	9.40	0.49	8.30	30 000	51 000	15.5	8.3	0.154	7.61	60.5	—	74.5	75.5	1	0.6	—	6 000	0.01~0.02	50	150	300	—	32	50	67	—
	80	13	1	0.6	—	3NCHAC911CA	16.9	9.20	0.47	—	29 000	49 000	18.8	8.3	0.154	9.25	60.5	—	74.5	75.5	1	0.6	—	6 000	0.01~0.02	70	210	420	—	74	109	141	—
	90	18	1.1	0.6	—	7011C-5	42.6	28.6	1.65	15.5	16 000	26 000	18.7	17	0.420	13.3	62	—	83	85.5	1	0.6	—	12 000	0.01~0.02	65	195	440	880	41	65	95	136
	90	18	1.1	0.6	—	7011AC-5	40.4	27.2	1.55	—	14 000	21 000	25.9	17	0.420	9.18	62	—	83	85.5	1	0.6	—	12 000	0.01~0.02	—	295	780	1 370	—	157	229	290
	90	18	1.1	0.6	—	7011-5	38.9	26.3	1.50	—	12 000	16 000	29.9	17	0.420	6.35	62	—	83	85.5	1	0.6	—	12 000	0.01~0.02	—	295	780	1 370	—	207	297	368
	90	18	1.1	0.6	—	HAR011C	17.6	9.90	0.51	8.40	21 000	32 000	18.7	13	0.403	12.6	62	—	83	85.5	1	0.6	—	12 000	0.01~0.02	60	180	360	—	35	55	75	—
	90	18	1.1	0.6	—	3NCHAR011C	17.6	9.90	0.36	8.40	29 000	47 000	18.7	13	0.382	8.03	62	—	83	85.5	1	0.6	—	12 000	0.01~0.02	65	195	390	—	41	63	86	—

- [Remarks] 1. For the dimensions of the spacers for oil / air lubrication, refer to Table 15. 4 on page 53 to 57.
 2. For the discharge intervals of the oil / air, refer to Supplementary table 6 on page 215.
 3. C, CA, and no character string in the bearing number indicate nominal contact angles of 15

1. Angular contact ball bearings



We recommend that recesses be added at r_a , r_b , and r_c .

Static equivalent load $P_0 = X_0 F_r + Y_0 F_a$

Contact angle	Single row/Tandem		Back-to-back/Face-to-face	
	X_0	Y_0	X_0	Y_0
15°	0.5	0.46	1	0.92
20°	0.5	0.42	1	0.84
30°	0.5	0.33	1	0.66

Note that in the case of single row or tandem, assume $P_0 = F_r$ if $P_0 < F_r$.

Dynamic equivalent load $P = X F_r + Y F_a$

Contact angle	$\frac{i_0 F_a}{C_{0r}}$	e	Single row/Tandem				Back-to-back/Face-to-face			
			$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
			X	Y	X	Y	X	Y	X	Y
15°	0.178	0.38			1.47			1.65		2.39
	0.357	0.40			1.40			1.57		2.28
	0.714	0.43			1.30			1.46		2.11
	1.07	0.46			1.23			1.38		2.00
	1.43	0.47	1	0	1.19	1	1.34	0.72	1.93	1.93
	2.14	0.50			1.12			1.26		1.82
	3.57	0.55			1.02			1.14		1.66
	5.35	0.56			1.00			1.12		1.63
7.14	0.56			1.00			1.12		1.63	
20°		0.57	1	0	0.43	1	1	1.09	0.70	1.63
30°		0.80	1	0	0.39	0.76	1	0.78	0.63	1.24

1) For i , use 2 for DB & DF and 1 for single & DT.

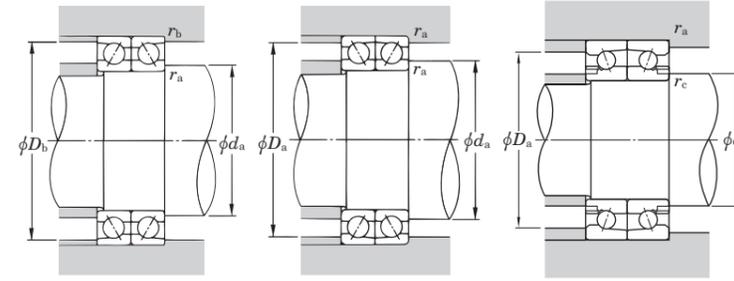
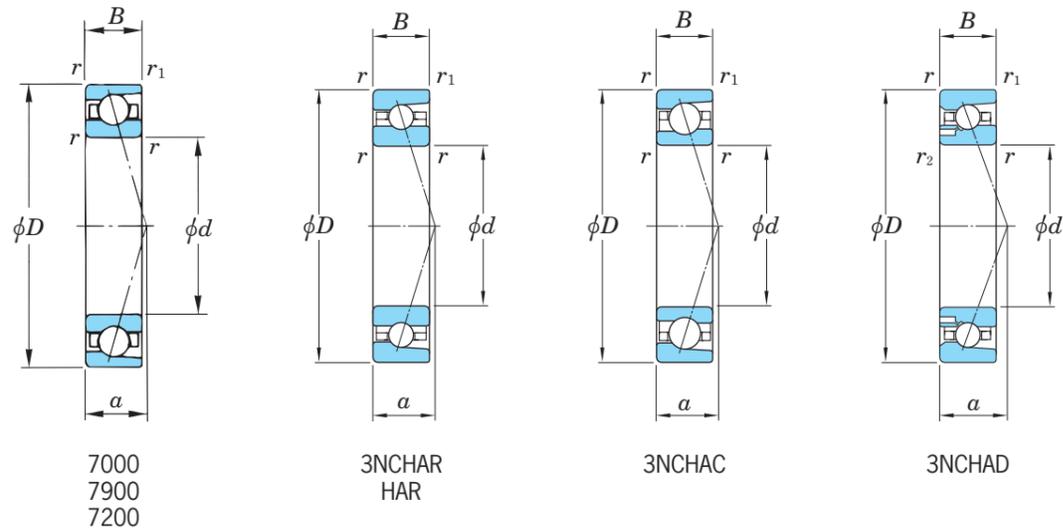
d (55) ~ (60)

d	Boundary dimensions (mm)					Bearing No.	Basic load ratings (kN)		Fatigue load limit (kN) C_u	Factor f_0	Limiting speeds (min ⁻¹)		Load center (mm) a	Interspace volume (cm ³ /row)	(Refer.) Mass (kg/row)	Permissible axial load (kN) (static)	Mounting dimensions (mm)							Nut axial tension (N)	Interference of retaining plate (mm)	Preload (Combination of DB and DF) (N)				Axial rigidity (Combination of DB and DF) (N/μm)			
	D	B	r min.	r ₁ min.	r ₂ min.		C_r	C_{0r}			Grease lub.	Oil lub.					d_a min.	d_b min.	D_a max.	D_b max.	r_a max.	r_b max.	r_c max.			S	L	M	H	S	L	M	H
55	90	18	1.1	0.6	—	HAR011CA	17.2	9.70	0.50	—	19 000	30 000	22.2	13	0.403	14.8	62	—	83	85.5	1	0.6	—	12 000	0.01~0.02	75	225	450	—	68	102	133	—
	90	18	1.1	0.6	—	3NCHAR011CA	17.2	9.70	0.35	—	26 000	44 000	22.2	13	0.382	9.75	62	—	83	85.5	1	0.6	—	12 000	0.01~0.02	85	255	510	—	81	120	157	—
	90	18	1.1	0.6	—	HAR011	16.0	9.00	0.47	—	14 000	19 000	29.9	13	0.403	12.8	62	—	83	85.5	1	0.6	—	12 000	0.01~0.02	115	345	690	—	135	197	256	—
	90	18	1.1	0.6	—	3NCHAC011C	29.4	14.6	0.75	7.90	29 000	47 000	18.7	17	0.319	11.7	62	—	83	85.5	1	0.6	—	12 000	0.01~0.02	65	195	390	—	37	57	76	—
	90	18	1.1	0.6	—	3NCHAC011CA	28.7	14.3	0.74	—	26 000	44 000	22.2	17	0.319	14.3	62	—	83	85.5	1	0.6	—	12 000	0.01~0.02	85	255	510	—	74	110	143	—
	90	18	1.1	0.6	0.3	3NCHAD011CA	16.2	8.90	0.46	—	—	47 000	22.2	—	0.395	8.94	62	—	83	85.5	1	0.6	0.3	12 000	0.01~0.02	85	255	510	—	76	113	148	—
	100	21	1.5	1	—	7211C-5	66.1	40.2	2.60	14.6	15 000	23 000	21.1	29	0.635	23.5	63.5	—	91.5	94.5	1.5	1	—	12 000	0.01~0.02	100	295	735	1 470	44	70	108	156
	100	21	1.5	1	—	7211AC-5	63.0	38.4	2.40	—	13 000	19 000	28.9	29	0.635	15.5	63.5	—	91.5	94.5	1.5	1	—	12 000	0.01~0.02	—	635	1 370	2 450	—	195	266	339
	100	21	1.5	1	—	7211-5	60.9	37.1	2.30	—	11 000	15 000	33.3	29	0.635	12.4	63.5	—	91.5	94.5	1.5	1	—	12 000	0.01~0.02	—	635	1 370	2 450	—	254	340	426
	60	85	13	1	0.6	—	7912C-5	29.0	21.8	1.15	16.3	16 000	26 000	16.3	8.8	0.187	11.3	65.5	—	79.5	80.5	1	0.6	—	8 000	0.01~0.02	40	115	235	—	36	55	77
85		13	1	0.6	—	HAR912C	12.4	7.75	0.40	8.60	21 000	32 000	16.2	7.0	0.202	9.89	65.5	—	79.5	80.5	1	0.6	—	8 000	0.01~0.02	50	150	300	—	36	56	76	—
85		13	1	0.6	—	3NCHAR912C	12.4	7.75	0.28	8.60	29 000	47 000	16.2	7.0	0.189	6.30	65.5	—	79.5	80.5	1	0.6	—	8 000	0.01~0.02	55	165	330	—	41	64	88	—
85		13	1	0.6	—	HAR912CA	12.1	7.55	0.39	—	19 000	30 000	19.7	7.0	0.202	11.5	65.5	—	79.5	80.5	1	0.6	—	8 000	0.01~0.02	70	210	420	—	72	108	141	—
85		13	1	0.6	—	3NCHAR912CA	12.1	7.55	0.27	—	26 000	44 000	19.7	7.0	0.189	7.62	65.5	—	79.5	80.5	1	0.6	—	8 000	0.01~0.02	75	225	450	—	83	123	162	—
85		13	1	0.6	—	HAR912	11.3	7.00	0.36	—	14 000	19 000	27.4	7.0	0.202	9.95	65.5	—	79.5	80.5	1	0.6	—	8 000	0.01~0.02	95	285	570	—	136	200	256	—
85		13	1	0.6	—	3NCHAC912C	20.4	11.1	0.57	8.30	29 000	47 000	16.3	9.5	0.156	8.95	65.5	—	79.5	80.5	1	0.6	—	8 000	0.01~0.02	55	165	330	—	37	57	76	—
85		13	1	0.6	—	3NCHAC912CA	19.9	10.8	0.56	—	26 000	44 000	19.8	9.5	0.156	10.8	65.5	—	79.5	80.5	1	0.6	—	8 000	0.01~0.02	75	225	450	—	67	99	130	—
95		18	1.1	0.6	—	7012C-5	43.8	30.6	1.75	15.7	15 000	23 000	19.4	19	0.450	13.5	67	—	88	90.5	1	0.6	—	12 000	0.01~0.02	65	195	490	980	42	67	103	147
95		18	1.1	0.6	—	7012AC-5	41.5	29.1	1.65	—	13 000	19 000	27.1	19	0.450	8.32	67	—	88	90.5	1	0.6	—	12 000	0.01~0.02	—	390	880	1 570	—	181	250	317
95		18	1.1	0.6	—	7012-5	39.9	28.1	1.55	—	11 000	15 000	31.4	19	0.450	6.37	67	—	88	90.5	1	0.6	—	12 000	0.01~0.02	—	390	880	1 570	—	236	320	400
95		18	1.1	0.6	—	HAR012C	18.4	10.8	0.56	8.50	19 000	30 000	19.4	15	0.433	13.8	67	—	88	90.5	1	0.6	—	12 000	0.01~0.02	65	195	390	—	38	60	82	—
95		18	1.1	0.6	—	3NCHAR012C	18.4	10.8	0.39	8.50	26 000	44 000	19.4	15	0.410	8.79	67	—	88	90.5	1	0.6	—	12 000	0.01~0.02	70	210	420	—	44	68	93	—
95		18	1.1	0.6	—	HAR012CA	17.9	10.6	0.55	—	19 000	29 000	23.1	15	0.433	16.1	67	—	88	90.5	1	0.6	—	12 000	0.01~0.02	80	240	480	—	74	110	143	—
95		18	1.1	0.6	—	3NCHAR012CA	17.9	10.6	0.39	—	25 000	42 000	23.1	15	0.410	10.6	67	—	88	90.5	1	0.6	—	12 000	0.01~0.02	90	270	540	—	88	129	167	—
95		18	1.1	0.6	—	HAR012	16.7	9.85	0.51	—	13 000	18 000	31.4	15	0.433	13.9	67	—	88	90.5	1	0.6	—	12 000	0.01~0.02	125	375	750	—	147	214	275	—
95		18	1.1	0.6	—	3NCHAC012C	30.3	15.6	0.81	8.00	26 000	44 000	19.4	19	0.340	12.5	67	—	88	90.5	1	0.6	—	12 000	0.01~0.02	70	210	420	—	39	60	81	—
95		18	1.1	0.6	—	3NCHAC012CA	29.6	15.3	0.79	—	25 000	42 000	23.1	19	0.340	15.3	67	—	88	90.5	1	0.6	—	12 000	0.01~0.02	90	270	540	—	78	115	151	—
95		18	1.1	0.6	0.3	3NCHAD012CA	17.0	9.75	0.50	—	—	44 000	23.1	—	0.427	9.84	67	—	88	90.5	1	0.6	0.3	12 000	0.01~0.02	90	270	540	—	82	123	160	—
110		22	1.5	1	—	7212C-5	80.0	49.5	3.20	14.5	13 000	21 000	22.7	36	0.820	29.5	68.5	—	101.5	104.5	1.5	1	—	15 000	0.01~0.02	110	345	780	1 670	47	76	111	165
110		22	1.5	1	—	7212AC-5	76.3	47.3	3.00	—	12 000	17 000	31.3	36	0.820	19.6	68.5	—	101.5	104.5	1.5	1	—	15 000	0.01~0.02	—	780	1 470	2 940	—	217	279	371

- [Remarks] 1. For the dimensions of the spacers for oil / air lubrication, refer to Table 15. 4 on page 53 to 57.
 2. For the discharge intervals of the oil / air, refer to Supplementary table 6 on page 215.
 3. C, CA, and no character string in the bearing number indicate nominal contact angles of 15°, 20°, and 30°, respectively.

Basic load ratings in case of multiple-row combination bearing

1. Angular contact ball bearings



We recommend that recesses be added at r_a , r_b , and r_c .

Static equivalent load $P_0 = X_0 F_r + Y_0 F_a$

Contact angle	Single row/Tandem		Back-to-back/Face-to-face	
	X_0	Y_0	X_0	Y_0
15°	0.5	0.46	1	0.92
20°	0.5	0.42	1	0.84
30°	0.5	0.33	1	0.66

Note that in the case of single row or tandem, assume $P_0 = F_r$ if $P_0 < F_r$.

Dynamic equivalent load $P = X F_r + Y F_a$

Contact angle	$\frac{i_0 F_a}{C_{0r}}$	e	Single row/Tandem				Back-to-back/Face-to-face			
			$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
			X	Y	X	Y	X	Y	X	Y
15°	0.178	0.38			1.47			1.65		2.39
	0.357	0.40			1.40			1.57		2.28
	0.714	0.43			1.30			1.46		2.11
	1.07	0.46			1.23			1.38		2.00
	1.43	0.47	1	0	1.19	1	0.72	1.34	0.72	1.93
	2.14	0.50			1.12			1.26		1.82
	3.57	0.55			1.02			1.14		1.66
	5.35	0.56			1.00			1.12		1.63
7.14	0.56			1.00			1.12		1.63	
20°		0.57	1	0	0.43	1	1	1.09	0.70	1.63
30°		0.80	1	0	0.39	0.76	1	0.78	0.63	1.24

1) For i , use 2 for DB & DF and 1 for single & DT.

d (60) ~ (70)

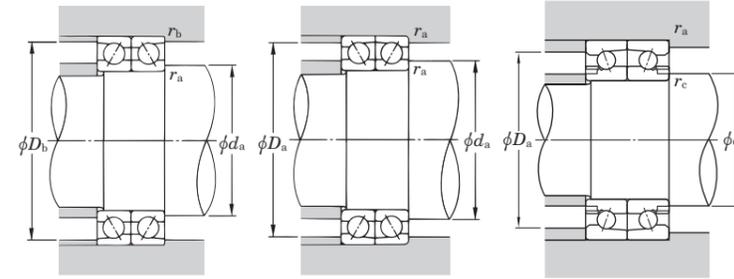
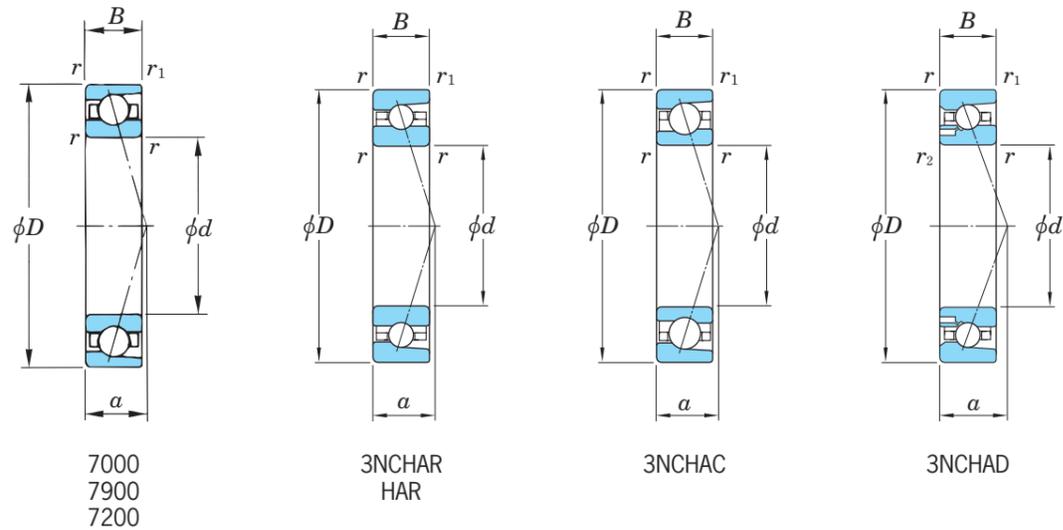
d	Boundary dimensions (mm)					Bearing No.	Basic load ratings (kN)		Fatigue load limit (kN) C_u	Factor f_0	Limiting speeds (min ⁻¹)		Load center (mm) a	Interspace volume (cm ³ /row)	(Refer.) Mass (kg/row)	Permissible axial load (kN) (static)	Mounting dimensions (mm)						Nut axial tension (N)	Interference of retaining plate (mm)	Preload (Combination of DB and DF) (N)				Axial rigidity (Combination of DB and DF) (N/μm)				
	D	B	$r_{min.}$	$r_{1 min.}$	$r_{2 min.}$		C_r	C_{0r}			Grease lub.	Oil lub.					d_a min.	d_b min.	D_a max.	D_b max.	r_a max.	r_b max.			r_c max.	S	L	M	H	S	L	M	H
60	110	22	1.5	1	—	7212-5	73.7	45.7	2.85	—	10 000	13 000	36.1	36	0.820	15.7	68.5	—	101.5	104.5	1.5	1	—	15 000	0.01~0.02	—	780	1 470	2 940	—	281	356	467
65	90	13	1	0.6	—	7913C-5	25.9	21.2	1.10	16.5	16 000	25 000	16.9	9.4	0.205	9.52	70.5	—	84.5	85.5	1	0.6	—	8 000	0.01~0.02	50	145	295	—	43	67	94	—
	90	13	1	0.6	—	HAR913C	14.7	9.45	0.49	8.60	19 000	30 000	16.9	7.9	0.212	12.0	70.5	—	84.5	85.5	1	0.6	—	8 000	0.01~0.02	55	165	330	—	39	61	83	—
	90	13	1	0.6	—	3NCHAR913C	14.7	9.45	0.34	8.60	26 000	44 000	16.9	7.9	0.196	7.70	70.5	—	84.5	85.5	1	0.6	—	8 000	0.01~0.02	60	180	360	—	44	70	95	—
	90	13	1	0.6	—	HAR913CA	14.3	9.25	0.48	—	19 000	29 000	20.6	7.9	0.212	14.1	70.5	—	84.5	85.5	1	0.6	—	8 000	0.01~0.02	75	225	450	—	79	117	153	—
	90	13	1	0.6	—	3NCHAR913CA	14.3	9.25	0.34	—	25 000	42 000	20.6	7.9	0.196	9.32	70.5	—	84.5	85.5	1	0.6	—	8 000	0.01~0.02	85	255	510	—	92	138	179	—
	90	13	1	0.6	—	HAR913	13.3	8.55	0.44	—	13 000	18 000	28.9	7.9	0.212	11.2	70.5	—	84.5	85.5	1	0.6	—	8 000	0.01~0.02	105	315	630	—	150	217	283	—
	90	13	1	0.6	—	3NCHAC913C	18.4	10.8	0.56	8.30	26 000	44 000	16.9	9.2	0.181	8.79	70.5	—	84.5	85.5	1	0.6	—	8 000	0.01~0.02	60	180	360	—	41	64	86	—
	90	13	1	0.6	—	3NCHAC913CA	17.9	10.6	0.55	—	25 000	42 000	20.6	9.2	0.181	10.6	70.5	—	84.5	85.5	1	0.6	—	8 000	0.01~0.02	85	255	510	—	85	126	165	—
	100	18	1.1	0.6	—	7013C-5	46.3	34.3	1.90	15.9	14 000	22 000	20.1	19	0.470	18.7	72	—	93	95.5	1	0.6	—	15 000	0.01~0.02	85	245	540	1 080	49	78	114	163
	100	18	1.1	0.6	—	7013AC-5	43.8	32.6	1.80	—	12 000	18 000	28.4	19	0.470	12.3	72	—	93	95.5	1	0.6	—	15 000	0.01~0.02	—	440	980	1 770	—	202	276	354
	100	18	1.1	0.6	—	7013-5	42.1	31.4	1.70	—	10 000	14 000	33.0	19	0.470	9.89	72	—	93	95.5	1	0.6	—	15 000	0.01~0.02	440	980	1 770	—	263	356	445	—
	100	18	1.1	0.6	—	HAR013C	19.1	11.8	0.61	8.50	18 000	29 000	20.1	16	0.462	14.9	72	—	93	95.5	1	0.6	—	15 000	0.01~0.02	65	195	390	—	40	62	85	—
	100	18	1.1	0.6	—	3NCHAR013C	19.1	11.8	0.43	8.50	25 000	42 000	20.1	16	0.437	9.55	72	—	93	95.5	1	0.6	—	15 000	0.01~0.02	70	210	420	—	46	71	96	—
	100	18	1.1	0.6	—	HAR013CA	18.6	11.5	0.59	—	18 000	26 000	24.0	16	0.462	17.5	72	—	93	95.5	1	0.6	—	15 000	0.01~0.02	85	255	510	—	79	117	155	—
	100	18	1.1	0.6	—	3NCHAR013CA	18.6	11.5	0.42	—	23 000	39 000	24.0	16	0.437	11.5	72	—	93	95.5	1	0.6	—	15 000	0.01~0.02	95	285	570	—	93	139	180	—
	100	18	1.1	0.6	—	HAR013	17.3	10.7	0.55	—	12 000	16 000	32.8	16	0.462	14.9	72	—	93	95.5	1	0.6	—	15 000	0.01~0.02	140	420	840	—	160	237	303	—
	100	18	1.1	0.6	—	3NCHAC013C	32.2	17.5	0.90	8.10	25 000	42 000	20.1	20	0.365	14.0	72	—	93	95.5	1	0.6	—	15 000	0.01~0.02	70	210	420	—	42	64	86	—
	100	18	1.1	0.6	—	3NCHAC013CA	31.5	17.1	0.88	—	23 000	39 000	24.1	20	0.365	17.1	72	—	93	95.5	1	0.6	—	15 000	0.01~0.02	95	285	570	—	84	127	163	—
100	18	1.1	0.6	0.3	3NCHAD013CA	17.7	10.7	0.55	—	—	42 000	24.0	—	0.456	10.7	72	—	93	95.5	1	0.6	0.3	15 000	0.01~0.02	95	285	570	—	88	131	171	—	
120	23	1.5	1	—	7213C-5	91.4	58.7	3.80	14.6	12 000	19 000	23.9	41	1.02	34.6	73.5	—	111.5	114.5	1.5	1	—	15 000	0.01~0.02	125	390	930	1 860	52	84	127	181	
120	23	1.5	1	—	7213AC-5	87.1	56.0	3.50	—	11 000	16 000	33.1	40	1.02	22.9	73.5	—	111.5	114.5	1.5	1	—	15 000	0.01~0.02	—	835	1 670	3 330	—	234	308	411	
120	23	1.5	1	—	7213-5	84.1	54.2	3.35	—	9 800	12 000	38.2	40	1.02	18.3	73.5	—	111.5	114.5	1.5	1	—	15 000	0.01~0.02	—	835	1 670	3 330	—	306	398	516	
70	100	16	1	0.6	—	7914C-5	36.2	29.0	1.55	16.4	15 000	22 000	19.4	16	0.332	12.9	75.5	—	94.5	95.5	1	0.6	—	10 000	0.01~0.02	65	195	390	—	46	74	103	—
	100	16	1	0.6	—	HAR914C	16.1	10.5	0.54	8.70	18 000	28 000	19.4	12	0.356	13.3	75.5	—	94.5	95.5	1	0.6	—	10 000	0.01~0.02	60	180	360	—	41	63	85	—
	100	16	1	0.6	—	3NCHAR914C	16.1	10.5	0.38	8.70	25 000	40 000	19.4	12	0.337	8.52	75.5	—	94.5	95.5	1	0.6	—	10 000	0.01~0.02	65	195	390	—	46	72	97	—
	100	16	1	0.6	—	HAR914CA	15.7	10.2	0.53	—	16 000	26 000	23.5	12	0.356	15.6	75.5	—	94.5	95.5	1	0.6	—	10 000	0.01~0.02	80	240	480	—	80	120	157	—
	100	16	1	0.6	—	3NCHAR914CA	15.7	10.2	0.37	—	22 000	39 000	23.5	12	0.337	10.3	75.5	—	94.5	95.5	1	0.6	—	10 000	0.01~0.02	90	270	540	—	92	138	183	—
	100	16	1	0.6	—	HAR914	14.6	9.45	0.49	—	12 000	16 000	32.5	12	0.356	12.9	75.5	—	94.5	95.5	1	0.6	—	10 000	0.01~0.02	110	330	660	—	152	224	287	—

- [Remarks] 1. For the dimensions of the spacers for oil / air lubrication, refer to Table 15. 4 on page 53 to 57.
- 2. For the discharge intervals of the oil / air, refer to Supplementary table 6 on page 215.
- 3. C, CA, and no character string in the bearing number indicate nominal contact angles of 15°, 20°, and 30°, respectively.

Basic load ratings in case of multiple-row combination bearing

	Basic dynamic load ratings	Basic static load ratings
2-row	$C_r \times 1.62$	$C_{0r} \times 2$
3-row	$C_r \times 2.16$	$C_{0r} \times 3$
4-row	$C_r \times 2.64$	$C_{0r} \times 4$

1. Angular contact ball bearings



We recommend that recesses be added at r_a , r_b , and r_c .

Static equivalent load $P_0 = X_0 F_r + Y_0 F_a$

Contact angle	Single row/Tandem		Back-to-back/Face-to-face	
	X_0	Y_0	X_0	Y_0
15°	0.5	0.46	1	0.92
20°	0.5	0.42	1	0.84
30°	0.5	0.33	1	0.66

Note that in the case of single row or tandem, assume $P_0 = F_r$ if $P_0 < F_r$.

Dynamic equivalent load $P = X F_r + Y F_a$

Contact angle	$\frac{i_0 F_a}{C_{0r}}$	e	Single row/Tandem				Back-to-back/Face-to-face				
			$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		
			X	Y	X	Y	X	Y	X	Y	
15°	0.178	0.38			1.47			1.65			2.39
	0.357	0.40			1.40			1.57			2.28
	0.714	0.43			1.30			1.46			2.11
	1.07	0.46			1.23			1.38			2.00
	1.43	0.47	1	0	1.19	1	0.72	1.34	0.72	1.93	
	2.14	0.50			1.12			1.26			1.82
	3.57	0.55			1.02			1.14			1.66
	5.35	0.56			1.00			1.12			1.63
7.14	0.56			1.00			1.12			1.63	
20°		0.57	1	0	0.43	1	1	1.09	0.70	1.63	
30°		0.80	1	0	0.39	0.76	1	0.78	0.63	1.24	

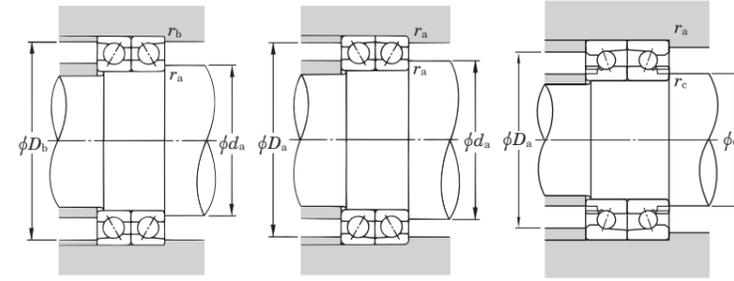
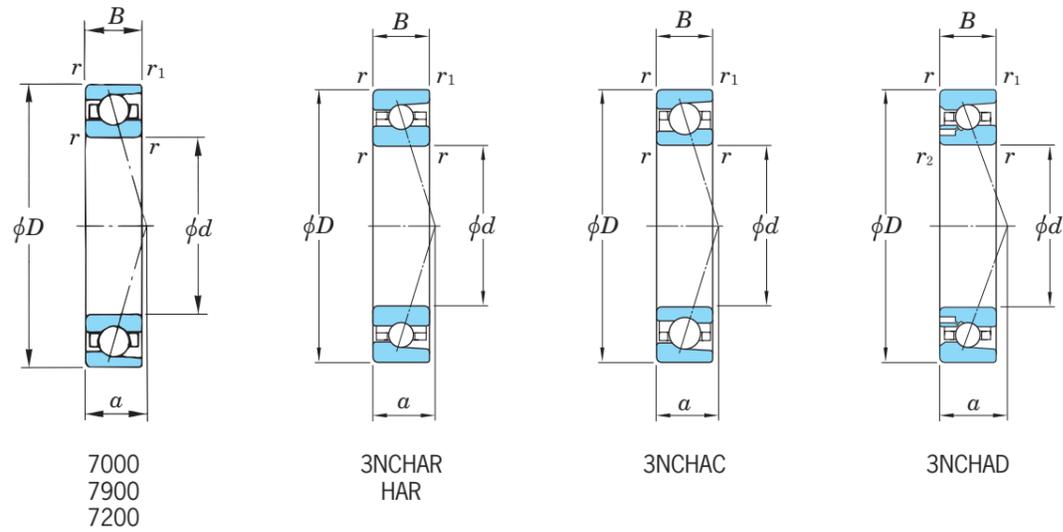
1) For i , use 2 for DB & DF and 1 for single & DT.

d (70) ~ (75)

d	Boundary dimensions (mm)					Bearing No.	Basic load ratings (kN)		Fatigue load limit (kN) C_u	Factor f_0	Limiting speeds (min ⁻¹)		Load center (mm) a	Interspace volume (cm ³ /row)	(Refer.) Mass (kg/row)	Permissible axial load (kN) (static)	Mounting dimensions (mm)							Nut axial tension (N)	Interference of retaining plate (mm)	Preload (Combination of DB and DF) (N)				Axial rigidity (Combination of DB and DF) (N/μm)			
	D	B	r min.	r ₁ min.	r ₂ min.		C_r	C_{0r}			Grease lub.	Oil lub.					d_a min.	d_b min.	D_a max.	D_b max.	r_a max.	r_b max.	r_c max.			S	L	M	H	S	L	M	H
70	100	16	1	0.6	—	3NCHAC914C	25.4	14.7	0.76	8.30	25 000	40 000	19.4	15	0.291	11.9	75.5	—	94.5	95.5	1	0.6	—	10 000	0.01~0.02	65	195	390	—	43	66	87	—
	100	16	1	0.6	—	3NCHAC914CA	24.8	14.4	0.74	—	22 000	39 000	23.5	15	0.291	14.5	75.5	—	94.5	95.5	1	0.6	—	10 000	0.01~0.02	90	270	540	—	86	129	166	—
	110	20	1.1	0.6	—	7014C-5	58.6	43.0	2.45	15.7	13 000	21 000	22.1	27	0.660	21.0	77	—	103	105.5	1	0.6	—	15 000	0.01~0.02	85	245	635	1 270	50	77	121	172
	110	20	1.1	0.6	—	7014AC-5	55.5	40.9	2.30	—	12 000	17 000	31.0	27	0.660	13.3	77	—	103	105.5	1	0.6	—	15 000	0.01~0.02	—	490	1 080	2 060	—	211	286	375
	110	20	1.1	0.6	—	7014-5	53.3	39.4	2.15	—	10 000	13 000	36.0	27	0.660	10.4	77	—	103	105.5	1	0.6	—	15 000	0.01~0.02	—	490	1 080	2 060	—	276	369	474
	110	20	1.1	0.6	—	HAR014C	25.9	15.5	0.80	8.40	16 000	26 000	22.1	23	0.629	19.7	77	—	103	105.5	1	0.6	—	15 000	0.01~0.02	70	210	420	—	40	62	84	—
	110	20	1.1	0.6	—	3NCHAR014C	25.9	15.5	0.56	8.40	23 000	39 000	22.1	23	0.588	12.5	77	—	103	105.5	1	0.6	—	15 000	0.01~0.02	75	225	450	—	46	71	95	—
	110	20	1.1	0.6	—	HAR014CA	25.3	15.1	0.78	—	16 000	25 000	26.4	23	0.629	23.1	77	—	103	105.5	1	0.6	—	15 000	0.01~0.02	90	270	540	—	78	117	154	—
	110	20	1.1	0.6	—	3NCHAR014CA	25.3	15.1	0.55	—	22 000	36 000	26.4	23	0.588	15.2	77	—	103	105.5	1	0.6	—	15 000	0.01~0.02	100	300	600	—	93	138	178	—
	110	20	1.1	0.6	—	HAR014	23.6	14.1	0.73	—	11 000	15 000	36.0	23	0.629	20.3	77	—	103	105.5	1	0.6	—	15 000	0.01~0.02	150	440	880	—	162	238	303	—
	110	20	1.1	0.6	—	3NCHAC014C	40.5	21.9	1.15	8.00	23 000	39 000	22.1	28	0.500	17.6	77	—	103	105.5	1	0.6	—	15 000	0.01~0.02	75	225	450	—	43	66	87	—
	110	20	1.1	0.6	—	3NCHAC014CA	39.6	21.4	1.10	—	22 000	36 000	26.4	28	0.500	21.5	77	—	103	105.5	1	0.6	—	15 000	0.01~0.02	100	300	600	—	87	129	168	—
	110	20	1.1	0.6	0.3	3NCHAD014CA	23.9	13.9	0.72	—	—	39 000	26.4	—	0.635	14.0	77	—	103	105.5	1	0.6	0.3	15 000	0.01~0.02	100	300	600	—	87	130	170	—
	125	24	1.5	1	—	7214C-5	94.9	60.2	3.90	14.6	12 000	19 000	25.1	48	1.12	35.3	78.5	—	116.5	119.5	1.5	1	—	15 000	0.01~0.02	160	490	980	2 060	56	90	125	184
	125	24	1.5	1	—	7214AC-5	90.4	57.5	3.60	—	11 000	16 000	34.7	48	1.12	23.2	78.5	—	116.5	119.5	1.5	1	—	15 000	0.01~0.02	—	930	1 860	3 730	—	237	311	417
125	24	1.5	1	—	7214-5	87.3	55.6	3.40	—	9 200	12 000	40.2	48	1.12	18.6	78.5	—	116.5	119.5	1.5	1	—	15 000	0.01~0.02	—	930	1 860	3 730	—	307	398	524	
75	105	16	1	0.6	—	7915C-5	36.7	30.5	1.60	16.5	13 000	21 000	20.1	17	0.350	13.5	80.5	—	99.5	100.5	1	0.6	—	10 000	0.01~0.02	65	195	390	—	48	76	105	—
	105	16	1	0.6	—	HAR915C	16.6	11.2	0.58	8.70	16 000	26 000	20.1	12	0.370	14.3	80.5	—	99.5	100.5	1	0.6	—	10 000	0.01~0.02	70	210	420	—	44	70	95	—
	105	16	1	0.6	—	3NCHAR915C	16.6	11.2	0.41	8.70	23 000	39 000	20.1	12	0.349	9.12	80.5	—	99.5	100.5	1	0.6	—	10 000	0.01~0.02	75	225	450	—	51	80	108	—
	105	16	1	0.6	—	HAR915CA	16.2	10.9	0.56	—	16 000	25 000	24.4	12	0.370	16.7	80.5	—	99.5	100.5	1	0.6	—	10 000	0.01~0.02	100	300	600	—	91	136	178	—
	105	16	1	0.6	—	3NCHAR915CA	16.2	10.9	0.40	—	22 000	36 000	24.4	12	0.349	11.0	80.5	—	99.5	100.5	1	0.6	—	10 000	0.01~0.02	110	330	660	—	102	155	205	—
	105	16	1	0.6	—	HAR915	15.0	10.1	0.52	—	11 000	15 000	34.0	12	0.370	13.8	80.5	—	99.5	100.5	1	0.6	—	10 000	0.01~0.02	125	375	750	—	167	246	313	—
	105	16	1	0.6	—	3NCHAC915C	25.9	15.5	0.80	8.40	23 000	39 000	20.1	16	0.311	12.5	80.5	—	99.5	100.5	1	0.6	—	10 000	0.01~0.02	75	225	450	—	46	71	95	—
	105	16	1	0.6	—	3NCHAC915CA	25.3	15.1	0.78	—	22 000	36 000	24.4	16	0.311	15.2	80.5	—	99.5	100.5	1	0.6	—	10 000	0.01~0.02	110	330	660	—	96	142	186	—
	115	20	1.1	0.6	—	7015C-5	60.1	45.6	2.55	15.9	12 000	19 000	22.7	29	0.690	22.0	82	—	108	110.5	1	0.6	—	15 000	0.01~0.02	100	295	685	1 370	55	86	128	183
	115	20	1.1	0.6	—	7015AC-5	56.8	43.3	2.35	—	11 000	16 000	32.1	28	0.690	14.0	82	—	108	110.5	1	0.6	—	15 000	0.01~0.02	—	590	1 180	2 160	—	234	306	395
	115	20	1.1	0.6	—	7015-5	54.6	41.7	2.25	—	9 500	12 000	37.4	28	0.690	10.6	82	—	108	110.5	1	0.6	—	15 000	0.01~0.02	—	590	1 180	2 160	—	306	393	497
	115	20	1.1	0.6	—	HAR015C	26.4	16.2	0.84	8.50	16 000	25 000	22.7	25	0.665	20.6	82	—	108	110.5	1	0.6	—	15 000	0.01~0.02	80	240	480	—	44	67	91	—
	115	20	1.1	0.6	—	3NCHAR015C	26.4	16.2	0.59	8.50	22 000	36 000	22.7	25	0.623	13.1	82	—	108	110.5	1	0.6	—	15 000	0.01~0.02	90	270	540	—	51	78	105	—
	115	20	1.1	0.6	—	HAR015CA	25.7	15.8	0.82	—	15 000	23 000	27.3	25	0.665	24.2	82	—	108	110.5	1	0.6	—	15 000	0.01~0.02	105	315	630	—	86	129	168	—

- [Remarks] 1. For the dimensions of the spacers for oil / air lubrication, refer to Table 15. 4 on page

1. Angular contact ball bearings



We recommend that recesses be added at r_a , r_b , and r_c .

Static equivalent load $P_0 = X_0 F_r + Y_0 F_a$

Contact angle	Single row/Tandem		Back-to-back/Face-to-face	
	X_0	Y_0	X_0	Y_0
15°	0.5	0.46	1	0.92
20°	0.5	0.42	1	0.84
30°	0.5	0.33	1	0.66

Note that in the case of single row or tandem, assume $P_0 = F_r$ if $P_0 < F_r$.

Dynamic equivalent load $P = X F_r + Y F_a$

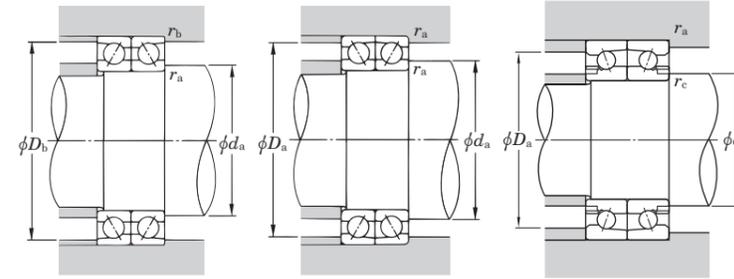
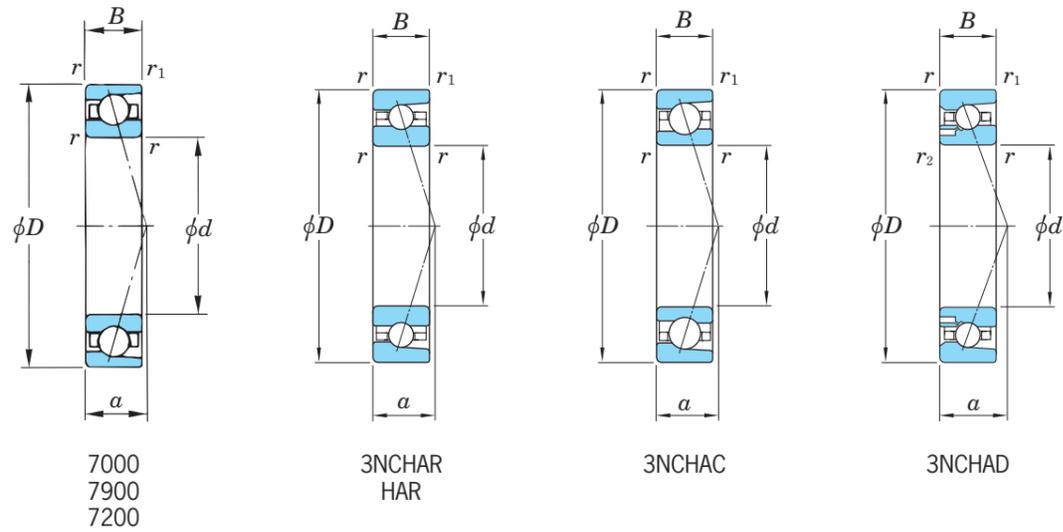
Contact angle	$\frac{i_0 F_a}{C_{0r}}$	e	Single row/Tandem				Back-to-back/Face-to-face				
			$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		
			X	Y	X	Y	X	Y	X	Y	
15°	0.178	0.38					1.47		1.65		2.39
	0.357	0.40					1.40		1.57		2.28
	0.714	0.43					1.30		1.46		2.11
	1.07	0.46					1.23		1.38		2.00
	1.43	0.47	1	0	0.44	1.19	1	1.34	0.72	1.93	
	2.14	0.50					1.12		1.26		1.82
	3.57	0.55					1.02		1.14		1.66
	5.35	0.56					1.00		1.12		1.63
7.14	0.56					1.00		1.12		1.63	
20°		0.57	1	0	0.43	1	1	1.09	0.70	1.63	
30°		0.80	1	0	0.39	0.76	1	0.78	0.63	1.24	

1) For i , use 2 for DB & DF and 1 for single & DT.

d (75) ~ 80

d	Boundary dimensions (mm)					Bearing No.	Basic load ratings (kN)		Fatigue load limit (kN) C_u	Factor f_0	Limiting speeds (min ⁻¹)		Load center (mm) a	Interspace volume (cm ³ /row)	(Refer.) Mass (kg/row)	Permissible axial load (kN) (static)	Mounting dimensions (mm)						Nut axial tension (N)	Interference of retaining plate (mm)	Preload (Combination of DB and DF) (N)				Axial rigidity (Combination of DB and DF) (N/μm)					
	D	B	r min.	r ₁ min.	r ₂ min.		C_r	C_{0r}			Grease lub.	Oil lub.					d_a min.	d_b min.	D_a max.	D_b max.	r_a max.	r_b max.			r_c max.	S	L	M	H	S	L	M	H	
75	115	20	1.1	0.6	—	3NCHAR015CA	25.7	15.8	0.58	—	21 000	35 000	27.3	25	0.623	15.9	82	—	108	110.5	1	0.6	—	15 000	0.01~0.02	115	345	690	—	98	148	193	—	
	115	20	1.1	0.6	—	HAR015	24.0	14.7	0.76	—	11 000	15 000	37.4	25	0.665	21.0	82	—	108	110.5	1	0.6	—	15 000	0.01~0.02	165	495	990	—	169	251	325	—	
	115	20	1.1	0.6	—	3NCHAC015C	41.7	23.2	1.20	8.10	22 000	36 000	22.7	28	0.539	18.7	82	—	108	110.5	1	0.6	—	15 000	0.01~0.02	90	270	540	—	48	73	97	—	
	115	20	1.1	0.6	—	3NCHAC015CA	40.7	22.7	1.15	—	21 000	35 000	27.3	28	0.539	22.8	82	—	108	110.5	1	0.6	—	15 000	0.01~0.02	115	345	690	—	94	139	182	—	
	115	20	1.1	0.6	0.3	3NCHAD015CA	24.4	14.6	0.75	—	—	36 000	27.3	—	0.657	14.7	82	—	108	110.5	1	0.6	0.3	15 000	0.01~0.02	115	345	690	—	96	141	184	—	
	130	25	1.5	1	—	7215C-5	108	70.6	4.50	14.6	11 000	18 000	26.2	54	1.23	41.1	83.5	—	121.5	124.5	1.5	1	—	15 000	0.01~0.02	195	590	1 180	2 350	64	102	142	203	
	130	25	1.5	1	—	7215AC-5	103	67.4	4.15	—	9 900	15 000	36.4	53	1.23	27.0	83.5	—	121.5	124.5	1.5	1	—	15 000	0.01~0.02	—	980	2 160	3 920	—	255	347	445	
	130	25	1.5	1	—	7215-5	99.0	65.2	3.95	—	8 800	11 000	42.1	53	1.23	21.6	83.5	—	121.5	124.5	1.5	1	—	15 000	0.01~0.02	—	980	2 160	3 920	—	332	445	562	
	80	110	16	1	0.6	—	7916C-5	37.3	31.6	1.65	16.5	13 000	21 000	20.7	18	0.368	14.0	85.5	—	104.5	105.5	1	0.6	—	10 000	0.01~0.02	65	195	390	—	49	78	108	—
		110	16	1	0.6	—	HAR916C	17.0	11.9	0.62	8.80	16 000	25 000	20.7	13	0.398	15.2	85.5	—	104.5	105.5	1	0.6	—	10 000	0.01~0.02	75	225	450	—	48	74	101	—
110		16	1	0.6	—	3NCHAR916C	17.0	11.9	0.43	8.80	22 000	36 000	20.7	13	0.376	9.73	85.5	—	104.5	105.5	1	0.6	—	10 000	0.01~0.02	85	255	510	—	56	86	118	—	
110		16	1	0.6	—	HAR916CA	16.6	11.6	0.60	—	15 000	23 000	25.3	13	0.398	17.8	85.5	—	104.5	105.5	1	0.6	—	10 000	0.01~0.02	120	360	720	—	100	152	197	—	
110		16	1	0.6	—	3NCHAR916CA	16.6	11.6	0.42	—	21 000	35 000	25.3	13	0.376	11.7	85.5	—	104.5	105.5	1	0.6	—	10 000	0.01~0.02	130	390	780	—	113	173	228	—	
110		16	1	0.6	—	HAR916	15.4	10.8	0.56	—	11 000	15 000	35.4	13	0.398	14.6	85.5	—	104.5	105.5	1	0.6	—	10 000	0.01~0.02	140	420	840	—	181	263	339	—	
110		16	1	0.6	—	3NCHAC916C	26.4	16.2	0.84	8.50	22 000	36 000	20.7	17	0.325	13.1	85.5	—	104.5	105.5	1	0.6	—	10 000	0.01~0.02	85	255	510	—	50	76	103	—	
110		16	1	0.6	—	3NCHAC916CA	25.7	15.8	0.82	—	21 000	35 000	25.3	17	0.325	15.9	85.5	—	104.5	105.5	1	0.6	—	10 000	0.01~0.02	130	390	780	—	106	156	201	—	
125		22	1.1	0.6	—	7016C-5	73.3	55.3	3.10	15.7	11 000	18 000	24.7	37	0.930	23.5	87	—	118	120.5	1	0.6	—	15 000	0.01~0.02	100	295	735	1 470	55	85	130	184	
125		22	1.1	0.6	—	7016AC-5	69.4	52.5	2.90	—	9 900	15 000	34.9	37	0.930	14.3	87	—	118	120.5	1	0.6	—	15 000	0.01~0.02	—	635	1 370	2 350	—	240	322	403	
125		22	1.1	0.6	—	7016-5	66.7	50.6	2.75	—	8 800	11 000	40.6	37	0.930	10.8	87	—	118	120.5	1	0.6	—	15 000	0.01~0.02	—	635	1 370	2 350	—	314	418	514	
125		22	1.1	0.6	—	HAR016C	30.9	19.2	0.98	8.40	14 000	22 000	24.7	31	0.903	24.5	87	—	118	120.5	1	0.6	—	15 000	0.01~0.02	90	270	540	—	47	72	97	—	
125		22	1.1	0.6	—	3NCHAR016C	30.9	19.2	0.69	8.40	19 000	32 000	24.7	31	0.848	15.6	87	—	118	120.5	1	0.6	—	15 000	0.01~0.02	100	300	600	—	54	83	112	—	
125		22	1.1	0.6	—	HAR016CA	30.1	18.8	0.96	—	13 000	21 000	29.7	31	0.903	28.7	87	—	118	120.5	1	0.6	—	15 000	0.01~0.02	120	360	720	—	92	137	180	—	
125		22	1.1	0.6	—	3NCHAR016CA	30.1	18.8	0.68	—	18 000	30 000	29.7	31	0.848	18.9	87	—	118	120.5	1	0.6	—	15 000	0.01~0.02	130	390	780	—	106	159	205	—	
125		22	1.1	0.6	—	HAR016	28.1	17.5	0.89	—	9 800	13 000	40.6	31	0.903	24.6	87	—	118	120.5	1	0.6	—	15 000	0.01~0.02	180	540	1 080	—	180	267	340	—	
125		22	1.1	0.6	—	3NCHAC016C	50.7	28.1	1.45	8.00	19 000	32 000	24.7	38	0.714	22.6	87	—	118	120.5	1	0.6	—	15 000	0.01~0.02	100	300	600	—	50	76	101	—	
125		22	1.1	0.6	—	3NCHAC016CA	49.6	27.5	1.40	—	18 000	30 000	29.7	38	0.714	27.6	87	—	118	120.5	1	0.6	—	15 000	0.01~0.02	130	390	780	—	100	147	190	—	
125		22	1.1	0.6	0.3	3NCHAD016CA	28.6	17.3	0.89	—	—	32 000	29.7	—	0.885	17.5	87	—	118	120.5	1	0.6	0.3	15 000	0.01~0.02	130	390	780	—	100	151	197	—	
140		26	2	1	—	7216C-5	116	77.5	4.70	14.7	10 000	16 000	27.7	63	1.50	44.5	90	—	130	134.5	2	1	—	18 000	0.01~0.02	225	685	1 370	2 750	68	110	153	220	
140		26	2	1	—	7216AC-5	110	74.0	4.35	—	9 100	13 000	38.6	63	1.50	29.2	90	—	130	134.5	2	1	—	18 000	0.01~0.02	—	1 080	2 450	4 310	—	267	368	467	
140		26	2	1	—	7216-5	107	71.5	4.10	—	8 100	10 000	44.8	63	1.50	23.3	90	—	130	134.5	2	1	—	18 000	0.01~0.02	—	1 080	2 450	4 310	—	348	471	586	

1. Angular contact ball bearings



We recommend that recesses be added at r_a , r_b , and r_c .

Static equivalent load $P_0 = X_0 F_r + Y_0 F_a$

Contact angle	Single row/Tandem		Back-to-back/Face-to-face	
	X_0	Y_0	X_0	Y_0
15°	0.5	0.46	1	0.92
20°	0.5	0.42	1	0.84
30°	0.5	0.33	1	0.66

Note that in the case of single row or tandem, assume $P_0 = F_r$ if $P_0 < F_r$.

Dynamic equivalent load $P = X F_r + Y F_a$

Contact angle	$\frac{i_0 F_a}{C_{0r}}$	e	Single row/Tandem				Back-to-back/Face-to-face				
			$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		
			X	Y	X	Y	X	Y	X	Y	
15°	0.178	0.38					1.47		1.65		2.39
	0.357	0.40					1.40		1.57		2.28
	0.714	0.43					1.30		1.46		2.11
	1.07	0.46					1.23		1.38		2.00
	1.43	0.47	1	0	0.44	1.19	1	1.34	0.72	1.93	
	2.14	0.50					1.12		1.26		1.82
	3.57	0.55					1.02		1.14		1.66
	5.35	0.56					1.00		1.12		1.63
7.14	0.56					1.00		1.12		1.63	
20°		0.57	1	0	0.43	1	1	1.09	0.70	1.63	
30°		0.80	1	0	0.39	0.76	1	0.78	0.63	1.24	

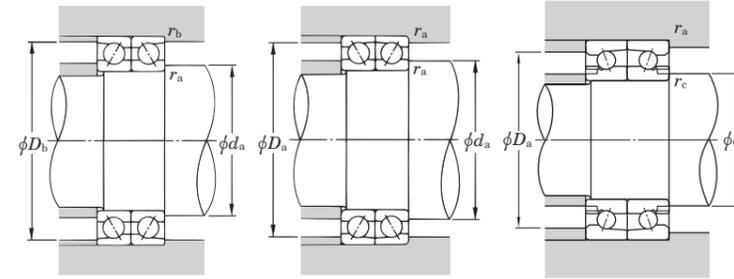
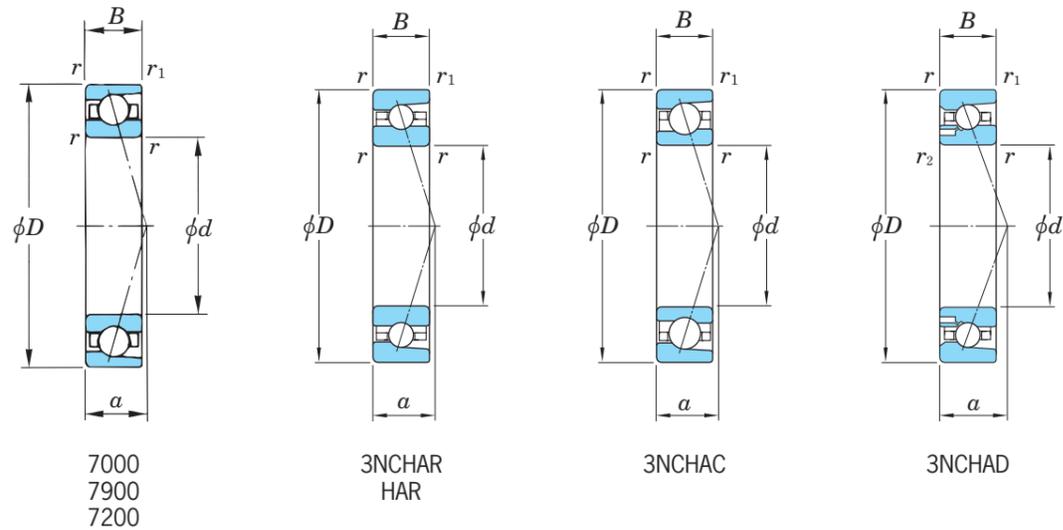
1) For i , use 2 for DB & DF and 1 for single & DT.

d 85 ~ (90)

d	Boundary dimensions (mm)					Bearing No.	Basic load ratings (kN)		Fatigue load limit (kN) C_u	Factor f_0	Limiting speeds (min ⁻¹)		Load center (mm) a	Interspace volume (cm ³ /row)	(Refer.) Mass (kg/row)	Permissible axial load (kN) (static)	Mounting dimensions (mm)							Nut axial tension (N)	Interference of retaining plate (mm)	Preload (Combination of DB and DF) (N)				Axial rigidity (Combination of DB and DF) (N/μm)			
	D	B	r min.	r ₁ min.	r ₂ min.		C_r	C_{0r}			Grease lub.	Oil lub.					d_a min.	d_b min.	D_a max.	D_b max.	r_a max.	r_b max.	r_c max.			S	L	M	H	S	L	M	H
85	120	18	1.1	0.6	—	7917C-5	48.6	40.6	2.10	16.5	12 000	19 000	22.7	25	0.523	19.5	92	—	113	115.5	1	0.6	—	12 000	0.01~0.02	85	245	490	—	54	84	116	—
	120	18	1.1	0.6	—	HAR917C	20.4	14.2	0.72	8.70	14 000	22 000	22.7	18	0.570	18.1	92	—	113	115.5	1	0.6	—	12 000	0.01~0.02	85	255	510	—	49	77	105	—
	120	18	1.1	0.6	—	3NCHAR917C	20.4	14.2	0.51	8.70	19 000	32 000	22.7	18	0.541	11.5	92	—	113	115.5	1	0.6	—	12 000	0.01~0.02	95	285	570	—	58	89	121	—
	120	18	1.1	0.6	—	HAR917CA	19.9	13.8	0.71	—	13 000	21 000	27.7	18	0.570	21.2	92	—	113	115.5	1	0.6	—	12 000	0.01~0.02	140	420	840	—	106	157	207	—
	120	18	1.1	0.6	—	3NCHAR917CA	19.9	13.8	0.50	—	18 000	30 000	27.7	18	0.541	13.9	92	—	113	115.5	1	0.6	—	12 000	0.01~0.02	155	465	930	—	122	182	240	—
	120	18	1.1	0.6	—	HAR917	18.5	12.8	0.65	—	9 800	13 000	38.6	18	0.570	17.0	92	—	113	115.5	1	0.6	—	12 000	0.01~0.02	155	465	930	—	182	270	351	—
	120	18	1.1	0.6	—	3NCHAC917C	34.2	20.6	1.05	8.40	19 000	32 000	22.7	24	0.473	16.7	92	—	113	115.5	1	0.6	—	12 000	0.01~0.02	95	285	570	—	51	79	106	—
	120	18	1.1	0.6	—	3NCHAC917CA	33.4	20.1	1.05	—	18 000	30 000	27.6	24	0.473	20.3	92	—	113	115.5	1	0.6	—	12 000	0.01~0.02	155	465	930	—	111	165	214	—
	130	22	1.1	0.6	—	7017C-5	75.1	58.7	3.15	15.9	10 000	16 000	25.5	39	0.970	28.2	92	—	123	125.5	1	0.6	—	18 000	0.01~0.02	125	390	880	1 770	61	99	145	208
	130	22	1.1	0.6	—	7017AC-5	71.0	55.7	2.90	—	9 100	13 000	36.3	39	0.970	18.0	92	—	123	125.5	1	0.6	—	18 000	0.01~0.02	—	735	1 570	2 550	—	260	353	430
	130	22	1.1	0.6	—	7017-5	68.2	53.7	2.75	—	8 200	10 000	42.3	39	0.970	14.0	92	—	123	125.5	1	0.6	—	18 000	0.01~0.02	—	735	1 570	2 550	—	342	452	543
	130	22	1.1	0.6	—	HAR017C	31.4	20.1	1.00	8.50	13 000	21 000	25.4	33	0.947	25.6	92	—	123	125.5	1	0.6	—	18 000	0.01~0.02	100	300	600	—	49	76	104	—
	130	22	1.1	0.6	—	3NCHAR017C	31.4	20.1	0.71	8.50	18 000	30 000	25.4	33	0.890	16.3	92	—	123	125.5	1	0.6	—	18 000	0.01~0.02	110	330	660	—	57	88	119	—
	130	22	1.1	0.6	—	HAR017CA	30.7	19.6	0.98	—	13 000	19 000	30.6	33	0.947	30.0	92	—	123	125.5	1	0.6	—	18 000	0.01~0.02	135	405	810	—	98	147	193	—
	130	22	1.1	0.6	—	3NCHAR017CA	30.7	19.6	0.69	—	16 000	29 000	30.6	33	0.890	19.8	92	—	123	125.5	1	0.6	—	18 000	0.01~0.02	150	450	900	—	115	171	222	—
	130	22	1.1	0.6	—	HAR017	28.5	18.3	0.91	—	9 200	12 000	42.0	33	0.947	26.3	92	—	123	125.5	1	0.6	—	18 000	0.01~0.02	195	585	1 170	—	190	282	363	—
	130	22	1.1	0.6	—	3NCHAC017C	52.1	29.8	1.50	8.10	18 000	30 000	25.5	40	0.741	24.0	92	—	123	125.5	1	0.6	—	18 000	0.01~0.02	110	330	660	—	54	81	108	—
	130	22	1.1	0.6	—	3NCHAC017CA	51.0	29.2	1.45	—	16 000	29 000	30.7	40	0.741	29.3	92	—	123	125.5	1	0.6	—	18 000	0.01~0.02	150	450	900	—	109	161	207	—
	130	22	1.1	0.6	0.3	3NCHAD017CA	29.1	18.2	0.91	—	—	30 000	30.6	—	0.924	18.3	92	—	123	125.5	1	0.6	0.3	18 000	0.01~0.02	150	450	900	—	109	164	213	—
	150	28	2	1	—	7217C-5	134	90.6	5.35	14.7	9 900	15 000	29.7	76	1.87	52.9	95	—	140	144.5	2	1	—	18 000	0.01~0.02	260	780	1 570	2 940	73	117	164	227
150	28	2	1	—	7217AC-5	128	86.5	4.95	—	8 700	13 000	41.4	75	1.87	34.9	95	—	140	144.5	2	1	—	18 000	0.01~0.02	—	1 270	2 940	4 900	—	290	404	499	
150	28	2	1	—	7217-5	123	83.6	4.70	—	7 500	9 900	47.9	75	1.87	27.9	95	—	140	144.5	2	1	—	18 000	0.01~0.02	—	1 270	2 940	4 900	—	379	516	628	
90	125	18	1.1	0.6	—	7918C-5	49.5	42.6	2.15	16.6	11 000	18 000	23.4	26	0.551	20.4	97	—	118	120.5	1	0.6	—	12 000	0.01~0.02	100	295	590	—	59	94	130	—
	125	18	1.1	0.6	—	HAR918C	21.1	15.1	0.75	8.80	13 000	21 000	23.4	19	0.598	19.3	97	—	118	120.5	1	0.6	—	12 000	0.01~0.02	90	270	540	—	52	82	111	—
	125	18	1.1	0.6	—	3NCHAR918C	21.1	15.1	0.53	8.80	18 000	30 000	23.4	19	0.567	12.3	97	—	118	120.5	1	0.6	—	12 000	0.01~0.02	100	300	600	—	60	94	128	—
	125	18	1.1	0.6	—	HAR918CA	20.5	14.7	0.73	—	13 000	19 000	28.6	19	0.598	22.6	97	—	118	120.5	1	0.6	—	12 000	0.01~0.02	160	480	960	—	116	173	229	—
	125	18	1.1	0.6	—	3NCHAR918CA	20.5	14.7	0.52	—	16 000	29 000	28.6	19	0.567	14.8	97	—	118	120.5	1	0.6	—	12 000	0.01~0.02	175	525	1 050	—	132	200	261	—
	125	18	1.1	0.6	—	HAR918	19.0	13.7	0.68	—	9 200	12 000	40.0	19	0.598	18.0	97	—	118	120.5	1	0.6	—	12 000	0.01~0.02	170	510	1 020	—	200	291	374	—
	125	18	1.1	0.6	—	3NCHAC918C	34.9	21.6	1.10	8.40	18 000	30 000	23.4	27	0.465	17.5	97	—	118	120.5	1	0.6	—	12 000	0.01~0.02	100	300	600	—	53	82	110	—
	125	18	1.1	0.6	—	3NCHAC918CA	34.1	21.1	1.05	—	16 000	29 000	28.6	27	0.465	21.2	97	—	118	120.5	1	0.6	—	12 000	0.01~0.02	175	525	1 050	—	113	168	219	—

- [Remarks] 1. For the dimensions of the spacers for oil / air lubrication, refer to Table 15. 4 on page 53 to 57.
 2. For the discharge intervals of the oil / air, refer to Supplementary

1. Angular contact ball bearings



We recommend that recesses be added at r_a , r_b , and r_c .

Static equivalent load $P_0 = X_0 F_r + Y_0 F_a$

Contact angle	Single row/Tandem		Back-to-back/Face-to-face	
	X_0	Y_0	X_0	Y_0
15°	0.5	0.46	1	0.92
20°	0.5	0.42	1	0.84
30°	0.5	0.33	1	0.66

Note that in the case of single row or tandem, assume $P_0 = F_r$ if $P_0 < F_r$.

Dynamic equivalent load $P = X F_r + Y F_a$

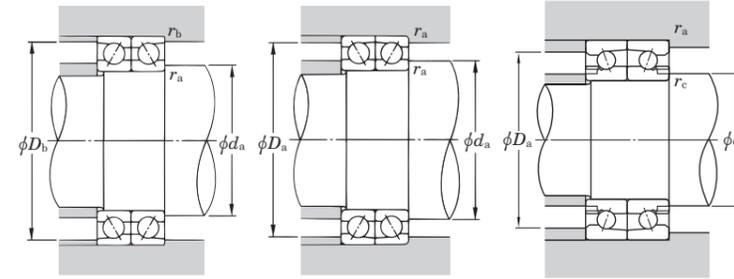
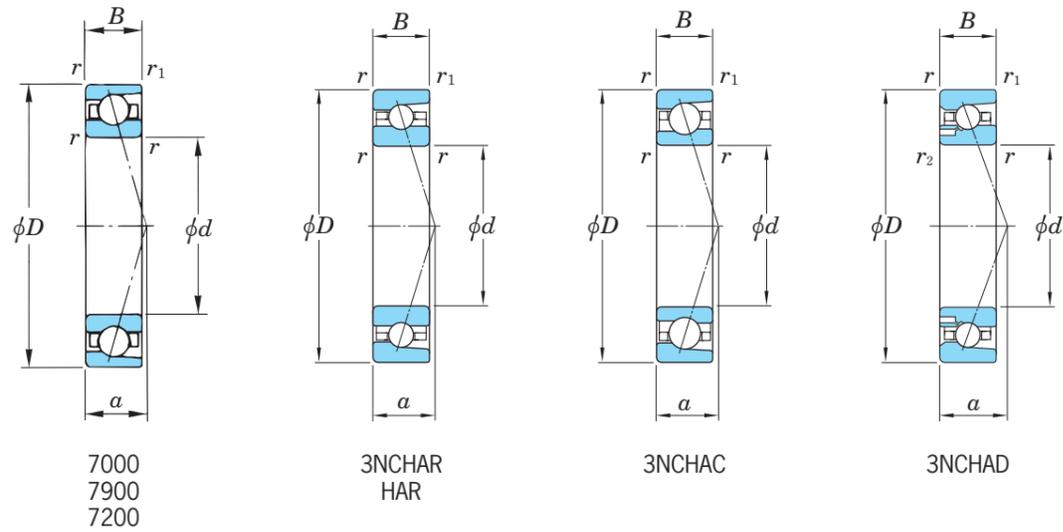
Contact angle	$\frac{i_0 F_a}{C_{0r}}$	e	Single row/Tandem				Back-to-back/Face-to-face				
			$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		
			X	Y	X	Y	X	Y	X	Y	
15°	0.178	0.38					1.47		1.65		2.39
	0.357	0.40					1.40		1.57		2.28
	0.714	0.43					1.30		1.46		2.11
	1.07	0.46					1.23		1.38		2.00
	1.43	0.47	1	0	0.44	1.19	1	1.34	0.72	1.93	
	2.14	0.50				1.12		1.26		1.82	
	3.57	0.55				1.02		1.14		1.66	
	5.35	0.56				1.00		1.12		1.63	
7.14	0.56				1.00		1.12		1.63		
20°		0.57	1	0	0.43	1	1	1.09	0.70	1.63	
30°		0.80	1	0	0.39	0.76	1	0.78	0.63	1.24	

1) For i , use 2 for DB & DF and 1 for single & DT.

d (90) ~ (95)

d	Boundary dimensions (mm)					Bearing No.	Basic load ratings (kN)		Fatigue load limit (kN) C_u	Factor f_0	Limiting speeds (min ⁻¹)		Load center (mm) a	Interspace volume (cm ³ /row)	(Refer.) Mass (kg/row)	Permissible axial load (kN) (static)	Mounting dimensions (mm)							Nut axial tension (N)	Interference of retaining plate (mm)	Preload (Combination of DB and DF) (N)				Axial rigidity (Combination of DB and DF) (N/μm)				
	D	B	r min.	r ₁ min.	r ₂ min.		C_r	C_{0r}			Grease lub.	Oil lub.					d_a min.	d_b min.	D_a max.	D_b max.	r_a max.	r_b max.	r_c max.			S	L	M	H	S	L	M	H	
90	140	24	1.5	1	—	7018C-5	89.6	69.1	3.65	15.7	10 000	16 000	27.4	47	1.26	37.3	98.5	—	131.5	134.5	1.5	1	—	18 000	0.01~0.02	145	440	980	1 960	65	103	150	213	
	140	24	1.5	1	—	7018AC-5	84.8	65.7	3.40	—	8 900	13 000	38.8	47	1.26	24.5	98.5	—	131.5	134.5	1.5	1	—	18 000	0.01~0.02	—	780	1 670	2 840	—	267	359	445	
	140	24	1.5	1	—	7018-5	81.5	63.3	3.25	—	7 800	10 000	45.2	47	1.26	19.0	98.5	—	131.5	134.5	1.5	1	—	18 000	0.01~0.02	—	780	1 670	2 840	—	347	464	565	
	140	24	1.5	1	—	HAR018C	41.0	26.1	1.25	8.40	12 000	19 000	27.4	43	1.21	33.1	98.5	—	131.5	134.5	1.5	1	—	18 000	0.01~0.02	105	315	630	—	51	78	105	—	
	140	24	1.5	1	—	3NCHAR018C	41.0	26.1	0.89	8.40	16 000	29 000	27.4	43	1.12	21.1	98.5	—	131.5	134.5	1.5	1	—	18 000	0.01~0.02	115	345	690	—	59	90	121	—	
	140	24	1.5	1	—	HAR018CA	40.0	25.4	1.25	—	12 000	18 000	32.9	43	1.21	38.9	98.5	—	131.5	134.5	1.5	1	—	18 000	0.01~0.02	150	450	900	—	105	157	202	—	
	140	24	1.5	1	—	3NCHAR018CA	40.0	25.4	0.86	—	16 000	26 000	32.9	43	1.12	25.6	98.5	—	131.5	134.5	1.5	1	—	18 000	0.01~0.02	165	495	990	—	120	180	234	—	
	140	24	1.5	1	—	HAR018	37.3	23.7	1.15	—	8 600	11 000	45.2	43	1.12	33.4	98.5	—	131.5	134.5	1.5	1	—	18 000	0.01~0.02	210	630	1 260	—	205	293	376	—	
	140	24	1.5	1	—	3NCHAC018C	62.0	35.2	1.70	8.00	16 000	29 000	27.4	51	0.943	28.3	98.5	—	131.5	134.5	1.5	1	—	18 000	0.01~0.02	115	345	690	—	54	82	109	—	
	140	24	1.5	1	—	3NCHAC018CA	60.6	34.4	1.65	—	16 000	26 000	32.9	51	0.943	34.5	98.5	—	131.5	134.5	1.5	1	—	18 000	0.01~0.02	165	495	990	—	112	165	214	—	
	140	24	1.5	1	0.3	3NCHAD018CA	38.0	23.5	1.15	—	—	29 000	32.9	—	—	1.15	23.6	98.5	—	131.5	134.5	1.5	1	0.3	18 000	0.01~0.02	165	495	990	—	116	171	222	—
	160	30	2	1	—	7218C-5	153	105	6.00	14.6	9 300	15 000	31.7	93	2.30	62.3	100	—	150	154.5	2	1	—	20 000	0.01~0.02	260	780	1 770	3 430	74	118	174	245	
	160	30	2	1	—	7218AC-5	146	100	5.60	—	8 200	12 000	44.1	92	2.30	41.2	100	—	150	154.5	2	1	—	20 000	0.01~0.02	—	1 470	3 240	5 390	—	311	425	526	
	160	30	2	1	—	7218-5	141	96.7	5.30	—	7 100	9 300	51.1	92	2.30	33.0	100	—	150	154.5	2	1	—	20 000	0.01~0.02	—	1 470	3 240	5 390	—	408	545	663	
	95	130	18	1.1	0.6	—	7919C-5	50.3	44.1	2.15	16.5	11 000	16 000	24.1	27	0.574	20.9	102	—	123	125.5	1	0.6	—	12 000	0.01~0.02	100	295	590	—	60	95	133	—
		130	18	1.1	0.6	—	HAR919C	21.6	16.0	0.78	8.80	13 000	19 000	24.1	19	0.626	20.5	102	—	123	125.5	1	0.6	—	12 000	0.01~0.02	100	300	600	—	56	88	120	—
130		18	1.1	0.6	—	3NCHAR919C	21.6	16.0	0.55	8.80	18 000	29 000	24.1	19	0.593	13.0	102	—	123	125.5	1	0.6	—	12 000	0.01~0.02	110	330	660	—	65	102	137	—	
130		18	1.1	0.6	—	HAR919CA	21.1	15.6	0.76	—	12 000	19 000	29.5	19	0.626	23.9	102	—	123	125.5	1	0.6	—	12 000	0.01~0.02	180	540	1 080	—	124	188	247	—	
130		18	1.1	0.6	—	3NCHAR919CA	21.1	15.6	0.54	—	16 000	28 000	29.5	19	0.593	15.8	102	—	123	125.5	1	0.6	—	12 000	0.01~0.02	200	600	1 200	—	143	218	286	—	
130		18	1.1	0.6	—	HAR919	19.6	14.5	0.71	—	8 800	11 000	41.5	19	0.626	19.0	102	—	123	125.5	1	0.6	—	12 000	0.01~0.02	185	555	1 110	—	211	313	400	—	
130		18	1.1	0.6	—	3NCHAC919C	35.6	22.6	1.10	8.50	18 000	29 000	24.1	26	0.491	18.3	102	—	123	125.5	1	0.6	—	12 000	0.01~0.02	110	330	660	—	57	87	118	—	
130		18	1.1	0.6	—	3NCHAC919CA	34.7	22.1	1.10	—	16 000	28 000	29.5	26	0.491	22.2	102	—	123	125.5	1	0.6	—	12 000	0.01~0.02	200	600	1 200	—	127	190	247	—	
145		24	1.5	1	—	7019C-5	91.7	73.4	3.70	15.9	9 600	15 000	28.3	50	1.32	37.8	103.5	—	136.5	139.5	1.5	1	—	18 000	0.01~0.02	160	490	1 080	2 060	70	111	161	225	
145		24	1.5	1	—	7019AC-5	86.7	69.7	3.45	—	8 400	12 000	40.4	50	1.32	25.8	103.5	—	136.5	139.5	1.5	1	—	18 000	0.01~0.02	—	880	1 770	3 140	—	286	379	478	
145		24	1.5	1	—	7019-5	83.3	67.1	3.25	—	7 200	9 600	47.2	50	1.32	19.1	103.5	—	136.5	139.5	1.5	1	—	18 000	0.01~0.02	—	880	1 770	3 140	—	378	488	607	
145		24	1.5	1	—	HAR019C	41.8	27.2	1.30	8.50	12 000	18 000	28.1	45	1.28	34.6	103.5	—	136.5	139.5	1.5	1	—	18 000	0.01~0.02	110	330	660	—	53	82	110	—	
145		24	1.5	1	—	3NCHAR019C	41.8	27.2	0.91	8.50	16 000	26 000	28.1	45	1.19	22.1	103.5	—	136.5	139.5	1.5	1	—	18 000	0.01~0.02	120	360	720	—	62	94	126	—	
145		24	1.5	1	—	HAR019CA	40.8	26.6	1.25	—	11 000	18 000	33.8	45	1.28	40.6	103.5	—	136.5	139.5	1.5	1	—	18 000	0.01~0.02	170	510	1 020	—	113	167	218	—	
145		24	1.5	1	—	3NCHAR019CA	40.8	26.6	0.88	—	15 000	25 000	33.8	45	1.19	26.8	103.5	—	136.5	139.5	1.5	1	—	18 000	0.01~0.02	185	555	1 110	—	130	193	249	—	
145		24	1.5	1	—	HAR019	38.0	24.7	1.15	—	8 200	11 000	46.6	45	1.28	33.5	103.5	—	136.5	139.5	1.5	1	—	18 000	0.01~0.02	225	675	1 350	—	214	310	397	—	

1. Angular contact ball bearings



We recommend that recesses be added at r_a , r_b , and r_c .

Static equivalent load $P_0 = X_0 F_r + Y_0 F_a$

Contact angle	Single row/Tandem		Back-to-back/Face-to-face	
	X_0	Y_0	X_0	Y_0
15°	0.5	0.46	1	0.92
20°	0.5	0.42	1	0.84
30°	0.5	0.33	1	0.66

Note that in the case of single row or tandem, assume $P_0 = F_r$ if $P_0 < F_r$.

Dynamic equivalent load $P = X F_r + Y F_a$

Contact angle	$\frac{i_0 F_a}{C_{0r}}$	e	Single row/Tandem				Back-to-back/Face-to-face			
			$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
			X	Y	X	Y	X	Y	X	Y
15°	0.178	0.38			1.47			1.65		2.39
	0.357	0.40			1.40			1.57		2.28
	0.714	0.43			1.30			1.46		2.11
	1.07	0.46			1.23			1.38		2.00
	1.43	0.47	1	0	1.19	1	0.72	1.34	0.72	1.93
	2.14	0.50			1.12			1.26		1.82
	3.57	0.55			1.02			1.14		1.66
	5.35	0.56			1.00			1.12		1.63
7.14	0.56			1.00			1.12		1.63	
20°		0.57	1	0	0.43	1	1	1.09	0.70	1.63
30°		0.80	1	0	0.39	0.76	1	0.78	0.63	1.24

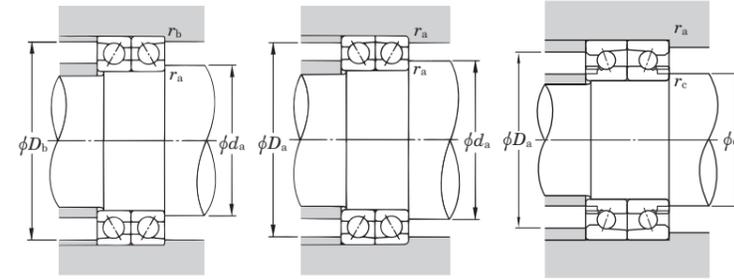
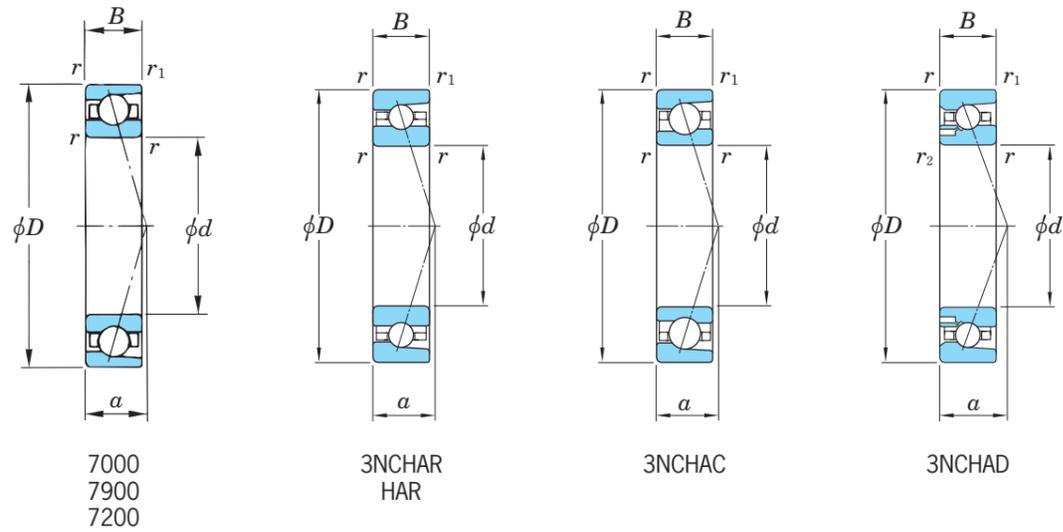
1) For i , use 2 for DB & DF and 1 for single & DT.

d (95) ~ (105)

d	Boundary dimensions (mm)					Bearing No.	Basic load ratings (kN)		Fatigue load limit (kN) C_u	Factor f_0	Limiting speeds (min ⁻¹)		Load center (mm) a	Interspace volume (cm ³ /row)	(Refer.) Mass (kg/row)	Permissible axial load (kN) (static)	Mounting dimensions (mm)							Nut axial tension (N)	Interference of retaining plate (mm)	Preload (Combination of DB and DF) (N)				Axial rigidity (Combination of DB and DF) (N/μm)				
	D	B	r min.	r ₁ min.	r ₂ min.		C_r	C_{0r}			Grease lub.	Oil lub.					d_a min.	d_b min.	D_a max.	D_b max.	r_a max.	r_b max.	r_c max.			S	L	M	H	S	L	M	H	
95	145	24	1.5	1	—	3NCHAC019C	63.7	37.3	1.75	8.10	16 000	26 000	28.3	55	0.96	30.1	103.5	—	136.5	139.5	1.5	1	—	18 000	0.01~0.02	120	360	720	—	57	86	114	—	
	145	24	1.5	1	—	3NCHAC019CA	62.3	36.5	1.70	—	15 000	25 000	34.2	55	0.96	36.7	103.5	—	136.5	139.5	1.5	1	—	18 000	0.01~0.02	185	555	1 110	—	121	178	230	—	
	145	24	1.5	1	0.3	3NCHAD019CA	38.7	24.6	1.15	—	—	28 000	—	1.3	24.8	99	—	139.5	1.5	1	0.3	18	18 000	0.01~0.02	185	555	1 110	—	123	183	239	—		
	170	32	2.1	1.1	—	7219C-5	166	112	6.30	14.6	8 800	14 000	33.8	116	2.78	65.9	107	—	158	163	2	1	—	20 000	0.01~0.02	290	880	1 960	3 920	75	121	177	254	
	170	32	2.1	1.1	—	7219AC-5	158	107	5.80	—	7 800	11 000	46.9	115	2.78	43.6	107	—	158	163	2	1	—	20 000	0.01~0.02	—	1 670	3 430	5 880	—	318	423	530	
	170	32	2.1	1.1	—	7219-5	153	103	5.50	—	6 700	8 800	54.3	115	2.78	34.8	107	—	158	163	2	1	—	20 000	0.01~0.02	—	1 670	3 430	5 880	—	415	542	668	
100	140	20	1.1	0.6	—	7920C-5	69.4	58.5	2.85	16.3	10 000	15 000	26.1	35	0.773	31.9	107	—	133	135.5	1	0.6	—	15 000	0.01~0.02	100	345	685	—	58	98	135	—	
	140	20	1.1	0.6	—	HAR920C	30.2	21.7	1.05	8.70	12 000	18 000	26.1	28	0.839	27.8	107	—	133	135.5	1	0.6	—	15 000	0.01~0.02	110	330	660	—	58	90	122	—	
	140	20	1.1	0.6	—	3NCHAR920C	30.2	21.7	0.72	8.70	16 000	28 000	26.1	28	0.784	17.7	107	—	133	135.5	1	0.6	—	15 000	0.01~0.02	120	360	720	—	68	104	139	—	
	140	20	1.1	0.6	—	HAR920CA	29.4	21.2	1.00	—	11 000	18 000	31.8	28	0.839	32.5	107	—	133	135.5	1	0.6	—	15 000	0.01~0.02	190	570	1 140	—	127	190	249	—	
	140	20	1.1	0.6	—	3NCHAR920CA	29.4	21.2	0.71	—	15 000	26 000	31.8	28	0.784	21.4	107	—	133	135.5	1	0.6	—	15 000	0.01~0.02	210	630	1 260	—	145	221	288	—	
	140	20	1.1	0.6	—	HAR920	27.3	19.7	0.93	—	8 200	11 000	44.6	28	0.839	27.5	107	—	133	135.5	1	0.6	—	15 000	0.01~0.02	200	600	1 200	—	222	320	410	—	
	140	20	1.1	0.6	—	3NCHAC920C	48.7	29.7	1.40	8.30	16 000	28 000	26.1	38	0.632	24.0	107	—	133	135.5	1	0.6	—	15 000	0.01~0.02	120	360	720	—	57	88	117	—	
	140	20	1.1	0.6	—	3NCHAC920CA	47.6	29.0	1.35	—	15 000	26 000	31.8	38	0.632	29.2	107	—	133	135.5	1	0.6	—	15 000	0.01~0.02	210	630	1 260	—	127	189	246	—	
	150	24	1.5	1	—	7020C-5	94.2	77.2	3.80	16.0	9 300	15 000	28.7	51	1.37	38.1	108.5	—	141.5	144.5	1.5	1	—	20 000	0.01~0.02	175	540	1 180	2 160	74	119	172	235	
	150	24	1.5	1	—	7020AC-5	89.0	73.3	3.55	—	8 200	12 000	41.1	51	1.37	24.5	108.5	—	141.5	144.5	1.5	1	—	20 000	0.01~0.02	—	880	1 960	3 530	—	296	404	517	
	150	24	1.5	1	—	7020-5	85.5	70.6	3.35	—	7 100	9 300	48.1	51	1.37	19.2	108.5	—	141.5	144.5	1.5	1	—	20 000	0.01~0.02	—	880	1 960	3 530	—	387	523	651	
	150	24	1.5	1	—	HAR020C	42.5	28.4	1.30	8.50	11 000	18 000	28.7	47	1.32	36.1	108.5	—	141.5	144.5	1.5	1	—	20 000	0.01~0.02	120	360	720	—	56	87	117	—	
	150	24	1.5	1	—	3NCHAR020C	42.5	28.4	0.92	8.50	15 000	26 000	28.7	47	1.23	23.0	108.5	—	141.5	144.5	1.5	1	—	20 000	0.01~0.02	130	390	780	—	65	99	133	—	
	150	24	1.5	1	—	HAR020CA	41.5	27.7	1.30	—	11 000	16 000	34.7	47	1.32	42.4	108.5	—	141.5	144.5	1.5	1	—	20 000	0.01~0.02	185	555	1 110	—	117	176	230	—	
	150	24	1.5	1	—	3NCHAR020CA	41.5	27.7	0.90	—	15 000	25 000	34.7	47	1.23	27.9	108.5	—	141.5	144.5	1.5	1	—	20 000	0.01~0.02	205	615	1 230	—	137	203	266	—	
	150	24	1.5	1	—	HAR020	38.6	25.8	1.20	—	7 900	10 000	48.1	47	1.32	37.4	108.5	—	141.5	144.5	1.5	1	—	20 000	0.01~0.02	240	720	1 440	—	218	324	414	—	
	150	24	1.5	1	—	3NCHAC020C	65.5	39.3	1.80	8.10	15 000	26 000	28.7	56	1.03	31.7	108.5	—	141.5	144.5	1.5	1	—	20 000	0.01~0.02	130	390	780	—	60	91	121	—	
	150	24	1.5	1	—	3NCHAC020CA	64.0	38.4	1.75	—	15 000	25 000	34.7	56	1.03	38.6	108.5	—	141.5	144.5	1.5	1	—	20 000	0.01~0.02	205	615	1 230	—	130	191	247	—	
	150	24	1.5	1	0.3	3NCHAD020CA	39.5	25.7	1.20	—	—	26 000	34.7	—	1.28	25.9	108.5	—	141.5	144.5	1.5	1	0.3	20 000	0.01~0.02	205	615	1 230	—	130	195	255	—	
	180	34	2.1	1.1	—	7220C-5	186	127	6.95	14.6	8 200	13 000	35.9	140	3.32	74.2	112	—	168	173	2	1	—	25 000	0.01~0.02	325	980	2 160	4 410	80	128	186	269	
	180	34	2.1	1.1	—	7220AC-5	178	121	6.40	—	7 300	11 000	49.9	139	3.32	48.8	112	—	168	173	2	1	—	25 000	0.01~0.02	—	1 860	3 920	6 370	—	337	453	553	
	180	34	2.1	1.1	—	7220-5	171	117	6.10	—	6 300	8 200	57.7	139	3.32	39.0	112	—	168	173	2	1	—	25 000	0.01~0.02	—	1 860	3 920	6 370	—	440	579	698	
	105	145	20	1.1	0.6	—	7921C-5	70.8	61.5	2.90	16.4	9 900	15 000	26.7	37	0.81	34.0	112	—	138	140.5	1	0.6	—	15 000	0.02~0.04	100	345	685	—	61	101	138	—
		145	20	1.1	0.6	—	HAR921C	31.1	23.1	1.05	8.70	11 000	18 000	26.7	29	0.874	29.6	112	—	138	140.5	1	0.6	—	15 000	0.02~0.04	120	360	720	—	62	97	131	—

- [Remarks] 1. For the dimensions of the spacers for oil / air lubrication, refer to Table

1. Angular contact ball bearings



Static equivalent load $P_0 = X_0 F_r + Y_0 F_a$

Contact angle	Single row/Tandem		Back-to-back/Face-to-face	
	X_0	Y_0	X_0	Y_0
15°	0.5	0.46	1	0.92
20°	0.5	0.42	1	0.84
30°	0.5	0.33	1	0.66

Note that in the case of single row or tandem, assume $P_0 = F_r$ if $P_0 < F_r$.

Dynamic equivalent load $P = X F_r + Y F_a$

Contact angle	$\frac{i_0 F_a}{C_{0r}}$	e	Single row/Tandem				Back-to-back/Face-to-face			
			$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
			X	Y	X	Y	X	Y	X	Y
15°	0.178	0.38			1.47			1.65		2.39
	0.357	0.40			1.40			1.57		2.28
	0.714	0.43			1.30			1.46		2.11
	1.07	0.46			1.23			1.38		2.00
	1.43	0.47	1	0	1.19	1	0.72	1.34	0.72	1.93
	2.14	0.50			1.12			1.26		1.82
	3.57	0.55			1.02			1.14		1.66
	5.35	0.56			1.00			1.12		1.63
7.14	0.56			1.00			1.12		1.63	
20°		0.57	1	0	0.43	1	1	1.09	0.70	1.63
30°		0.80	1	0	0.39	0.76	1	0.78	0.63	1.24

1) For i, use 2 for DB & DF and 1 for single & DT.

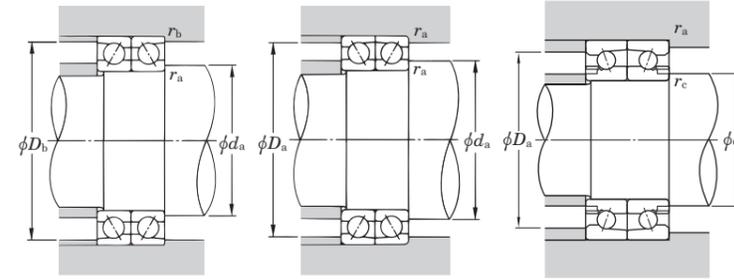
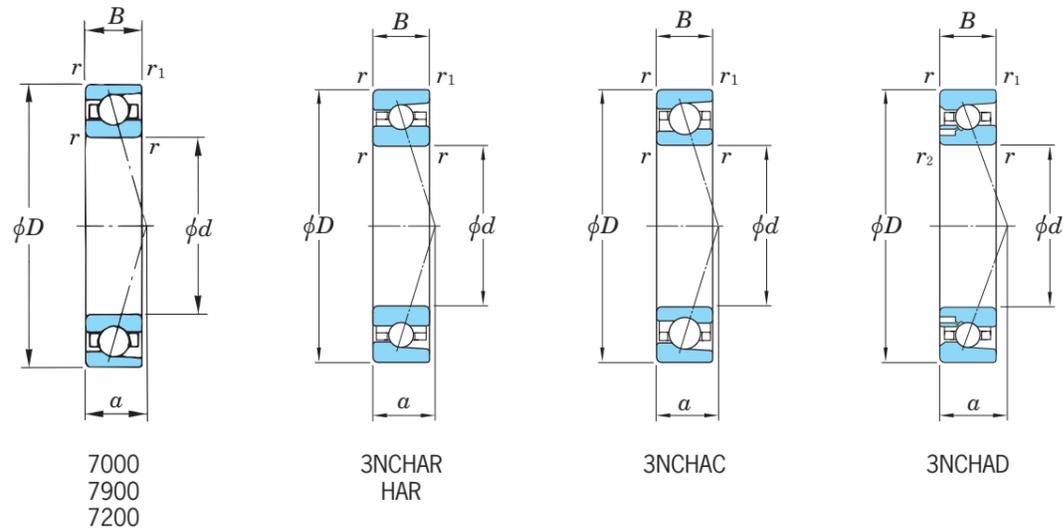
d (105) ~ (110)

d	Boundary dimensions (mm)					Bearing No.	Basic load ratings (kN)		Fatigue load limit (kN) C_u	Factor f_0	Limiting speeds (min ⁻¹)		Load center (mm) a	Interspace volume (cm ³ /row)	(Refer.) Mass (kg/row)	Permissible axial load (kN) (static)	Mounting dimensions (mm)						Nut axial tension (N)	Interference of retaining plate (mm)	Preload (Combination of DB and DF) (N)				Axial rigidity (Combination of DB and DF) (N/μm)				
	D	B	r min.	r1 min.	r2 min.		C_r	C_{0r}			Grease lub.	Oil lub.					d_a min.	d_b min.	D_a max.	D_b max.	r_a max.	r_b max.			r_c max.	S	L	M	H	S	L	M	H
105	145	20	1.1	0.6	—	3NCHAR921C	31.1	23.1	0.75	8.70	15 000	26 000	26.4	29	0.816	18.8	112	—	138	140.5	1	0.6	—	15 000	0.02~0.04	130	390	780	—	71	111	149	—
	145	20	1.1	0.6	—	HAR921CA	30.3	22.5	1.05	—	11 000	16 000	32.7	29	0.874	34.6	112	—	138	140.5	1	0.6	—	15 000	0.02~0.04	200	600	1 200	—	136	202	264	—
	145	20	1.1	0.6	—	3NCHAR921CA	30.3	22.5	0.73	—	15 000	25 000	32.7	29	0.816	22.8	112	—	138	140.5	1	0.6	—	15 000	0.02~0.04	220	660	1 320	—	154	234	303	—
	145	20	1.1	0.6	—	HAR921	28.2	20.9	0.97	—	7 900	10 000	46.1	29	0.874	29.1	112	—	138	140.5	1	0.6	—	15 000	0.02~0.04	220	650	1 360	—	238	342	446	—
	145	20	1.1	0.6	—	3NCHAC921C	49.8	31.2	1.45	8.30	15 000	26 000	26.7	40	0.658	25.3	112	—	138	140.5	1	0.6	—	15 000	0.02~0.04	130	390	780	—	61	93	124	—
	145	20	1.1	0.6	—	3NCHAC921CA	48.7	30.5	1.40	—	15 000	25 000	32.7	40	0.658	30.7	112	—	138	140.5	1	0.6	—	15 000	0.02~0.04	220	660	1 320	—	133	198	256	—
	160	26	2	1	—	7021C-5	110	89.6	4.30	15.9	8 600	13 000	31.0	68	1.73	48.9	115	—	150	154.5	2	1	—	20 000	0.02~0.04	195	590	1 270	2 350	76	122	175	239
	160	26	2	1	—	7021AC-5	104	85.1	4.00	—	7 600	11 000	44.4	68	1.73	32.3	115	—	150	154.5	2	1	—	20 000	0.02~0.04	—	980	2 160	3 920	—	306	417	533
	160	26	2	1	—	7021-5	99.7	81.9	3.80	—	6 500	8 600	51.8	68	1.73	25.0	115	—	150	154.5	2	1	—	20 000	0.02~0.04	—	980	2 160	3 920	—	400	540	676
	160	26	2	1	—	HAR021C	48.2	32.5	1.45	8.50	11 000	16 000	30.8	57	1.68	41.4	115	—	150	154.5	2	1	—	20 000	0.02~0.04	130	390	780	—	59	91	122	—
	160	26	2	1	—	3NCHAR021C	48.2	32.5	1.05	8.50	15 000	25 000	30.8	57	1.56	26.4	115	—	150	154.5	2	1	—	20 000	0.02~0.04	145	435	870	—	68	105	141	—
	160	26	2	1	—	HAR021CA	47.1	31.7	1.45	—	10 000	15 000	37.1	57	1.68	48.6	115	—	150	154.5	2	1	—	20 000	0.02~0.04	200	600	1 200	—	125	185	241	—
	160	26	2	1	—	3NCHAR021CA	47.1	31.7	1.00	—	13 000	23 000	37.1	57	1.56	32.0	115	—	150	154.5	2	1	—	20 000	0.02~0.04	220	660	1 320	—	144	213	279	—
	160	26	2	1	—	HAR021	43.8	29.5	1.35	—	7 500	10 000	51.2	57	1.68	42.0	115	—	150	154.5	2	1	—	20 000	0.02~0.04	250	750	1 500	—	233	333	429	—
	160	26	2	1	—	3NCHAC021C	76.2	45.6	2.05	8.10	15 000	25 000	31.0	71	1.28	36.7	115	—	150	154.5	2	1	—	20 000	0.02~0.04	145	435	870	—	62	95	125	—
	160	26	2	1	—	3NCHAC021CA	74.6	44.6	2.00	—	13 000	23 000	37.5	71	1.28	44.8	115	—	150	154.5	2	1	—	20 000	0.02~0.04	220	660	1 320	—	133	194	251	—
	160	26	2	1	0.6	3NCHAD021CA	47.1	31.8	1.45	—	—	25 000	37.1	—	1.65	32.0	115	—	150	154.5	2	1	0.6	20 000	0.02~0.04	220	660	1 320	—	144	213	279	—
	190	36	2.1	1.1	—	7221C-5	203	143	7.60	14.6	7 700	12 000	38.0	171	3.95	84.8	117	—	178	183	2	1	—	30 000	0.02~0.04	355	1 080	2 350	4 900	84	134	194	283
	190	36	2.1	1.1	—	7221AC-5	193	137	7.05	—	6 800	9 900	52.7	171	3.95	56.0	117	—	178	183	2	1	—	30 000	0.02~0.04	—	2 060	4 310	7 060	—	355	475	583
	190	36	2.1	1.1	—	7221-5	187	132	6.70	—	5 800	7 700	61.0	171	3.95	44.8	117	—	178	183	2	1	—	30 000	0.02~0.04	—	2 060	4 310	7 060	—	466	609	737
110	150	20	1.1	0.6	—	7922C-5	72.2	64.4	2.95	16.5	9 500	15 000	27.4	40	0.84	34.2	117	—	143	145.5	1	0.6	—	15 000	0.02~0.04	145	410	785	—	71	111	150	—
	150	20	1.1	0.6	—	HAR922C	31.4	23.8	1.10	8.70	11 000	16 000	27.4	30	0.909	30.5	117	—	143	145.5	1	0.6	—	15 000	0.02~0.04	145	435	870	—	67	107	144	—
	150	20	1.1	0.6	—	3NCHAR922C	31.4	23.8	0.76	8.70	15 000	25 000	27.4	30	0.849	19.4	117	—	143	145.5	1	0.6	—	15 000	0.02~0.04	160	480	960	—	79	123	166	—
	150	20	1.1	0.6	—	HAR922CA	30.6	23.2	1.05	—	10 000	16 000	33.7	30	0.909	35.7	117	—	143	145.5	1	0.6	—	15 000	0.02~0.04	230	690	1 380	—	144	216	285	—
	150	20	1.1	0.6	—	3NCHAR922CA	30.6	23.2	0.74	—	14 000	23 000	33.7	30	0.849	23.5	117	—	143	145.5	1	0.6	—	15 000	0.02~0.04	255	765	1 530	—	167	249	329	—
	150	20	1.1	0.6	—	HAR922	28.4	21.6	0.98	—	7 700	10 000	47.5	30	0.909	29.9	117	—	143	145.5	1	0.6	—	15 000	0.02~0.04	270	810	1 620	—	257	377	484	—
	150	20	1.1	0.6	—	3NCHAC922C	50.9	32.7	1.50	8.40	15 000	25 000	27.4	41	0.687	26.5	117	—	143	145.5	1	0.6	—	15 000	0.02~0.04	160	480	960	—	67	104	139	—
	150	20	1.1	0.6	—	3NCHAC922CA	49.7	31.9	1.45	—	14 000	23 000	33.7	41	0.687	32.1	117	—	143	145.5	1	0.6	—	15 000	0.02~0.04	255	765	1 530	—	146	214	279	—
	170	28	2	1	—	7022C-5	126	101	4.85	15.7	8 200	13 000	32.8	80	2.14	50.3	120	—	160	164.5	2	1	—	20 000	0.02~0.04	210	635	1 470	2 550	78	124	183	242
	170	28	2	1	—	7022AC-5	120	96.3	4.50	—	7 300	11 000	46.6	80	2.14	32.2	120	—	160	164.5	2	1	—	20 000	0.02~0.04	—	1 080	2 350	4 410	—	315	427	551

- [Remarks] 1. For the dimensions of the spacers for oil / air lubrication, refer to Table 15. 4 on page 53 to 57.
 2. For the discharge intervals of the oil / air, refer to Supplementary table 6 on page 215.
 3. C, CA, and no character string in the bearing number indicate nominal contact angles of 15°, 20°, and 30°, respectively.

Basic load ratings in case of multiple-row combination bearing

1. Angular contact ball bearings



We recommend that recesses be added at r_a , r_b , and r_c .

Static equivalent load $P_0 = X_0 F_r + Y_0 F_a$

Contact angle	Single row/Tandem		Back-to-back/Face-to-face	
	X_0	Y_0	X_0	Y_0
15°	0.5	0.46	1	0.92
20°	0.5	0.42	1	0.84
30°	0.5	0.33	1	0.66

Note that in the case of single row or tandem, assume $P_0 = F_r$ if $P_0 < F_r$.

Dynamic equivalent load $P = X F_r + Y F_a$

Contact angle	$\frac{i_0 F_a}{C_{0r}}$	e	Single row/Tandem				Back-to-back/Face-to-face			
			$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
			X	Y	X	Y	X	Y	X	Y
15°	0.178	0.38			1.47			1.65		2.39
	0.357	0.40			1.40			1.57		2.28
	0.714	0.43			1.30			1.46		2.11
	1.07	0.46			1.23			1.38		2.00
	1.43	0.47	1	0	1.19	1	1.34	0.72	1.93	1.93
	2.14	0.50			1.12			1.26		1.82
	3.57	0.55			1.02			1.14		1.66
	5.35	0.56			1.00			1.12		1.63
7.14	0.56			1.00			1.12		1.63	
20°		0.57	1	0	0.43	1	1	1.09	0.70	1.63
30°		0.80	1	0	0.39	0.76	1	0.78	0.63	1.24

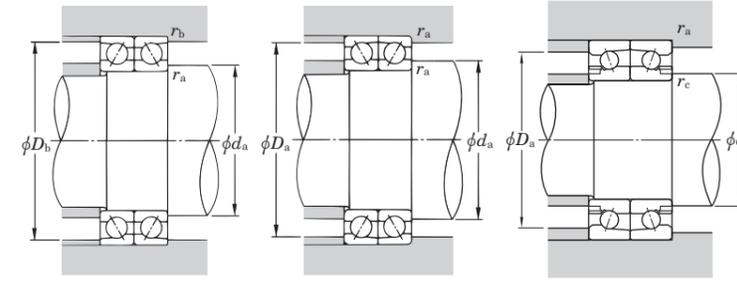
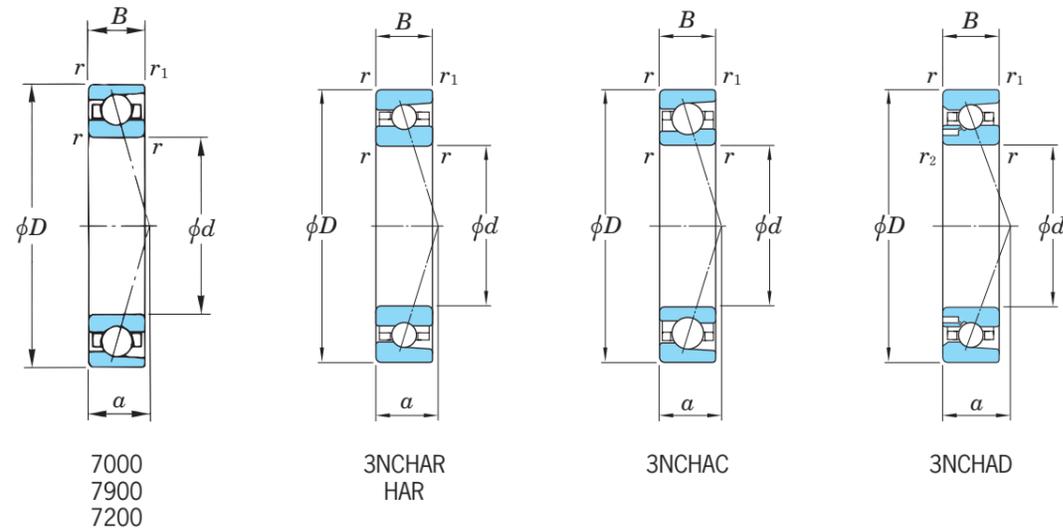
1) For i , use 2 for DB & DF and 1 for single & DT.

d (110) ~ (120)

d	Boundary dimensions (mm)					Bearing No.	Basic load ratings (kN)		Fatigue load limit (kN) C_u	Factor f_0	Limiting speeds (min ⁻¹)		Load center (mm) a	Interspace volume (cm ³ /row)	(Refer.) Mass (kg/row)	Permissible axial load (kN) (static)	Mounting dimensions (mm)							Nut axial tension (N)	Interference of retaining plate (mm)	Preload (Combination of DB and DF) (N)				Axial rigidity (Combination of DB and DF) (N/μm)				
	D	B	r min.	r_1 min.	r_2 min.		C_r	C_{0r}			Grease lub.	Oil lub.					d_a min.	d_b min.	D_a max.	D_b max.	r_a max.	r_b max.	r_c max.			S	L	M	H	S	L	M	H	
110	170	28	2	1	—	7022-5	115	92.8	4.30	—	6 300	8 200	54.4	80	2.14	25.2	120	—	160	164.5	2	1	—	20 000	0.02~0.04	—	1 080	2 350	4 410	—	415	550	700	
	170	28	2	1	—	HAR022C	54.2	37.0	1.60	8.50	10 000	16 000	32.8	68	2.11	47.1	120	—	160	164.5	2	1	—	20 000	0.02~0.04	170	510	1 020	—	66	103	138	—	
	170	28	2	1	—	3NCHAR022C	54.2	37.0	1.15	8.50	14 000	23 000	32.8	68	1.97	30.0	120	—	160	164.5	2	1	—	20 000	0.02~0.04	185	555	1 110	—	76	117	158	—	
	170	28	2	1	—	HAR022CA	52.9	36.1	1.60	—	9 900	15 000	39.5	68	2.11	55.2	120	—	160	164.5	2	1	—	20 000	0.02~0.04	250	750	1 500	—	137	205	267	—	
	170	28	2	1	—	3NCHAR022CA	52.9	36.1	1.10	—	13 000	22 000	39.5	68	1.97	36.4	120	—	160	164.5	2	1	—	20 000	0.02~0.04	275	825	1 650	—	159	236	308	—	
	170	28	2	1	—	HAR022	49.3	33.6	1.45	—	7 100	9 500	54.4	68	2.11	47.0	120	—	160	164.5	2	1	—	20 000	0.02~0.04	310	930	1 860	—	253	368	474	—	
	170	28	2	1	—	3NCHAC022C	87.4	51.6	2.25	8.00	14 000	23 000	32.8	89	1.60	41.6	120	—	160	164.5	2	1	—	20 000	0.02~0.04	185	555	1 110	—	68	103	137	—	
	170	28	2	1	—	3NCHAC022CA	85.5	50.4	2.20	—	13 000	22 000	39.5	89	1.60	50.7	120	—	160	164.5	2	1	—	20 000	0.02~0.04	275	825	1 650	—	143	210	272	—	
	170	28	2	1	0.6	3NCHAD022CA	52.9	36.1	1.60	—	—	23 000	39.5	—	2.06	36.4	120	—	160	164.5	2	1	0.6	20 000	0.02~0.04	275	825	1 650	—	159	236	308	—	
	200	38	2.1	1.1	—	7222C-5	220	160	8.35	14.5	7 200	11 000	40.0	202	4.65	95.9	122	—	188	193	2	1	—	30 000	0.02~0.04	385	1 180	2 450	5 300	88	141	198	294	
	200	38	2.1	1.1	—	7222AC-5	210	153	7.70	—	6 400	9 100	55.6	202	4.65	63.5	122	—	188	193	2	1	—	30 000	0.02~0.04	—	2 260	4 900	7 850	—	374	505	616	
	200	38	2.1	1.1	—	7222-5	202	148	7.30	—	5 600	7 200	64.3	202	4.65	50.9	122	—	188	193	2	1	—	30 000	0.02~0.04	—	2 260	4 900	7 850	—	489	651	779	
	120	165	22	1.1	0.6	—	7924C-5	89.7	81.2	3.55	16.5	8 600	13 000	30.1	57	1.15	44.9	127	—	158	160.5	1	0.6	—	15 000	0.02~0.04	145	490	—	—	72	122	—	—
		165	22	1.1	0.6	—	HAR924C	36.7	28.4	1.25	8.80	10 000	15 000	30.1	40	1.25	36.3	127	—	158	160.5	1	0.6	—	15 000	0.02~0.04	170	510	1 020	—	74	115	157	—
165		22	1.1	0.6	—	3NCHAR924C	36.7	28.4	0.87	8.80	14 000	23 000	30.1	40	1.17	23.1	127	—	158	160.5	1	0.6	—	15 000	0.02~0.04	185	555	1 110	—	84	132	180	—	
165		22	1.1	0.6	—	HAR924CA	35.8	27.7	1.20	—	9 800	15 000	36.9	40	1.25	42.4	127	—	158	160.5	1	0.6	—	15 000	0.02~0.04	260	780	1 560	—	149	223	293	—	
165		22	1.1	0.6	—	3NCHAR924CA	35.8	27.7	0.84	—	13 000	22 000	36.9	40	1.17	28.0	127	—	158	160.5	1	0.6	—	15 000	0.02~0.04	285	855	1 710	—	173	257	339	—	
165		22	1.1	0.6	—	HAR924	33.2	25.7	1.10	—	7 000	9 300	52.1	40	1.25	34.8	127	—	158	160.5	1	0.6	—	15 000	0.02~0.04	320	960	1 920	—	272	396	509	—	
165		22	1.1	0.6	—	3NCHAC924C	63.2	41.2	1.80	8.40	14 000	23 000	30.1	55	0.934	33.4	127	—	158	160.5	1	0.6	—	15 000	0.02~0.04	185	555	1 110	—	73	113	151	—	
165		22	1.1	0.6	—	3NCHAC924CA	61.7	40.3	1.75	—	13 000	22 000	36.9	55	0.934	40.5	127	—	158	160.5	1	0.6	—	15 000	0.02~0.04	285	855	1 710	—	154	230	299	—	
180		28	2	1	—	7024C-5	133	113	5.10	16.0	7 700	12 000	34.1	85	2.27	60.8	130	—	170	174.5	2	1	—	20 000	0.02~0.04	225	685	1 670	2 840	85	135	205	269	
180		28	2	1	—	7024AC-5	126	107	4.75	—	6 800	9 850	49.0	85	2.27	40.0	130	—	170	174.5	2	1	—	20 000	0.02~0.04	—	1 180	2 650	4 900	—	347	473	611	
180		28	2	1	—	7024-5	121	103	4.50	—	5 800	7 700	57.3	78	2.27	31.9	130	—	170	174.5	2	1	—	20 000	0.02~0.04	—	1 180	2 650	4 900	—	454	613	772	
180		28	2	1	—	HAR024C	56.1	39.9	1.70	8.50	9 800	15 000	34.1	73	2.26	50.9	130	—	170	174.5	2	1	—	20 000	0.02~0.04	210	630	1 260	—	75	116	158	—	
180		28	2	1	—	3NCHAR024C	56.1	39.9	1.20	8.50	13 000	22 000	34.1	73	2.11	32.4	130	—	170	174.5	2	1	—	20 000	0.02~0.04	230	690	1 380	—	87	134	181	—	
180		28	2	1	—	HAR024CA	54.8	39.0	1.65	—	9 300	14 000	41.3	73	2.26	59.7	130	—	170	174.5	2	1	—	20 000	0.02~0.04	300	900	1 800	—	152	229	299	—	
180		28	2	1	—	3NCHAR024CA	54.8	39.0	1.15	—	12 000	21 000	41.3	73	2.11	39.3	130	—	170	174.5	2	1	—	20 000	0.02~0.04	330	990	1 980	—	176	264	346	—	
180		28	2	1	—	HAR024	50.9	36.2	1.55	—	6 700	8 800	57.3	73	2.26	50.3	130	—	170	174.5	2	1	—	20 000	0.02~0.04	375	1 125	2 250	—	283	413	526	—	
180		28	2	1	—	3NCHAC024C	92.5	57.5	2.40	8.10	13 000	22 000	34.1	95	1.72	46.4	130	—	170	174.5	2	1	—	20 000	0.02~0.04	230	690	1 380	—	78	119	159	—	
180		28	2	1	—	3NCHAC024CA	90.4	56.2	2.35	—	12 000	21 000	41.3	95	1.72	56.5	130	—	170	174.5	2	1	—	20 000	0.02~0.04	330	990	1 980	—	161	239	309	—	

- [Remarks] 1. For the dimensions of the spacers for oil / air lubrication, refer to Table 15. 4 on page 53 to 57.
 2. For the discharge intervals of the oil / air, refer to Supplementary table 6 on page 215.
 3. C, CA, and no character string in the bearing number indicate nominal contact angles of 15°, 20°, and 30°, respectively.

1. Angular contact ball bearings



We recommend that recesses be added at r_a , r_b , and r_c .

Static equivalent load $P_0 = X_0 F_r + Y_0 F_a$

Contact angle	Single row/Tandem		Back-to-back/Face-to-face	
	X_0	Y_0	X_0	Y_0
15°	0.5	0.46	1	0.92
20°	0.5	0.42	1	0.84
30°	0.5	0.33	1	0.66

Note that in the case of single row or tandem, assume $P_0 = F_r$ if $P_0 < F_r$.

Dynamic equivalent load $P = X F_r + Y F_a$

Contact angle	$\frac{i_0 F_a}{C_{0r}}$	e	Single row/Tandem				Back-to-back/Face-to-face				
			$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		
			X	Y	X	Y	X	Y	X	Y	
15°	0.178	0.38			1.47			1.65			2.39
	0.357	0.40			1.40			1.57			2.28
	0.714	0.43			1.30			1.46			2.11
	1.07	0.46			1.23			1.38			2.00
	1.43	0.47	1	0	1.19	1	0.72	1.34	0.72	1.93	1.93
	2.14	0.50			1.12			1.26			1.82
	3.57	0.55			1.02			1.14			1.66
	5.35	0.56			1.00			1.12			1.63
7.14	0.56			1.00			1.12			1.63	
20°		0.57	1	0	0.43	1	1	1.09	0.70	1.63	
30°		0.80	1	0	0.39	0.76	1	0.78	0.63	1.24	

1) For i , use 2 for DB & DF and 1 for single & DT.

d (120) ~ (140)

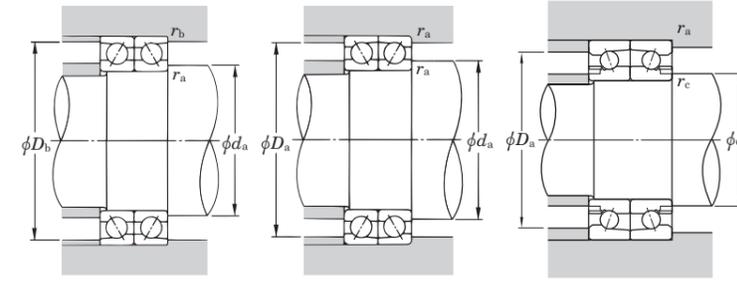
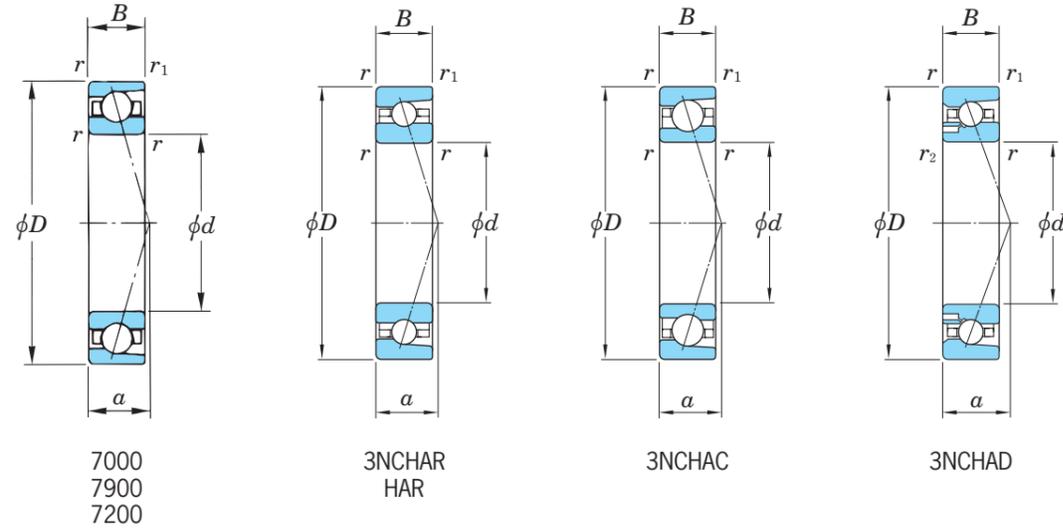
d	Boundary dimensions (mm)					Bearing No.	Basic load ratings (kN)		Fatigue load limit (kN) C_u	Factor f_0	Limiting speeds (min ⁻¹)		Load center (mm) a	Interspace volume (cm ³ /row)	(Refer.) Mass (kg/row)	Permissible axial load (kN) (static)	Mounting dimensions (mm)						Nut axial tension (N)	Interference of retaining plate (mm)	Preload (Combination of DB and DF) (N)				Axial rigidity (Combination of DB and DF) (N/μm)				
	D	B	r min.	r_1 min.	r_2 min.		C_r	C_{0r}			Grease lub.	Oil lub.					d_a min.	d_b min.	D_a max.	D_b max.	r_a max.	r_b max.			r_c max.	S	L	M	H	S	L	M	H
120	180	28	2	1	0.6	3NCHAD024CA	54.8	39.0	1.65	—	—	22 000	41.3	—	2.21	39.3	130	—	170	174.5	2	1	0.6	20 000	0.02~0.04	330	990	1 980	—	176	264	346	—
	215	40	2.1	1.1	—	7224C-5	237	180	8.95	14.6	6 800	10 000	42.5	241	5.49	108	132	—	203	208	2	1	—	30 000	0.02~0.04	420	1 270	2 840	5 490	92	146	213	299
	215	40	2.1	1.1	—	7224AC-5	226	181	8.30	—	6 000	8 400	59.2	240	5.49	71.7	132	—	203	208	2	1	—	30 000	0.02~0.04	—	2 450	5 390	8 830	—	390	531	653
	215	40	2.1	1.1	—	7224-5	218	166	7.85	—	5 100	6 800	68.5	240	5.49	57.5	132	—	203	208	2	1	—	30 000	0.02~0.04	—	2 450	5 390	8 830	—	510	682	823
130	180	24	1.5	1	—	7926C-5	109	99.9	4.20	16.4	7 800	12 000	32.8	61	1.50	53.4	138.5	—	171.5	174.5	1.5	1	—	20 000	0.02~0.04	195	590	—	—	84	133	—	—
	180	24	1.5	1	—	HAR926C	43.9	35.1	1.45	8.80	9 300	14 000	32.8	51	1.66	44.9	138.5	—	171.5	174.5	1.5	1	—	20 000	0.02~0.04	195	585	1 170	—	81	127	173	—
	180	24	1.5	1	—	3NCHAR926C	43.9	35.1	1.05	8.80	12 000	21 000	32.8	51	1.56	28.6	138.5	—	171.5	174.5	1.5	1	—	20 000	0.02~0.04	215	645	1 290	—	95	147	199	—
	180	24	1.5	1	—	HAR926CA	42.8	34.3	1.40	—	8 900	13 000	40.2	51	1.66	52.5	138.5	—	171.5	174.5	1.5	1	—	20 000	0.02~0.04	290	870	1 740	—	171	252	331	—
	180	24	1.5	1	—	3NCHAR926CA	42.8	34.3	1.00	—	12 000	19 000	40.2	51	1.56	34.6	138.5	—	171.5	174.5	1.5	1	—	20 000	0.02~0.04	320	960	1 920	—	197	293	382	—
	180	24	1.5	1	—	HAR926	39.7	31.8	1.30	—	6 400	8 500	56.7	51	1.66	42.3	138.5	—	171.5	174.5	1.5	1	—	20 000	0.02~0.04	370	1 110	2 220	—	315	458	588	—
	180	24	1.5	1	—	3NCHAC926C	76.6	50.8	2.10	8.30	12 000	21 000	32.8	72	1.23	41.1	138.5	—	171.5	174.5	1.5	1	—	20 000	0.02~0.04	215	645	1 290	—	80	122	163	—
	180	24	1.5	1	—	3NCHAC926CA	74.8	49.6	2.05	—	12 000	19 000	40.3	72	1.23	49.9	138.5	—	171.5	174.5	1.5	1	—	20 000	0.02~0.04	320	960	1 920	—	166	248	320	—
	200	33	2	1	—	7026C-5	161	137	5.95	15.9	7 000	11 000	38.6	130	3.43	74.7	140	—	190	194.5	2	1	—	20 000	0.02~0.04	245	735	1 770	3 140	94	149	225	301
	200	33	2	1	—	7026AC-5	153	130	5.55	—	6 200	9 000	55.0	129	3.43	49.3	140	—	190	194.5	2	1	—	20 000	0.02~0.04	—	1 370	3 140	5 390	—	368	506	630
	200	33	2	1	—	7026-5	147	125	5.25	—	5 300	7 000	64.1	129	3.43	39.4	140	—	190	194.5	2	1	—	20 000	0.02~0.04	—	1 370	3 140	5 390	—	485	654	801
	200	33	2	1	—	HAR026C	70.4	48.4	1.95	8.50	8 800	13 000	38.6	115	3.38	61.6	140	—	190	194.5	2	1	—	20 000	0.02~0.04	240	720	1 440	—	75	117	158	—
	200	33	2	1	—	3NCHAR026C	70.4	48.4	1.35	8.50	12 000	19 000	38.6	115	3.16	39.2	140	—	190	194.5	2	1	—	20 000	0.02~0.04	265	795	1 590	—	87	135	181	—
	200	33	2	1	—	HAR026CA	68.7	47.2	1.90	—	8 400	12 000	46.5	115	3.38	72.2	140	—	190	194.5	2	1	—	20 000	0.02~0.04	350	1 050	2 100	—	154	231	302	—
	200	33	2	1	—	3NCHAR026CA	68.7	47.2	1.35	—	11 000	19 000	46.5	115	3.16	47.6	140	—	190	194.5	2	1	—	20 000	0.02~0.04	385	1 155	2 310	—	179	267	347	—
	200	33	2	1	—	HAR026	64.0	43.9	1.75	—	6 000	8 100	64.1	115	3.38	62.3	140	—	190	194.5	2	1	—	20 000	0.02~0.04	440	1 320	2 640	—	284	419	536	—
	200	33	2	1	—	3NCHAC026C	112	69.7	2.80	8.10	12 000	19 000	38.6	139	2.68	56.3	140	—	190	194.5	2	1	—	20 000	0.02~0.04	265	795	1 590	—	83	125	167	—
	200	33	2	1	—	3NCHAC026CA	110	68.2	2.75	—	11 000	19 000	46.5	139	2.68	68.6	140	—	190	194.5	2	1	—	20 000	0.02~0.04	385	1 155	2 310	—	171	254	328	—
	200	33	2	1	0.6	3NCHAD026CA	68.7	47.2	1.90	—	—	19 000	46.5	—	3.30	47.6	140	—	190	194.5	2	1	0.6	20 000	0.02~0.04	385	1 155	2 310	—	179	267	347	—
	230	40	3	1.1	—	7226C-5	266	214	8.25	14.7	6 300	10 000	44.1	258	6.21	116	144	—	216	223	2.5	1	—	30 000	0.02~0.04	485	1 470	3 140	5 880	120	197	287	403
230	40	3	1.1	—	7226AC-5	254	204	7.85	—	5 500	8 200	62.0	257	6.21	40.2	144	—	216	223	2.5	1	—	30 000	0.02~0.04	—	2 750	5 880	9 320	—	500	684	836	
230	40	3	1.1	—	7226-5	245	198	7.60	—	4 700	6 300	72.0	257	6.21	62.1	144	—	216	223	2.5	1	—	30 000	0.02~0.04	—	2 750	5 880	9 320	—	651	868	1 041	
140	190	24	1.5	1	—	7928C-5	110	105	4.20	16.6	7 400	11 000	34.1	66	1.59	55.6	148.5	—	181.5	184.5	1.5	1	—	20 000	0.02~0.04	195	635	—	—	86	141	—	—
	190	24	1.5	1	—	HAR928C	44.0	36.2	1.45	8.80	8 800	13 000	34.1	57	1.76	46.3	148.5	—	181.5	184.5	1.5	1	—	20 000	0.02~0.04	220	660	1 320	—	87	135	185	—
	190	24	1.5	1	—	3NCHAR928C	44.0	36.2	1.05	8.80	12 000	19 000	34.1	57	1.65	29.5	148.5	—	181.5	184.5	1.5	1	—	20 000	0.02~0.04	240	720	1 440	—	100	157	213	—

- [Remarks] 1. For the dimensions of the spacers for oil / air lubrication, refer to Table 15. 4 on page 53 to 57.
 2. For the discharge intervals of the oil / air, refer to Supplementary table 6 on page 215.
 3. C, CA, and no character string in the bearing number indicate nominal contact angles of 15°, 20°, and 30°, respectively.

Basic load ratings in case of multiple-row combination bearing

	Basic dynamic load ratings	Basic static load ratings
2-row	$C_r \times 1.62$	$C_{0r} \times 2$
3-row	$C_r \times 2.16$	$C_{0r} \times 3$

1. Angular contact ball bearings



Static equivalent load $P_0 = X_0 F_r + Y_0 F_a$

Contact angle	Single row/Tandem		Back-to-back/Face-to-face	
	X_0	Y_0	X_0	Y_0
15°	0.5	0.46	1	0.92
20°	0.5	0.42	1	0.84
30°	0.5	0.33	1	0.66

Note that in the case of single row or tandem, assume $P_0 = F_r$ if $P_0 < F_r$.

Dynamic equivalent load $P = X F_r + Y F_a$

Contact angle	$\frac{i_0 F_a}{C_{0r}}$	e	Single row/Tandem				Back-to-back/Face-to-face				
			$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		
			X	Y	X	Y	X	Y	X	Y	
15°	0.178	0.38			1.47			1.65		2.39	
	0.357	0.40			1.40			1.57		2.28	
	0.714	0.43			1.30			1.46		2.11	
	1.07	0.46			1.23			1.38		2.00	
	1.43	0.47	1	0	1.19	1	0.72	1.34	0.72	1.93	
	2.14	0.50			1.12			1.26		1.82	
	3.57	0.55			1.02			1.14		1.66	
	5.35	0.56			1.00			1.12		1.63	
7.14	0.56			1.00			1.12		1.63		
20°			0.57	1	0	0.43	1	1	1.09	0.70	1.63
30°			0.80	1	0	0.39	0.76	1	0.78	0.63	1.24

1) For i , use 2 for DB & DF and 1 for single & DT.

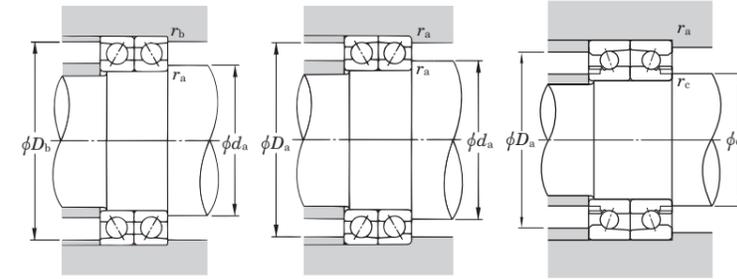
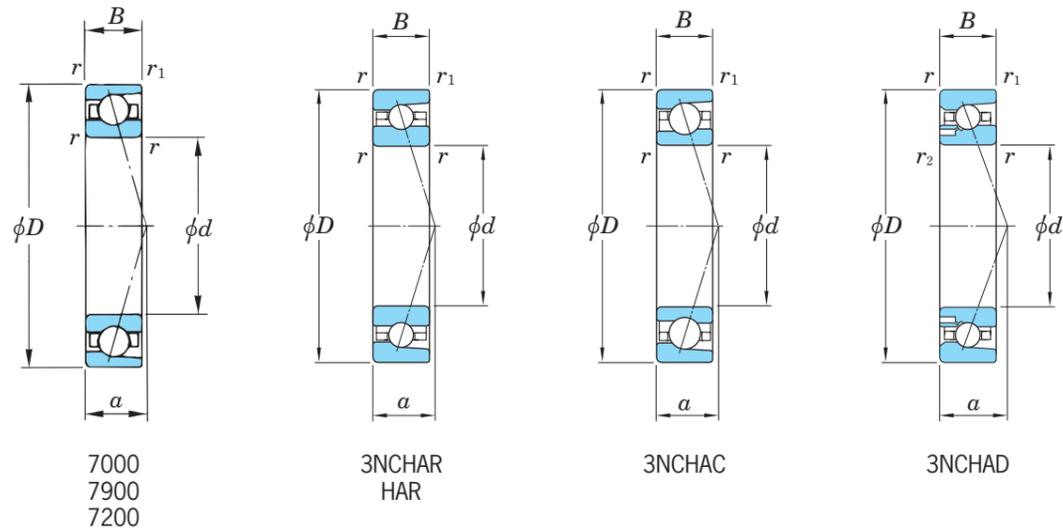
d (140) ~ (150)

d	Boundary dimensions (mm)					Bearing No.	Basic load ratings (kN)		Fatigue load limit (kN) C_u	Factor f_0	Limiting speeds (min ⁻¹)		Load center (mm) a	Interspace volume (cm ³ /row)	(Refer.) Mass (kg/row)	Permissible axial load (kN) (static)	Mounting dimensions (mm)						Nut axial tension (N)	Interference of retaining plate (mm)	Preload (Combination of DB and DF) (N)				Axial rigidity (Combination of DB and DF) (N/ μ m)				
	D	B	r min.	r_1 min.	r_2 min.		C_r	C_{0r}			Grease lub.	Oil lub.					d_a min.	d_b min.	D_a max.	D_b max.	r_a max.	r_b max.			r_c max.	S	L	M	H	S	L	M	H
140	190	24	1.5	1	—	HAR928CA	42.9	35.3	1.40	—	8 400	12 000	42.0	57	1.76	54.2	148.5	—	181.5	184.5	1.5	1	—	20 000	0.02~0.04	320	960	1 920	—	178	267	349	—
	190	24	1.5	1	—	3NCHAR928CA	42.9	35.3	1.00	—	11 000	19 000	42.0	57	1.65	35.7	148.5	—	181.5	184.5	1.5	1	—	20 000	0.02~0.04	350	1 050	2 100	—	203	309	404	—
	190	24	1.5	1	—	HAR928	39.8	32.8	1.30	—	6 000	8 100	59.6	57	1.76	43.3	148.5	—	181.5	184.5	1.5	1	—	20 000	0.02~0.04	420	1 260	2 520	—	329	489	626	—
	190	24	1.5	1	—	3NCHAC928C	77.9	53.2	2.15	8.40	12 000	19 000	34.1	77	1.31	43.2	148.5	—	181.5	184.5	1.5	1	—	20 000	0.02~0.04	240	720	1 440	—	86	130	175	—
	190	24	1.5	1	—	3NCHAC928CA	76.0	52.0	2.10	—	11 000	19 000	42.0	77	1.31	52.4	148.5	—	181.5	184.5	1.5	1	—	20 000	0.02~0.04	350	1 050	2 100	—	177	261	340	—
	210	33	2	1	—	7028C-5	165	145	6.00	16.0	6 500	10 000	39.9	137	3.64	78.3	150	—	200	204.5	2	1	—	25 000	0.02~0.04	260	780	1 960	3 920	92	145	222	315
	210	33	2	1	—	7028AC-5	156	138	5.60	—	5 800	8 200	57.3	136	3.64	51.7	150	—	200	204.5	2	1	—	25 000	0.02~0.04	—	1 470	3 430	5 880	—	389	538	672
	210	33	2	1	—	7028-5	150	133	5.30	—	5 000	6 400	67.0	136	3.64	41.3	150	—	200	204.5	2	1	—	25 000	0.02~0.04	—	1 470	3 430	5 880	—	507	696	852
	210	33	2	1	—	HAR028C	76.7	56.2	2.20	8.50	8 400	12 000	39.9	120	3.62	71.6	150	—	200	204.5	2	1	—	25 000	0.02~0.04	270	810	1 620	—	86	133	180	—
	210	33	2	1	—	3NCHAR028C	76.7	56.2	1.55	8.50	11 000	19 000	39.9	120	3.37	45.6	150	—	200	204.5	2	1	—	25 000	0.02~0.04	295	885	1 770	—	100	153	206	—
	210	33	2	1	—	HAR028CA	74.8	54.8	2.15	—	7 900	12 000	48.3	120	3.62	84	150	—	200	204.5	2	1	—	25 000	0.02~0.04	400	1 200	2 400	—	180	265	348	—
	210	33	2	1	—	3NCHAR028CA	74.8	54.8	1.50	—	10 000	18 000	48.3	120	3.37	55.3	150	—	200	204.5	2	1	—	25 000	0.02~0.04	440	1 320	2 640	—	207	307	400	—
	210	33	2	1	—	HAR028	69.6	51.0	2.00	—	5 700	7 500	67.0	120	3.62	71.9	150	—	200	204.5	2	1	—	25 000	0.02~0.04	505	1 515	3 030	—	326	481	618	—
	210	33	2	1	—	3NCHAC028C	115	73.8	2.90	8.20	11 000	19 000	40.0	146	2.84	59.6	150	—	200	204.5	2	1	—	25 000	0.02~0.04	295	885	1 770	—	88	135	180	—
	210	33	2	1	—	3NCHAC028CA	112	72.1	2.80	—	10 000	18 000	48.4	146	2.84	72.6	150	—	200	204.5	2	1	—	25 000	0.02~0.04	440	1 320	2 640	—	185	275	356	—
	250	42	3	1.1	—	7228C-5	297	254	9.40	14.8	5 700	9 100	47.1	301	7.76	136	154	—	236	243	2.5	1	—	35 000	0.02~0.04	520	1 570	3 430	6 370	129	211	310	431
	250	42	3	1.1	—	7228AC-5	283	242	8.95	—	5 000	7 400	66.5	300	7.76	47.0	154	—	236	243	2.5	1	—	35 000	0.02~0.04	—	2 940	6 370	9 810	—	542	741	892
	250	42	3	1.1	—	7228-5	273	234	8.65	—	4 300	5 700	77.3	300	7.76	72.8	154	—	236	243	2.5	1	—	35 000	0.02~0.04	—	2 940	6 370	9 810	—	704	940	1 118
150	210	28	2	1	—	7930C-5	148	132	5.45	16.3	6 700	10 000	38.1	117	2.47	69.0	160	—	200	204.5	2	1	—	20 000	0.02~0.04	245	735	—	—	93	146	—	—
	210	28	2	1	—	HAR930C	61.2	48.9	1.90	8.70	8 100	12 000	38.1	85	2.68	62.5	160	—	200	204.5	2	1	—	20 000	0.02~0.04	255	765	1 530	—	91	141	191	—
	210	28	2	1	—	3NCHAR930C	61.2	48.9	1.35	8.70	10 000	16 000	38.1	85	2.50	39.8	160	—	200	204.5	2	1	—	20 000	0.02~0.04	280	840	1 680	—	105	162	219	—
	210	28	2	1	—	HAR930CA	59.7	47.6	1.85	—	7 700	11 000	46.8	85	2.68	73.1	160	—	200	204.5	2	1	—	20 000	0.02~0.04	350	1 050	2 100	—	184	271	354	—
	210	28	2	1	—	3NCHAR930CA	59.7	47.6	1.30	—	9 800	16 000	46.8	85	2.50	48.1	160	—	200	204.5	2	1	—	20 000	0.02~0.04	385	1 155	2 310	—	211	314	409	—
	210	28	2	1	—	HAR930	55.4	44.2	1.70	—	5 600	7 400	66.0	85	2.68	60.3	160	—	200	204.5	2	1	—	20 000	0.02~0.04	470	1 410	2 820	—	342	504	645	—
	210	28	2	1	—	3NCHAC930C	104	69.8	2.70	8.30	10 000	16 000	38.1	118	2.00	56.5	160	—	200	204.5	2	1	—	20 000	0.02~0.04	280	840	1 680	—	90	137	183	—
	210	28	2	1	—	3NCHAC930CA	102	68.2	2.65	—	9 800	16 000	46.8	118	2.00	68.7	160	—	200	204.5	2	1	—	20 000	0.02~0.04	385	1 155	2 310	—	181	270	350	—
	225	35	2.1	1.1	—	7030C-5	188	169	6.70	16.1	6 000	9 500	42.8	169	4.43	89.9	162	—	213	218	2	1	—	25 000	0.02~0.04	275	835	2 160	4 410	96	150	234	335
	225	35	2.1	1.1	—	7030AC-5	178	160	6.25	—	5 300	7 800	61.6	168	4.43	59.1	162	—	213	218	2	1	—	25 000	0.02~0.04	—	1 770	3 920	6 860	—	424	576	724
	225	35	2.1	1.1	—	7030-5	171	154	5.95	—	4 600	6 000	72.1	168	4.43	47.1	162	—	213	218	2	1	—	25 000	0.02~0.04	—	1 770	3 920	6 860	—	553	743	921
	225	35	2	1	—	HAR030C	90.3	66.1	2.50	8.50	7 400	11 000	42.6	150	4.36	84.2	160	—	215	219.5	2	1	—	25 000	0.02~0.04	310	930	1 860	—	91	141	190	—

- [Remarks] 1. For the dimensions of the spacers for oil / air lubrication, refer to Table 15. 4 on page 53 to 57.
 2. For the discharge intervals of the oil / air, refer to Supplementary table 6 on page 215.
 3. C, CA, and no character string in the bearing number indicate nominal contact angles of 15°, 20°, and 30°, respectively.

Basic load ratings in

1. Angular contact ball bearings



We recommend that recesses be added at r_a , r_b , and r_c .

Static equivalent load $P_0 = X_0 F_r + Y_0 F_a$

Contact angle	Single row/Tandem		Back-to-back/Face-to-face	
	X_0	Y_0	X_0	Y_0
15°	0.5	0.46	1	0.92
20°	0.5	0.42	1	0.84
30°	0.5	0.33	1	0.66

Note that in the case of single row or tandem, assume $P_0 = F_r$ if $P_0 < F_r$.

Dynamic equivalent load $P = X F_r + Y F_a$

Contact angle	$\frac{i_0 F_a}{C_{0r}}$	e	Single row/Tandem				Back-to-back/Face-to-face			
			$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
			X	Y	X	Y	X	Y	X	Y
15°	0.178	0.38			1.47			1.65		2.39
	0.357	0.40			1.40			1.57		2.28
	0.714	0.43			1.30			1.46		2.11
	1.07	0.46			1.23			1.38		2.00
	1.43	0.47	1	0	1.19	1	0.72	1.34	0.72	1.93
	2.14	0.50			1.12			1.26		1.82
	3.57	0.55			1.02			1.14		1.66
	5.35	0.56			1.00			1.12		1.63
7.14	0.56			1.00			1.12		1.63	
20°		0.57	1	0	0.43	1	1	1.09	0.70	1.63
30°		0.80	1	0	0.39	0.76	1	0.78	0.63	1.24

1) For i , use 2 for DB & DF and 1 for single & DT.

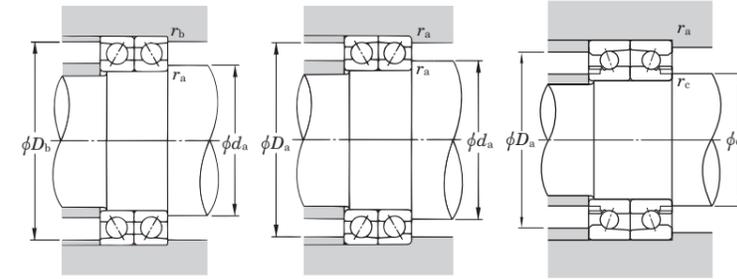
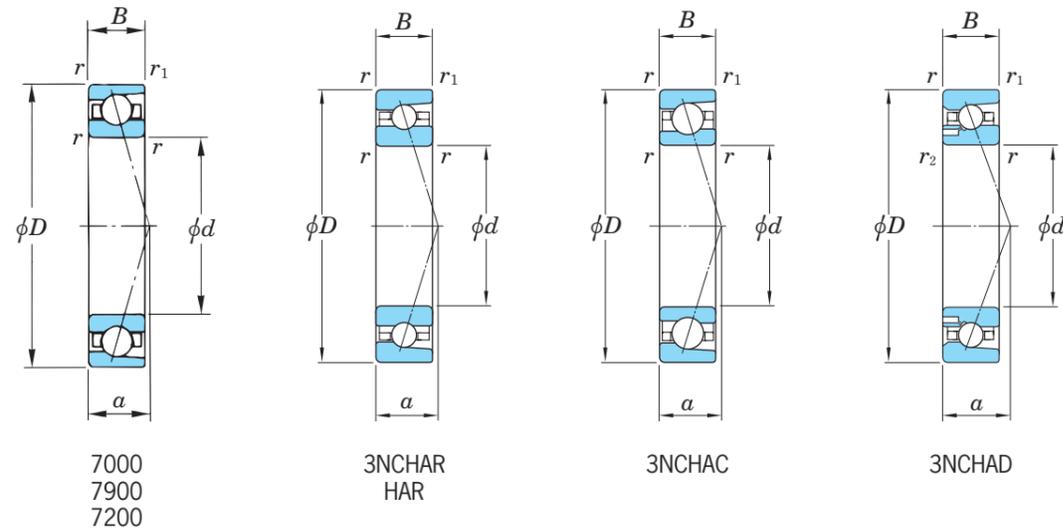
d (150) ~ (170)

d	Boundary dimensions (mm)					Bearing No.	Basic load ratings (kN)		Fatigue load limit (kN) C_u	Factor f_0	Limiting speeds (min ⁻¹)		Load center (mm) a	Interspace volume (cm ³ /row)	(Refer.) Mass (kg/row)	Permissible axial load (kN) (static)	Mounting dimensions (mm)							Nut axial tension (N)	Interference of retaining plate (mm)	Preload (Combination of DB and DF) (N)				Axial rigidity (Combination of DB and DF) (N/μm)				
	D	B	r min.	r ₁ min.	r ₂ min.		C_r	C_{0r}			Grease lub.	Oil lub.					d_a min.	d_b min.	D_a max.	D_b max.	r_a max.	r_b max.	r_c max.			S	L	M	H	S	L	M	H	
150	225	35	2	1	—	3NCHAR030C	90.3	66.1	1.75	8.50	9 900	16 000	42.6	150	4.03	53.7	160	—	215	219.5	2	1	—	25 000	0.02~0.04	340	1 020	2 040	—	105	161	218	—	
	225	35	2	1	—	HAR030CA	88.1	64.5	2.45	—	7 000	10 000	51.6	150	4.36	98.8	160	—	215	219.5	2	1	—	25 000	0.02~0.04	440	1 320	2 640	—	185	276	360	—	
	225	35	2	1	—	3NCHAR030CA	88.1	64.5	1.70	—	9 300	15 000	51.6	150	4.03	65.1	160	—	215	219.5	2	1	—	25 000	0.02~0.04	485	1 455	2 910	—	216	322	417	—	
	225	35	2	1	—	HAR030	82.0	60.0	2.25	—	5 000	6 700	71.6	150	4.36	82.9	160	—	215	219.5	2	1	—	25 000	0.02~0.04	570	1 710	3 420	—	345	507	648	—	
	225	35	2.1	1.1	—	3NCHAC030C	131	85.7	3.20	8.20	9 900	16 000	42.8	176	3.44	69.2	162	—	213	218	2	1	—	25 000	0.02~0.04	340	1 020	2 040	—	95	145	193	—	
	225	35	2.1	1.1	—	3NCHAC030CA	128	83.7	3.15	—	9 300	15 000	51.9	176	3.44	84.2	162	—	213	218	2	1	—	25 000	0.02~0.04	485	1 455	2 910	—	196	290	375	—	
	160	220	28	2	1	—	7932C-5	151	144	5.45	16.5	6 300	9 800	39.5	116	2.60	75.1	170	—	210	214.5	2	1	—	25 000	0.02~0.04	245	780	—	—	95	154	—	—
		220	28	2	1	—	HAR932C	62.7	51.8	1.95	8.80	7 200	11 000	39.5	90	2.83	66.3	170	—	210	214.5	2	1	—	25 000	0.02~0.04	280	840	1 680	—	97	151	205	—
220		28	2	1	—	3NCHAR932C	62.7	51.8	1.35	8.80	9 900	16 000	39.5	90	2.64	42.2	170	—	210	214.5	2	1	—	25 000	0.02~0.04	310	930	1 860	—	113	175	236	—	
220		28	2	1	—	HAR932CA	61.2	50.5	1.90	—	7 000	10 000	48.6	90	2.83	77.5	170	—	210	214.5	2	1	—	25 000	0.02~0.04	380	1 140	2 280	—	195	289	378	—	
220		28	2	1	—	3NCHAR932CA	61.2	50.5	1.35	—	9 200	15 000	48.6	90	2.64	51.1	170	—	210	214.5	2	1	—	25 000	0.02~0.04	420	1 260	2 520	—	224	336	438	—	
220		28	2	1	—	HAR932	56.7	46.9	1.75	—	5 000	6 500	68.8	90	2.83	63.6	170	—	210	214.5	2	1	—	25 000	0.02~0.04	520	1 560	3 120	—	365	538	693	—	
220		28	2	1	—	3NCHAC932C	106	73.3	2.75	8.40	9 900	16 000	39.5	124	2.11	59.4	170	—	210	214.5	2	1	—	25 000	0.02~0.04	310	930	1 860	—	95	146	195	—	
220		28	2	1	—	3NCHAC932CA	104	71.6	2.70	—	9 200	15 000	48.6	124	2.11	72.1	170	—	210	214.5	2	1	—	25 000	0.02~0.04	420	1 260	2 520	—	193	286	372	—	
240		38	2.1	1.1	—	7032C-5	214	193	7.5	16.0	5 600	8 900	45.8	232	5.45	111	172	—	228	233	2	1	—	30 000	0.02~0.04	290	880	2 350	4 900	99	156	244	353	
240		38	2.1	1.1	—	7032AC-5	202	183	7.00	—	5 000	7 300	65.6	232	5.45	75.2	172	—	228	233	2	1	—	30 000	0.02~0.04	—	2 160	4 410	7 850	—	465	613	777	
240		38	2.1	1.1	—	7032-5	194	176	6.65	—	4 300	5 600	76.8	232	5.45	60.7	172	—	228	233	2	1	—	30 000	0.02~0.04	—	2 160	4 410	7 850	—	608	791	984	
240		38	2.1	1.1	—	HAR032C	97.8	72.7	2.65	8.50	7 000	10 000	45.8	186	5.40	92.7	172	—	228	233	2	1	—	30 000	0.02~0.04	350	1 050	2 100	—	97	149	201	—	
240		38	2.1	1.1	—	3NCHAR032C	97.8	72.7	1.85	8.50	9 300	15 000	45.8	186	5.02	59.1	172	—	228	233	2	1	—	30 000	0.02~0.04	385	1 155	2 310	—	112	172	232	—	
240		38	2.1	1.1	—	HAR032CA	95.5	71.0	2.60	—	6 500	10 000	55.4	186	5.40	108	172	—	228	233	2	1	—	30 000	0.02~0.04	480	1 440	2 880	—	194	289	378	—	
240		38	2.1	1.1	—	3NCHAR032CA	95.5	71.0	1.85	—	8 800	15 000	55.4	186	5.02	71.6	172	—	228	233	2	1	—	30 000	0.02~0.04	530	1 590	3 180	—	226	335	436	—	
240		38	2.1	1.1	—	HAR032	88.8	66.0	2.40	—	4 700	6 300	76.7	186	5.40	90.0	172	—	228	233	2	1	—	30 000	0.02~0.04	635	1 905	3 810	—	363	537	683	—	
240		38	2.1	1.1	—	3NCHAC032C	149	98.1	3.60	8.10	9 300	15 000	45.8	223	4.23	79.3	172	—	228	233	2	1	—	30 000	0.02~0.04	385	1 155	2 310	—	101	155	206	—	
240		38	2.1	1.1	—	3NCHAC032CA	145	95.9	3.50	—	8 800	15 000	55.4	223	4.23	96.5	172	—	228	233	2	1	—	30 000	0.02~0.04	530	1 590	3 180	—	206	306	395	—	
170		230	28	2	1	—	7934C-5	153	151	5.50	16.6	5 800	9 200	40.8	115	3.21	78.1	180	—	220	224.5	2	1	—	25 000	0.02~0.04	345	880	—	—	112	166	—	—
		230	28	2	1	—	HAR934C	64.2	54.8	2.00	8.80	7 000	10 000	40.8	94	2.97	70.2	180	—	220	224.5	2	1	—	25 000	0.02~0.04	300	940	1 880	—	103	163	222	—
	230	28	2	1	—	3NCHAR934C	64.2	54.8	1.40	8.80	9 300	15 000	40.8	94	2.77	44.7	180	—	220	224.5	2	1	—	25 000	0.02~0.04	330	990	1 980	—	119	185	249	—	
	230	28	2	1	—	HAR934CA	62.6	53.4	1.95	—	6 500	10 000	50.4	94	2.97	82.0	180	—	220	224.5	2	1	—	25 000	0.02~0.04	400	1 200	2 400	—	205	304	398	—	
	230	28	2	1	—	3NCHAR934CA	62.6	53.4	1.40	—	8 800	15 000	50.4	94	2.77	54.0	180	—	220	224.5	2	1	—	25 000	0.02~0.04	440	1 320	2 640	—	238	352	459	—	
	230	28	2	1	—	HAR934	58.0	49.6	1.80	—	4 700	6 300	71.7	94	2.97	66.9	180	—	220	224.5	2	1	—	25 000	0.02~0.04	550	1 670	3 340	—	393	571	734	—	

- [Remarks] 1. For the dimensions of the spacers for oil / air lubrication, refer to Table 15. 4 on page 53 to 57.
 2. For the discharge intervals of the oil / air, refer to Supplementary table 6 on page 215.
 3. C, CA, and no character string in the bearing number indicate nominal contact angles of 15°, 20°, and 30°, respectively.

Basic load ratings

1. Angular contact ball bearings



We recommend that recesses be added at r_a , r_b , and r_c .

Static equivalent load $P_0 = X_0 F_r + Y_0 F_a$

Contact angle	Single row/Tandem		Back-to-back/Face-to-face	
	X_0	Y_0	X_0	Y_0
15°	0.5	0.46	1	0.92
20°	0.5	0.42	1	0.84
30°	0.5	0.33	1	0.66

Note that in the case of single row or tandem, assume $P_0 = F_r$ if $P_0 < F_r$.

Dynamic equivalent load $P = X F_r + Y F_a$

Contact angle	$\frac{i_0 F_a}{C_{0r}}$	e	Single row/Tandem				Back-to-back/Face-to-face				
			$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		
			X	Y	X	Y	X	Y	X	Y	
15°	0.178	0.38			1.47			1.65			2.39
	0.357	0.40			1.40			1.57			2.28
	0.714	0.43			1.30			1.46			2.11
	1.07	0.46			1.23			1.38			2.00
	1.43	0.47	1	0	1.19	1	0.72	1.34	0.72	1.93	
	2.14	0.50			1.12			1.26			1.82
	3.57	0.55			1.02			1.14			1.66
	5.35	0.56			1.00			1.12			1.63
7.14	0.56			1.00			1.12			1.63	
20°		0.57	1	0	0.43	1	1	1.09	0.70	1.63	
30°		0.80	1	0	0.39	0.76	1	0.78	0.63	1.24	

1) For i , use 2 for DB & DF and 1 for single & DT.

d (170) ~ 190

d	Boundary dimensions (mm)					Bearing No.	Basic load ratings (kN)		Fatigue load limit (kN) C_u	Factor f_0	Limiting speeds (min^{-1})		Load center (mm) a	Interspace volume (cm^3/row)	(Refer.) Mass (kg/row)	Permissible axial load (kN) (static)	Mounting dimensions (mm)						Nut axial tension (N)	Interference of retaining plate (mm)	Preload (Combination of DB and DF) (N)				Axial rigidity (Combination of DB and DF) ($\text{N}/\mu\text{m}$)					
	D	B	r_{min}	$r_{1\text{min}}$	$r_{2\text{min}}$		C_r	C_{0r}			Grease lub.	Oil lub.					d_a min.	d_b min.	D_a max.	D_b max.	r_a max.	r_b max.			r_c max.	S	L	M	H	S	L	M	H	
170	230	28	2	1	—	3NCHAC934C	108	76.7	2.80	8.40	9 300	15 000	40.8	148	3.07	62.3	180	—	220	224.5	2	1	—	25 000	0.02~0.04	330	990	1 980	—	101	153	205	—	
	230	28	2	1	—	3NCHAC934CA	105	74.9	2.75	—	8 800	15 000	50.4	148	3.07	75.6	180	—	220	224.5	2	1	—	25 000	0.02~0.04	440	1 320	2 640	—	200	298	385	—	
	260	42	2.1	1.1	—	7034C-5	256	234	8.95	15.9	5 100	8 100	49.8	301	7.57	128	182	—	248	253	2	1	—	30 000	0.02~0.04	325	980	2 450	5 390	103	162	244	361	
	260	42	2.1	1.1	—	7034AC-5	242	222	8.30	—	4 500	6 600	71.1	301	7.58	84.8	182	—	248	253	2	1	—	30 000	0.02~0.04	—	2 450	4 900	8 830	—	488	636	810	—
	260	42	2.1	1.1	—	7034-5	232	214	7.90	—	3 900	5 100	83.1	301	7.58	67.8	182	—	248	253	2	1	—	30 000	0.02~0.04	—	2 450	4 900	8 830	—	641	827	1 030	—
	260	42	2.1	1.1	—	HAR034C	115	86.4	3.05	8.50	6 400	9 900	49.8	236	7.32	110	182	—	248	253	2	1	—	30 000	0.02~0.04	390	1 170	2 340	—	103	158	213	—	
	260	42	2.1	1.1	—	3NCHAR034C	115	86.4	2.15	8.50	8 800	14 000	49.8	236	6.83	70.2	182	—	248	253	2	1	—	30 000	0.02~0.04	430	1 290	2 580	—	119	182	245	—	
	260	42	2.1	1.1	—	HAR034CA	112	84.3	2.95	—	6 100	9 300	60.1	236	7.32	129	182	—	248	253	2	1	—	30 000	0.02~0.04	530	1 600	3 200	—	206	308	400	—	
	260	42	2.1	1.1	—	3NCHAR034CA	112	84.3	2.10	—	8 200	13 000	60.1	236	6.83	85.1	182	—	248	253	2	1	—	30 000	0.02~0.04	585	1 755	3 510	—	239	355	462	—	
	260	42	2.1	1.1	—	HAR034	104	78.4	2.75	—	4 300	5 800	83.1	236	7.32	109	182	—	248	253	2	1	—	30 000	0.02~0.04	700	2 100	4 200	—	389	568	724	—	
	260	42	2.1	1.1	—	3NCHAC034C	177	119	4.20	8.10	8 800	14 000	49.8	299	5.76	96.2	182	—	248	253	2	1	—	30 000	0.02~0.04	430	1 290	2 580	—	106	161	214	—	
	260	42	2.1	1.1	—	3NCHAC034CA	173	117	4.10	—	8 200	13 000	60.1	299	5.76	117	182	—	248	253	2	1	—	30 000	0.02~0.04	585	1 755	3 510	—	215	318	411	—	
180	250	33	2	1	—	7936C-5	200	188	7.05	16.4	5 400	8 500	45.3	178	4.68	100	190	—	240	244.5	2	1	—	25 000	0.02~0.04	345	1 130	2 250	—	112	185	254	—	
190	260	33	2	1	—	7938C-5	198	197	6.85	16.5	5 100	7 900	46.6	195	4.83	113	200	—	250	254.5	2	1	—	25 000	0.02~0.04	345	1 170	2 400	—	113	188	262	—	

- [Remarks] 1. For the dimensions of the spacers for oil / air lubrication, refer to Table 15. 4 on page 53 to 57.
 2. For the discharge intervals of the oil / air, refer to Supplementary table 6 on page 215.
 3. C, CA, and no character string in the bearing number indicate nominal contact angles of 15°, 20°, and 30°, respectively.

Basic load ratings in case of multiple-row combination bearing

	Basic dynamic load ratings	Basic static load ratings
2-row	$C_r \times 1.62$	$C_{0r} \times 2$
3-row	$C_r \times 2.16$	$C_{0r} \times 3$
4-row	$C_r \times 2.64$	$C_{0r} \times 4$

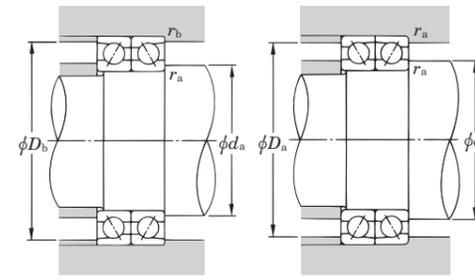
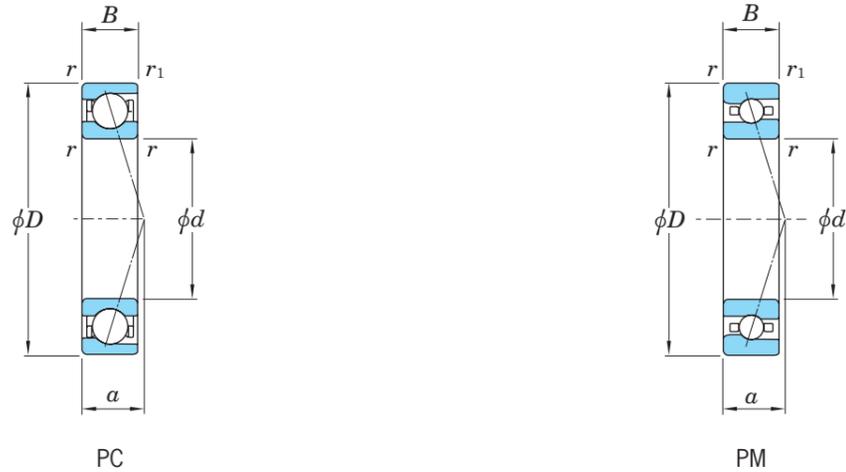
Speed coefficients in case of multiple-row combination bearing

Combination types	Combination symbols	Preload when mounting			
		Preload S	Preload L	Preload M	Preload H
⊗	DB	0.85	0.80	0.65	0.55
⊗ ⊗	DBB	0.80	0.75	0.60	0.45
⊗ ⊗ ⊗	DBD	0.75	0.70	0.55	0.40

*Speed coefficients also vary depending on the distance of bearings.
 *Consult JTEKT for information on High Ability bearings.

1. Angular contact ball bearings

PRECILENCE



We recommend that recesses be added at r_a , r_b , and r_c .

Static equivalent load $P_0 = X_0 F_r + Y_0 F_a$

Contact angle	Single row/Tandem		Back-to-back/Face-to-face	
	X_0	Y_0	X_0	Y_0
15°	0.5	0.46	1	0.92
20°	0.5	0.42	1	0.84

Note that in the case of single row or tandem, assume $P_0 = F_r$, if $P_0 < F_r$.

Dynamic equivalent load $P = X F_r + Y F_a$

Contact angle	$i f_0 \frac{F_a}{C_{0r}}$	e	Single row/Tandem				Back-to-back/Face-to-face			
			$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
			X	Y	X	Y	X	Y	X	Y
15°	0.178	0.38			1.47	1.65			2.39	
	0.357	0.40			1.40	1.57			2.28	
	0.714	0.43			1.30	1.46			2.11	
	1.07	0.46			1.23	1.38			2.00	
	1.43	0.47	1	0	0.44	1.19	1	1.34	0.72	1.93
	2.14	0.50			1.12	1.26			1.82	
	3.57	0.55			1.02	1.14			1.66	
	5.35	0.56			1.00	1.12			1.63	
7.14	0.56			1.00	1.12			1.63		
20°	0.57	1	0	0.43	1	1	1.09	0.70	1.63	

1) For i , use 2 for DB & DF and 1 for single & DT.

d 25 ~ (35)

d	Boundary dimensions (mm)				Bearing No.	Basic load ratings (kN)		Fatigue load limit (kN) C_u	Factor f_0	Limiting speeds (min ⁻¹)		Load center (mm) a	Interspace volume (cm ³ /row)	(Refer.) Mass (kg/row)	Permissible axial load (kN) (static)	Mounting dimensions (mm)					Nut axial tension (N)	Interference of retaining plate (mm)	Preload (Combination of DB and DF) (N)			Axial rigidity (Combination of DB and DF) (N/μm)			
	D	B	r min.	r ₁ min.		C_r	C_{0r}			Grease lub.	Oil lub.					d_a min.	D_a max.	D_b max.	r_a max.	r_b max.			S	L	M	S	L	M	
25	42	9	0.3	0.15	PC7905C	8.05	3.80	0.14	10.8	69 000	103 000	9.1	1.9	0.038	3.70	27.5	39.5	40.8	0.3	0.15	3 000	0.01~0.02	15	64	147	17	31	46	
	42	9	0.3	0.15	PC7905CA	7.85	3.7	0.14	—	65 000	97 000	10.7	1.9	0.038	4.30	27.5	39.5	40.8	0.3	0.15	3 000	0.01~0.02	15	64	147	30	52	72	
	42	9	0.3	0.15	H1-PC7905C	8.05	3.80	0.14	10.8	69 000	89 000	9.1	1.9	0.038	3.70	27.5	39.5	40.8	0.3	0.15	3 000	0.01~0.02	15	64	147	17	31	46	
	42	9	0.3	0.15	H1-PC7905CA	7.85	3.7	0.14	—	65 000	89 000	10.7	1.9	0.038	4.30	27.5	39.5	40.8	0.3	0.15	3 000	0.01~0.02	15	64	147	30	52	72	
	47	12	0.6	0.3	PC7005C	14.7	6.35	0.23	9.9	66 000	100 000	10.8	4.1	0.063	5.88	29.5	42.5	44.5	0.6	0.3	5 000	0.01~0.02	34	130	281	23	40	57	
	47	12	0.6	0.3	PC7005CA	14.4	6.20	0.23	—	62 000	100 000	12.6	4.1	0.063	6.89	29.5	42.5	44.5	0.6	0.3	5 000	0.01~0.02	34	130	281	40	66	89	
	47	12	0.6	0.3	H1-PC7005C	14.7	6.35	0.23	9.9	66 000	100 000	10.8	4.1	0.063	5.88	29.5	42.5	44.5	0.6	0.3	5 000	0.01~0.02	34	130	281	23	40	57	
	47	12	0.6	0.3	H1-PC7005CA	14.4	6.20	0.23	—	62 000	100 000	12.6	4.1	0.063	6.89	29.5	42.5	44.5	0.6	0.3	5 000	0.01~0.02	34	130	281	40	66	89	
	30	47	9	0.3	0.15	PC7906C	8.60	4.40	0.16	11.1	61 000	92 000	9.7	2.0	0.042	4.30	32.5	44.5	45.8	0.3	0.15	5 000	0.01~0.02	17	66	153	19	33	49
		47	9	0.3	0.15	PC7906CA	8.4	4.3	0.16	—	57 000	87 000	11.5	2.0	0.042	5.00	32.5	44.5	45.8	0.3	0.15	5 000	0.01~0.02	17	66	153	34	57	78
47		9	0.3	0.15	H1-PC7906C	8.60	4.40	0.16	11.1	61 000	77 000	9.7	2.0	0.042	4.30	32.5	44.5	45.8	0.3	0.15	5 000	0.01~0.02	17	66	153	19	33	49	
47		9	0.3	0.15	H1-PC7906CA	8.4	4.3	0.16	—	57 000	77 000	11.5	2.0	0.042	5.00	32.5	44.5	45.8	0.3	0.15	5 000	0.01~0.02	17	66	153	34	57	78	
55		13	1	0.6	PC7006C	15.4	7.15	0.26	10.4	56 000	84 000	12.2	5.5	0.099	6.68	35.5	49.5	50.5	1	0.6	5 000	0.01~0.02	35	137	297	24	42	61	
55		13	1	0.6	PC7006CA	15.1	7.00	0.26	—	53 000	79 000	14.2	5.5	0.099	7.79	35.5	49.5	50.5	1	0.6	5 000	0.01~0.02	35	137	297	42	70	96	
55		13	1	0.6	H1-PC7006C	15.4	7.15	0.26	10.4	56 000	70 000	12.2	5.5	0.099	6.68	35.5	49.5	50.5	1	0.6	5 000	0.01~0.02	35	137	297	24	42	61	
55		13	1	0.6	H1-PC7006CA	15.1	7.00	0.26	—	53 000	70 000	14.2	5.5	0.099	7.79	35.5	49.5	50.5	1	0.6	5 000	0.01~0.02	35	137	297	42	70	96	
55		13	1	0.6	PM7006C	13.0	6.65	0.24	10.8	56 000	84 000	12.2	4.4	0.108	6.26	35.5	49.5	50.5	1	0.6	5 000	0.01~0.02	35	137	297	27	48	69	
55		13	1	0.6	PM7006CA	12.7	6.55	0.24	—	53 000	79 000	14.2	4.4	0.108	7.27	35.5	49.5	50.5	1	0.6	5 000	0.01~0.02	35	137	297	47	79	107	
55		13	1	0.6	H1-PM7006C	13.0	6.65	0.24	10.8	56 000	70 000	12.2	4.4	0.108	6.26	35.5	49.5	50.5	1	0.6	5 000	0.01~0.02	35	137	297	27	48	69	
55		13	1	0.6	H1-PM7006CA	12.7	6.55	0.24	—	53 000	70 000	14.2	4.4	0.108	7.27	35.5	49.5	50.5	1	0.6	5 000	0.01~0.02	35	137	297	47	79	107	
35		55	10	0.6	0.3	PC7907C	12.9	6.75	0.25	11.0	50 000	77 000	11.0	3.0	0.064	6.20	39.5	50.5	52.5	0.6	0.3	5 000	0.01~0.02	25	96	217	24	40	59
		55	10	0.6	0.3	PC7907CA	12.6	6.6	0.24	—	47 000	73 000	13.2	3.0	0.064	7.20	39.5	50.5	52.5	0.6	0.3	5 000	0.01~0.02	25	96	217	42	69	94
	55	10	0.6	0.3	H1-PC7907C	12.9	6.75	0.25	11.0	50 000	66 000	11.0	3.0	0.064	6.20	39.5	50.5	52.5	0.6	0.3	5 000	0.01~0.02	25	96	217	24	40	59	
	55	10	0.6	0.3	H1-PC7907CA	12.6	6.6	0.24	—	47 000	66 000	13.2	3.0	0.064	7.20	39.5	50.5	52.5	0.6	0.3	5 000	0.01~0.02	25	96	217	42	69	94	
	62	14	1	0.6	PC7007C	19.5	9.55	0.35	10.4	49 000	73 000	13.5	7.3	0.132	8.90	40.5	56.5	57.5	1	0.6	8 000	0.01~0.02	42	177	382	28	50	71	
	62	14	1	0.6	PC7007CA	19.1	9.35	0.34	—	46 000	69 000	15.8	7.3	0.132	10.3	40.5	56.5	57.5	1	0.6	8 000	0.01~0.02	42	177	382	49	83	112	
	62	14	1	0.6	H1-PC7007C	19.5	9.55	0.35	10.4	49 000	61 000	13.5	7.3	0.132	8.90	40.5	56.5	57.5	1	0.6	8 000	0.01~0.02	42	177	382	28	50	71	
	62	14	1	0.6	H1-PC7007CA	19.1	9.35	0.34	—	46 000	61 000	15.8	7.3	0.132	10.3	40.5	56.5	57.5	1	0.6	8 000	0.01~0.02	42	177	382	49	83	112	
	62	14	1	0.6	PM7007C	13.7	7.60	0.28	11.1	49 000	73 000	13.5	5.5	0.154	7.16	40.5	56.5	57.5	1	0.6	8 000	0.01~0.02	42	177	382	31	57	83	
	62	14	1	0.6	PM7007CA	13.4	7.45	0.27	—	46 000	69 000	15.8	5.5	0.154	8.29	40.5	56.5	57.5	1	0.6	8 000	0.01~0.02	42	177	382	54	92	126	

[Remarks] 1. Use the QR code to inquire about series, sizes, ball specifications, low-NRRO specifications, and contact angles.

<https://www.precilence.com/en/contact/>



Basic load ratings in case of multiple-row combination bearing

	Basic dynamic load ratings	Basic static load ratings
2-row	$C_r \times 1.62$	$C_{0r} \times 2$
3-row	$C_r \times 2.16$	$C_{0r} \times 3$
4-row	$C_r \times 2.64$	$C_{0r} \times 4$

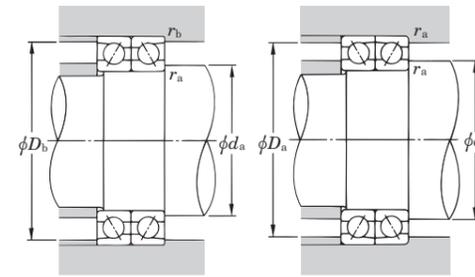
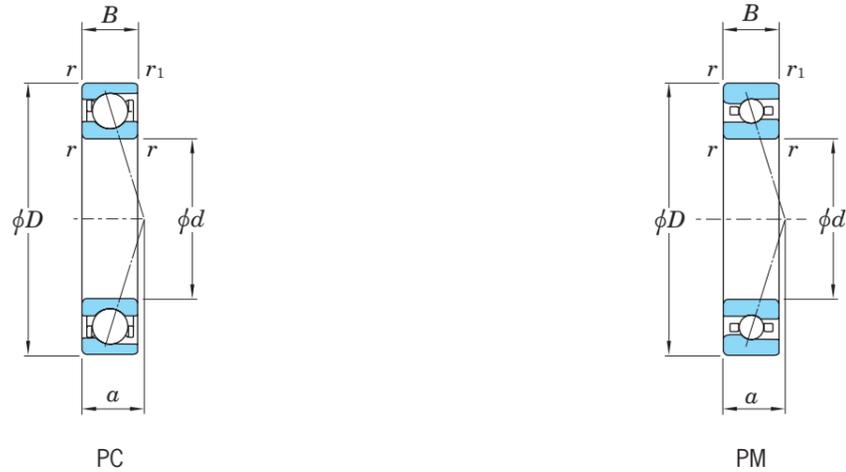
Speed coefficients in case of multiple-row combination bearing

Combination types	Combination symbols	Preload when mounting			
		Preload S	Preload L	Preload M	Preload H
⊗ ⊗ ⊗ ⊗	DB	0.85	0.80	0.65	0.55
⊗ ⊗ ⊗ ⊗	DBB	0.80	0.75	0.60	0.45
⊗ ⊗ ⊗ ⊗	DBD	0.75	0.70	0.55	0.40

*Speed coefficients also vary depending on the distance of bearings.

1. Angular contact ball bearings

PRECILENCE



We recommend that recesses be added at r_a , r_b , and r_c .

Static equivalent load $P_0 = X_0 F_r + Y_0 F_a$

Contact angle	Single row/Tandem		Back-to-back/Face-to-face	
	X_0	Y_0	X_0	Y_0
15°	0.5	0.46	1	0.92
20°	0.5	0.42	1	0.84

Note that in the case of single row or tandem, assume $P_0 = F_r$, if $P_0 < F_r$.

Dynamic equivalent load $P = X F_r + Y F_a$

Contact angle	$i f_0 \frac{F_a}{C_{0r}}$	e	Single row/Tandem				Back-to-back/Face-to-face				
			$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		
			X	Y	X	Y	X	Y	X	Y	
15°	0.178	0.38			1.47	1.65			2.39		
	0.357	0.40			1.40	1.57			2.28		
	0.714	0.43			1.30	1.46			2.11		
	1.07	0.46			1.23	1.38			2.00		
	1.43	0.47	1	0	0.44	1.19	1	1.34	0.72	1.93	
	2.14	0.50			1.12	1.26			1.82		
	3.57	0.55			1.02	1.14			1.66		
20°	5.35	0.56			1.00	1.12			1.63		
	7.14	0.56			1.00	1.12			1.63		
		0.57	1	0	0.43	1	1	1.09	0.70	1.63	

1) For i , use 2 for DB & DF and 1 for single & DT.

d (35) ~ (50)

Boundary dimensions (mm)					Bearing No.	Basic load ratings (kN)		Fatigue load limit (kN) C_u	Factor f_0	Limiting speeds (min ⁻¹)		Load center (mm) a	Interspace volume (cm ³ /row)	(Refer.) Mass (kg/row)	Permissible axial load (kN) (static)	Mounting dimensions (mm)					Nut axial tension (N)	Interference of retaining plate (mm)	Preload (Combination of DB and DF) (N)			Axial rigidity (Combination of DB and DF) (N/μm)		
d	D	B	r min.	r ₁ min.		C_r	C_{0r}			Grease lub.	Oil lub.					d_a min.	D_a max.	D_b max.	r_a max.	r_b max.			S	L	M	S	L	M
35	62	14	1	0.6	H1-PM7007C	13.7	7.60	0.28	11.1	49 000	61 000	13.5	5.5	0.154	7.16	40.5	56.5	57.5	1	0.6	8 000	0.01~0.02	42	177	382	31	57	83
	62	14	1	0.6	H1-PM7007CA	13.4	7.45	0.27	—	46 000	61 000	15.8	5.5	0.154	8.29	40.5	56.5	57.5	1	0.6	8 000	0.01~0.02	42	177	382	54	92	126
40	62	12	0.6	0.3	PC7908C	16.2	8.65	0.32	11.0	46 000	67 000	12.8	5.2	0.092	9.00	44.5	57.5	59.5	0.6	0.3	5 000	0.01~0.02	25	156	341	24	52	74
	62	12	0.6	0.3	PC7908CA	15.8	8.5	0.31	—	43 000	63 000	15.3	5.2	0.092	10.4	44.5	57.5	59.5	0.6	0.3	5 000	0.01~0.02	25	156	341	45	85	116
	62	12	0.6	0.3	H1-PC7908C	16.2	8.65	0.32	11.0	46 000	58 000	12.8	5.2	0.092	9.00	44.5	57.5	59.5	0.6	0.3	5 000	0.01~0.02	25	156	341	24	52	74
	62	12	0.6	0.3	H1-PC7908CA	15.8	8.5	0.31	—	43 000	58 000	15.3	5.2	0.092	10.4	44.5	57.5	59.5	0.6	0.3	5 000	0.01~0.02	25	156	341	45	85	116
	68	15	1	0.6	PC7008C	21.1	11.1	0.40	10.7	44 000	65 000	14.7	8.9	0.164	10.3	45.5	62.5	63.5	1	0.6	8 000	0.01~0.02	44	187	406	31	55	78
	68	15	1	0.6	PC7008CA	20.6	10.9	0.40	—	41 000	61 000	17.3	8.9	0.164	12.0	45.5	62.5	63.5	1	0.6	8 000	0.01~0.02	44	187	406	55	91	124
	68	15	1	0.6	H1-PC7008C	21.1	11.1	0.40	10.7	44 000	55 000	14.7	8.9	0.164	10.3	45.5	62.5	63.5	1	0.6	8 000	0.01~0.02	44	187	406	31	55	78
	68	15	1	0.6	H1-PC7008CA	20.6	10.9	0.40	—	41 000	55 000	17.3	8.9	0.164	12.0	45.5	62.5	63.5	1	0.6	8 000	0.01~0.02	44	187	406	55	91	124
	68	15	1	0.6	PM7008C	14.4	8.50	0.31	11.3	44 000	65 000	14.7	6.6	0.187	8.04	45.5	62.5	63.5	1	0.6	8 000	0.01~0.02	44	187	406	34	61	89
	68	15	1	0.6	PM7008CA	14.1	8.35	0.30	—	41 000	61 000	17.3	6.6	0.187	9.30	45.5	62.5	63.5	1	0.6	8 000	0.01~0.02	44	187	406	62	101	138
	68	15	1	0.6	H1-PM7008C	14.4	8.50	0.31	11.3	44 000	55 000	14.7	6.6	0.187	8.04	45.5	62.5	63.5	1	0.6	8 000	0.01~0.02	44	187	406	34	61	89
	68	15	1	0.6	H1-PM7008CA	14.1	8.35	0.30	—	41 000	55 000	17.3	6.6	0.187	9.30	45.5	62.5	63.5	1	0.6	8 000	0.01~0.02	44	187	406	62	101	138
45	68	12	0.6	0.3	PC7909C	17.2	9.80	0.36	11.2	40 000	61 000	13.6	5.7	0.11	10.2	49.5	63.5	65.5	0.6	0.3	6 000	0.01~0.02	35	164	360	30	56	80
	68	12	0.6	0.3	PC7909CA	16.8	9.6	0.35	—	38 000	57 000	16.3	5.7	0.11	11.8	49.5	63.5	65.5	0.6	0.3	6 000	0.01~0.02	35	164	360	54	92	126
	68	12	0.6	0.3	H1-PC7909C	17.2	9.80	0.36	11.2	40 000	53 000	13.6	5.7	0.11	10.2	49.5	63.5	65.5	0.6	0.3	6 000	0.01~0.02	35	164	360	30	56	80
	68	12	0.6	0.3	H1-PC7909CA	16.8	9.6	0.35	—	38 000	53 000	16.3	5.7	0.11	11.8	49.5	63.5	65.5	0.6	0.3	6 000	0.01~0.02	35	164	360	54	92	126
	75	16	1	0.6	PC7009C	28.3	14.8	0.54	10.5	39 000	58 000	16.0	12	0.194	13.8	50.5	69.5	70.5	1	0.6	10 000	0.01~0.02	65	264	562	35	63	89
	75	16	1	0.6	PC7009CA	27.7	14.5	0.53	—	37 000	55 000	18.9	12	0.194	16.0	50.5	69.5	70.5	1	0.6	10 000	0.01~0.02	65	264	562	62	106	141
	75	16	1	0.6	H1-PC7009C	28.3	14.8	0.54	10.5	39 000	50 000	16.0	12	0.194	13.8	50.5	69.5	70.5	1	0.6	10 000	0.01~0.02	65	264	562	35	63	89
	75	16	1	0.6	H1-PC7009CA	27.7	14.5	0.53	—	37 000	50 000	18.9	12	0.194	16.0	50.5	69.5	70.5	1	0.6	10 000	0.01~0.02	65	264	562	62	106	141
	75	16	1	0.6	PM7009C	16.1	9.75	0.36	11.4	39 000	58 000	16.0	8.4	0.245	9.21	50.5	69.5	70.5	1	0.6	10 000	0.01~0.02	65	264	562	39	72	105
	75	16	1	0.6	PM7009CA	15.7	9.55	0.35	—	37 000	55 000	18.9	8.4	0.245	10.6	50.5	69.5	70.5	1	0.6	10 000	0.01~0.02	65	264	562	68	117	159
	75	16	1	0.6	H1-PM7009C	16.1	9.75	0.36	11.4	39 000	50 000	16.0	8.4	0.245	9.21	50.5	69.5	70.5	1	0.6	10 000	0.01~0.02	65	264	562	39	72	105
	75	16	1	0.6	H1-PM7009CA	15.7	9.55	0.35	—	37 000	50 000	18.9	8.4	0.245	10.6	50.5	69.5	70.5	1	0.6	10 000	0.01~0.02	65	264	562	68	117	159
50	72	12	0.6	0.3	PC7910C	19.6	11.6	0.42	11.2	37 000	55 000	14.2	6.2	0.11	10.9	54.5	67.5	69.5	0.6	0.3	6 000	0.01~0.02	37	166	366	31	58	83
	72	12	0.6	0.3	PC7910CA	19.2	11.3	0.41	—	35 000	52 000	17.1	6.2	0.11	12.6	54.5	67.5	69.5	0.6	0.3	6 000	0.01~0.02	37	166	366	57	98	133
	72	12	0.6	0.3	H1-PC7910C	19.6	11.6	0.42	11.2	37 000	49 000	14.2	6.2	0.11	10.9	54.5	67.5	69.5	0.6	0.3	6 000	0.01~0.02	37	166	366	31	58	83

[Remarks] 1. Use the QR code to inquire about series, sizes, ball specifications, low-NRRO specifications, and contact angles.

<https://www.precilence.com/en/contact/>



Basic load ratings in case of multiple-row combination bearing

	Basic dynamic load ratings	Basic static load ratings
2-row	$C_r \times 1.62$	$C_{0r} \times 2$
3-row	$C_r \times 2.16$	$C_{0r} \times 3$
4-row	$C_r \times 2.64$	$C_{0r} \times 4$

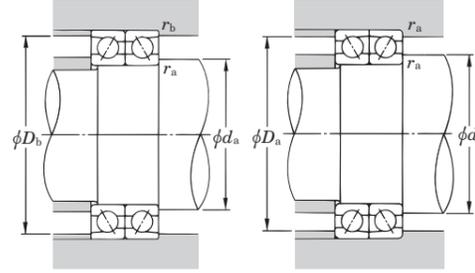
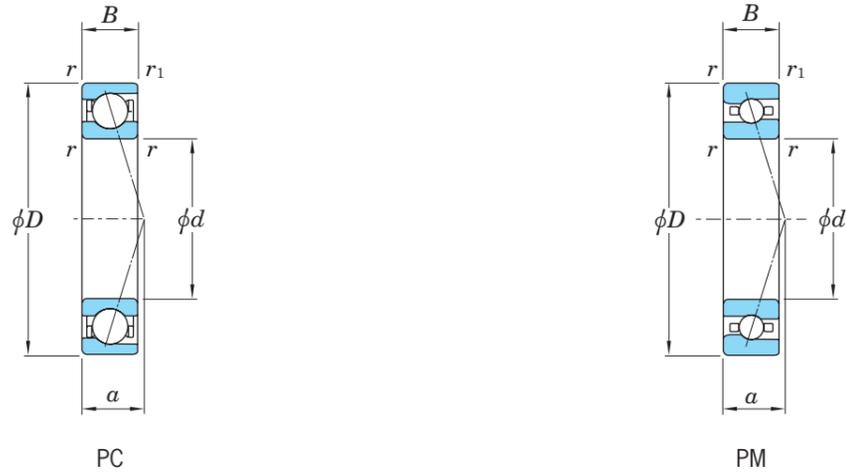
Speed coefficients in case of multiple-row combination bearing

Combination types	Combination symbols	Preload when mounting			
		Preload S	Preload L	Preload M	Preload H
⊗ ⊗	DB	0.85	0.80	0.65	0.55
⊗ ⊗ ⊗ ⊗	DBB	0.80	0.75	0.60	0.45
⊗ ⊗ ⊗	DBD	0.75	0.70	0.55	0.40

*Speed coefficients also vary depending on the distance of bearings.

1. Angular contact ball bearings

PRECILENCE



We recommend that recesses be added at r_a , r_b , and r_c .

Static equivalent load $P_0 = X_0 F_r + Y_0 F_a$

Contact angle	Single row/Tandem		Back-to-back/Face-to-face	
	X_0	Y_0	X_0	Y_0
15°	0.5	0.46	1	0.92
20°	0.5	0.42	1	0.84

Note that in the case of single row or tandem, assume $P_0 = F_r$, if $P_0 < F_r$.

Dynamic equivalent load $P = X F_r + Y F_a$

Contact angle	$i f_0 \frac{F_a}{C_{0r}}$	e	Single row/Tandem				Back-to-back/Face-to-face			
			$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
			X	Y	X	Y	X	Y	X	Y
15°	0.178	0.38			1.47	1.65			2.39	
	0.357	0.40			1.40	1.57			2.28	
	0.714	0.43			1.30	1.46			2.11	
	1.07	0.46			1.23	1.38			2.00	
	1.43	0.47	1	0	1.19	1.34	0.72	1.93		
	2.14	0.50			1.12	1.26			1.82	
	3.57	0.55			1.02	1.14			1.66	
5.35	0.56			1.00	1.12			1.63		
7.14	0.56			1.00	1.12			1.63		
20°	0.57	1	0	0.43	1	1	1.09	0.70	1.63	

1) For i , use 2 for DB & DF and 1 for single & DT.

d (50) ~ (60)

d	Boundary dimensions (mm)				Bearing No.	Basic load ratings (kN)		Fatigue load limit (kN) C_u	Factor f_0	Limiting speeds (min ⁻¹)		Load center (mm) a	Interspace volume (cm ³ /row)	(Refer.) Mass (kg/row)	Permissible axial load (kN) (static)	Mounting dimensions (mm)					Nut axial tension (N)	Interference of retaining plate (mm)	Preload (Combination of DB and DF) (N)			Axial rigidity (Combination of DB and DF) (N/μm)		
	D	B	r min.	r ₁ min.		C_r	C_{0r}			Grease lub.	Oil lub.					d_a min.	D_a max.	D_b max.	r_a max.	r_b max.			S	L	M	S	L	M
50	72	12	0.6	0.3	H1-PC7910CA	19.2	11.3	0.41	—	35 000	49 000	17.1	6.2	0.11	12.6	54.5	67.5	69.5	0.6	0.3	6 000	0.01~0.02	37	166	366	57	98	133
	80	16	1	0.6	PC7010C	29.3	16.0	0.58	10.7	37 000	53 000	16.7	13	0.209	15.0	55.5	74.5	75.5	1	0.6	10 000	0.01~0.02	66	275	586	37	66	95
	80	16	1	0.6	PC7010CA	28.7	15.6	0.57	—	35 000	50 000	19.8	13	0.209	17.4	55.5	74.5	75.5	1	0.6	10 000	0.01~0.02	66	275	586	66	110	149
	80	16	1	0.6	H1-PC7010C	29.3	16.0	0.58	10.7	37 000	46 000	16.7	13	0.209	15.0	55.5	74.5	75.5	1	0.6	10 000	0.01~0.02	66	275	586	37	66	95
	80	16	1	0.6	H1-PC7010CA	28.7	15.6	0.57	—	35 000	46 000	19.8	13	0.209	17.4	55.5	74.5	75.5	1	0.6	10 000	0.01~0.02	66	275	586	66	110	149
	80	16	1	0.6	PM7010C	16.8	10.8	0.39	11.5	37 000	53 000	16.7	10	0.255	10.1	55.5	74.5	75.5	1	0.6	10 000	0.01~0.02	66	275	586	42	77	112
	80	16	1	0.6	PM7010CA	16.4	10.5	0.38	—	35 000	50 000	19.8	10	0.255	11.7	55.5	74.5	75.5	1	0.6	10 000	0.01~0.02	66	275	586	73	126	170
	80	16	1	0.6	H1-PM7010C	16.8	10.8	0.39	11.5	37 000	46 000	16.7	10	0.255	10.1	55.5	74.5	75.5	1	0.6	10 000	0.01~0.02	66	275	586	42	77	112
	80	16	1	0.6	H1-PM7010CA	16.4	10.5	0.38	—	35 000	46 000	19.8	10	0.255	11.7	55.5	74.5	75.5	1	0.6	10 000	0.01~0.02	66	275	586	73	126	170
	55	80	13	1	0.6	PC7911C	20.5	12.9	0.47	11.4	33 000	52 000	15.5	8.1	0.151	13.4	60.5	74.5	75.5	1	0.6	6 000	0.01~0.02	51	204	444	37	67
80		13	1	0.6	PC7911CA	20	12.6	0.46	—	31 000	49 000	18.8	8.1	0.151	15.6	60.5	74.5	75.5	1	0.6	6 000	0.01~0.02	51	204	444	68	112	151
80		13	1	0.6	H1-PC7911C	20.5	12.9	0.47	11.4	33 000	44 000	15.5	8.1	0.151	13.4	60.5	74.5	75.5	1	0.6	6 000	0.01~0.02	51	204	444	37	67	95
80		13	1	0.6	H1-PC7911CA	20	12.6	0.46	—	31 000	44 000	18.8	8.1	0.151	15.6	60.5	74.5	75.5	1	0.6	6 000	0.01~0.02	51	204	444	68	112	151
90		18	1.1	0.6	PC7011C	35.0	20.0	0.73	10.8	31 000	48 000	18.7	16	0.330	18.7	62	83	85.5	1	0.6	12 000	0.01~0.02	104	373	789	46	79	113
90		18	1.1	0.6	PC7011CA	34.3	19.6	0.71	—	29 000	45 000	22.2	16	0.330	21.7	62	83	85.5	1	0.6	12 000	0.01~0.02	104	373	789	83	132	177
90		18	1.1	0.6	H1-PC7011C	35.0	20.0	0.73	10.8	31 000	41 000	18.7	16	0.330	18.7	62	83	85.5	1	0.6	12 000	0.01~0.02	104	373	789	46	79	113
90		18	1.1	0.6	H1-PC7011CA	34.3	19.6	0.71	—	29 000	41 000	22.2	16	0.330	21.7	62	83	85.5	1	0.6	12 000	0.01~0.02	104	373	789	83	132	177
90		18	1.1	0.6	PM7011C	20.9	13.6	0.50	11.5	31 000	48 000	18.7	13	0.377	12.8	62	83	85.5	1	0.6	12 000	0.01~0.02	104	373	789	51	90	130
90		18	1.1	0.6	PM7011CA	20.4	13.3	0.48	—	29 000	45 000	22.2	13	0.377	14.8	62	83	85.5	1	0.6	12 000	0.01~0.02	104	373	789	89	145	197
90		18	1.1	0.6	H1-PM7011C	20.9	13.6	0.50	11.5	31 000	41 000	18.7	13	0.377	12.8	62	83	85.5	1	0.6	12 000	0.01~0.02	104	373	789	51	90	130
90		18	1.1	0.6	H1-PM7011CA	20.4	13.3	0.48	—	29 000	41 000	22.2	13	0.377	14.8	62	83	85.5	1	0.6	12 000	0.01~0.02	104	373	789	89	145	197
60	85	13	1	0.6	PC7912C	24.2	15.2	0.55	11.3	31 000	48 000	16.3	8.8	0.159	14.9	65.5	79.5	80.5	1	0.6	8 000	0.01~0.02	54	215	470	39	67	96
	85	13	1	0.6	PC7912CA	23.6	14.8	0.54	—	29 000	45 000	19.8	8.8	0.159	17.3	65.5	79.5	80.5	1	0.6	8 000	0.01~0.02	54	215	470	67	113	153
	85	13	1	0.6	H1-PC7912C	24.2	15.2	0.55	11.3	31 000	41 000	16.3	8.8	0.159	14.9	65.5	79.5	80.5	1	0.6	8 000	0.01~0.02	54	215	470	39	67	96
	85	13	1	0.6	H1-PC7912CA	23.6	14.8	0.54	—	29 000	41 000	19.8	8.8	0.159	17.3	65.5	79.5	80.5	1	0.6	8 000	0.01~0.02	54	215	470	67	113	153
	95	18	1.1	0.6	PC7012C	36.1	21.4	0.78	10.9	29 000	45 000	19.4	20	0.336	20.0	67	88	90.5	1	0.6	12 000	0.01~0.02	105	378	801	48	82	117
	95	18	1.1	0.6	PC7012CA	35.3	20.9	0.76	—	27 000	42 000	23.1	20	0.336	23.3	67	88	90.5	1	0.6	12 000	0.01~0.02	105	378	801	86	136	184
	95	18	1.1	0.6	H1-PC7012C	36.1	21.4	0.78	10.9	29 000	38 000	19.4	20	0.336	20.0	67	88	90.5	1	0.6	12 000	0.01~0.02	105	378	801	48	82	117
	95	18	1.1	0.6	H1-PC7012CA	35.3	20.9	0.76	—	27 000	38 000	23.1	20	0.336	23.3	67	88	90.5	1	0.6	12 000	0.01~0.02	105	378	801	86	136	184
	95	18	1.1	0.6	PM7012C	21.7	14.9	0.54	11.6	29 000	45 000	19.4	15	0.405	14.1	67	88	90.5	1	0.6	12 000	0.01~0.02	105	378	801	54	95	136

[Remarks] 1. Use the QR code to inquire about series, sizes, ball specifications, low-NRRO specifications, and contact angles.

<https://www.precilence.com/en/contact/>



Basic load ratings in case of multiple-row combination bearing

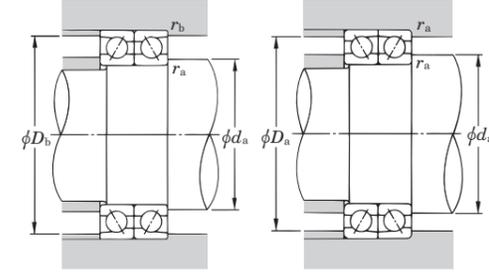
	Basic dynamic load ratings	Basic static load ratings
2-row	$C_r \times 1.62$	$C_{0r} \times 2$
3-row	$C_r \times 2.16$	$C_{0r} \times 3$
4-row	$C_r \times 2.64$	$C_{0r} \times 4$

Speed coefficients in case of multiple-row combination bearing

Combination types	Combination symbols	Preload when mounting			
		Preload S	Preload L	Preload M	Preload H
⊗ ⊗	DB	0.85	0.80	0.65	0.55
⊗ ⊗ ⊗ ⊗	DBB	0.80	0.75	0.60	0.45
⊗ ⊗ ⊗	DBD	0.75	0.70	0.55	0.40

*Speed coefficients also vary depending on the distance of bearings.

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We recommend that recesses be added at r_a , r_b , and r_c .

Static equivalent load $P_0 = X_0 F_r + Y_0 F_a$

Contact angle	Single row/Tandem		Back-to-back/Face-to-face	
	X_0	Y_0	X_0	Y_0
15°	0.5	0.46	1	0.92
20°	0.5	0.42	1	0.84

Note that in the case of single row or tandem, assume $P_0 = F_r$, if $P_0 < F_r$.

Dynamic equivalent load $P = X F_r + Y F_a$

Contact angle	$i f_0 \frac{F_a}{C_{0r}}$	e	Single row/Tandem				Back-to-back/Face-to-face			
			$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
			X	Y	X	Y	X	Y	X	Y
15°	0.178	0.38			1.47	1.65			2.39	
	0.357	0.40			1.40	1.57			2.28	
	0.714	0.43			1.30	1.46			2.11	
	1.07	0.46			1.23	1.38			2.00	
	1.43	0.47	1	0	1.19	1.34	0.72	1.93		
	2.14	0.50			1.12	1.26			1.82	
	3.57	0.55			1.02	1.14			1.66	
5.35	0.56			1.00	1.12			1.63		
7.14	0.56			1.00	1.12			1.63		
20°	0.57	1	0	0.43	1	1	1.09	0.70	1.63	

1) For i , use 2 for DB & DF and 1 for single & DT.

d (60) ~ (75)

Boundary dimensions (mm)					Bearing No.	Basic load ratings (kN)		Fatigue load limit (kN) C_u	Factor f_0	Limiting speeds (min ⁻¹)		Load center (mm) a	Interspace volume (cm ³ /row)	(Refer.) Mass (kg/row)	Permissible axial load (kN) (static)	Mounting dimensions (mm)					Nut axial tension (N)	Interference of retaining plate (mm)	Preload (Combination of DB and DF) (N)			Axial rigidity (Combination of DB and DF) (N/μm)		
d	D	B	$r_{min.}$	$r_{1min.}$		C_r	C_{0r}			Grease lub.	Oil lub.					d_a min.	D_a max.	D_b max.	r_a max.	r_b max.			S	L	M	S	L	M
60	95	18	1.1	0.6	PM7012CA	21.2	14.5	0.53	—	27 000	42 000	23.1	15	0.405	16.2	67	88	90.5	1	0.6	12 000	0.01~0.02	105	378	801	95	153	207
	95	18	1.1	0.6	H1-PM7012C	21.7	14.9	0.54	11.6	29 000	38 000	19.4	15	0.405	14.1	67	88	90.5	1	0.6	12 000	0.01~0.02	105	378	801	54	95	136
	95	18	1.1	0.6	H1-PM7012CA	21.2	14.5	0.53	—	27 000	38 000	23.1	15	0.405	16.2	67	88	90.5	1	0.6	12 000	0.01~0.02	105	378	801	95	153	207
65	90	13	1	0.6	PC7913C	21.7	14.9	0.54	11.6	29 000	45 000	16.9	9.4	0.181	15.8	70.5	84.5	85.5	1	0.6	8 000	0.01~0.02	55	219	479	42	74	105
	90	13	1	0.6	PC7913CA	21.2	14.5	0.53	—	27 000	42 000	20.6	9.4	0.181	18.2	70.5	84.5	85.5	1	0.6	8 000	0.01~0.02	55	219	479	76	123	168
	90	13	1	0.6	H1-PC7913C	21.7	14.9	0.54	11.6	29 000	38 000	16.9	9.4	0.181	15.8	70.5	84.5	85.5	1	0.6	8 000	0.01~0.02	55	219	479	42	74	105
	90	13	1	0.6	H1-PC7913CA	21.2	14.5	0.53	—	27 000	38 000	20.6	9.4	0.181	18.2	70.5	84.5	85.5	1	0.6	8 000	0.01~0.02	55	219	479	76	123	168
	100	18	1.1	0.6	PC7013C	41.3	24.7	0.90	10.9	27 000	42 000	20.1	22	0.351	23.2	72	93	95.5	1	0.6	15 000	0.01~0.02	109	391	830	43	84	119
	100	18	1.1	0.6	PC7013CA	40.4	24.2	0.88	—	25 000	39 000	24.0	22	0.351	27.0	72	93	95.5	1	0.6	15 000	0.01~0.02	109	391	830	78	141	189
	100	18	1.1	0.6	H1-PC7013C	41.3	24.7	0.90	10.9	27 000	36 000	20.1	22	0.351	23.2	72	93	95.5	1	0.6	15 000	0.01~0.02	109	391	830	43	84	119
	100	18	1.1	0.6	H1-PC7013CA	40.4	24.2	0.88	—	25 000	36 000	24.0	22	0.351	27.0	72	93	95.5	1	0.6	15 000	0.01~0.02	109	391	830	78	141	189
	100	18	1.1	0.6	PM7013C	22.6	16.2	0.59	11.7	27 000	42 000	20.1	16	0.432	15.3	72	93	95.5	1	0.6	15 000	0.01~0.02	109	391	830	49	100	144
	100	18	1.1	0.6	PM7013CA	22.0	15.8	0.57	—	25 000	39 000	24.0	16	0.432	17.6	72	93	95.5	1	0.6	15 000	0.01~0.02	109	391	830	89	161	220
	100	18	1.1	0.6	H1-PM7013C	22.6	16.2	0.59	11.7	27 000	36 000	20.1	16	0.432	15.3	72	93	95.5	1	0.6	15 000	0.01~0.02	109	391	830	49	100	144
	100	18	1.1	0.6	H1-PM7013CA	22.0	15.8	0.57	—	25 000	36 000	24.0	16	0.432	17.6	72	93	95.5	1	0.6	15 000	0.01~0.02	109	391	830	89	161	220
70	100	16	1	0.6	PC7914C	30.1	20.2	0.74	11.4	26 000	41 000	19.4	16	0.294	21.4	75.5	94.5	95.5	1	0.6	10 000	0.01~0.02	82	311	671	49	84	120
	100	16	1	0.6	PC7914CA	29.4	19.7	0.72	—	24 000	38 000	23.5	16	0.294	24.8	75.5	94.5	95.5	1	0.6	10 000	0.01~0.02	82	311	671	86	141	190
	100	16	1	0.6	H1-PC7914C	30.1	20.2	0.74	11.4	26 000	35 000	19.4	16	0.294	21.4	75.5	94.5	95.5	1	0.6	10 000	0.01~0.02	82	311	671	49	84	120
	100	16	1	0.6	H1-PC7914CA	29.4	19.7	0.72	—	24 000	35 000	23.5	16	0.294	24.8	75.5	94.5	95.5	1	0.6	10 000	0.01~0.02	82	311	671	86	141	190
	110	20	1.1	0.6	PC7014C	50.9	30.3	1.10	10.8	25 000	39 000	22.1	30	0.488	28.4	77	103	105.5	1	0.6	15 000	0.01~0.02	118	492	841	51	92	117
	110	20	1.1	0.6	PC7014CA	49.8	29.7	1.10	—	23 000	37 000	26.4	30	0.488	33.0	77	103	105.5	1	0.6	15 000	0.01~0.02	118	492	841	93	154	189
	110	20	1.1	0.6	H1-PC7014C	50.9	30.3	1.10	10.8	25 000	33 000	22.1	30	0.488	28.4	77	103	105.5	1	0.6	15 000	0.01~0.02	118	492	841	51	92	117
	110	20	1.1	0.6	H1-PC7014CA	49.8	29.7	1.10	—	23 000	33 000	26.4	30	0.488	33.0	77	103	105.5	1	0.6	15 000	0.01~0.02	118	492	841	93	154	189
	110	20	1.1	0.6	PM7014C	30.7	21.2	0.78	11.5	25 000	39 000	22.1	24	0.585	20.2	77	103	105.5	1	0.6	15 000	0.01~0.02	118	492	841	58	106	137
	110	20	1.1	0.6	PM7014CA	30.0	20.7	0.76	—	23 000	37 000	26.4	24	0.585	23.3	77	103	105.5	1	0.6	15 000	0.01~0.02	118	492	841	103	173	214
	110	20	1.1	0.6	H1-PM7014C	30.7	21.2	0.78	11.5	25 000	33 000	22.1	24	0.585	20.2	77	103	105.5	1	0.6	15 000	0.01~0.02	118	492	841	58	106	137
	110	20	1.1	0.6	H1-PM7014CA	30.0	20.7	0.76	—	23 000	33 000	26.4	24	0.585	23.3	77	103	105.5	1	0.6	15 000	0.01~0.02	118	492	841	103	173	214
75	105	16	1	0.6	PC7915C	30.7	21.2	0.77	11.5	24 000	38 000	20.1	17	0.31	22.6	80.5	99.5	100.5	1	0.6	10 000	0.01~0.02	83	319	689	51	88	124
	105	16	1	0.6	PC7915CA	29.9	20.7	0.76	—	22 000	36 000	24.4	17	0.31	26.1	80.5	99.5	100.5	1	0.6	10 000	0.01~0.02	83	319	689	91	145	197
	105	16	1	0.6	H1-PC7915C	30.7	21.2	0.77	11.5	24 000	33 000	20.1	17	0.31	22.6	80.5	99.5	100.5	1	0.6	10 000	0.01~0.02	83	319	689	51	88	124

[Remarks] 1. Use the QR code to inquire about series, sizes, ball specifications, low-NRRO specifications, and contact angles.
<https://www.precilence.com/en/contact/>



Basic load ratings in case of multiple-row combination bearing

	Basic dynamic load ratings	Basic static load ratings
2-row	$C_r \times 1.62$	$C_{0r} \times 2$
3-row	$C_r \times 2.16$	$C_{0r} \times 3$
4-row	$C_r \times 2.64$	$C_{0r} \times 4$

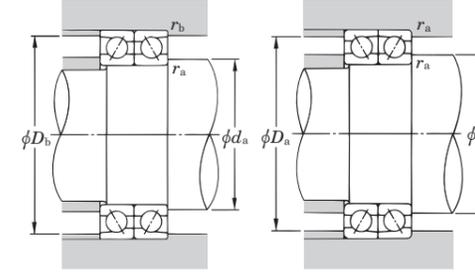
Speed coefficients in case of multiple-row combination bearing

Combination types	Combination symbols	Preload when mounting			
		Preload S	Preload L	Preload M	Preload H
⊗	DB	0.85	0.80	0.65	0.55
⊗ ⊗ ⊗ ⊗	DBB	0.80	0.75	0.60	0.45
⊗ ⊗ ⊗ ⊗ ⊗	DBD	0.75	0.70	0.55	0.40

*Speed coefficients also vary depending on the distance of bearings.

1. Angular contact ball bearings

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We recommend that recesses be added at r_a , r_b , and r_c .

Static equivalent load $P_0 = X_0 F_r + Y_0 F_a$

Contact angle	Single row/Tandem		Back-to-back/Face-to-face	
	X_0	Y_0	X_0	Y_0
15°	0.5	0.46	1	0.92
20°	0.5	0.42	1	0.84

Note that in the case of single row or tandem, assume $P_0 = F_r$, if $P_0 < F_r$.

Dynamic equivalent load $P = X F_r + Y F_a$

Contact angle	$i f_0 \frac{F_a}{C_{0r}}$	e	Single row/Tandem				Back-to-back/Face-to-face			
			$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
			X	Y	X	Y	X	Y	X	Y
15°	0.178	0.38			1.47	1.65			2.39	
	0.357	0.40			1.40	1.57			2.28	
	0.714	0.43			1.30	1.46			2.11	
	1.07	0.46			1.23	1.38			2.00	
	1.43	0.47	1	0	0.44	1.19	1	1.34	0.72	1.93
	2.14	0.50			1.12	1.26			1.82	
	3.57	0.55			1.02	1.14			1.66	
5.35	0.56			1.00	1.12			1.63		
7.14	0.56			1.00	1.12			1.63		
20°	0.57	1	0	0.43	1	1	1.09	0.70	1.63	

1) For i , use 2 for DB & DF and 1 for single & DT.

d (75) ~ 85

Boundary dimensions (mm)					Bearing No.	Basic load ratings (kN)		Fatigue load limit (kN) C_u	Factor f_0	Limiting speeds (min ⁻¹)		Load center (mm) a	Interspace volume (cm ³ /row)	(Refer.) Mass (kg/row)	Permissible axial load (kN) (static)	Mounting dimensions (mm)					Nut axial tension (N)	Interference of retaining plate (mm)	Preload (Combination of DB and DF) (N)			Axial rigidity (Combination of DB and DF) (N/μm)		
d	D	B	r min.	r ₁ min.		C_r	C_{0r}			Grease lub.	Oil lub.					d_a min.	D_a max.	D_b max.	r_a max.	r_b max.			S	L	M	S	L	M
75	105	16	1	0.6	H1-PC7915CA	29.9	20.7	0.76	—	22 000	33 000	24.4	17	0.31	26.1	80.5	99.5	100.5	1	0.6	10 000	0.01~0.02	83	319	689	91	145	197
	115	20	1.1	0.6	PC7015C	52.5	32.4	1.20	10.9	23 000	36 000	22.7	32	0.539	30.4	82	108	110.5	1	0.6	15 000	0.01~0.02	144	509	1 071	57	96	135
	115	20	1.1	0.6	PC7015CA	51.3	31.7	1.15	—	21 000	34 000	27.3	32	0.539	35.3	82	108	110.5	1	0.6	15 000	0.01~0.02	144	509	1 071	103	162	215
	115	20	1.1	0.6	H1-PC7015C	52.5	32.4	1.20	10.9	23 000	31 000	22.7	32	0.539	30.4	82	108	110.5	1	0.6	15 000	0.01~0.02	144	509	1 071	57	96	135
	115	20	1.1	0.6	H1-PC7015CA	51.3	31.7	1.15	—	21 000	31 000	27.3	32	0.539	35.3	82	108	110.5	1	0.6	15 000	0.01~0.02	144	509	1 071	103	162	215
	115	20	1.1	0.6	PM7015C	31.2	22.2	0.81	11.6	23 000	36 000	22.7	26	0.621	21.0	82	108	110.5	1	0.6	15 000	0.01~0.02	144	509	1 071	64	110	158
	115	20	1.1	0.6	PM7015CA	30.4	21.7	0.79	—	21 000	34 000	27.3	26	0.621	24.3	82	108	110.5	1	0.6	15 000	0.01~0.02	144	509	1 071	111	179	242
	115	20	1.1	0.6	H1-PM7015C	31.2	22.2	0.81	11.6	23 000	31 000	22.7	26	0.621	21.0	82	108	110.5	1	0.6	15 000	0.01~0.02	144	509	1 071	64	110	158
	115	20	1.1	0.6	H1-PM7015CA	30.4	21.7	0.79	—	21 000	31 000	27.3	26	0.621	24.3	82	108	110.5	1	0.6	15 000	0.01~0.02	144	509	1 071	111	179	242
	80	110	16	1	0.6	PC7916C	31.2	22.2	0.81	11.6	23 000	37 000	20.7	18	0.326	23.8	85.5	104.5	105.5	1	0.6	10 000	0.01~0.02	83	319	689	51	89
110		16	1	0.6	PC7916CA	30.4	21.7	0.79	—	21 000	35 000	25.3	18	0.326	27.4	85.5	104.5	105.5	1	0.6	10 000	0.01~0.02	83	319	689	90	150	201
110		16	1	0.6	H1-PC7916C	31.2	22.2	0.81	11.6	23 000	31 000	20.7	18	0.326	23.8	85.5	104.5	105.5	1	0.6	10 000	0.01~0.02	83	319	689	51	89	126
110		16	1	0.6	H1-PC7916CA	30.4	21.7	0.79	—	21 000	31 000	25.3	18	0.326	27.4	85.5	104.5	105.5	1	0.6	10 000	0.01~0.02	83	319	689	90	150	201
125		22	1.1	0.6	PC7016C	60.5	38.6	1.40	11.0	21 000	34 000	24.7	33	0.714	36.2	87	118	120.5	1	0.6	15 000	0.01~0.02	185	643	1 345	66	110	155
125		22	1.1	0.6	PC7016CA	59.1	37.7	1.35	—	20 000	32 000	29.7	33	0.714	42.0	87	118	120.5	1	0.6	15 000	0.01~0.02	185	643	1 345	117	185	246
125		22	1.1	0.6	H1-PC7016C	60.5	38.6	1.40	11.0	21 000	29 000	24.7	33	0.714	36.2	87	118	120.5	1	0.6	15 000	0.01~0.02	185	643	1 345	66	110	155
125		22	1.1	0.6	H1-PC7016CA	59.1	37.7	1.35	—	20 000	29 000	29.7	33	0.714	42.0	87	118	120.5	1	0.6	15 000	0.01~0.02	185	643	1 345	117	185	246
125		22	1.1	0.6	PM7016C	36.5	26.4	0.95	11.6	21 000	34 000	24.7	32	0.844	25.0	87	118	120.5	1	0.6	15 000	0.01~0.02	185	643	1 345	72	123	176
125		22	1.1	0.6	PM7016CA	35.7	25.8	0.93	—	20 000	32 000	29.7	32	0.844	28.9	87	118	120.5	1	0.6	15 000	0.01~0.02	185	643	1 345	125	201	269
125		22	1.1	0.6	H1-PM7016C	36.5	26.4	0.95	11.6	21 000	29 000	24.7	32	0.844	25.0	87	118	120.5	1	0.6	15 000	0.01~0.02	185	643	1 345	72	123	176
125		22	1.1	0.6	H1-PM7016CA	35.7	25.8	0.93	—	20 000	29 000	29.7	32	0.844	28.9	87	118	120.5	1	0.6	15 000	0.01~0.02	185	643	1 345	125	201	269
85	130	22	1.1	0.6	PC7017C	62.0	40.9	1.45	11.1	20 000	32 000	25.5	43	0.947	38.5	92	123	125.5	1	0.6	18 000	0.01~0.02	187	667	1 401	69	115	162
	130	22	1.1	0.6	PC7017CA	60.7	40.0	1.40	—	19 000	30 000	30.7	43	0.947	44.6	92	123	125.5	1	0.6	18 000	0.01~0.02	187	667	1 401	122	193	258
	130	22	1.1	0.6	H1-PC7017C	62.0	40.9	1.45	11.1	20 000	27 000	25.5	43	0.947	38.5	92	123	125.5	1	0.6	18 000	0.01~0.02	187	667	1 401	69	115	162
	130	22	1.1	0.6	H1-PC7017CA	60.7	40.0	1.40	—	19 000	27 000	30.7	43	0.947	44.6	92	123	125.5	1	0.6	18 000	0.01~0.02	187	667	1 401	122	193	258
	130	22	1.1	0.6	PM7017C	35.3	25.6	0.90	11.7	20 000	32 000	25.4	34	0.889	24.2	92	123	125.5	1	0.6	18 000	0.01~0.02	187	667	1 401	71	122	177
	130	22	1.1	0.6	PM7017CA	34.4	25.0	0.88	—	19 000	30 000	30.7	34	0.889	27.8	92	123	125.5	1	0.6	18 000	0.01~0.02	187	667	1 401	124	199	268
	130	22	1.1	0.6	H1-PM7017C	35.3	25.6	0.90	11.7	20 000	27 000	25.4	34	0.889	24.2	92	123	125.5	1	0.6	18 000	0.01~0.02	187	667	1 401	71	122	177
	130	22	1.1	0.6	H1-PM7017CA	34.4	25.0	0.88	—	19 000	27 000	30.7	34	0.889	27.8	92	123	125.5	1	0.6	18 000	0.01~0.02	187	667	1 401	124	199	268

[Remarks] 1. Use the QR code to inquire about series, sizes, ball specifications, low-NRRO specifications, and contact angles.

<https://www.precilence.com/en/contact/>



Basic load ratings in case of multiple-row combination bearing

	Basic dynamic load ratings	Basic static load ratings
2-row	$C_r \times 1.62$	$C_{0r} \times 2$
3-row	$C_r \times 2.16$	$C_{0r} \times 3$
4-row	$C_r \times 2.64$	$C_{0r} \times 4$

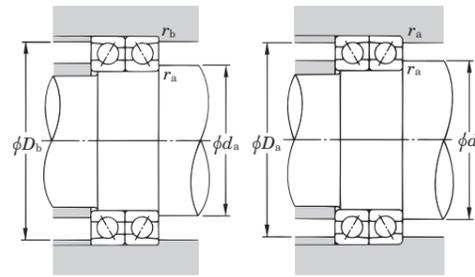
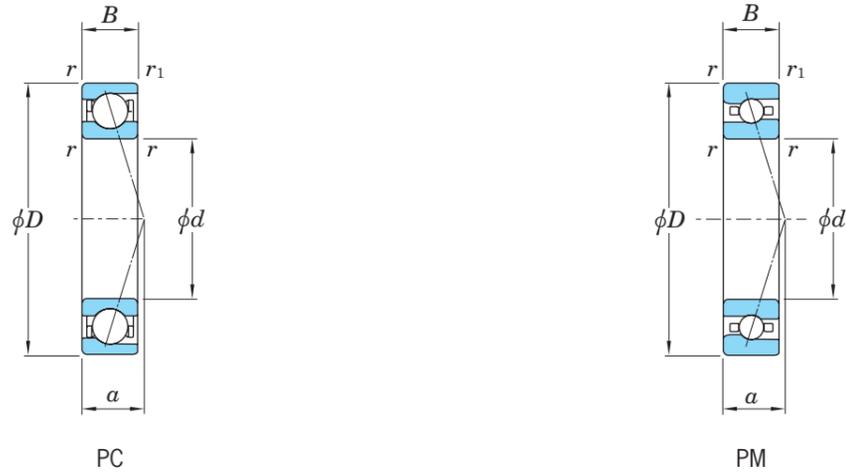
Speed coefficients in case of multiple-row combination bearing

Combination types	Combination symbols	Preload when mounting				
		Preload S	Preload L	Preload M	Preload H	
⊗	⊗	DB	0.85	0.80	0.65	0.55
⊗ ⊗	⊗ ⊗	DBB	0.80	0.75	0.60	0.45
⊗ ⊗	⊗	DBD	0.75	0.70	0.55	0.40

*Speed coefficients also vary depending on the distance of bearings.

1. Angular contact ball bearings

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We recommend that recesses be added at r_a , r_b , and r_c .

Static equivalent load $P_0 = X_0 F_r + Y_0 F_a$

Contact angle	Single row/Tandem		Back-to-back/Face-to-face	
	X_0	Y_0	X_0	Y_0
15°	0.5	0.46	1	0.92
20°	0.5	0.42	1	0.84

Note that in the case of single row or tandem, assume $P_0 = F_r$, if $P_0 < F_r$.

Dynamic equivalent load $P = X F_r + Y F_a$

Contact angle	$\frac{i f_0 F_a}{C_{0r}}$	e	Single row/Tandem				Back-to-back/Face-to-face				
			$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		
			X	Y	X	Y	X	Y	X	Y	
15°	0.178	0.38			1.47	1.65			2.39		
	0.357	0.40			1.40	1.57			2.28		
	0.714	0.43			1.30	1.46			2.11		
	1.07	0.46			1.23	1.38			2.00		
	1.43	0.47	1	0	0.44	1.19	1	1.34	0.72	1.93	
	2.14	0.50			1.12	1.26			1.82		
	3.57	0.55			1.02	1.14			1.66		
5.35	0.56			1.00	1.12			1.63			
7.14	0.56			1.00	1.12			1.63			
20°		0.57	1	0	0.43	1	1	1.09	0.70	1.63	

1) For i , use 2 for DB & DF and 1 for single & DT.

d 90 ~ 100

d	Boundary dimensions (mm)				Bearing No.	Basic load ratings (kN)		Fatigue load limit (kN) C_u	Factor f_0	Limiting speeds (min ⁻¹)		Load center (mm) a	Interspace volume (cm ³ /row)	(Refer.) Mass (kg/row)	Permissible axial load (kN) (static)	Mounting dimensions (mm)					Nut axial tension (N)	Interference of retaining plate (mm)	Preload (Combination of DB and DF) (N)			Axial rigidity (Combination of DB and DF) (N/μm)		
	D	B	r min.	r ₁ min.		C_r	C_{0r}			Grease lub.	Oil lub.					d_a min.	D_a max.	D_b max.	r_a max.	r_b max.			S	L	M	S	L	M
90	140	24	1.5	1	PC7018C	78.7	50.2	1.70	10.9	19 000	30 000	27.4	54	0.936	47.2	98.5	131.5	134.5	1.5	1	18 000	0.01~0.02	190	775	1 622	67	119	166
	140	24	1.5	1	PC7018CA	77.0	49.2	1.65	—	18 000	28 000	32.9	54	0.936	54.7	98.5	131.5	134.5	1.5	1	18 000	0.01~0.02	190	775	1 622	121	199	265
	140	24	1.5	1	H1-PC7018C	78.7	50.2	1.70	10.9	19 000	26 000	27.4	54	0.936	47.2	98.5	131.5	134.5	1.5	1	18 000	0.01~0.02	190	775	1 622	67	119	166
	140	24	1.5	1	H1-PC7018CA	77.0	49.2	1.65	—	18 000	26 000	32.9	54	0.936	54.7	98.5	131.5	134.5	1.5	1	18 000	0.01~0.02	190	775	1 622	121	199	265
	140	24	1.5	1	PM7018C	48.6	35.8	1.20	11.5	19 000	30 000	27.4	44	1.13	33.9	98.5	131.5	134.5	1.5	1	18 000	0.01~0.02	190	775	1 622	75	136	194
	140	24	1.5	1	PM7018CA	47.4	34.9	1.20	—	18 000	28 000	32.9	44	1.13	39.1	98.5	131.5	134.5	1.5	1	18 000	0.01~0.02	190	775	1 622	133	223	299
	140	24	1.5	1	H1-PM7018C	48.6	35.8	1.20	11.5	19 000	26 000	27.4	44	1.13	33.9	98.5	131.5	134.5	1.5	1	18 000	0.01~0.02	190	775	1 622	75	136	194
	140	24	1.5	1	H1-PM7018CA	47.4	34.9	1.20	—	18 000	26 000	32.9	44	1.13	39.1	98.5	131.5	134.5	1.5	1	18 000	0.01~0.02	190	775	1 622	133	223	299
95	145	24	1.5	1	PC7019C	75.9	51.0	1.70	11.1	18 000	28 000	28.3	57	0.96	48.1	103.5	136.5	139.5	1.5	1	18 000	0.01~0.02	238	811	1 692	76	127	178
	145	24	1.5	1	PC7019CA	74.2	49.9	1.65	—	17 000	26 000	34.2	57	0.96	55.8	103.5	136.5	139.5	1.5	1	18 000	0.01~0.02	238	811	1 692	136	213	283
	145	24	1.5	1	H1-PC7019C	75.9	51.0	1.70	11.1	18 000	25 000	28.3	57	0.96	48.1	103.5	136.5	139.5	1.5	1	18 000	0.01~0.02	238	811	1 692	76	127	178
	145	24	1.5	1	H1-PC7019CA	74.2	49.9	1.65	—	17 000	25 000	34.2	57	0.96	55.8	103.5	136.5	139.5	1.5	1	18 000	0.01~0.02	238	811	1 692	136	213	283
	145	24	1.5	1	PM7019C	49.4	37.4	1.25	11.6	18 000	28 000	28.1	46	1.2	35.4	103.5	136.5	139.5	1.5	1	18 000	0.01~0.02	238	811	1 692	84	142	201
	145	24	1.5	1	PM7019CA	48.2	36.5	1.20	—	17 000	26 000	34.2	46	1.2	40.8	103.5	136.5	139.5	1.5	1	18 000	0.01~0.02	238	811	1 692	146	232	312
	145	24	1.5	1	H1-PM7019C	49.4	37.4	1.25	11.6	18 000	25 000	28.1	46	1.2	35.4	103.5	136.5	139.5	1.5	1	18 000	0.01~0.02	238	811	1 692	84	142	201
	145	24	1.5	1	H1-PM7019CA	48.2	36.5	1.20	—	17 000	25 000	34.2	46	1.2	40.8	103.5	136.5	139.5	1.5	1	18 000	0.01~0.02	238	811	1 692	146	232	312
100	150	24	1.5	1	PC7020C	77.9	53.9	1.75	11.1	17 000	27 000	28.7	59	1.06	50.7	108.5	141.5	144.5	1.5	1	20 000	0.01~0.02	238	818	1 707	79	131	183
	150	24	1.5	1	PC7020CA	76.1	52.7	1.70	—	16 000	25 000	34.8	59	1.06	58.7	108.5	141.5	144.5	1.5	1	20 000	0.01~0.02	238	818	1 707	140	220	293
	150	24	1.5	1	H1-PC7020C	77.9	53.9	1.75	11.1	17 000	24 000	28.7	59	1.06	50.7	108.5	141.5	144.5	1.5	1	20 000	0.01~0.02	238	818	1 707	79	131	183
	150	24	1.5	1	H1-PC7020CA	76.1	52.7	1.70	—	16 000	24 000	34.8	59	1.06	58.7	108.5	141.5	144.5	1.5	1	20 000	0.01~0.02	238	818	1 707	140	220	293
	150	24	1.5	1	PM7020C	50.2	39.0	1.25	11.7	17 000	27 000	28.7	48	1.23	36.9	108.5	141.5	144.5	1.5	1	20 000	0.01~0.02	238	818	1 707	85	145	206
	150	24	1.5	1	PM7020CA	49.0	38.0	1.25	—	16 000	25 000	34.8	48	1.23	42.6	108.5	141.5	144.5	1.5	1	20 000	0.01~0.02	238	818	1 707	149	237	319
	150	24	1.5	1	H1-PM7020C	50.2	39.0	1.25	11.7	17 000	24 000	28.7	48	1.23	36.9	108.5	141.5	144.5	1.5	1	20 000	0.01~0.02	238	818	1 707	85	145	206
	150	24	1.5	1	H1-PM7020CA	49.0	38.0	1.25	—	16 000	24 000	34.8	48	1.23	42.6	108.5	141.5	144.5	1.5	1	20 000	0.01~0.02	238	818	1 707	149	237	319

[Remarks] 1. Use the QR code to inquire about series, sizes, ball specifications, low-NRRO specifications, and contact angles.

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Basic load ratings in case of multiple-row combination bearing

	Basic dynamic load ratings	Basic static load ratings
2-row	$C_r \times 1.62$	$C_{0r} \times 2$
3-row	$C_r \times 2.16$	$C_{0r} \times 3$
4-row	$C_r \times 2.64$	$C_{0r} \times 4$

Speed coefficients in case of multiple-row combination bearing

Combination types	Combination symbols	Preload when mounting				
		Preload S	Preload L	Preload M	Preload H	
⊗	⊗	DB	0.85	0.80	0.65	0.55
⊗ ⊗	⊗ ⊗	DBB	0.80	0.75	0.60	0.45
⊗ ⊗	⊗	DBD	0.75	0.70	0.55	0.40

*Speed coefficients also vary depending on the distance of bearings.

2. Cylindrical Roller Bearings

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2. Cylindrical roller bearings

The cylindrical roller bearing has high radial rigidity and is suitable for high-speed rotation through an arrangement of many rollers and a line contact which is made between the rollers and raceways.

The bores of cylindrical roller bearings are either cylindrical or tapered. With a bearing having a tapered bore, its radial internal clearance can be set with ease to a given value by adjusting the extent to which the bearing is pushed onto the shaft.

2.1 Types and features of cylindrical roller bearings

The cylindrical roller bearing is divided into two types: double row and single row bearings. Both having outer ring which is separable from the inner to facilitate mounting and dismounting from shaft and housing (see Fig. 2. 1).

1) Double row cylindrical roller bearings

The double row cylindrical roller bearing is classified into the NN3000 and NNU4900 series.

Some of these bearings have a lubrication groove and holes provided at the center of the outside surface of the outer rings in order to attain a sufficient supply of lubricant to the inside of the bearing (the suffix W is added).

2) Single row cylindrical roller bearings

Single row cylindrical roller bearings for the spindles of machine tools are often selected from the N1000 series.

The bore and outside diameters of the N1000 series are the same as those of the NN3000: double row cylindrical roller bearing series.

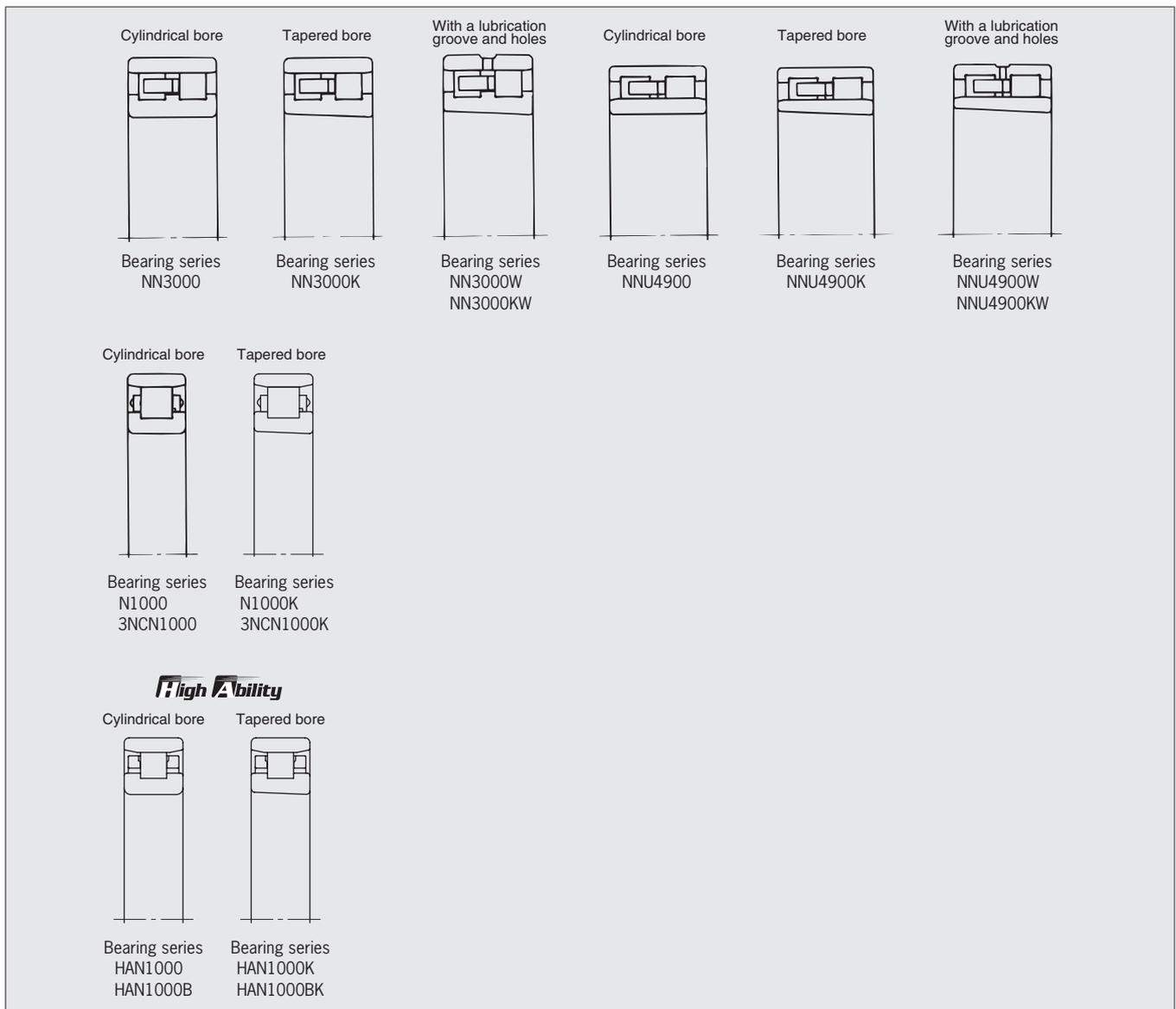
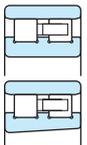
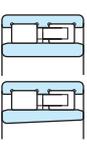
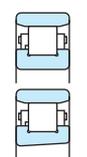
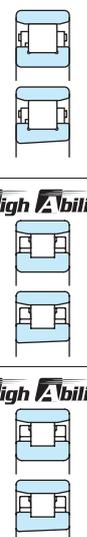


Fig. 2. 1 Types and series of cylindrical roller bearings for machine tool spindles

2. Cylindrical roller bearings

3) Performance comparison of cylindrical roller bearings

Fig. 2. 2 Performance comparison of cylindrical roller bearings

Bearing types	Cross-sections	Main applications	Product name	Bearing series	Rolling element material	Bearing ring material				
 NN-type double row cylindrical roller bearings		High precision / long service life	Standard series	NN3000	Bearing steel	Bearing steel				
				NN3000K						
 NNU-type double row cylindrical roller bearings				High precision / high speed			High Ability	NNU4900	Ceramics	Bearing steel
								NNU4900K		
 N-type single row cylindrical roller bearings				High precision / high speed			High Ability	N1000	Ceramics	Bearing steel
								N1000K		
		High precision / ultra-high speed	High Ability	High Ability	3NCN1000	Bearing steel	Bearing steel			
					3NCN1000K					
					HAN1000					
					HAN1000K					
				HAN1000B						
				HAN1000BK						

	Limiting speeds (Grease)	Limiting speeds (Oil / Air)	Basic load ratings		Page No.
	d_{mn} value → high		C_r → high	C_{0r} → high	
					P138
					P142

2.2 Composition of bearing numbers (cylindrical roller bearings)

NN3009 KWC1NAFWP4
N1009 C1NAFY P4
HAN1009BK C1NAPGP4

Bearing type symbols

NN : double row / inner ring with rib
 NNU : double row / outer ring with rib
 N : single row / inner ring with rib
 HAN : *High Ability* single row / inner ring with rib
 Ultrahigh-speed type

Dimension series symbols

30 : dimension series 30
 49 : dimension series 49
 10 : dimension series 10

Bore diameter number

09 : nominal bore diameter : 45 mm
 (Bore diameter number × 5 equals nominal bore diameter.)

Internal design code

Ring shape symbols

K : bearing with tapered bore (1/12 taper)
 W : outer ring with a lubrication groove and holes

Tolerance class symbols

P5 : JIS class 5
 P4 : JIS class 4
 P2 : JIS class 2

Cage symbols

FW : separable machined cage made of copper alloy
 FY : integrated machined cage made of copper alloy (Double row bearing)
 Machined cage made of copper alloy with rivets (single row bearing)
 FG : molded cage made of polyamide resin
 (Consult **JTEKT** for detailed information about the available types.)
 PG : PEEK resin cage

Internal clearance symbols

C9NA : radial internal clearance of
 ~C1NA : non-interchangeable bearings
 (For values of radial internal clearances, see the dimension tables.)

For ceramic bearings

3N CN1009C1NAFY P4

Ceramic bearing

2.3 Tolerance of cylindrical roller bearings

1) Boundary dimension and running accuracies

The tolerance of precision cylindrical roller bearings is compliant with permissible dimensional deviations and limits of classes 5, 4, and 2 as specified in JIS B 1514 for radial bearings (tapered roller bearings not included).

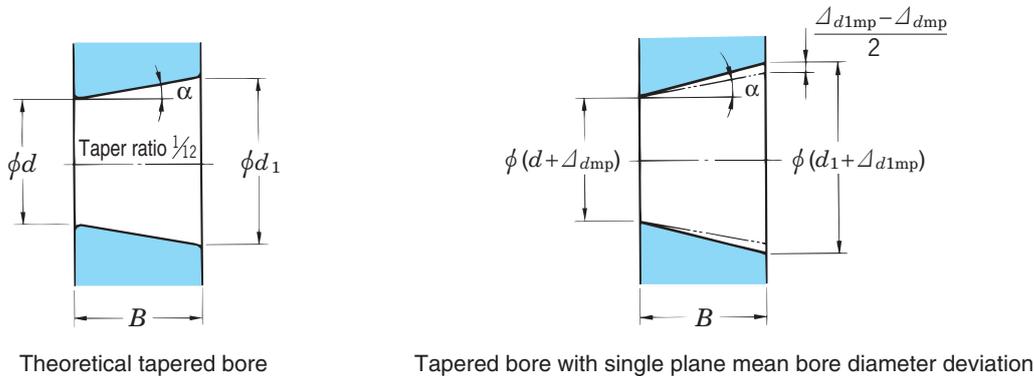
Permissible dimensional deviations and limits to boundary dimension and running accuracies are shown in **Table 1. 2** on page 70.

2) Permissible dimensional deviations and limits for tapered bores

The dimensional deviations and limits for tapered bores of radial bearings of class 0 only are specified in JIS B 1514.

JTEKT has formulated special standards for dimensional deviations and limits for tapered bores of radial bearings of classes 5, 4, and 2 (see **Table 2. 1**).

Table 2. 1 Dimensional deviations and limits for tapered bores of radial bearings (classes 5, 4, and 2)



Unit : μm

Nominal bore diameter d (mm)		Δ_{dmp}				$\Delta_{d1mp} - \Delta_{dmp}^{1)}$				$V_{dsp}^{2)}$				
										Class 5		Classes 4, 2		Class 5
over	up to	upper	lower	upper	lower	upper	lower	max.		max.		max.		
18	30	+10	0	+6	0	+3	0	6	5	5	4	2.5		
30	50	+12	0	+8	0	+3	0	8	6	6	5	2.5		
50	80	+15	0	+9	0	+5	0	9	7	7	5	4		
80	120	+20	0	+10	0	+6	0	10	8	8	6	5		
120	180	+25	0	+13	0	+8	0	13	10	10	8	7		
180	250	+30	0	+15	0	+9	0	15	12	12	9	8		
250	315	+35	0	+18	0	+10	0	18	15	14	11	—		
315	400	+40	0	+23	0	+12	0	23	18	18	14	—		

- [Notes] 1) Permissible dimensional deviation for the taper angle is $4^{\circ}46'18.8''^{+26''}$
 2) Applied to all radial planes of tapered bores.

[Remarks] 1. **Scope** These values are applied to the tapered bores with a reference taper ratio of 1/12.

2. **Symbols for quantities** d_1 : reference diameter at theoretical large end of tapered bore $d_1 = d + \frac{1}{12}B$

Δ_{dmp} : single plane mean bore diameter deviation at theoretical small end of tapered bore

Δ_{d1mp} : single plane mean bore diameter deviation at theoretical large end of tapered bore

V_{dsp} : single plane bore diameter variation

B : nominal inner ring width

α : $\frac{1}{2}$ of the nominal taper angle of tapered bore

$\alpha = 2^{\circ}23'9.4''$

$= 2.38594^{\circ}$

$= 0.041643 \text{ rad}$

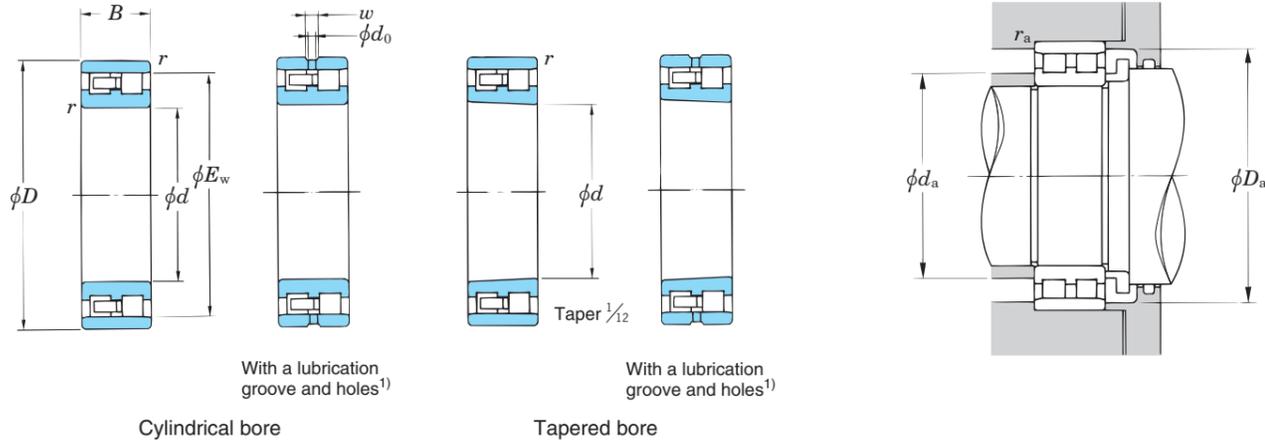
2.4 Radial internal clearances of cylindrical roller bearings

In order to minimize variations in the running accuracy of machine tool spindles, the values of the radial internal clearance should be same as those of special radial internal clearance of non-interchangeable bearings.

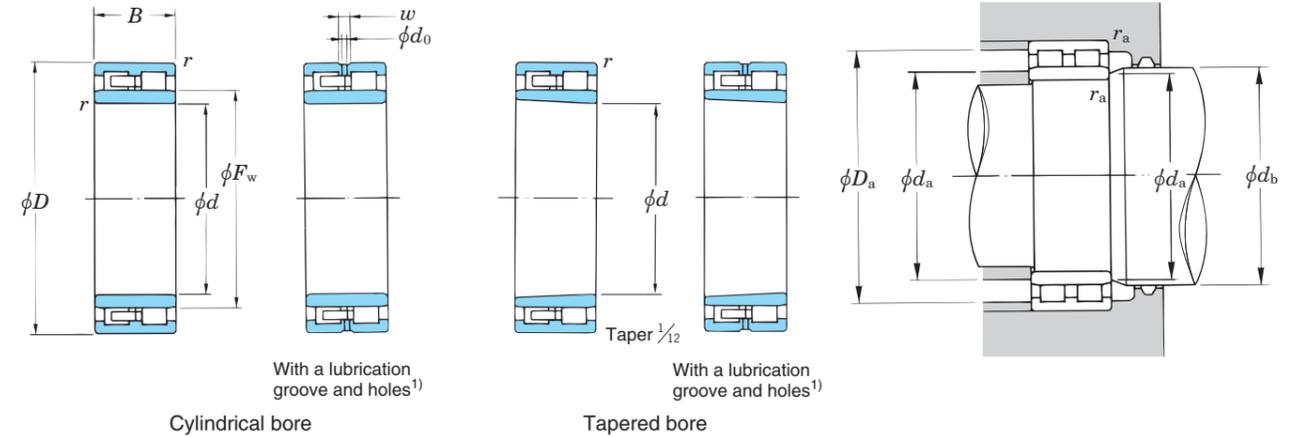
The dimension tables show values of non-interchangeable radial internal clearances for cylindrical roller bearings.

Since the inner and outer rings of cylindrical roller bearings for spindles of machine tools are not interchangeable, care should be taken when using them.

NN3000(K) series



NNU4900(K) series



d 25 ~ 150

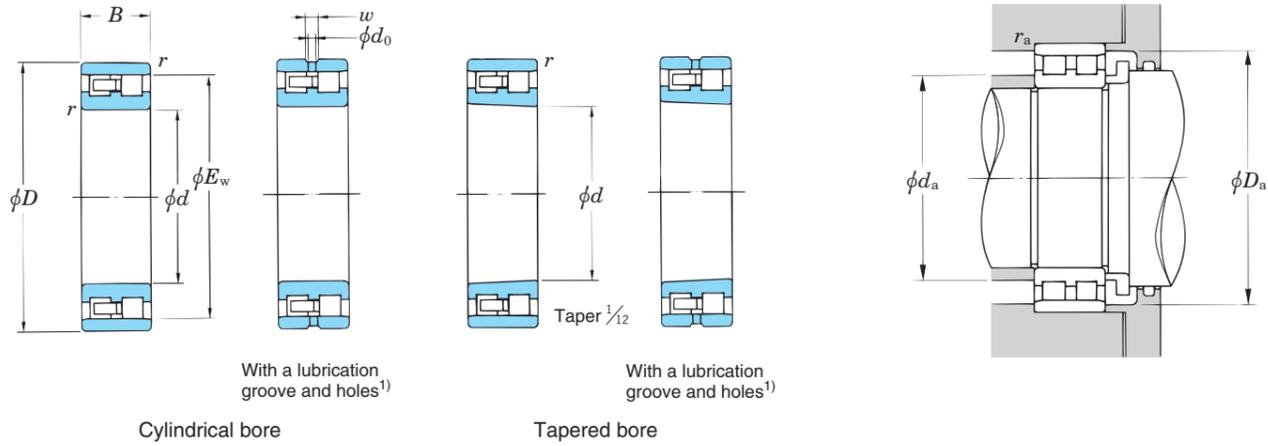
Dynamic equivalent load $P_r = F_r$
Static equivalent load $P_{0r} = F_r$

Boundary dimensions (mm)						Bearing No. ¹⁾		Basic load ratings (kN)		Fatigue load limit (kN)	Limiting speeds (min ⁻¹)		Interspace volume (cm ³)	(Refer.) Mass (kg)	Mounting dimensions (mm)				Interference of retaining plate (mm)	Values of non-interchangeable clearances of bearings with cylindrical bores (mm)		Values of non-interchangeable clearances of bearings with tapered bores (mm)									
d	D	B	r min.	E _w	F _w	Cylindrical bore	Tapered bore	C _r	C _{0r}	C _u	Grease lub.	Oil lub.			d ₀	w	d _a min.	d _a max.		d _b min.	d _b max.	D _a min.	D _a max.	r _a min.	r _a max.	C _{1NA} min.	C _{1NA} max.	C _{9NA} min.	C _{9NA} max.	C _{0NA} min.	C _{0NA} max.
25	47	16	0.6	41.3	—	NN3005	NN3005K	32.2	30.0	5.20	19 000	23 000	3.5	0.125	2	4	29	—	—	43	42	0.6	0.01~0.02	5	10	5	10	10	20	10	25
30	55	19	1	48.5	—	NN3006	NN3006K	46.0	44.1	4.95	16 000	20 000	6	0.195	2	4	35	—	—	50	49	1	0.01~0.02	5	10	5	10	10	20	10	25
35	62	20	1	55	—	NN3007	NN3007K	49.1	50.0	5.65	14 000	17 000	8	0.250	2	4	40	—	—	57	56	1	0.01~0.02	5	12	5	12	10	20	12	25
40	68	21	1	61	—	NN3008	NN3008K	52.0	55.9	6.35	13 000	15 000	10	0.303	2	4	45	—	—	63	62	1	0.01~0.02	5	12	5	12	10	20	12	25
45	75	23	1	67.5	—	NN3009	NN3009K	67.1	71.9	8.75	12 000	14 000	13	0.393	3	6	50	—	—	70	69	1	0.01~0.02	5	15	5	15	10	20	15	30
50	80	23	1	72.5	—	NN3010	NN3010K	66.4	72.6	8.85	11 000	13 000	14	0.422	3	6	55	—	—	75	74	1	0.01~0.02	5	15	5	15	10	20	15	30
55	90	26	1.1	81	—	NN3011	NN3011K	89.6	101	13.2	9 600	12 000	20	0.628	3	6	61.5	—	—	83.5	82	1	0.01~0.02	5	15	5	15	10	20	15	35
60	95	26	1.1	86.1	—	NN3012	NN3012K	91.6	106	13.9	9 000	11 000	22	0.675	3	6	66.5	—	—	88.5	87	1	0.01~0.02	5	15	5	15	10	20	15	35
65	100	26	1.1	91	—	NN3013	NN3013K	93.6	111	14.6	8 400	10 000	23	0.717	3	6	71.5	—	—	93.5	92	1	0.01~0.02	5	15	5	15	10	20	15	35
70	110	30	1.1	100	—	NN3014	NN3014K	122	148	20.6	7 600	9 200	33	1.03	3	6	76.5	—	—	103.5	101	1	0.01~0.02	10	20	10	20	15	30	20	40
75	115	30	1.1	105	—	NN3015	NN3015K	124	155	21.5	7 200	8 700	35	1.10	3	6	81.5	—	—	108.5	106	1	0.01~0.02	10	20	10	20	15	30	20	40
80	125	34	1.1	113	—	NN3016	NN3016K	149	186	26.6	6 700	8 100	48	1.53	4	7	86.5	—	—	118.5	114	1	0.01~0.02	10	20	10	20	15	30	20	40
85	130	34	1.1	118	—	NN3017	NN3017K	152	194	27.3	6 400	7 700	50	1.61	4	7	91.5	—	—	123.5	119	1	0.01~0.02	10	25	10	25	20	35	25	45
90	140	37	1.5	127	—	NN3018	NN3018K	179	228	29.3	5 900	7 100	65	2.04	4	7	98	—	—	132	129	1.5	0.01~0.02	10	25	10	25	20	35	25	45
95	145	37	1.5	132	—	NN3019	NN3019K	188	246	31.3	5 700	6 800	67	2.14	4	7	103	—	—	137	134	1.5	0.01~0.02	10	25	10	25	20	35	25	45
100	150	37	1.5	137	—	NN3020	NN3020K	191	256	32.1	5 500	6 500	68	2.25	4	7	108	—	—	142	139	1.5	0.01~0.02	10	25	10	25	20	35	25	45
	140	40	1.1	—	113	NNU4920	NNU4920K	173	258	32.9	5 600	6 800	61	1.91	2.5	6	106.5	111	115	133.5	—	1	0.01~0.02	10	25	10	25	20	35	25	45
105	160	41	2	146	—	NN3021	NN3021K	247	322	42.5	5 200	6 200	94	2.85	4	7	114	—	—	151	148	2	0.02~0.04	10	25	10	25	20	35	25	50
	145	40	1.1	—	118	NNU4921	NNU4921K	196	306	40.2	5 400	6 500	61	1.96	2.5	6	111.5	116	120	138.5	—	1	0.02~0.04	10	25	10	25	20	35	25	50
110	170	45	2	155	—	NN3022	NN3022K	278	361	47.9	4 800	5 800	117	3.61	4	7	119	—	—	161	157	2	0.02~0.04	10	25	10	25	20	35	25	50
	150	40	1.1	—	123	NNU4922	NNU4922K	204	326	42.4	5 200	6 200	60	2.06	2.5	6	116.5	121	125	143.5	—	1	0.02~0.04	10	25	10	25	20	35	25	50
120	180	46	2	165	—	NN3024	NN3024K	291	392	51.1	4 500	5 400	127	3.94	4	7	129	—	—	171	167	2	0.02~0.04	10	25	10	25	20	35	25	50
	165	45	1.1	—	134.5	NNU4924	NNU4924K	234	373	47.6	4 700	5 700	84	2.84	3	7	126.5	132	137	158.5	—	1	0.02~0.04	10	25	10	25	20	35	25	50
130	200	52	2	182	—	NN3026	NN3026K	356	476	57.7	4 100	4 900	185	5.85	5	8.5	139	—	—	191	183	2	0.02~0.04	15	30	15	30	25	40	30	60
	180	50	1.5	—	146	NNU4926	NNU4926K	269	428	50.2	4 300	5 200	116	3.82	3	7	138	143.5	148	172	—	1.5	0.02~0.04	15	30	15	30	25	40	30	60
140	210	53	2	192	—	NN3028	NN3028K	372	516	61.5	3 800	4 600	193	6.31	6	10	149	—	—	201	194	2	0.02~0.04	15	30	15	30	25	40	30	60
	190	50	1.5	—	156	NNU4928	NNU4928K	277	456	52.5	4 000	4 800	125	4.06	3	7	148	153.5	158	182	—	1.5	0.02~0.04	15	30	15	30	25	40	30	60
150	225	56	2.1	206	—	NN3030	NN3030K	418	587	70.1	3 500	4 200	239	7.62	6	10	161	—	—	214	208	2	0.02~0.04	15	35	15	35	30	45	35	65
	210	60	2	—	168.5	NNU4930	NNU4930K	430	692	80.7	3 700	4 400	192	6.36	4	7	159	166	171	201	—	2	0.02~0.04	15	35	15	35	30	45	35	65

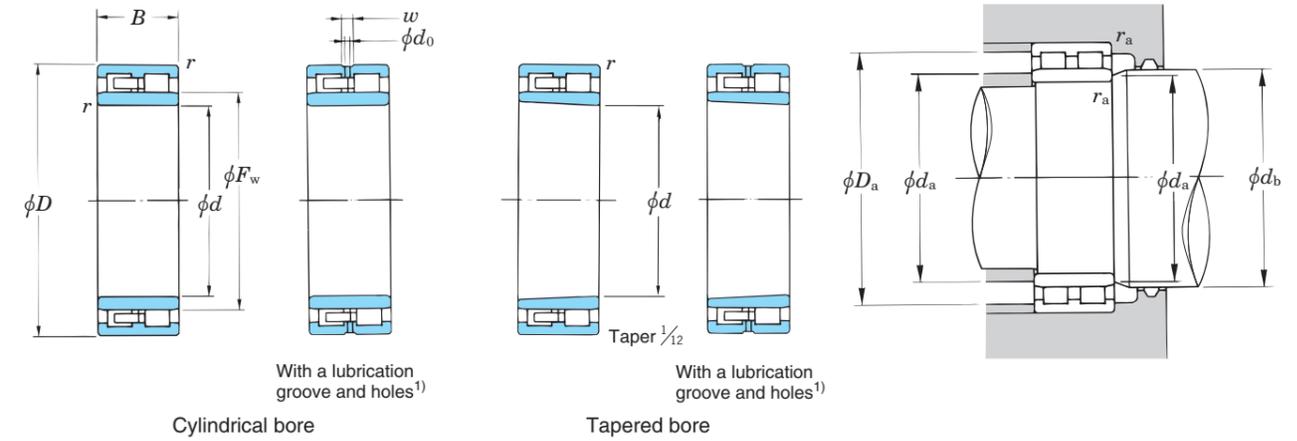
[Note] 1) The symbol W is added to the end of bearing numbers to denote bearings whose outer ring has a lubrication groove and holes.

[Remarks] 1. For the dimensions of the spacers for oil / air lubrication, refer to Table 15. 4 on page 57.
2. For the discharge intervals of the oil / air, refer to Supplementary table 6 on page 215.

NN3000(K) series



NNU4900(K) series



d 160 ~ 190

Dynamic equivalent load $P_r = F_r$
Static equivalent load $P_{0r} = F_r$

d	Boundary dimensions (mm)					Bearing No. ¹⁾		Basic load ratings (kN)		Fatigue load limit (kN) C_u	Limiting speeds (min ⁻¹)		Interspace volume (cm ³)	(Refer.) Mass (kg)	Dimensions of lubrication groove and holes (mm)		Mounting dimensions (mm)					Interference of retaining plate (mm)	Values of non-interchangeable clearances of bearings with cylindrical bores (mm) C_{1NA}		Values of non-interchangeable clearances of bearings with tapered bores (mm)						
	D	B	$r_{min.}$	E_w	F_w	Cylindrical bore	Tapered bore	C_r	C_{0r}		Grease lub.	Oil lub.			d_0	w	d_a min.	d_a max.	d_b min.	d_b max.	D_a min.		D_a max.	r_a min.	r_a max.	min.	max.	C_{9NA} min.	C_{9NA} max.	C_{0NA} min.	C_{0NA} max.
160	240	60	2.1	219	—	NN3032	NN3032K	499	695	79.6	3 300	4 000	281	9.23	6	10	171	—	—	229	221	2	0.02~0.04	15	35	15	35	30	45	35	65
	220	60	2	—	178.5	NNU4932	NNU4932K	425	695	79.8	3 400	4 100	186	6.80	4	7	169	176	182	211	—	2	0.02~0.04	15	35	15	35	30	45	35	65
170	260	67	2.1	236	—	NN3034	NN3034K	592	824	105	3 000	3 600	371	12.6	6	10	181	—	—	249	238	2	0.02~0.04	15	35	15	35	30	45	35	75
	230	60	2	—	188.5	NNU4934	NNU4934K	451	763	86.4	3 200	3 900	216	7.04	4	7	179	186	192	221	—	2	0.02~0.04	15	35	15	35	30	45	35	75
180	250	69	2	—	202	NNU4936	NNU4936K	572	964	117	3 000	3 600	297	10.3	4	7	189	199.5	205	241	—	2	0.02~0.04	15	35	15	35	30	45	35	75
190	260	69	2	—	210	NNU4938	NNU4938K	581	996	119	2 900	3 400	313	10.8	5	8.5	199	207	215	251	—	2	0.02~0.04	20	40	20	40	30	50	40	80

[Note] 1) The symbol W is added to the end of bearing numbers to denote bearings whose outer ring has a lubrication groove and holes.

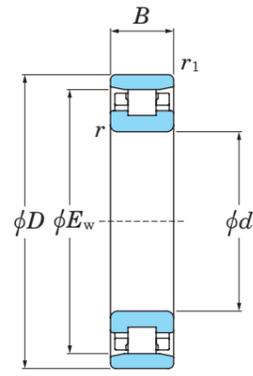
[Remarks] 1. For the dimensions of the spacers for oil / air lubrication, refer to Table 15. 4 on page 57.
2. For the discharge intervals of the oil / air, refer to Supplementary table 6 on page 215.

2. Cylindrical roller bearings

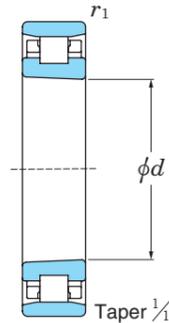
High Ability

HAN1000(K) series
HAN1000B(K) series

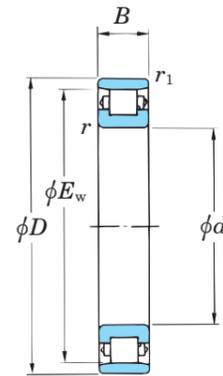
N1000(K) series
3NCN1000(K) series Ceramic bearings



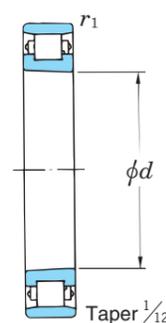
Cylindrical bore



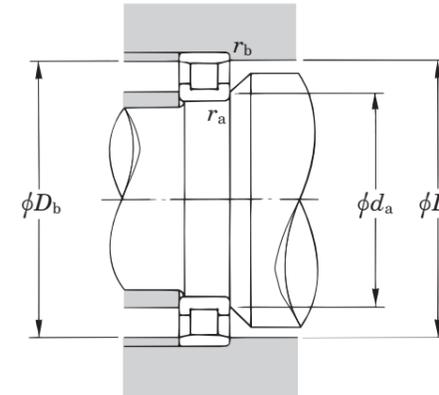
Tapered bore
Taper 1/12



Cylindrical bore



Tapered bore
Taper 1/12



d 30 ~ 65

Dynamic equivalent load $P_r = F_r$
Static equivalent load $P_{0r} = F_r$

d	Boundary dimensions (mm)					Bearing No.		Basic load ratings (kN)		Fatigue load limit (kN) C_u	Limiting speeds (min ⁻¹)		Interspace volume (cm ³)	(Refer.) Mass (kg)	Mounting dimensions (mm)					Interference of retaining plate (mm)	Values of non-interchangeable clearances of bearings with cylindrical bores (mm)		Values of non-interchangeable clearances of bearings with tapered bores (mm)							
	D	B	r min.	r ₁ min.	E _w	Cylindrical bore	Tapered bore	C _r	C _{0r}		Grease lub.	Oil lub.			d _a min.	D _b max.	r _a min.	r _b max.	C _{1NA} min.		C _{1NA} max.	C _{9NA} min.	C _{9NA} max.	C _{0NA} min.	C _{0NA} max.	C _{1NA} min.	C _{1NA} max.			
30	55	13	1	0.6	48.5	N1006	N1006K	23.4	18.4	2.05	18 000	21 000	4.8	0.137	35	50	49.5	1	0.6	0.01~0.02	5	10	5	10	5	10	10	20	10	25
	55	13	1	0.6	48.5	3NCN1006	3NCN1006K	23.4	18.4	2.05	23 000	27 000	4.8	0.125	35	50	49.5	1	0.6	0.01~0.02	5	10	5	10	5	10	10	20	10	25
35	62	14	1	0.6	55	N1007	N1007K	25.3	21.3	2.40	15 000	18 000	6.4	0.175	40	57	56	1	0.6	0.01~0.02	5	12	5	12	5	12	10	20	12	25
	62	14	1	0.6	55	3NCN1007	3NCN1007K	25.3	21.3	2.40	20 000	23 000	6.4	0.162	40	57	56	1	0.6	0.01~0.02	5	12	5	12	5	12	10	20	12	25
	62	14	1	0.6	55	HAN1007	HAN1007K	21.6	17.4	2.90	25 000	28 000	6.0	0.157	40	57	56	1	0.6	0.01~0.02	5	12	5	12	5	12	10	20	12	25
40	68	15	1	0.6	61	N1008	N1008K	28.2	25.4	2.90	14 000	16 000	8.3	0.213	45	63	62	1	0.6	0.01~0.02	5	12	5	12	5	12	10	20	12	25
	68	15	1	0.6	61	3NCN1008	3NCN1008K	28.2	25.4	2.90	18 000	21 000	8.3	0.197	45	63	62	1	0.6	0.01~0.02	5	12	5	12	5	12	10	20	12	25
	68	15	1	0.6	61	HAN1008	HAN1008K	23.4	20.0	2.90	23 000	26 000	7.4	0.195	45	63	62	1	0.6	0.01~0.02	5	12	5	12	5	12	10	20	12	25
45	75	16	1	0.6	68.5	N1009	N1009K	40.7	34.2	4.45	13 000	15 000	11	0.265	50	70	68.5	1	0.6	0.01~0.02	5	15	5	15	5	15	10	20	15	30
	75	16	1	0.6	68.5	3NCN1009	3NCN1009K	40.7	34.2	4.45	17 000	20 000	11	0.235	50	70	68.5	1	0.6	0.01~0.02	5	15	5	15	5	15	10	20	15	30
	75	16	1	0.6	68.5	HAN1009	HAN1009K	30.6	26.1	3.90	21 000	23 000	10	0.225	50	70	68.5	1	0.6	0.01~0.02	5	15	5	15	5	15	10	20	15	30
	75	16	1	0.6	67.5	HAN1009B	HAN1009BK	36.9	29.9	3.90	25 000	40 000	9.2	0.222	50	70	68.5	1	0.6	0.01~0.02	5	15	5	15	5	15	10	20	15	30
50	80	16	1	0.6	72.5	N1010	N1010K	44.1	38.9	5.10	11 000	13 000	12	0.289	55	75	73.5	1	0.6	0.01~0.02	5	15	5	15	5	15	10	20	15	30
	80	16	1	0.6	72.5	3NCN1010	3NCN1010K	44.1	38.9	5.10	14 000	17 000	12	0.256	55	75	73.5	1	0.6	0.01~0.02	5	15	5	15	5	15	10	20	15	30
	80	16	1	0.6	72.5	HAN1010	HAN1010K	31.8	28.0	4.50	19 000	22 000	12	0.250	55	75	73.5	1	0.6	0.01~0.02	5	15	5	15	5	15	10	20	15	30
	80	16	1	0.6	72.5	HAN1010B	HAN1010BK	40.4	34.5	4.50	23 000	37 000	12	0.254	55	75	73.5	1	0.6	0.01~0.02	5	15	5	15	5	15	10	20	15	30
55	90	18	1.1	1	81	N1011	N1011K	47.1	43.9	5.35	10 000	12 000	17	0.425	61.5	83.5	82	1	1	0.01~0.02	5	15	5	15	5	15	10	20	15	35
	90	18	1.1	1	81	3NCN1011	3NCN1011K	47.1	43.9	4.25	13 000	16 000	17	0.388	61.5	83.5	82	1	1	0.01~0.02	5	15	5	15	5	15	10	20	15	35
	90	18	1.1	1	81	HAN1011	HAN1011K	43.5	39.5	5.20	17 000	19 000	15	0.373	61.5	83.5	82	1	1	0.01~0.02	5	15	5	15	5	15	10	20	15	35
	90	18	1.1	1	81	HAN1011B	HAN1011BK	43.5	39.5	5.20	21 000	33 000	14	0.377	61.5	83.5	82	1	1	0.01~0.02	5	15	5	15	5	15	10	20	15	35
60	95	18	1.1	1	86.1	N1012	N1012K	48.3	46.4	6.10	9 600	11 000	18	0.453	66.5	88.5	87	1	1	0.01~0.02	5	15	5	15	5	15	10	20	15	35
	95	18	1.1	1	86.1	3NCN1012	3NCN1012K	48.3	46.4	6.10	12 000	14 000	18	0.414	66.5	88.5	87	1	1	0.01~0.02	5	15	5	15	5	15	10	20	15	35
	95	18	1.1	1	86.1	HAN1012	HAN1012K	44.8	42.0	5.50	16 000	18 000	16	0.426	66.5	88.5	87	1	1	0.01~0.02	5	15	5	15	5	15	10	20	15	35
	95	18	1.1	1	86.1	HAN1012B	HAN1012BK	44.8	42.0	5.50	19 000	31 000	16	0.404	66.5	88.5	87	1	1	0.01~0.02	5	15	5	15	5	15	10	20	15	35
65	100	18	1.1	1	91.5	N1013	N1013K	51.3	51.2	6.75	9 000	11 000	20	0.481	71.5	93.5	92	1	1	0.01~0.02	5	15	5	15	5	15	10	20	15	35
	100	18	1.1	1	91.5	3NCN1013	3NCN1013K	51.3	51.2	6.75	12 000	14 000	20	0.440	71.5	93.5	92	1	1	0.01~0.02	5	15	5	15	5	15	10	20	15	35
	100	18	1.1	1	91.5	HAN1013	HAN1013K	46.2	44.5	5.90	15 000	17 000	19	0.424	71.5	93.5	92	1	1	0.01~0.02	5	15	5	15	5	15	10	20	15	35
	100	18	1.1	1	91	HAN1013B	HAN1013BK	46.2	44.5	5.90	18 000	29 000	17	0.438	71.5	93.5	92	1	1	0.01~0.02	5	15	5	15	5	15	10	20	15	35

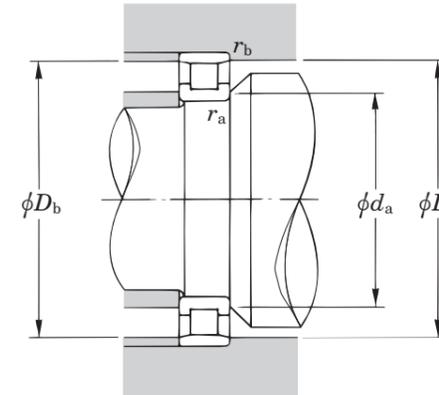
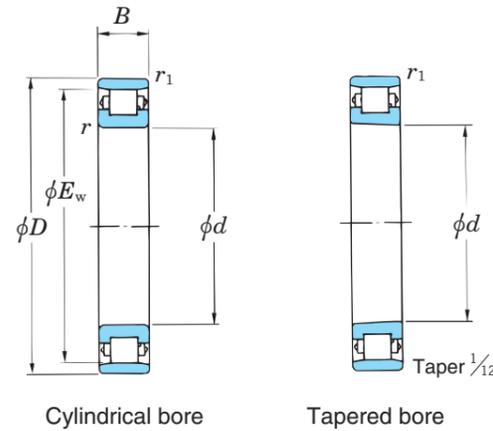
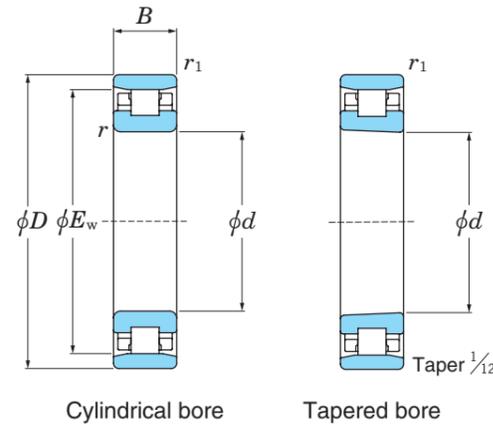
[Remarks] 1. For the dimensions of the spacers for oil / air lubrication, refer to Table 15. 4 on page 57.
2. For the discharge intervals of the oil / air, refer to Supplementary table 6 on page 215.

2. Cylindrical roller bearings

High Ability

HAN1000(K) series
HAN1000B(K) series

N1000(K) series
3NCN1000(K) series Ceramic bearings



d 70 ~ 110

Dynamic equivalent load $P_r = F_r$
Static equivalent load $P_{0r} = F_r$

d	Boundary dimensions (mm)					Bearing No.		Basic load ratings (kN)		Fatigue load limit (kN) C_u	Limiting speeds (min ⁻¹)		Interspace volume (cm ³)	(Refer.) Mass (kg)	Mounting dimensions (mm)					Interference of retaining plate (mm)	Values of non-interchangeable clearances of bearings with cylindrical bores (mm) C_{1NA}		Values of non-interchangeable clearances of bearings with tapered bores (mm)					
	D	B	r min.	r ₁ min.	E _w	Cylindrical bore	Tapered bore	C _r	C _{0r}		Grease lub.	Oil lub.			d _a min.	D _b max.	r _a min.	r _b max.	min.		max.	min.	max.	min.	max.	min.	max.	
70	110	20	1.1	1	100	N1014	N1014K	72.9	70.4	10.1	8 300	9 700	27	0.669	76.5	103.5	101	1	1	0.01~0.02	10	20	10	20	15	30	20	40
	110	20	1.1	1	100	3NCN1014	3NCN1014K	72.9	70.4	10.1	11 000	13 000	27	0.611	76.5	103.5	101	1	1	0.01~0.02	10	20	10	20	15	30	20	40
	111	20	1.1	1	100	HAN1014	HAN1014K	53.6	51.4	9.10	14 000	15 000	25	0.618	76.5	103.5	101	1	1	0.01~0.02	10	20	10	20	15	30	20	40
	110	20	1.1	1	100	HAN1014B	HAN1014BK	72.9	70.4	9.10	17 000	27 000	24	0.593	76.5	103.5	101	1	1	0.01~0.02	10	20	10	20	15	30	20	40
75	115	20	1.1	1	106	N1015	N1015K	68.4	74.5	9.95	7 800	9 100	29	0.704	81.5	108.5	106	1	1	0.01~0.02	10	20	10	20	15	30	20	40
	115	20	1.1	1	106	3NCN1015	3NCN1015K	68.4	74.5	9.95	10 000	12 000	29	0.628	81.5	108.5	106	1	1	0.01~0.02	10	20	10	20	15	30	20	40
	115	20	1.1	1	105	HAN1015B	HAN1015BK	66.8	63.8	9.20	16 000	25 000	34	0.648	81.5	108.5	106	1	1	0.01~0.02	10	20	10	20	15	30	20	40
80	125	22	1.1	1	113	N1016	N1016K	79.3	82.2	11.7	7 200	8 500	36	0.947	86.5	118.5	114	1	1	0.01~0.02	10	20	10	20	15	30	20	40
	125	22	1.1	1	113	3NCN1016	3NCN1016K	79.3	82.2	11.7	9 400	11 000	36	0.864	86.5	118.5	114	1	1	0.01~0.02	10	20	10	20	15	30	20	40
	125	22	1.1	1	113	HAN1016	HAN1016K	68.4	67.9	10.2	12 000	14 000	32	0.841	86.5	118.5	114	1	1	0.01~0.02	10	20	10	20	15	30	20	40
	125	22	1.1	1	113	HAN1016B	HAN1016BK	71.4	71.5	10.2	15 000	23 000	31	0.878	86.5	118.5	114	1	1	0.01~0.02	10	20	10	20	15	30	20	40
85	130	22	1.1	1	118	N1017	N1017K	81.3	86.2	12.2	6 900	8 100	39	1.00	91.5	123	119	1	1	0.01~0.02	10	25	10	25	20	35	25	45
	130	22	1.1	1	118	3NCN1017	3NCN1017K	81.3	86.2	12.2	9 000	11 000	39	0.913	91.5	123	119	1	1	0.01~0.02	10	25	10	25	20	35	25	45
	130	22	1.1	1	118	HAN1017B	HAN1017BK	70.9	71.9	10.1	14 000	22 000	40	0.870	91.5	123	119	1	1	0.01~0.02	10	25	10	25	20	35	25	45
90	140	24	1.5	1.1	129	N1018	N1018K	121	122	16.7	6 400	7 500	52	1.29	98	132	129	1.5	1	0.01~0.02	10	25	10	25	20	35	25	45
	140	24	1.5	1.1	129	3NCN1018	3NCN1018K	121	122	16.7	8 300	9 800	52	1.13	98	132	129	1.5	1	0.01~0.02	10	25	10	25	20	35	25	45
	140	24	1.5	1.1	129	HAN1018	HAN1018K	85.1	87.6	11.3	11 000	12 000	47	1.18	98	132	129	1.5	1	0.01~0.02	10	25	10	25	20	35	25	45
	140	24	1.5	1.1	127	HAN1018B	HAN1018BK	103	104	11.3	13 000	21 000	53	1.12	98	132	129	1.5	1	0.01~0.02	10	25	10	25	20	35	25	45
95	145	24	1.5	1.1	133	N1019	N1019K	125	129	17.5	6 200	7 200	53	1.35	103	137	134	1.5	1	0.01~0.02	10	25	10	25	20	35	25	45
	145	24	1.5	1.1	133	3NCN1019	3NCN1019K	125	129	17.5	8 100	9 400	53	1.18	103	137	134	1.5	1	0.01~0.02	10	25	10	25	20	35	25	45
	145	24	1.5	1.1	132	HAN1019B	HAN1019BK	111	110	12.3	13 000	20 000	48	1.19	103	137	134	1.5	1	0.01~0.02	10	25	10	25	20	35	25	45
100	150	24	1.5	1.1	139	N1020	N1020K	99.8	129	13.9	5 900	6 900	56	1.41	108	142	139	1.5	1	0.01~0.02	10	25	10	25	20	35	25	45
	150	24	1.5	1.1	139	3NCN1020	3NCN1020K	99.8	129	13.9	7 700	9 000	56	1.24	108	142	139	1.5	1	0.01~0.02	10	25	10	25	20	35	25	45
	150	24	1.5	1.1	137	HAN1020B	HAN1020BK	120	123	12.2	12 000	19 000	52	1.28	108	142	139	1.5	1	0.01~0.02	10	25	10	25	20	35	25	45
105	160	26	2	1.1	146	N1021	N1021K	136	149	19.6	5 500	6 500	66	1.80	114	151	148	2	1	0.02~0.04	10	25	10	25	20	35	25	50
	160	26	2	1.1	146	3NCN1021	3NCN1021K	136	149	19.6	7 200	8 500	66	1.62	114	151	148	2	1	0.02~0.04	10	25	10	25	20	35	25	50
110	170	28	2	1.1	157	N1022	N1022K	147	171	21.1	5 200	6 100	84	2.22	119	161	157	2	1	0.02~0.04	10	25	10	25	20	35	25	50
	170	28	2	1.1	157	3NCN1022	3NCN1022K	147	171	21.1	6 800	7 900	84	2.00	119	161	157	2	1	0.02~0.04	10	25	10	25	20	35	25	50

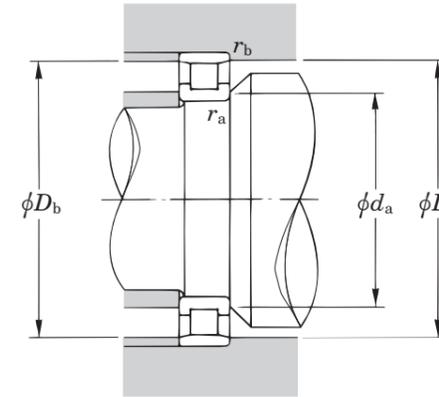
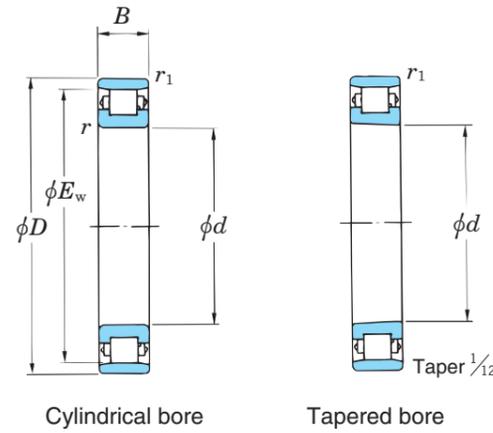
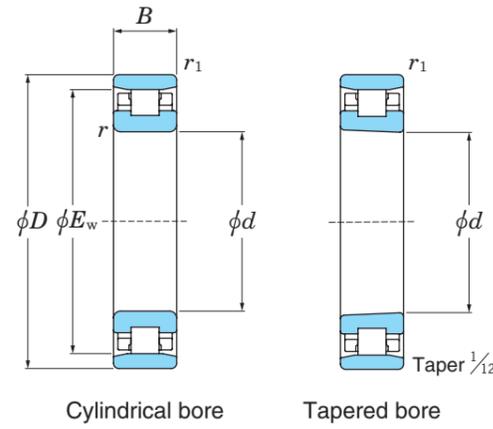
[Remarks] 1. For the dimensions of the spacers for oil / air lubrication, refer to Table 15. 4 on page 57.
2. For the discharge intervals of the oil / air, refer to Supplementary table 6 on page 215.

2. Cylindrical roller bearings

High Ability

HAN1000(K) series
HAN1000B(K) series

N1000(K) series
3NCN1000(K) series Ceramic bearings



d 120 ~ 160

Dynamic equivalent load $P_r = F_r$
Static equivalent load $P_{0r} = F_r$

d	Boundary dimensions (mm)					Bearing No.		Basic load ratings (kN)		Fatigue load limit (kN) C_u	Limiting speeds (min^{-1})		Interspace volume (cm^3)	(Refer.) Mass (kg)	Mounting dimensions (mm)					Interference of retaining plate (mm)	Values of non-interchangeable clearances of bearings with cylindrical bores (mm) C_{1NA}		Values of non-interchangeable clearances of bearings with tapered bores (mm)					
	D	B	r min.	r_1 min.	E_w	Cylindrical bore	Tapered bore	C_r	C_{0r}		Grease lub.	Oil lub.			d_a min.	D_b max.	r_a min.	r_b max.	min.		max.	C_{9NA} min.	C_{9NA} max.	C_{0NA} min.	C_{0NA} max.	C_{1NA} min.	C_{1NA} max.	
120	180	28	2	1.1	167	N1024	N1024K	173	181	22.6	4 800	5 700	92	2.38	129	171	167	2	1	0.02~0.04	10	25	10	25	20	35	25	50
	180	28	2	1.1	167	3NCN1024	3NCN1024K	173	181	22.6	6 200	7 400	92	2.08	129	171	167	2	1	0.02~0.04	10	25	10	25	20	35	25	50
130	200	33	2	1.1	182	N1026	N1026K	215	238	29.5	4 400	5 100	135	3.61	139	191	184	2	1	0.02~0.04	15	30	15	30	25	40	30	60
	200	33	2	1.1	182	3NCN1026	3NCN1026K	215	238	29.5	5 700	6 600	135	3.20	139	191	184	2	1	0.02~0.04	15	30	15	30	25	40	30	60
140	210	33	2	1.1	192	N1028	N1028K	220	250	30.5	4 100	4 800	140	3.84	149	201	194	2	1	0.02~0.04	15	30	15	30	25	40	30	60
	210	33	2	1.1	192	3NCN1028	3NCN1028K	220	250	30.5	5 300	6 200	140	3.41	149	201	194	2	1	0.02~0.04	15	30	15	30	25	40	30	60
150	225	35	2.1	1.5	207.5	N1030	N1030K	252	281	32.8	3 800	4 400	177	4.63	161	214	208	2	1.5	0.02~0.04	15	35	15	35	30	45	35	65
	225	35	2.1	1.5	207.5	3NCN1030	3NCN1030K	252	281	32.8	4 900	5 700	177	4.09	161	214	208	2	1.5	0.02~0.04	15	35	15	35	30	45	35	65
160	240	38	2.1	1.5	219	N1032	N1032K	297	330	42.8	3 500	4 100	191	5.74	171	229	221	2	1.5	0.02~0.04	15	35	15	35	30	45	35	65
	240	38	2.1	1.5	219	3NCN1032	3NCN1032K	297	330	42.8	4 600	5 300	191	5.07	171	229	221	2	1.5	0.02~0.04	15	35	15	35	30	45	35	65

[Remarks] 1. For the dimensions of the spacers for oil / air lubrication, refer to Table 15. 4 on page 57.
2. For the discharge intervals of the oil / air, refer to Supplementary table 6 on page 215.

3. Angular Contact Ball Bearings for Axial Load

Contents

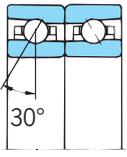
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3. Angular contact ball bearings for axial load

JTEKT produces high-speed matched pair angular contact ball bearings to receive the axial loads from spindles of machine tools.

3.1 Types and features of angular contact ball bearings for axial load

Table 3.1 Types and features of angular contact ball bearings for axial load

Type	High-speed matched pair angular contact ball bearings		To combine with double row cylindrical roller bearings Remark: These bearings are used primarily in combination with double row cylindrical roller bearings for radial load. Combinations are as shown below.
	Diameter series		
0	ACT 000 DB	ACT 000 BDB	Placed next to the small tapered bore diameter side of NN3000K, or used in tandem with NN3000 (cylindrical bore).
	—	—	Placed next to the large tapered bore diameter side of NN3000K.
Features	<ul style="list-style-type: none"> Negative tolerances on the outside diameters are used to permit axial load only. Having small contact angles, these are suitable for high-speed rotations. 		—

3.2 Composition of bearing numbers (angular contact ball bearings for axial load)

High-speed matched pair angular contact ball bearings

ACT 0 18 B DB M FT P4

High-speed matched pair angular contact ball bearings

Diameter series 0

Bore diameter number

18 : nominal bore diameter 90 mm
(Bore diameter number × 5 equals nominal bore diameter.)

Contact angle symbols

A (to be omitted) : nominal contact angle 30°
B : nominal contact angle 40°

Back-to-back symbols

Tolerance class symbols

P5 : equivalent of JIS class 5
P4 : equivalent of JIS class 4

Cage symbols

FG : molded cage made of polyamide resin (ball-guiding type)
FT : machined cage made of reinforced phenolic resin (outer ring-guiding type)
FY : machined cage made of copper alloy (outer ring-guiding type)

Preload symbols

L : light preload
M : medium preload
(For amount of preload, see the dimension tables.)

3. 3 Tolerance of angular contact ball bearings for axial load

The tolerance of high-speed matched pair angular contact ball bearings is shown in **Table 3. 2** (page 151 and 152).

The tolerance of these bearings complies with **JTEKT standards Classes 5 and 4** (equivalent of JIS Classes 5 and 4).

Table 3. 2(1) Permissible dimensional deviations and limits of high-speed matched pair angular contact ball bearings (JTEKT standards)

(1) Inner ring

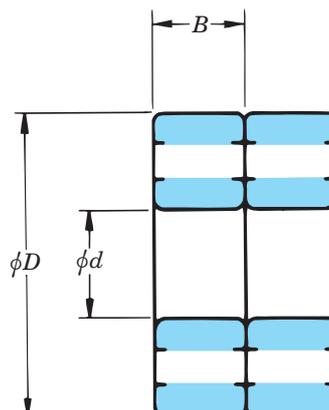
Unit : μm

Nominal bore diameter d (mm)		Single plane mean bore diameter deviation Δ_{dmp}				Single bore diameter deviation $\Delta_{ds}^{(1)}$		Single plane bore diameter variation V_{dsp}		Mean bore diameter variation V_{dmp}	
								Diameter series 9, 0			
				Class 5		Class 4		Class 4		Class 5	
over	up to	upper	lower	upper	lower	upper	lower	max.		max.	
18	30	0	-6	0	-5	0	-5	6	5	3	2.5
30	50	0	-8	0	-6	0	-6	8	6	4	3
50	80	0	-9	0	-7	0	-7	9	7	5	3.5
80	120	0	-10	0	-8	0	-8	10	8	5	4
120	150	0	-13	0	-10	0	-10	13	10	7	5
150	180	0	-13	0	-10	0	-10	13	10	7	5
180	250	0	-15	0	-12	0	-12	15	12	8	6
250	315	0	-18	0	-15	0	-15	18	15	9	8
315	400	0	-23	0	-18	0	-18	23	18	12	9

Nominal bore diameter d (mm)		Radial runout of assembled bearing inner ring K_{ia}		Perpendicularity of inner ring face with respect to the bore S_d		Axial runout of assembled bearing inner ring S_{ia}		Single inner ring width deviation Δ_{Bs}		Single inner ring width deviation $\Delta_{Bs}^{(2)}$		Inner ring width variation V_{Bs}	
		Class 5	Class 4	Class 5	Class 4	Class 5	Class 4	Classes 5, 4		Classes 5, 4		Class 5	Class 4
over	up to	max.		max.		max.		upper	lower	upper	lower	max.	
18	30	4	3	8	4	8	4	0	-120	0	-250	5	2.5
30	50	5	4	8	4	8	4	0	-120	0	-250	5	3
50	80	5	4	8	5	8	5	0	-150	0	-250	6	4
80	120	6	5	9	5	9	5	0	-200	0	-380	7	4
120	150	8	6	10	6	10	7	0	-250	0	-380	8	5
150	180	8	6	10	6	10	7	0	-250	0	-380	8	5
180	250	10	8	11	7	13	8	0	-300	0	-500	10	6
250	315	13	10	13	8	15	9	0	-350	0	-500	13	8
315	400	15	13	15	9	20	12	0	-400	0	-630	15	9

[Notes] 1) Tolerance class 4 is applied to bearings of diameter series 0.

2) Applied to individual bearing rings manufactured for matched pair or stack bearings.



d : nominal bore diameter
 D : nominal outside diameter
 B : nominal bearing width

3. Angular contact ball bearings for axial load

Table 3. 2(2) Permissible dimensional deviations and limits for high-speed matched pair angular contact ball bearings (JTEKT standards)

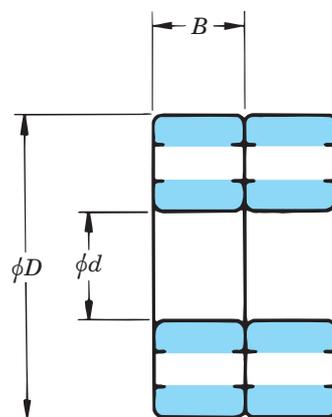
(2) Outer ring

Unit : μm

Nominal outside diameter D (mm)		$\Delta_{D_{mp}}$ or Δ_{D_s} ^{1), 2)}		Single plane outside diameter variation $V_{D_{sp}}$		Mean outside diameter variation $V_{D_{mp}}$	
				Diameter series 9, 0		Class 5	Class 4
		Classes 5, 4		Class 5	Class 4		
over	up to	upper	lower	max.		max.	
50	80	-32	- 47	9	7	5	3.5
80	120	-39	- 56	10	8	5	4
120	150	-44	- 66	11	9	6	5
150	180	-44	- 68	13	10	7	5
180	250	-51	- 79	15	11	8	6
250	315	-56	- 89	18	13	9	7
315	400	-63	- 99	20	15	10	8
400	500	-71	-111	23	17	12	9

Nominal outside diameter D (mm)		Radial runout of assembled bearing outer ring K_{ea}		Perpendicularity of outer ring out side surface with respect to the face S_D		Axial runout of assembled bearing outer ring S_{ea}		Deviation of a single outer ring width Δ_{C_s}		Ring width variation V_{C_s}	
		Class 5	Class 4	Class 5	Class 4	Class 5	Class 4	Classes 5, 4		Class 5	Class 4
over	up to	max.		max.		max.		upper	lower	max.	
50	80	8	5	8	4	10	5	Same as tolerance Δ_{B_s} , d being that of the same bearing.		6	3
80	120	10	6	9	5	11	6		8	4	
120	150	11	7	10	5	13	7		8	5	
150	180	13	8	10	5	14	8		8	5	
180	250	15	10	11	7	15	10		10	7	
250	315	18	11	13	8	18	10		11	7	
315	400	20	13	13	10	20	13		13	8	
400	500	23	15	15	12	23	15	15	9		

- [Notes] 1) Single plane mean outside diameter deviation or single outside diameter deviation
2) Dimensional tolerance for outside diameter of class 4 is applied to bearings of diameter series 0.



d : nominal bore diameter
 D : nominal outside diameter
 B : nominal bearing width

3. 4 Standard preloads for high-speed matched pair angular contact ball bearings

The dimension tables show standard preloads for high-speed matched pair angular contact ball bearings.

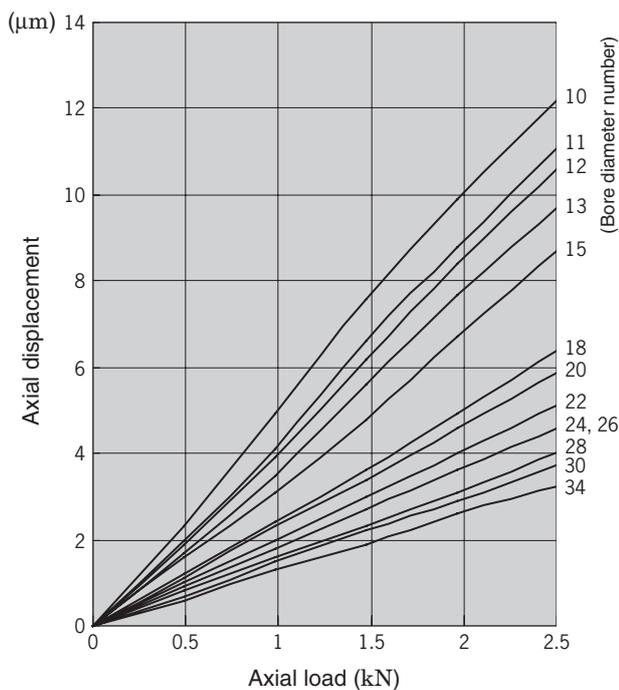
3.5 Axial load and displacement (angular contact ball bearings for axial load)

Fig. 3. 1 shows the relationships between axial load and displacement for high-speed matched pair angular

contact ball bearings when a standard preload is applied.

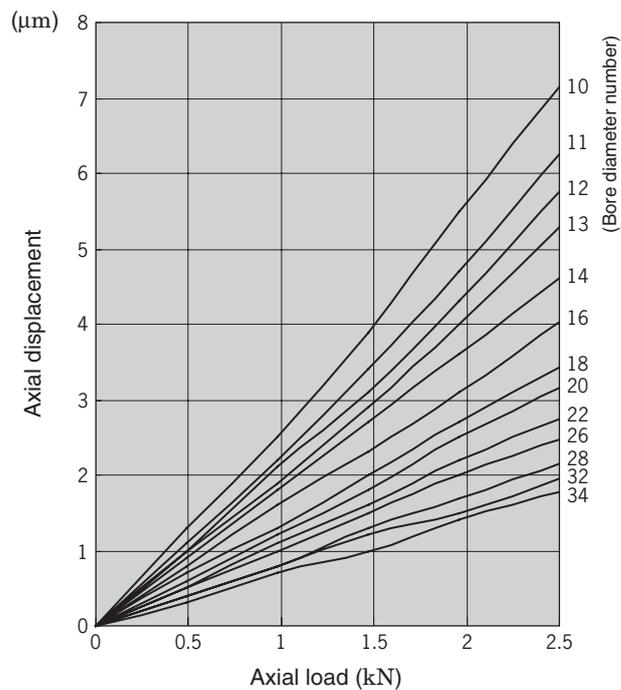
(1) ACT000 series (contact angle 30°)

a) When preload L is applied

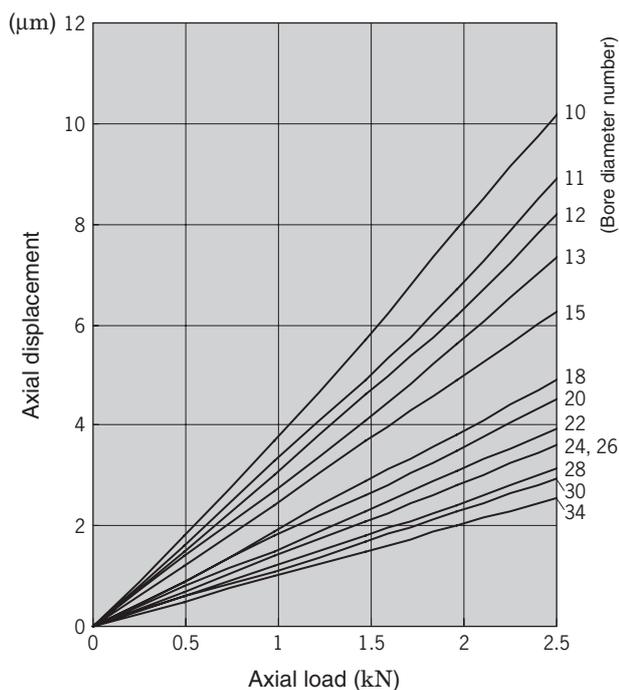


(2) ACT000B series (contact angle 40°)

a) When preload L is applied



b) When preload M is applied



b) When preload M is applied

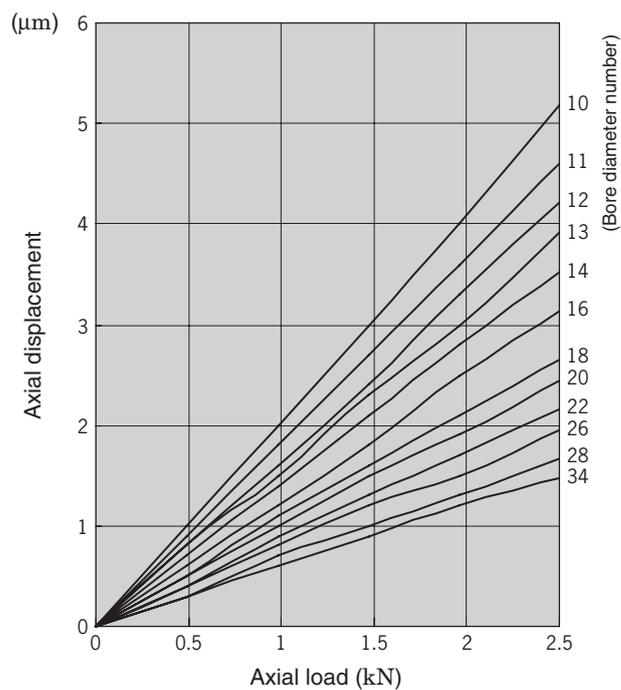
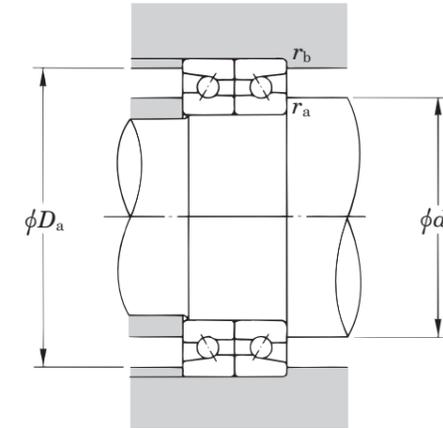
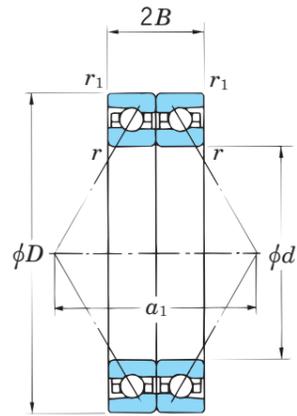


Fig. 3. 1 Relationships between axial load and displacement (high-speed matched pair angular contact ball bearings)

ACT000DB/BDB series

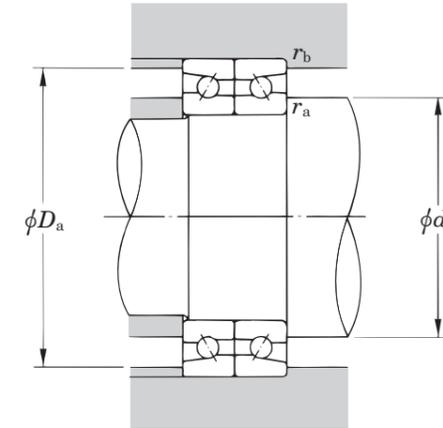
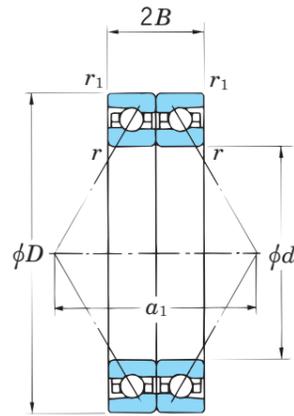


d 30 ~ 95

Dynamic equivalent load $P_a = F_a$
Static equivalent load $P_{0a} = F_a$

d	Boundary dimensions (mm)				Bearing No.	Basic load ratings (kN)		Limiting speeds (min ⁻¹)		Permissible axial load (kN) (static)	Load center spread (mm) a ₁	Mounting dimensions (mm)				Interspace volume (cm ³ /row)	(Refer.) Mass (kg/row)	Preload (Combination of DB and DF) (N)		Axial rigidity (Combination of DB and DF) (N/μm)	
	D	2B	r min.	r ₁ min.		C _a	C _{0a}	Grease lub.	Oil lub.			d _a min.	D _a max.	r _a max.	r _b max.			L	M	L	M
30	55	24	1	0.6	ACT006DB	18.9	26.6	15 000	20 000	2.92	48.5	41	50	1	0.6	3	0.235	195	345	130	160
	55	24	1	0.6	ACT006BDB	22.6	30.5	13 000	18 000	9.86	59.6	41	50	1	0.6	3	0.235	295	685	197	240
35	62	25.5	1	0.6	ACT007DB	19.8	30.2	13 000	17 000	3.25	53.5	46	57	1	0.6	4.2	0.312	195	390	150	195
	62	25.5	1	0.6	ACT007BDB	23.6	34.5	12 000	15 000	10.9	66.2	46	57	1	0.6	4.2	0.312	390	735	294	363
40	68	27	1	0.6	ACT008DB	20.6	33.8	12 000	15 000	3.58	58.2	51	63	1	0.6	5	0.391	245	440	160	200
	68	27	1	0.6	ACT008BDB	24.5	37.7	11 000	14 000	12.1	72.3	51	63	1	0.6	5	0.391	440	835	300	374
45	75	28.5	1	0.6	ACT009DB	23.0	38.6	11 000	14 000	3.84	63.1	56	70	1	0.6	5.7	0.536	245	490	175	228
	75	28.5	1	0.6	ACT009BDB	27.3	42.7	9 500	13 000	13.2	78.8	56	70	1	0.6	5.7	0.536	490	930	344	428
50	80	28.5	1	0.6	ACT010DB	23.9	41.7	9 700	13 000	4.2	51.8	61	75	1	0.6	8	0.551	295	540	200	251
	80	28.5	1	0.6	ACT010BDB	28.4	46.3	8 800	12 000	14.5	83	61	75	1	0.6	8	0.551	540	1 030	372	474
55	90	33	1.1	0.6	ACT011DB	29.6	52.8	8 700	11 000	5.63	58.4	68	84	1	0.6	12	0.831	390	685	229	282
	90	33	1.1	0.6	ACT011BDB	35.1	58.6	7 900	10 000	19	89.3	68	84	1	0.6	12	0.831	685	1 270	422	524
60	95	33	1.1	0.6	ACT012DB	30.7	56.9	8 100	11 000	6.11	61.2	73	89	1	0.6	13	0.887	390	735	244	306
	95	33	1.1	0.6	ACT012BDB	36.4	63.1	7 400	9 700	20.6	93.5	73	89	1	0.6	13	0.887	735	1 420	452	574
65	100	33	1.1	0.6	ACT013DB	31.8	60.9	7 600	10 000	6.59	64.1	78	94	1	0.6	14	0.943	440	835	267	334
	100	33	1.1	0.6	ACT013BDB	37.7	67.6	6 900	9 000	22.2	85.8	78	94	1	0.6	14	0.945	785	1 520	483	620
70	110	36	1.1	0.6	ACT014DB	43.5	82.1	7 000	9 200	8.39	70	85	104	1	0.6	16	1.33	590	1 130	288	367
	110	36	1.1	0.6	ACT014BDB	51.7	91.1	6 300	8 300	28.8	93.5	85	104	1	0.6	16	1.33	1 030	2 010	528	676
75	115	36	1.1	0.6	ACT015DB	44.1	84.9	6 600	8 700	8.74	72.8	90	109	1	0.6	20	1.35	590	1 130	299	377
	115	36	1.1	0.6	ACT015BDB	52.3	94.2	6 000	7 800	30	97.7	90	109	1	0.6	20	1.35	1 080	2 110	554	698
80	125	40.5	1.1	0.6	ACT016DB	51.7	101	6 100	8 000	10.8	79.4	97	118	1	0.6	27	1.86	685	1 370	322	412
	125	40.5	1.1	0.6	ACT016BDB	61.3	112	5 500	7 200	36.6	106.3	97	118	1	0.6	27	1.86	1 270	2 500	598	763
85	130	40.5	1.1	0.6	ACT017DB	52.4	105	5 800	7 600	11.2	82.3	102	123	1	0.6	29	1.94	735	1 420	334	430
	130	40.5	1.1	0.6	ACT017BDB	62.1	116	5 200	6 900	38	110.5	102	123	1	0.6	29	1.94	1 320	2 600	621	794
90	140	45	1.5	1	ACT018DB	68.8	138	5 400	7 100	14.2	88.9	109	132	1.5	1	39	2.55	980	1 860	381	483
	140	45	1.5	1	ACT018BDB	81.7	153	4 900	6 400	48.7	119	109	132	1.5	1	39	2.55	1 770	3 380	708	889
95	145	45	1.5	1	ACT019DB	69.8	143	5 200	6 800	14.8	91.8	114	137	1.5	1	40	2.62	980	1 960	388	503
	145	45	1.5	1	ACT019BDB	82.8	159	4 700	6 200	50.6	123.2	114	137	1.5	1	40	2.62	1 860	3 530	737	923

ACT000DB/BDB series



d 100 ~ 170

Dynamic equivalent load $P_a = F_a$
 Static equivalent load $P_{0a} = F_a$

d	Boundary dimensions (mm)				Bearing No.	Basic load ratings (kN)		Limiting speeds (min ⁻¹)		Permissible axial load (kN) (static)	Load center spread (mm) a ₁	Mounting dimensions (mm)				Interspace volume (cm ³ /row)	(Refer.) Mass (kg/row)	Preload (Combination of DB and DF) (N)		Axial rigidity (Combination of DB and DF) (N/μm)	
	D	2B	r min.	r ₁ min.		C _a	C _{0a}	Grease lub.	Oil lub.			d _a min.	D _a max.	r _a max.	r _b max.			L	M	L	M
100	150	45	1.5	1	ACT020DB	70.8	148	5 000	6 500	15.3	94.7	119	143	1.5	1	42	2.77	1 030	2 010	404	519
	150	45	1.5	1	ACT020BDB	84.0	164	4 500	5 900	52.5	127.4	119	143	1.5	1	42	2.77	1 910	3 680	764	962
105	160	49.5	2	1	ACT021DB	80.5	170	4 700	6 100	18.2	101.2	125	151	2	1	50	3.61	1 180	2 250	433	552
	160	49.5	2	1	ACT021BDB	95.5	188	4 200	5 500	63.2	135.9	125	151	2	1	50	3.61	2 150	3 770	811	986
110	170	54	2	1	ACT022DB	90.6	193	4 400	5 800	19.6	107.8	132	160	2	1	64	4.52	1 320	2 600	459	591
	170	54	2	1	ACT022BDB	107	214	4 000	5 200	71.3	144.5	132	160	2	1	64	4.52	2 450	4 760	867	1 094
120	180	54	2	1	ACT024DB	93.2	206	4 100	5 400	21	113.6	142	170	2	1	69	4.83	1 420	2 800	494	636
	180	54	2	1	ACT024BDB	111	228	3 700	4 900	76.4	152.9	142	170	2	1	69	4.83	2 550	5 100	919	1 172
130	200	63	2	1	ACT026DB	118	253	3 700	4 800	25.9	126.8	156	188	2	1	106	7.21	1 770	3 380	513	650
	200	63	2	1	ACT026BDB	140	281	3 300	4 400	93	170	156	188	2	1	106	7.21	3 230	6 230	957	1 204
140	210	63	2	1	ACT028DB	128	290	3 400	4 500	29.9	132.5	166	198	2	1	110	7.69	2 010	3 920	587	754
	210	63	2	1	ACT028BDB	151	323	3 100	4 100	107	178.3	166	198	2	1	110	7.65	3 720	7 210	1 094	1 393
150	225	67.5	2.1	1.1	ACT030DB	150	344	3 200	4 200	34.7	142	178	213	2	1	138	9.39	2 400	4 610	627	802
	225	67.5	2.1	1.1	ACT030BDB	179	382	2 900	3 800	125	191.1	178	213	2	1	138	9.39	4 410	8 480	1 176	1 481
160	240	72	2.1	1.1	ACT032DB	163	377	3 000	3 900	39.1	151.5	190	227	2	1	167	11.4	2 500	4 850	645	826
	240	72	2.1	1.1	ACT032BDB	193	419	2 700	3 500	139	203.8	190	227	2	1	167	11.4	2 500	4 850	980	1 236
170	260	81	2.1	1.1	ACT034DB	191	449	2 700	3 600	45.7	164.6	204	245	2	1	221	15.7	3 090	6 030	719	917
	260	81	2.1	1.1	ACT034BDB	227	499	2 500	3 200	163	221	204	245	2	1	221	15.7	5 730	9 320	1 340	1 593

4. Tapered Roller Bearings

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4. Tapered roller bearings

The tapered roller bearing is a bearing in which tapered rollers (truncated conical rollers) are inserted between the outer ring and inner ring. The rollers are guided by the inner ring back face rib (see Fig. 4. 1).

A radial load and an axial load can be simultaneously applied to the tapered roller bearing. This bearing has high rigidity.

In addition, tapered roller bearings allow easy adjustments of preload.

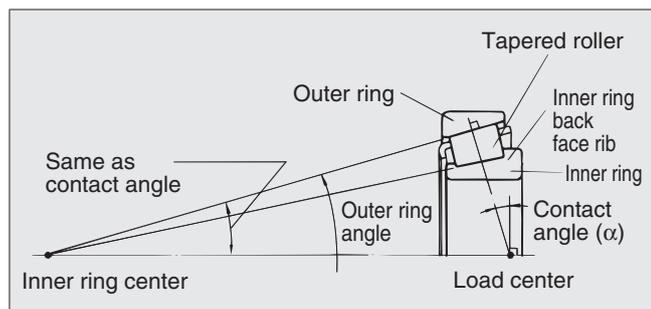


Fig. 4. 1 Structure of tapered roller bearing

The single row tapered roller bearing can receive only a unidirectional axial load. For this reason, a pair of single row bearings are mounted apart and facing each other or used in a face-to-face or back-to-back arrangement.

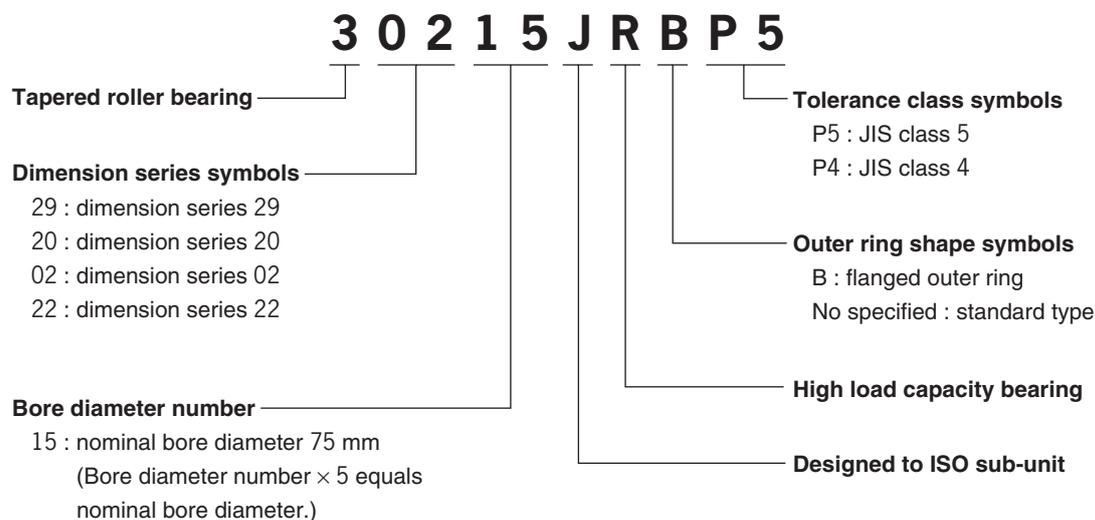
4. 1 Types and features of tapered roller bearings

Two types of tapered roller bearings are available for machine tools: the single row tapered roller bearing (auxiliary symbol: JR) and the tapered roller bearing with flanged outer ring (auxiliary symbol: B) (see Table 4. 1).

Table 4. 1 Types and features of tapered roller bearings for machine tools

Types	Features
Tapered roller bearing with J designation ISO sub-unit specifications	Bearings whose basic numbers are followed by "J" are made to the ISO sub-unit specifications. Consequently, inner ring assemblies and outer rings, if given the same bearing number, are interchangeable on an international level. Reference: The symbol R denotes high load capacity bearings.
Tapered roller bearing with flanged outer ring 	This bearing allows easy positioning in axial direction using a simple housing structure.

4. 2 Composition of bearing numbers (metric series tapered roller bearings)



4.3 Tolerance of tapered roller bearings

The tolerance of the tapered roller bearing is compliant with permissible dimensional deviations and limits of classes 5 and 4 as specified in JIS B 1514 for tapered roller bearings.

Permissible dimensional deviations and limits to tapered roller bearings are shown in **Table 4.2**.

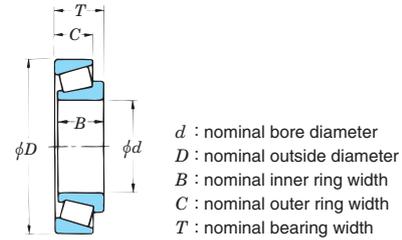


Table 4.2 Permissible dimensional deviations and limits to metric tapered roller bearings

(1) Inner ring

Unit : μm

Nominal bore diameter d (mm)		Single plane mean bore diameter deviation Δ_{dmp}				Single bore diameter deviation Δ_{ds}		Single plane bore diameter variation V_{dsp}		Mean bore diameter variation V_{dmp}	
		Class 5		Class 4		Class 4		Class 5	Class 4	Class 5	Class 4
over	up to	upper	lower	upper	lower	upper	lower	max.		max.	
10	18	0	-7	0	-5	0	-5	5	4	5	4
18	30	0	-8	0	-6	0	-6	6	5	5	4
30	50	0	-10	0	-8	0	-8	8	6	5	5
50	80	0	-12	0	-9	0	-9	9	7	6	5
80	120	0	-15	0	-10	0	-10	11	8	8	5
120	180	0	-18	0	-13	0	-13	14	10	9	7

Nominal bore diameter d (mm)		Radial runout of assembled bearing inner ring K_{ia}		Face runout with bore S_d		Assembled bearing inner ring back face runout with raceway S_{ia}		Single inner ring width deviation Δ_{Bs}		Actual bearing width deviation Δ_{Ts}	
		Class 5	Class 4	Class 5	Class 4	Class 4		Classes 5, 4		Classes 5, 4	
over	up to	max.		max.		max.		upper	lower	upper	lower
10	18	5	3	7	3	3		0	-200	+200	-200
18	30	5	3	8	4	4		0	-200	+200	-200
30	50	6	4	8	4	4		0	-240	+200	-200
50	80	7	4	8	5	4		0	-300	+200	-200
80	120	8	5	9	5	5		0	-400	+200	-200
120	180	11	6	10	6	7		0	-500	+350	-250

(2) Outer ring

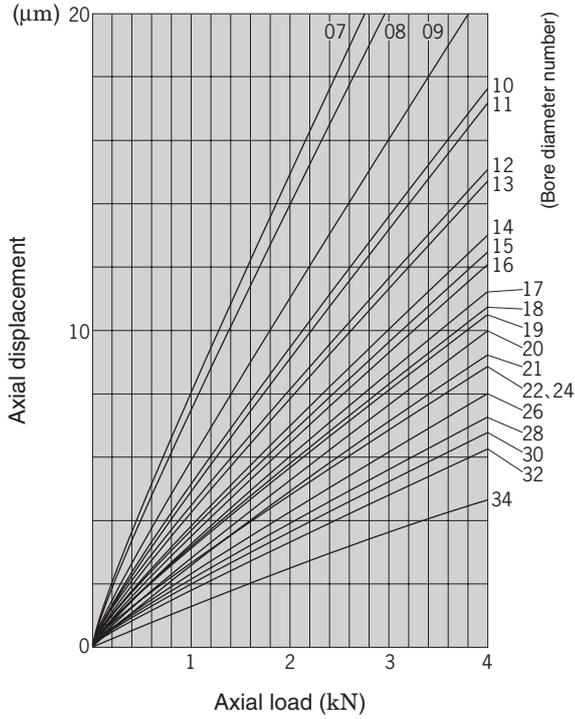
Unit : μm

Nominal outside diameter D (mm)		Single plane mean outside diameter deviation Δ_{Dmp}				Single outside diameter deviation Δ_{Ds}		Single radial plane outside diameter variation V_{Dsp}		Mean outside diameter variation V_{Dmp}		Radial runout of assembled bearing outer ring K_{ea}		Variation of outside surface generatrix inclination with face S_D		Assembled bearing outer ring back face runout with raceway S_{ea}		Single outer ring width deviation Δ_{Cs}	
		Class 5		Class 4		Class 4		Class 5	Class 4	Class 5	Class 4	Class 5	Class 4	Class 5	Class 4	Class 4	Classes 5, 4		
over	up to	upper	lower	upper	lower	upper	lower	max.		max.		max.		max.		max.	upper	lower	
18	30	0	-8	0	-6	0	-6	6	5	5	4	6	4	8	4	5	Same as tolerance Δ_{Bs}, d being that of the same bearing.		
30	50	0	-9	0	-7	0	-7	7	5	5	5	7	5	8	4	5			
50	80	0	-11	0	-9	0	-9	8	7	6	5	8	5	8	4	5			
80	120	0	-13	0	-10	0	-10	10	8	7	5	10	6	9	5	6			
120	150	0	-15	0	-11	0	-11	11	8	8	6	11	7	10	5	7			
150	180	0	-18	0	-13	0	-13	14	10	9	7	13	8	10	5	8			
180	250	0	-20	0	-15	0	-15	15	11	10	8	15	10	11	7	10			
250	315	0	-25	0	-18	0	-18	19	14	13	9	18	11	13	8	10			

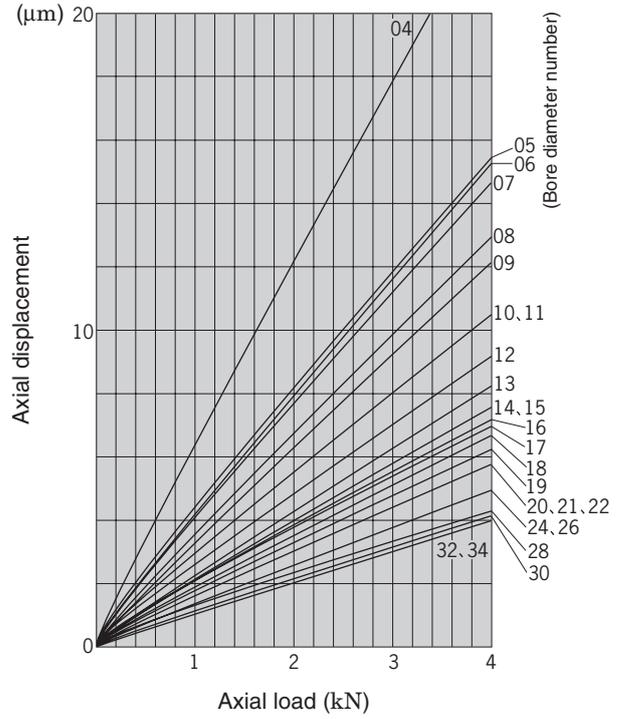
4. 4 Axial load and displacement (tapered roller bearings)

Fig 4. 2 shows relationships between axial load and displacement of tapered roller bearings.

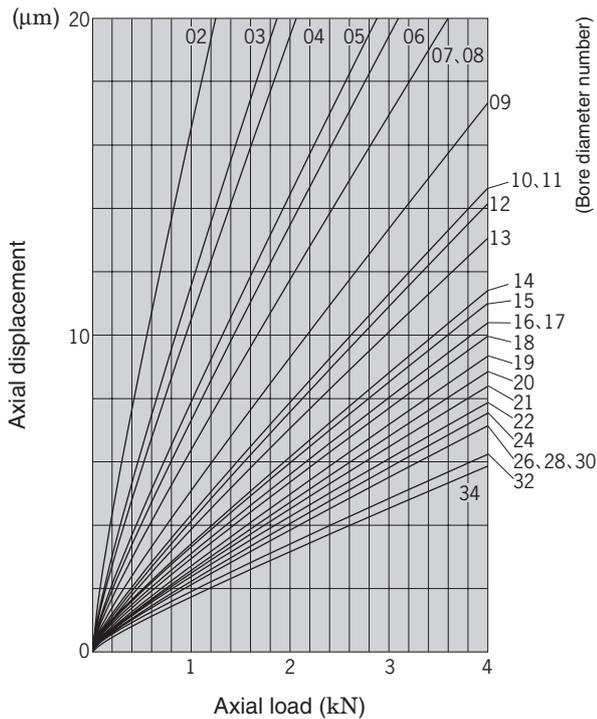
(1) 32900JR series



(2) 32000JR series



(3) 30200JR series



(4) 32200JR series

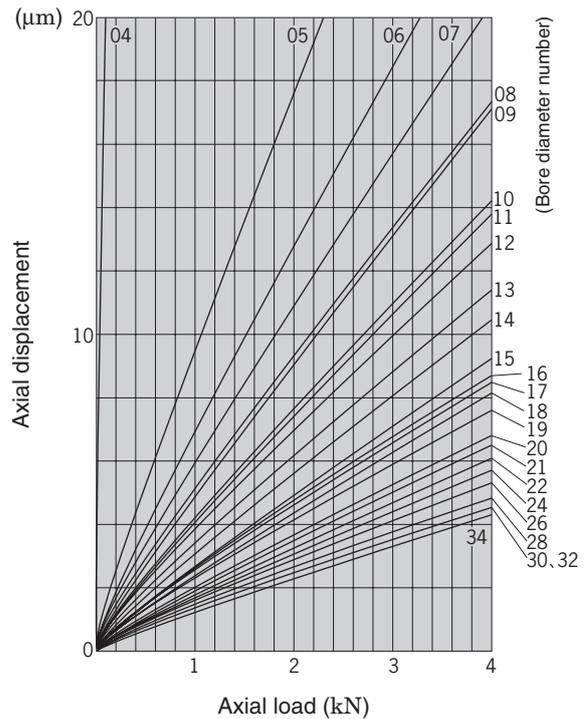
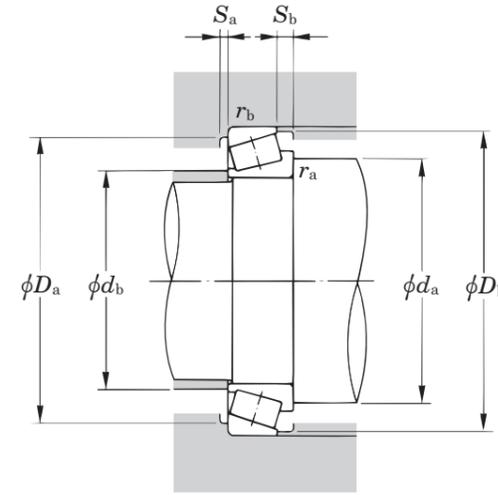
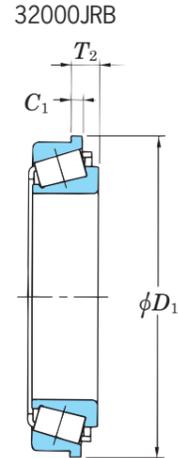
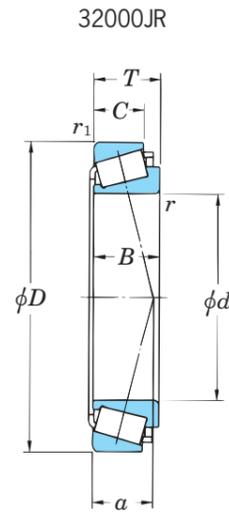


Fig. 4. 2 Relationships between axial load and displacement (tapered roller bearings)

*The axial displacements shown above are values of the single-row bearings not preloaded.



Dynamic equivalent load $P = XF_r + YF_a$

$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
X	Y	X	Y
1	0	0.4	Y_1

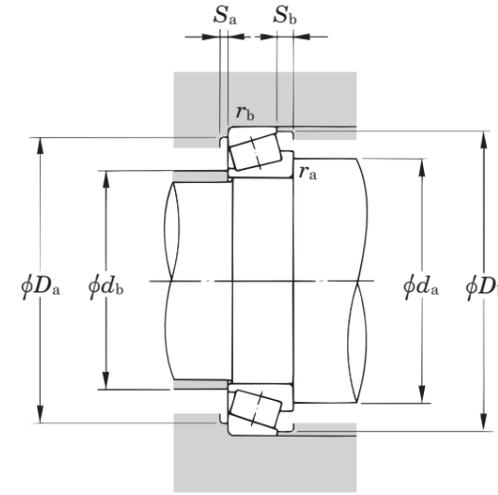
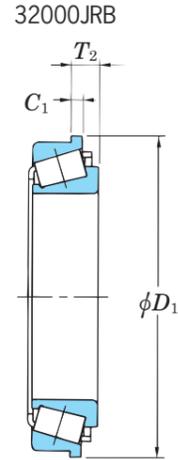
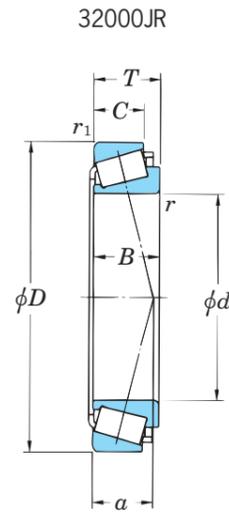
Static equivalent load $P_0 = 0.5F_r + Y_0F_a$

Note that if $P_0 < F_r$, it is assumed that $P_0 = F_r$.
For e , Y_1 , and Y_0 , use values given in the table.

d 35 ~ (70)

d	Boundary dimensions (mm)						Bearing No.	Basic load ratings (kN)		Fatigue load limit (kN) C_u	Limiting speeds (min ⁻¹)		Load center (mm) a	(Refer.) Mass (kg)	Flange dimensions (mm)			Mounting dimensions (mm)						Constant e	Axial load coefficients				
	D	T	B	C	r min.	r1 min.		C_r	C_{0r}		Grease lub.	Oil lub.			D_1	C_1	T_2	d_a min.	d_b max.	D_a max.	D_b min.	D_b max.	S_a min.		S_b min.	r_a max.	r_b max.	Y_1	Y_0
35	55	14	14	11.5	0.6	0.6	32907JR-2	32.8	36.5	5.10	6 600	8 800	10.9	0.120	59	3	5.5	39.5	40	50.5	49	52	2.5	2.5	0.6	0.6	0.29	2.06	1.13
	62	18	18	14	1	1	32007JR	57.0	59.4	8.40	6 200	8 200	15.1	0.231	66	3	7	40.5	40	56.5	54	59	4	4	1	1	0.45	1.32	0.73
	72	18.25	17	15	1.5	1.5	30207JR	68.8	60.9	8.95	5 600	7 400	15.3	0.344	77	4	7.25	43.5	44	63.5	62	67	3	3	1.5	1.5	0.37	1.6	0.88
	72	24.25	23	19	1.5	1.5	32207JR	86.9	82.4	12.2	5 600	7 500	18.2	0.453	77	4.5	9.75	43.5	43	63.5	61	67	3	5	1.5	1.5	0.37	1.6	0.88
40	62	15	15	12	0.6	0.6	32908JR	42.1	48.5	6.90	5 900	7 800	11.9	0.164	66	3	6	44.5	45	57.5	55	59	3	3	0.6	0.6	0.29	2.07	1.14
	68	19	19	14.5	1	1	32008JR	67.2	71.4	10.3	5 600	7 400	15.1	0.282	72	3.5	8	45.5	46	62.5	60	65	4	4.5	1	1	0.38	1.58	0.87
	80	19.75	18	16	1.5	1.5	30208JR	78.4	69.2	10.3	5 000	6 700	17	0.434	85	4	7.75	48.5	49	71.5	69	75	3	3.5	1.5	1.5	0.37	1.6	0.88
	80	24.75	23	19	1.5	1.5	32208JR	97.0	90.8	13.6	5 000	6 600	19.4	0.554	85	4.5	10.25	48.5	48	71.5	68	75	3	5.5	1.5	1.5	0.37	1.6	0.88
45	68	15	15	12	0.6	0.6	32909JR	43.5	52.4	7.45	5 300	7 100	12.5	0.190	73	3	6	49.5	50	63.5	61	64	3	3	0.6	0.6	0.32	1.88	1.04
	75	20	20	15.5	1	1	32009JR	78.8	86.5	12.6	5 000	6 600	16.5	0.354	79	3.5	8	50.5	51	69.5	67	72	4	4.5	1	1	0.39	1.53	0.84
	85	20.75	19	16	1.5	1.5	30209JR	83.9	77.4	11.6	4 600	6 100	18.9	0.502	90	4	8.75	53.5	54	76.5	74	80	3	4.5	1.5	1.5	0.4	1.48	0.81
	85	24.75	23	19	1.5	1.5	32209JR-1	105	104	15.6	4 600	6 100	20.3	0.597	90	4.5	10.25	53.5	53	76.5	73	81	3	5.5	1.5	1.5	0.4	1.48	0.81
50	72	15	15	12	0.6	0.6	32910JR	45.0	56.3	8.00	4 900	6 600	13.7	0.195	77	3	6	54.5	55	67.5	65	69	3	3	0.6	0.6	0.34	1.76	0.97
	80	20	20	15.5	1	1	32010JR	82.7	94.5	13.8	4 600	6 100	17.7	0.389	84	3.5	8	55.5	56	74.5	72	77	4	4.5	1	1	0.42	1.42	0.78
	90	21.75	20	17	1.5	1.5	30210JR	95.6	91.7	13.8	4 300	5 700	20.1	0.566	95	4	8.75	58.5	58	81.5	79	85	3	4.5	1.5	1.5	0.42	1.43	0.79
	90	24.75	23	19	1.5	1.5	32210JR	106	105	15.9	4 300	5 700	20.6	0.643	95	4.5	10.25	58.5	58	81.5	78	85	3	5.5	1.5	1.5	0.42	1.43	0.79
55	80	17	17	14	1	1	32911JR	55.8	73.3	10.6	4 400	5 900	14.5	0.285	85	3	6	61	61	74	72	76	3	3	1	1	0.31	1.94	1.07
	90	23	23	17.5	1.5	1.5	32011JR	106	121	18.2	4 100	5 500	19.8	0.569	94	4	9.5	63.5	63	81.5	81	86	4	5.5	1.5	1.5	0.41	1.48	0.81
	100	22.75	21	18	2	1.5	30211JR	118	113	17.3	3 900	5 200	20.7	0.732	106	4.5	9.25	65	64	90	88	94	4	4.5	2	1.5	0.4	1.48	0.81
	100	26.75	25	21	2	1.5	32211JR-1	134	133	20.5	3 900	5 200	23	0.863	106	5	10.75	65	63	90	87	95	4	5.5	2	1.5	0.4	1.48	0.81
60	85	17	17	14	1	1	32912JR	57.6	78.2	11.3	4 100	5 500	15.6	0.306	90	3	6	65.5	66	79.5	77	81	3	3	1	1	0.33	1.81	1
	95	23	23	17.5	1.5	1.5	32012JR	108	127	19.0	3 900	5 200	21	0.621	99	4	9.5	68.5	67	86.5	85	91	4	5.5	1.5	1.5	0.43	1.39	0.77
	110	23.75	22	19	2	1.5	30212JR	133	127	19.7	3 500	4 700	21.9	0.945	116	4.5	9.25	70	70	100	96	103	4	4.5	2	1.5	0.4	1.48	0.81
	110	29.75	28	24	2	1.5	32212JR	164	167	25.9	3 500	4 700	25.1	1.19	116	5	10.75	70	69	100	95	104	4	5.5	2	1.5	0.4	1.48	0.81
65	90	17	17	14	1	1	32913JR	59.2	83.1	12.0	3 900	5 200	16.8	0.327	95	3	6	70.5	70	84.5	81	86	3	3	1	1	0.35	1.7	0.93
	100	23	23	17.5	1.5	1.5	32013JR	113	137	20.6	3 600	4 800	22.5	0.664	104	4	9.5	73.5	72	91.5	90	97	4	5.5	1.5	1.5	0.46	1.31	0.72
	120	24.75	23	20	2	1.5	30213JR	160	156	24.3	3 200	4 300	24.2	1.18	127	4.5	9.25	75	77	110	106	113	4	4.5	2	1.5	0.4	1.48	0.81
	120	32.75	31	27	2	1.5	32213JR	196	203	31.7	3 200	4 300	26.6	1.58	127	6	11.75	75	76	110	104	115	4	5.5	2	1.5	0.4	1.48	0.81
70	100	20	20	16	1	1	32914JR	89.0	115	17.2	3 500	4 700	17.8	0.496	105	3	7	75.5	77	94.5	91	96	4	4	1	1	0.32	1.9	1.05
	110	25	25	19	1.5	1.5	32014JR	136	163	24.8	3 300	4 400	23.6	0.884	116	4.5	10.5	78.5	78	101.5	98	105	5	6	1.5	1.5	0.43	1.38	0.76

[Note] 1) The bearing number of a tapered roller bearing with a flanged outer ring contains the auxiliary symbol B.
Example 30203JRB



Dynamic equivalent load $P = XF_r + YF_a$

$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
X	Y	X	Y
1	0	0.4	Y_1

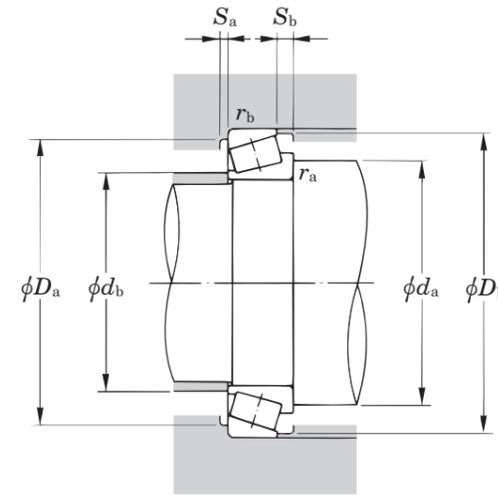
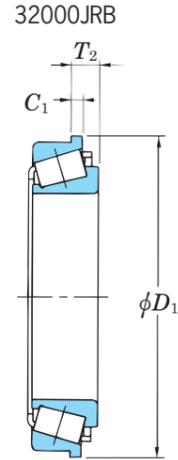
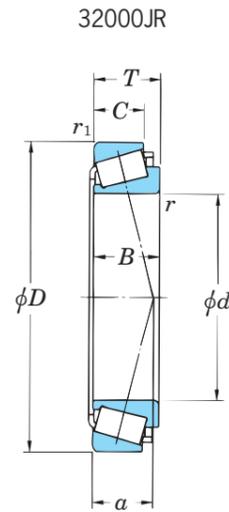
Static equivalent load $P_0 = 0.5F_r + Y_0F_a$

Note that if $P_0 < F_r$, it is assumed that $P_0 = F_r$.
For e , Y_1 , and Y_0 , use values given in the table.

d (70) ~ 105

d	Boundary dimensions (mm)						Bearing No.	Basic load ratings (kN)		Fatigue load limit (kN) C_u	Limiting speeds (min ⁻¹)		Load center (mm) a	(Refer.) Mass (kg)	Flange dimensions (mm)			Mounting dimensions (mm)						Constant e	Axial load coefficients				
	D	T	B	C	r min.	r1 min.		C_r	C_{0r}		Grease lub.	Oil lub.			D_1	C_1	T_2	d_a min.	d_b max.	D_a max.	D_b min.	D_b max.	S_a min.		S_b min.	r_a max.	r_b max.	Y_1	Y_0
70	125	26.25	24	21	2	1.5	30214JR	173	173	27.1	3 100	4 100	25.9	1.32	132	5	10.25	80	81	116.5	110	118	4	5	2	1.5	0.42	1.43	0.79
	125	33.25	31	27	2	1.5	32214JR	212	225	35.2	3 100	4 100	29.2	1.71	132	6	12.25	80	80	116.5	108	119	4	6	2	1.5	0.42	1.43	0.79
75	105	20	20	16	1	1	32915JR	92.2	123	18.4	3 300	4 400	18.9	0.526	111	3	7	80.5	81	99.5	96	101	4	4	1	1	0.33	1.8	0.99
	115	25	25	19	1.5	1.5	32015JR	139	169	25.8	3 100	4 200	25.1	0.930	121	4.5	10.5	83.5	83	106.5	103	110	5	6	1.5	1.5	0.46	1.31	0.72
	130	27.25	25	22	2	1.5	30215JR	178	181	28.2	2 900	3 900	27.6	1.42	137	5	10.25	85	86	121.5	115	124	4	5	2	1.5	0.44	1.38	0.76
	130	33.25	31	27	2	1.5	32215JR	218	234	36.4	2 900	3 900	30.2	1.77	137	6	12.25	85	85	121.5	114	125	4	6	2	1.5	0.44	1.38	0.76
80	110	20	20	16	1	1	32916JR	95.1	131	19.5	3 100	4 200	20.1	0.556	116	3	7	85.5	86	104.5	101	106	4	4	1	1	0.35	1.71	0.94
	125	29	29	22	1.5	1.5	32016JR	185	225	34.6	2 900	3 900	26.7	1.32	131	5	12	88.5	89	116.5	112	120	6	7	1.5	1.5	0.42	1.42	0.78
	140	28.25	26	22	2.5	2	30216JR	202	202	31.2	2 700	3 600	28.6	1.72	147	5	11.25	92	91	130	124	132	4	6	2	2	0.42	1.43	0.79
	140	35.25	33	28	2.5	2	32216JR	253	271	41.5	2 700	3 600	31.7	2.17	147	6	13.25	92	90	130	122	134	4	7	2	2	0.42	1.43	0.79
85	120	23	23	18	1.5	1.5	32917JR	122	165	25.0	2 900	3 900	21.2	0.794	126	3	8	93.5	93	111.5	109	115	5	5	1.5	1.5	0.33	1.83	1.01
	130	29	29	22	1.5	1.5	32017JR	189	234	35.5	2 800	3 700	28	1.38	136	5	12	93.5	94	121.5	117	125	6	7	1.5	1.5	0.44	1.36	0.75
	150	30.5	28	24	2.5	2	30217JR	228	231	35.1	2 500	3 400	30.4	2.17	158	5	11.5	97	97	140	132	141	5	6.5	2	2	0.42	1.43	0.79
	150	38.5	36	30	2.5	2	32217JR	290	315	47.5	2 500	3 400	34.2	2.80	158	7	15.5	97	96	140	130	142	5	8.5	2	2	0.42	1.43	0.79
90	125	23	23	18	1.5	1.5	32918JR	126	175	26.2	2 800	3 700	22.3	0.834	131	3	8	98.5	97	116.5	114	120	5	5	1.5	1.5	0.34	1.75	0.96
	140	32	32	24	2	1.5	32018JR	224	276	41.5	2 600	3 500	29.8	1.80	146	5.5	13.5	100	100	131.5	125	134	6	8	2	1.5	0.42	1.42	0.78
	160	32.5	30	26	2.5	2	30218JR	255	261	39.0	2 400	3 200	32.6	2.65	168	6	12.5	102	103	150	140	150	5	6.5	2	2	0.42	1.43	0.79
	160	42.5	40	34	2.5	2	32218JR	329	362	53.7	2 400	3 200	37	3.47	168	8	16.5	102	102	150	138	152	5	8.5	2	2	0.42	1.43	0.79
95	130	23	23	18	1.5	1.5	32919JR	130	186	27.4	2 600	3 500	23.5	0.876	133	3	8	103.5	102	121.5	119	125	5	5	1.5	1.5	0.36	1.68	0.92
	145	32	32	24	2	1.5	32019JR	229	287	42.6	2 500	3 300	31.2	1.88	151	5.5	13.5	105	105	136.5	130	140	6	8	2	1.5	0.44	1.36	0.75
	170	34.5	32	27	3	2.5	30219JR	289	299	44.0	2 200	3 000	34.9	3.20	179	6.5	14	109	110	158	149	159	5	7.5	2.5	2	0.42	1.43	0.79
	170	45.5	43	37	3	2.5	32219JR	389	439	64.1	2 200	3 000	38.9	4.34	179	8	16.5	109	108	158	145	161	5	8.5	2.5	2	0.42	1.43	0.79
100	140	25	25	20	1.5	1.5	32920JR	158	217	32.0	2 400	3 300	24	1.19	147	4	9	108.5	108	131.5	128	135	5	5	1.5	1.5	0.33	1.82	1
	150	32	32	24	2	1.5	32020JR	233	298	43.8	2 400	3 200	32.6	1.95	156	5.5	13.5	110	109	141.5	134	144	6	8	2	1.5	0.46	1.31	0.72
	180	37	34	29	3	2.5	30220JR	323	338	49.1	2 100	2 800	36.8	3.83	190	7	15	114	116	168	157	168	5	8	2.5	2	0.42	1.43	0.79
	180	49	46	39	3	2.5	32220JR	435	495	63.9	2 100	2 800	42.1	5.21	190	8	18	114	114	168	154	171	5	10	2.5	2	0.42	1.43	0.79
105	145	25	25	20	1.5	1.5	32921JR	160	224	32.6	2 400	3 100	25.1	1.23	152	4	9	113.5	113	136.5	133	140	5	5	1.5	1.5	0.34	1.75	0.96
	160	35	35	26	2.5	2	32021JR	270	344	49.9	2 200	3 000	34.5	2.45	168	6.5	15.5	117	116	150	143	154	6	9	2	2	0.44	1.35	0.74
	190	39	36	30	3	2.5	30221JR	360	380	52.3	2 000	2 600	39	4.49	200	7	16	119	122	178	165	178	6	9	2.5	2	0.42	1.43	0.79
	190	53	50	43	3	2.5	32221JR	490	567	73.0	2 000	2 700	44.8	6.37	200	9	19	119	120	178	161	180	6	10	2.5	2	0.42	1.43	0.79

[Note] 1) The bearing number of a tapered roller bearing with a flanged outer ring contains the auxiliary symbol B.
Example 32912JRB



Dynamic equivalent load $P = XF_r + YF_a$

$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
X	Y	X	Y
1	0	0.4	Y_1

Static equivalent load $P_0 = 0.5F_r + Y_0F_a$

Note that if $P_0 < F_r$, it is assumed that $P_0 = F_r$.
For e , Y_1 , and Y_0 , use values given in the table.

d 110 ~ 170

d	Boundary dimensions (mm)						Bearing No.	Basic load ratings (kN)		Fatigue load limit (kN) C_u	Limiting speeds (min ⁻¹)		Load center (mm) a	(Refer.) Mass (kg)	Flange dimensions (mm)			Mounting dimensions (mm)						Constant e	Axial load coefficients				
	D	T	B	C	r min.	r ₁ min.		C_r	C_{0r}		Grease lub.	Oil lub.			D_1	C_1	T_2	d_a min.	d_b max.	D_a max.	d_a min.	d_b max.	S_a min.		S_b min.	r_a max.	r_b max.	Y_1	Y_0
110	150	25	25	20	1.5	1.5	32922JR	162	231	33.3	2 300	3 000	26.3	1.28	157	4	9	118.5	118	141.5	138	145	5	5	1.5	1.5	0.36	1.69	0.93
	170	38	38	29	2.5	2	32022JR	312	395	56.7	2 100	2 800	36.1	3.12	178	6.5	15.5	122	122	160	152	163	7	9	2	2	0.43	1.39	0.77
	200	41	38	32	3	2.5	30222JR	405	434	58.1	1 900	2 500	40.8	5.33	210	7	16	124	129	188	174	188	6	9	2.5	2	0.42	1.43	0.79
	200	56	53	46	3	2.5	32222JR	547	640	80.4	1 900	2 500	46.7	7.45	210	10	20	124	126	188	170	190	6	10	2.5	2	0.42	1.43	0.79
120	165	29	29	23	1.5	1.5	32924JR	215	298	42.5	2 100	2 700	29.4	1.77	172	5	11	128.5	128	156.5	152	160	6	6	1.5	1.5	0.35	1.72	0.95
	180	38	38	29	2.5	2	32024JR	325	427	60.0	2 000	2 600	38.8	3.34	188	6.5	15.5	132	131	170	161	173	7	9	2	2	0.46	1.31	0.72
	215	43.5	40	34	3	2.5	30224JR	435	473	61.7	1 700	2 300	44.2	6.36	225	8	17.5	134	140	203	187	203	6	9.5	2.5	2	0.44	1.38	0.76
	215	61.5	58	50	3	2.5	32224JR	589	691	84.0	1 700	2 300	51.6	9.04	225	11	22.5	134	136	203	181	204	7	11.5	2.5	2	0.44	1.38	0.76
130	180	32	32	25	2	1.5	32926JR	251	368	51.2	1 900	2 500	31.4	2.42	187	5	12	140	141	171.5	165	174	6	7	2	1.5	0.34	1.77	0.97
	200	45	45	34	2.5	2	32026JR	428	563	77.4	1 800	2 300	42.9	5.04	208	8	19	142	144	190	178	192	8	11	2	2	0.43	1.38	0.76
	230	43.75	40	34	4	3	30226JR	472	511	65.7	1 600	2 100	46.2	7.24	241	8	17.75	148	152	216	203	218	7	9.5	3	2.5	0.44	1.38	0.76
	230	67.75	64	54	4	3	32226JR	693	830	99.9	1 600	2 200	56	11.5	241	11	24.75	148	146	216	193	219	7	13.5	3	2.5	0.44	1.38	0.76
140	190	32	32	25	2	1.5	32928JR	258	390	53.2	1 800	2 300	33.6	2.57	197	5	12	150	150	181.5	174	184	6	7	2	1.5	0.36	1.67	0.92
	210	45	45	34	2.5	2	32028JR	435	585	79.2	1 700	2 200	45.6	5.28	218	8	19	152	153	200	187	202	8	11	2	2	0.46	1.31	0.72
	250	45.75	42	36	4	3	30228JR	526	570	71.8	1 500	1 900	49.4	8.97	261	9	18.75	158	163	236	219	237	9	9.5	3	2.5	0.44	1.38	0.76
	250	71.75	68	58	4	3	32228JR	796	961	112	1 500	2 000	60	14.7	261	12	25.75	158	158	236	210	238	9	13.5	3	2.5	0.44	1.38	0.76
150	210	38	38	30	2.5	2	32930JR	358	536	72.1	1 600	2 100	36.1	3.96	218	6	14	162	163	200	194	202	7	8	2	2	0.33	1.83	1.01
	225	48	48	36	3	2.5	32030JR	492	668	79.6	1 500	2 000	48.8	6.41	233	8.5	20.5	164	164	213	200	216	8	12	2.5	2	0.46	1.31	0.72
160	220	38	38	30	2.5	2	32932JR	368	568	75.2	1 500	2 000	38.4	4.19	228	6	14	172	173	210	204	212	7	8	2	2	0.35	1.73	0.95
	240	51	51	38	3	2.5	32032JR	553	758	90.3	1 400	1 900	52.1	7.75	248	9	22	174	175	228	213	231	8	13	2.5	2	0.46	1.31	0.72
170	230	38	38	30	2.5	2	32934JR	370	606	78.8	1 400	1 900	42	4.49	238	6	14	182	183	220	213	222	7	8	2	2	0.38	1.57	0.86
	260	57	57	43	3	2.5	32034JR	661	905	105	1 300	1 700	55.8	10.5	268	10	24	184	187	248	230	249	10	14	2.5	2	0.44	1.35	0.74

[Note] 1) The bearing number of a tapered roller bearing with a flanged outer ring contains the auxiliary symbol B.
Example 30219JRB

5. Support Bearings and Support Bearing Units for Precision Ball Screws

Contents

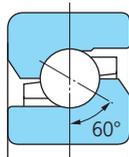
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5. Support bearings and support bearing units for precision ball screws

5.1 Structure and features

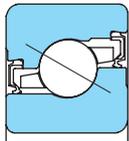
Support bearings for precision ball screws

The SAC type support bearings are angular contact thrust ball bearings specifically for supporting the screw shafts of precision ball screws (see Fig. 5. 1).

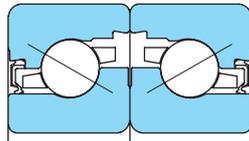


The bearings supporting the precision ball screws correspond to the type with contact seal.

Consult **JTEKT** for details about the type with contact seal and the pair patterns.



Both-side sealed type



Matching example of one-side sealed type

Fig. 5. 1 Structure of support bearings for precision ball screws

These bearings have many, small-diameter balls and thick section inner and outer rings.

The contact angle of these bearings is 60° enabling a high axial load and a certain degree of radial load to be applied simultaneously.

1) Features of support bearings for precision ball screws

- High rigidity
Has higher rigidity against axial load than conventional standard bearings (see Fig. 5. 2).
- Compact and lightweight
Since this bearing eliminates the need for an additional radial bearing or thrust bearing, it allows a compact surrounding design, thereby contributing to a reduction in the weight of the total system.
- High precision
A high-precision bearing suitable for precision ball screws.
- Preload adjustments not required
Preload is preadjusted to ensure an adequate preload after mounting. As a result, complicated adjustments are not required during mounting.
- Low torque
Requires lower friction torque than the tapered roller bearing or thrust roller bearing.

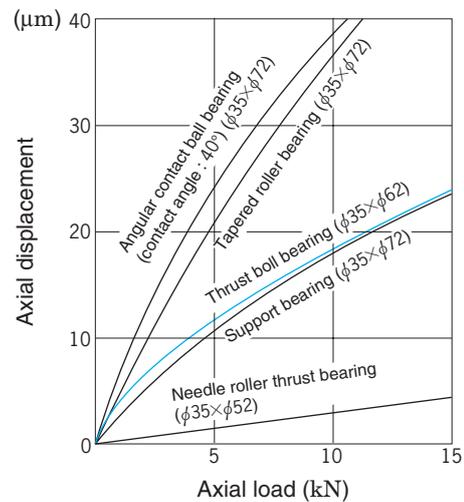


Fig. 5. 2 Relationship between axial load and displacement (comparison between support bearings and other bearings)

*The axial displacements shown above are values of the single-row bearings not preloaded.

2) Matched pair or stack support bearings

Table 5. 1 Types and suffixes of support bearings

Type and suffix of support bearing	
Combination of two	<p>Suffix DB Suffix DF</p>
Combination of three	<p>Suffix DFD</p>
Combination of four	<p>Suffix DFF</p>

- [Remarks]
1. A "V" mark is put on the outside surfaces of the outer rings of matched pair and stack bearings to indicate their combination type. For handling precautions of the type G bearing, refer to the bearing dimension table "1. 2 Matched pair angular contact ball bearings."
 2. Type G bearings are also manufactured, which enable any desired combinations. For descriptions of the type G bearing, refer to the bearing dimension table "1. 2 Matched pair angular contact ball bearings."

Support bearing units for precision ball screws

The support bearing unit for precision ball screws is a unit product combining the SAC type support bearing and a housing machined to a high precision.

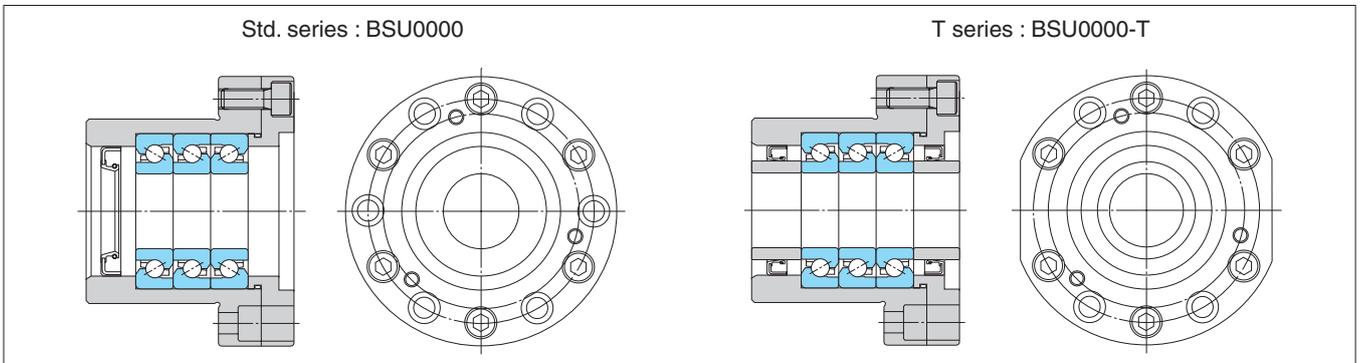


Fig. 5. 3 Series and structures of support bearing units for precision ball screws

1) Types of matched pair or stack bearing

Table 5. 2 Types of matched pair or stack bearing

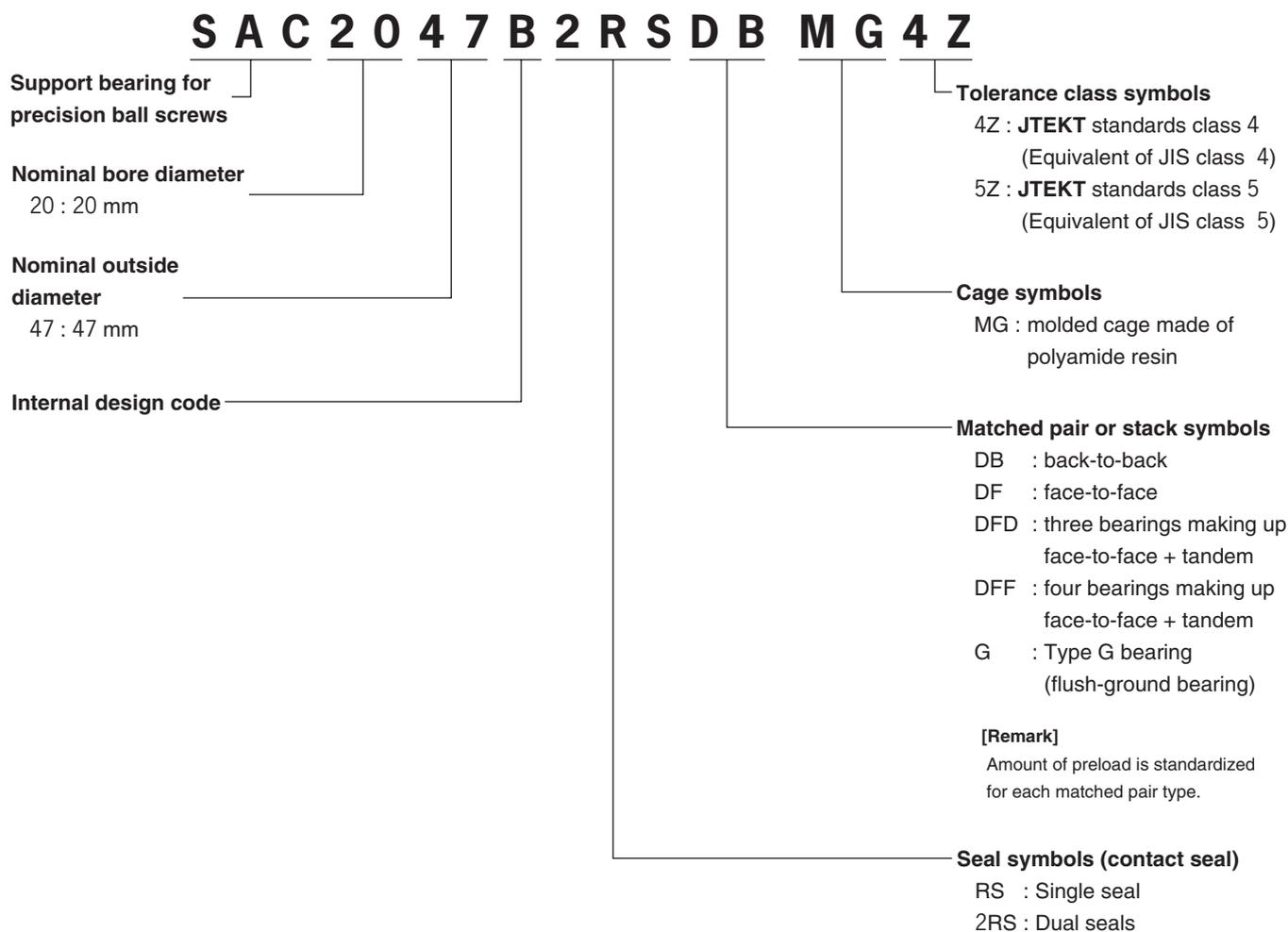
	Type and symbol
Combination of two bearings	<p>(Suffix : DF)</p>
Combination of three bearings	<p>(Suffix : DFD)</p>
Combination of four bearings	<p>(Suffix : DFF)</p>

2) Features of support bearing units for precision ball screws

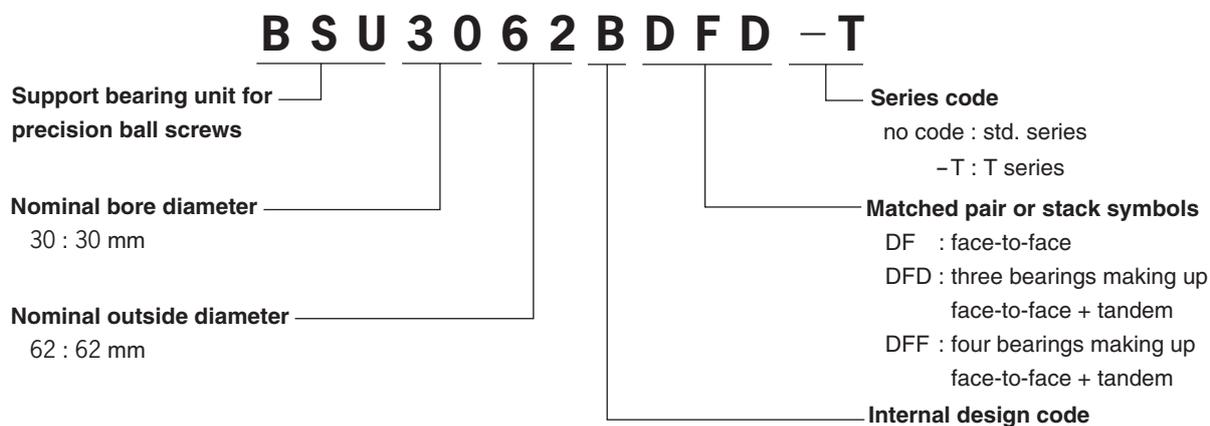
- Simple mounting work
This is a unit product consisting of a bearing where the preload is adjusted and an adequate quantity of grease is sealed within the bearing, and is mounted in a compact housing.
Thus the support bearing unit can be easily mounted on a machine.
- Excellent dust-proof performance
Having a high-performance built in oil seal the support bearing unit, with low torque operation, is excellent in dust-proof performance.
- Capability of coping with any desired design
In addition to the standard products listed in the dimension tables, **JTEKT** manufactures support bearing units to meet the support structures of various ball screws.
Consult **JTEKT** for more information.

**5.2 Composition of identification numbers
(support bearings and support bearing units for precision ball screws)**

Support bearings for precision ball screws



Support bearing units for precision ball screws



5.3 Tolerance of support bearings for precision ball screws

The support bearings for precision ball screws are manufactured to specific JTEKT standards suitable for

the requirements of precision ball screws (see **Table 5. 3**).

Table 5. 3 Permissible dimensional deviations and limits of support bearings for precision ball screws

(1) Inner ring

Unit : μm

Nominal bore diameter d (mm)		Single plane mean bore diameter deviation Δ_{dmp}				Single bore diameter deviation Δ_{ds}				Single plane bore diameter variation V_{dsp}		Mean bore diameter variation V_{dmp}	
		Class 5Z		Class 4Z		Class 5Z		Class 4Z		Class 5Z	Class 4Z	Class 5Z	Class 4Z
over	up to	upper	lower	upper	lower	upper	lower	upper	lower	max.		max.	
10	18	0	-5	0	-4	0	-5	0	-4	4	3	3	2
18	30	0	-6	0	-5	0	-6	0	-5	5	4	3	2.5
30	50	0	-8	0	-6	0	-8	0	-6	6	5	4	3
50	80	0	-9	0	-7	0	-9	0	-7	7	5	5	3.5

Nominal bore diameter d (mm)		Radial runout of assembled bearing inner ring K_{ia}		Perpendicularity of inner ring face with respect to the bore S_d		Axial runout of assembled bearing inner ring S_{ia}		Single inner ring width deviation Δ_{Bs}		Inner ring width variation V_{Bs}	
		Class 5Z	Class 4Z	Class 5Z	Class 4Z	Class 5Z	Class 4Z	Classes 5Z, 4Z		Class 5Z	Class 4Z
over	up to	max.		max.		max.		upper	lower	max.	
10	18	4	2.5	7	3	5	3	0	-80	5	2.5
18	30	4	3	8	4	5	3	0	-120	5	2.5
30	50	5	4	8	4	6	3	0	-120	5	3
50	80	5	4	8	5	7	4	0	-150	6	4

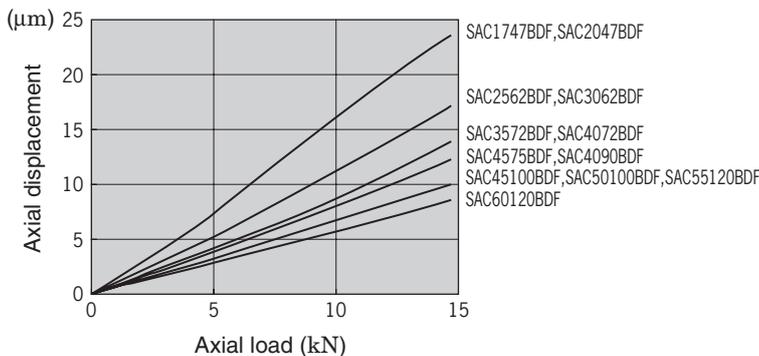
(2) Outer ring

Unit : μm

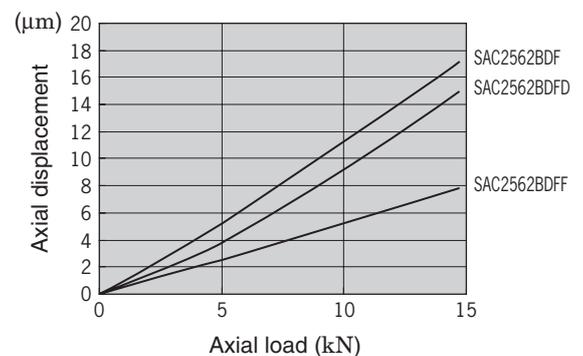
Nominal outside diameter D (mm)		Single plane mean outside diameter deviation Δ_{Dmp}				Single outside diameter deviation Δ_{Ds}				Single plane outside diameter variation V_{Dsp}		Mean outside diameter variation V_{Dmp}	
		Class 5Z		Class 4Z		Class 5Z		Class 4Z		Class 5Z	Class 4Z	Class 5Z	Class 4Z
over	up to	upper	lower	upper	lower	upper	lower	upper	lower	max.		max.	
30	50	0	-7	0	-6	0	-7	0	-6	5	5	4	3
50	80	0	-9	0	-7	0	-9	0	-7	7	5	5	3.5
80	120	0	-10	0	-8	0	-10	0	-8	8	6	5	4

Nominal outside diameter D (mm)		Radial runout of assembled bearing outer ring K_{ea}		Perpendicularity of outer ring surface with respect to the face S_D		Axial runout of assembled bearing outer ring S_{ea}		Deviation of a single outer ring width Δ_{Cs}		Ring width variation V_{Cs}	
		Class 5Z	Class 4Z	Class 5Z	Class 4Z	Class 5Z	Class 4Z	Classes 5Z, 4Z		Class 5Z	Class 4Z
over	up to	max.		max.		max.		upper	lower	max.	
30	50	7	5	8	4	Same as tolerance S_{ia} , d being that of the same bearing.		Same as tolerance Δ_{Bs} , d being that of the same bearing.		5	2.5
50	80	8	5	8	4					6	3
80	120	10	6	9	5					8	4

5.4 Axial load and displacement (support bearings for precision ball screws)



(Matched pair, standard preload)



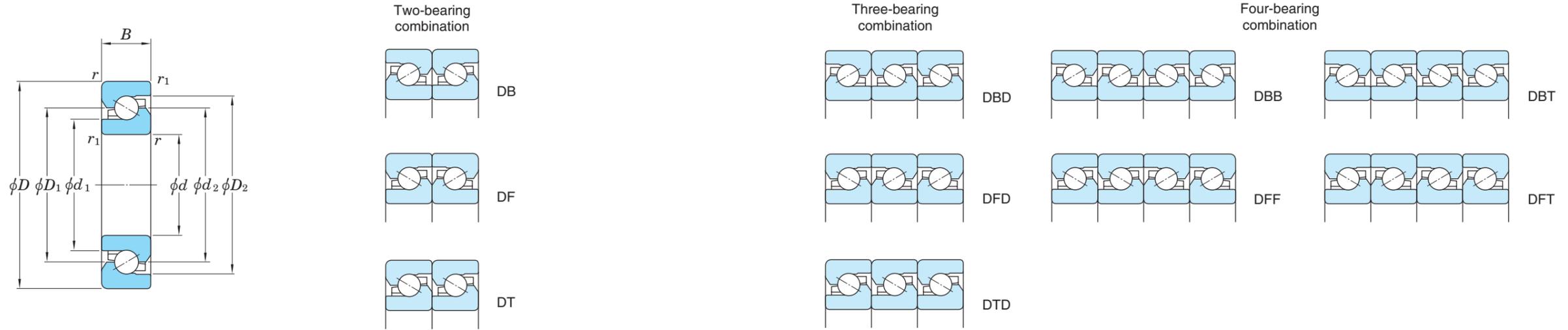
(Comparison of number of bearing rows)

Fig. 5. 4 Relationship between axial load and displacement (support bearings for precision ball screws)

5. Support bearings and support bearing units for precision ball screws

SAC0000B, SAC00000B series

Contact angle 60°



d	Boundary dimensions (mm)				Basic dynamic load rating ¹⁾ (kN) C _a	Max. axial loads (kN)			Limiting speeds (min ⁻¹)		Bearing ²⁾ No.	Interspace volume (cm ³ /row)	Dimensions (mm)				Standard preloads (kN)			Starting torques (mN·m)			Axial rigidity (N/μm)			(Refer.) Mass (kg/row)	
	D	B	r min.	r ₁ min.		Single row	Double row	Triple row	Grease lub.	Oil lub.			d ₁	d ₂	D ₁	D ₂	Two bearings	Three bearings	Four bearings	Two bearings	Three bearings	Four bearings	Two bearings	Three bearings	Four bearings		
17	47	15	1	0.6	32.5	34.3	68.6	103	6 300	8 000	SAC1747B	3.7		25.5	33.7	33.5	41	2.15	2.92	4.3	140	180	280	695	1 030	1 390	0.130
20	47	15	1	0.6	32.5	34.3	68.6	103	6 300	8 000	SAC2047B	3.7		26.8	33.7	33.5	41	2.15	2.92	4.3	140	180	280	695	1 030	1 390	0.120
25	62	15	1	0.6	37.8	48.1	96.2	144	4 600	6 000	SAC2562B	4.9		38	46.2	46	53.5	3.04	4.13	6.08	200	260	400	970	1 440	1 940	0.240
30	62	15	1	0.6	37.8	48.1	96.2	144	4 600	6 000	SAC3062B	4.9		38	46.2	46	53.5	3.04	4.13	6.08	200	260	400	970	1 440	1 940	0.210
35	72	15	1	0.6	41.0	58.8	118	176	3 700	5 000	SAC3572B	6.2		48	56.3	55.9	63.5	3.73	5.07	7.46	240	320	480	1 180	1 760	2 360	0.290
40	72	15	1	0.6	41.0	58.8	118	176	3 700	4 800	SAC4072B	6.2		48	56.3	55.9	63.5	3.73	5.07	7.46	240	320	480	1 180	1 760	2 360	0.260
	90	20	1	0.6	81.8	122	244	366	3 100	4 000	SAC4090B	15		54.5	67.5	66.8	78.5	5	6.8	10	440	610	880	1 270	1 890	2 540	0.620
45	75	15	1	0.6	42.5	64.4	129	193	3 400	4 300	SAC4575B	6.9		54	61.7	61.5	69	3.89	5.29	7.78	250	330	500	1 270	1 890	2 540	0.250
	100	20	1	0.6	86.0	137	274	411	2 800	3 600	SAC45100B	16		61.5	74.2	74	85.5	5.95	8.09	11.9	540	730	1 080	1 450	2 150	2 900	0.790
50	100	20	1	0.6	87.9	144	288	432	2 700	3 400	SAC50100B	17		65.8	78.2	78	89.5	6	8.15	12	540	730	1 080	1 500	2 230	3 000	0.650
55	100	20	1	0.6	87.9	144	288	432	2 700	3 400	SAC55100B	17		65.8	78.2	78	89.5	6	8.15	12	540	730	1 080	1 500	2 230	3 000	0.650

[Notes] 1) The value of the basic dynamic load rating of a single bearing is shown. For those of matched pair and stack bearings, see table below.

2) The identification of a matched bearing is composed of the bearing number of a single row bearing followed by the suffix (DB, DF, etc.).

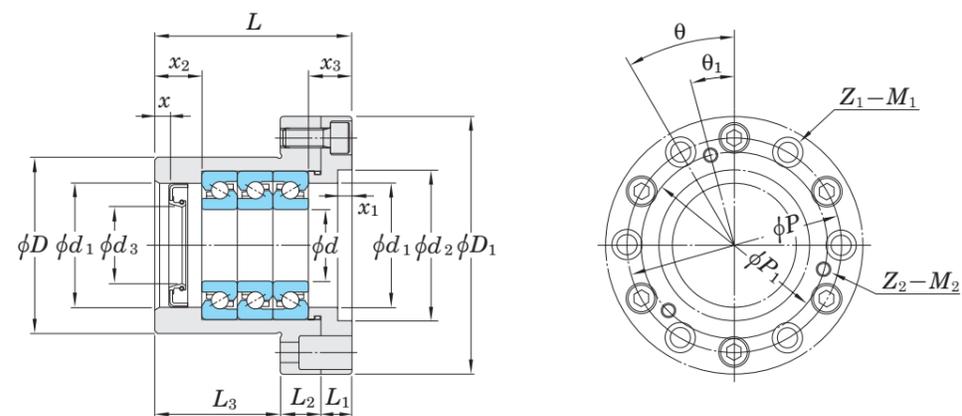
[Remarks] 1. We recommend a nut axial tension of two to three times the bearing preload.
2. We recommend a retaining plate holding allowance of 0.01 to 0.03 mm.

Dynamic equivalent load $P_a = XF_r + YF_a$

Number of rows to receive axial load	Basic dynamic load rating	Sample combination (arrow indicates direction of load.)
Single row	C _a	
Double row	C _a × 1.625	
Triple row	C _a × 2.16	

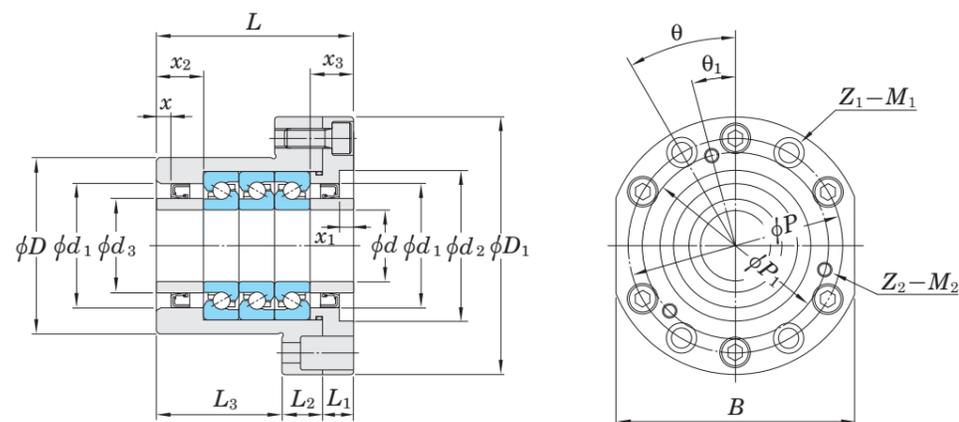
Sample combination	Two bearings		Three bearings			Four bearings			
	DB DF	DT	DBD DFD	DTD	DBT DFT	DBB DFF	DBT DFT		
Number of rows to receive axial load	Single row	Double row	Single row	Double row	Triple row	Single row	Double row	Triple row	
$\frac{F_a}{F_r} \leq 2.17$	X	1.9	—	1.43	2.33	—	1.17	2.33	2.53
	Y	0.54	—	0.77	0.35	—	0.89	0.35	0.26
$\frac{F_a}{F_r} > 2.17$	X	0.92							
	Y	1							

BSU0000BDF(DFD, DFF) series



d	D	D ₁	Dimensions (mm)										Applicable shaft dia. d ₃ (mm)	Unit identification number	Quantity of bearing	Mounting hole of housing			Tapped hole for Dust-proof cover/Damper			Standard preload (kN)	Starting torque (mN·m)	(Refer.) Mass (kg)
			L	L ₁	L ₂	L ₃	d ₁	d ₂	x	x ₁	x ₂	x ₃				P (mm)	θ (°)	Z ₁ -M ₁ <small>(No. of holes-threads)</small>	P ₁ (mm)	θ ₁ (°)	Z ₂ -M ₂ <small>(No. of holes-threads)</small>			
17	60	90	65	15	15	35	38	47	6	6	15	20	28	BSU1747BDF	2	75	45	4-M6	75	22.5	4-M6	2.15	140	1.72
20	60	90	65	15	15	35	38	47	6	6	15	20	28	BSU2047BDF	2	75	45	4-M6	75	22.5	4-M6	2.15	140	1.70
25	74	108	68	13	17	38	52	63	6	6	20	18	32	BSU2562BDF	2	90	30	6-M8	78	15	3-M6	3.04	200	2.45
	74	108	83	13	17	53	52	63	6	6	20	18	32	BSU2562BDFD	3	90	30	6-M8	78	15	3-M6	4.13	260	2.85
30	74	108	68	13	17	38	52	63	6	6	20	18	40	BSU3062BDF	2	90	30	6-M8	78	15	3-M6	3.04	200	2.38
	74	108	83	13	17	53	52	73	6	6	20	18	40	BSU3062BDFD	3	90	30	6-M8	78	15	3-M6	4.13	260	2.74
35	84	118	68	13	17	38	60	73	6	6	20	18	45	BSU3572BDF	2	100	30	6-M8	88	15	3-M6	3.73	240	2.81
	84	118	83	13	17	53	60	73	6	6	20	18	45	BSU3572BDFD	3	100	30	6-M8	88	15	3-M6	5.07	320	3.28
	84	118	98	13	17	68	60	73	6	6	20	18	45	BSU3572BDFD	4	100	30	6-M8	88	15	3-M6	7.46	480	3.74
40	84	118	68	13	17	38	60	73	6	6	20	18	50	BSU4072BDF	2	100	30	6-M8	88	15	3-M6	3.73	240	2.77
	84	118	83	13	17	53	60	73	6	6	20	18	50	BSU4072BDFD	3	100	30	6-M8	88	15	3-M6	5.07	320	3.20
	84	118	98	13	17	68	60	73	6	6	20	18	50	BSU4072BDFD	4	100	30	6-M8	88	15	3-M6	7.46	480	3.64

BSU0000BDF(DFD, DFF) - T series



d	D	D ₁	B	L	Dimensions (mm)					Unit identification number	Quantity of bearing	Mounting hole of housing			Tapped hole for Dust-proof cover/Damper			Standard preload (kN)	Starting torque (mN·m)	(Refer.) Mass (kg)					
					L ₁	L ₂	L ₃	d ₁	d ₂			d ₃	x	x ₁	x ₂	x ₃	P (mm)				θ (°)	Z ₁ -M ₁ <small>(No. of holes-threads)</small>	P ₁ (mm)	θ ₁ (°)	Z ₂ -M ₂ <small>(No. of holes-threads)</small>
17	60	90	80	65	15	15	35	38	47	28	6	6	15	20	BSU1747BDF - T	2	75	22.5	6-M6	57	10	4-M6	2.15	140	1.36
20	60	90	80	65	15	15	35	38	47	28	6	6	15	20	BSU2047BDF - T	2	75	22.5	6-M6	57	10	4-M6	2.15	140	1.32
25	74	108	100	68	13	17	38	52	63	32	6	6	20	18	BSU2562BDF - T	2	90	30	4-M8	78	15	3-M6	3.04	200	1.46
	74	108	100	83	13	17	53	52	63	32	6	6	20	18	BSU2562BDFD - T	3	90	30	4-M8	78	15	3-M6	4.13	260	2.44
30	74	108	100	68	13	17	38	52	63	40	6	6	20	18	BSU3062BDF - T	2	90	30	4-M8	78	15	3-M6	3.04	200	1.40
	74	108	100	83	13	17	53	52	63	40	6	6	20	18	BSU3062BDFD - T	3	90	30	4-M8	78	15	3-M6	4.13	260	2.47
35	84	118	105	68	13	17	38	60	73	45	6	6	20	18	BSU3572BDF - T	2	100	30	4-M8	88	15	3-M6	3.73	240	1.29
	84	118	105	83	13	17	53	60	73	45	6	6	20	18	BSU3572BDFD - T	3	100	30	4-M8	88	15	3-M6	5.07	320	2.68
	84	118	105	98	13	17	68	60	73	45	6	6	20	18	BSU3572BDFD - T	4	100	30	4-M8	88	15	3-M6	7.46	480	3.62
40	84	118	105	68	13	17	38	60	73	50	6	6	20	18	BSU4072BDF - T	2	100	30	4-M8	88	15	3-M6	3.73	240	1.24
	84	118	105	83	13	17	53	60	73	50	6	6	20	18	BSU4072BDFD - T	3	100	30	4-M8	88	15	3-M6	5.07	320	2.72
	84	118	105	98	13	17	68	60	73	50	6	6	20	18	BSU4072BDFD - T	4	100	30	4-M8	88	15	3-M6	7.46	480	3.64



III . Handling of Bearings

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1. Handling and mounting of bearings 184

1. Handling and mounting of bearings

1.1 Handling precautions of bearings

1.1.1 Handling of bearings

Since ball & roller bearings are made to a higher precision than general mechanical parts, they should be handled carefully.

- ① Maintain bearings and their surroundings in a clean condition.
- ② Handle with care.
A severe shock to a bearing by rough handling may result in damage such as flaws, nicks and chipping.
- ③ Use correct handling tools.
- ④ Exercise care for rust prevention of bearings.
Avoid handling and storing them in a highly humid atmosphere.
- ⑤ Bearing should be handled by an experienced person.
- ⑥ Standard operating procedure for handling bearings should be established.
 - Storage of bearings
 - Cleaning of bearings and their peripheral parts
 - Inspection of dimensions and finish of peripheral parts of bearings
 - Mounting
 - Dismounting
 - Inspection after mounting
 - Maintenance and inspection
 - Replenishment of lubricant

1.1.2 Storage of bearings

Bearings are shipped after a high-quality anticorrosive oil is applied to them followed by a suitable wrapping and packing.

Their quality is guaranteed as long as the wrapping and packing are not damaged.

Bearing, if they are to be stored for a long time, should be stored on a shelf at least 30cm from the ground at 65% or less humidity at a temperature of around 20°C. Avoid direct exposure to sunlight. Keep bearings at a distance from walls.

1.2 Mounting of bearings

The mounting condition of the bearings affects the accuracy, performance and life of machines.

To optimize the performance of the bearings, it is necessary to strictly follow the procedure and instructions to mount them.

The procedure for mounting the bearings is shown in Fig. 1. 1.

In this section, a general procedure for mounting the bearings is described in accordance with the workflow shown in Fig. 1. 1.

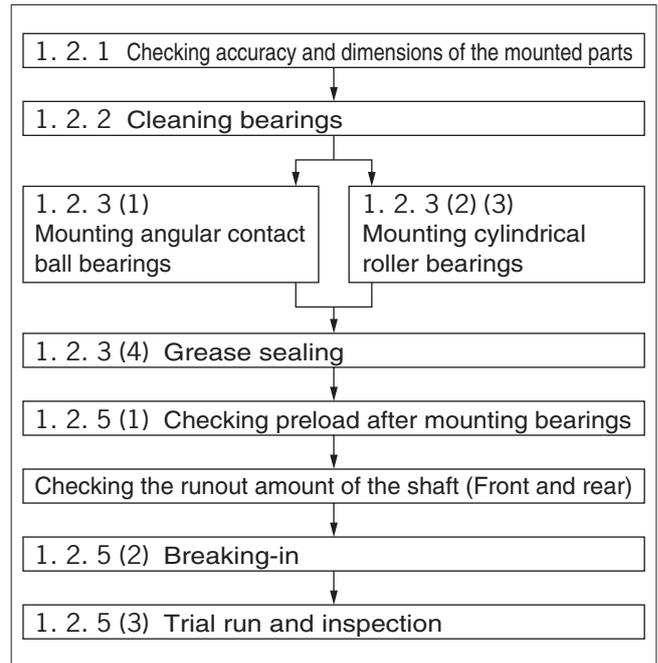


Fig. 1. 1 Mounting workflow

1.2.1 Checking dimensions of peripheral parts of bearings

Before mounting the bearing, clean the shaft, housing, spacer, etc. Ensure that the inside of the housing is absolutely free from any residual wrapping material (SiC, Al₂O₃, etc.), molding sand, or chips.

Next, inspect other parts. Check that the dimensions, shapes and roughness are as shown in the drawing, and there is no flaw, burr or barb. Measure the bearing diameter and the bore diameter of the housing at several positions as shown in Figs. 1. 2 and 1. 3, and confirm that the fitting is made correctly.

Record the measured values of these parts along with the inspection number of the bearing to be mounted.

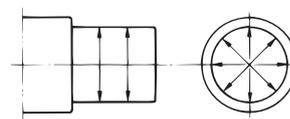


Fig. 1. 2 Measuring positions of shaft diameter

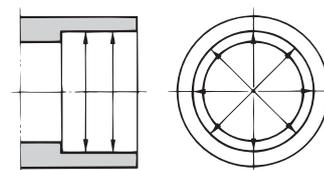


Fig. 1. 3 Measuring positions of housing bore diameter

Besides, pay attention to the fillet radii and the squareness of the shoulders of the shaft and housing.
(See Fig. 1. 4.)

For the tolerances for the shaft diameters and the bore diameters of the housing, refer to **Tables 11. 1** and **11. 2** (on pages 35 and 36) of "**11. Selecting a bearing fitting**".

Also, for the accuracy of the shaft and housing as well as the fillet radii, refer to "**15. Designing peripheral parts of bearings**" (on page 51).

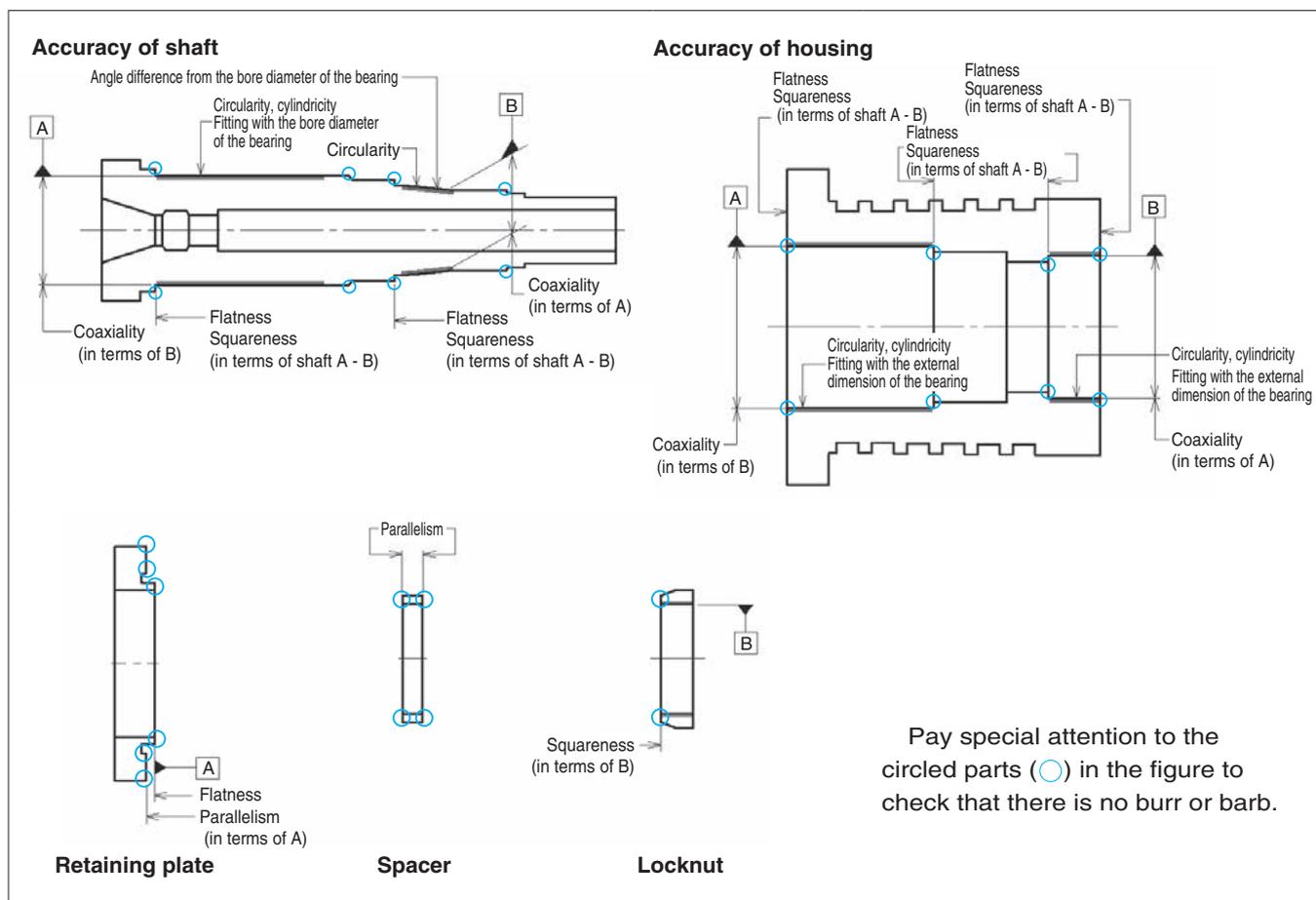


Fig. 1. 4 Points for checking the accuracy

1. 2. 2 Cleaning bearings

After preparing the parts necessary for mounting the bearings, unwrap the bearings just before starting to mount them.

Anticorrosive oil is applied to the bearings to prevent corrosion. After unwrapping the bearings, clean them to remove the anticorrosive oil following the procedure shown in Fig. 1. 5.

After cleaning, degrease and dry the bearings. Then, seal grease (in case of grease lubrication) and mount the bearings.

Point

- Be especially careful when cleaning the oil / air lubrication supply and discharge piping, air purge piping, and similar piping.
- After cleaning, ensure that no foreign matter adheres to the piping and store the piping in a clean environment.

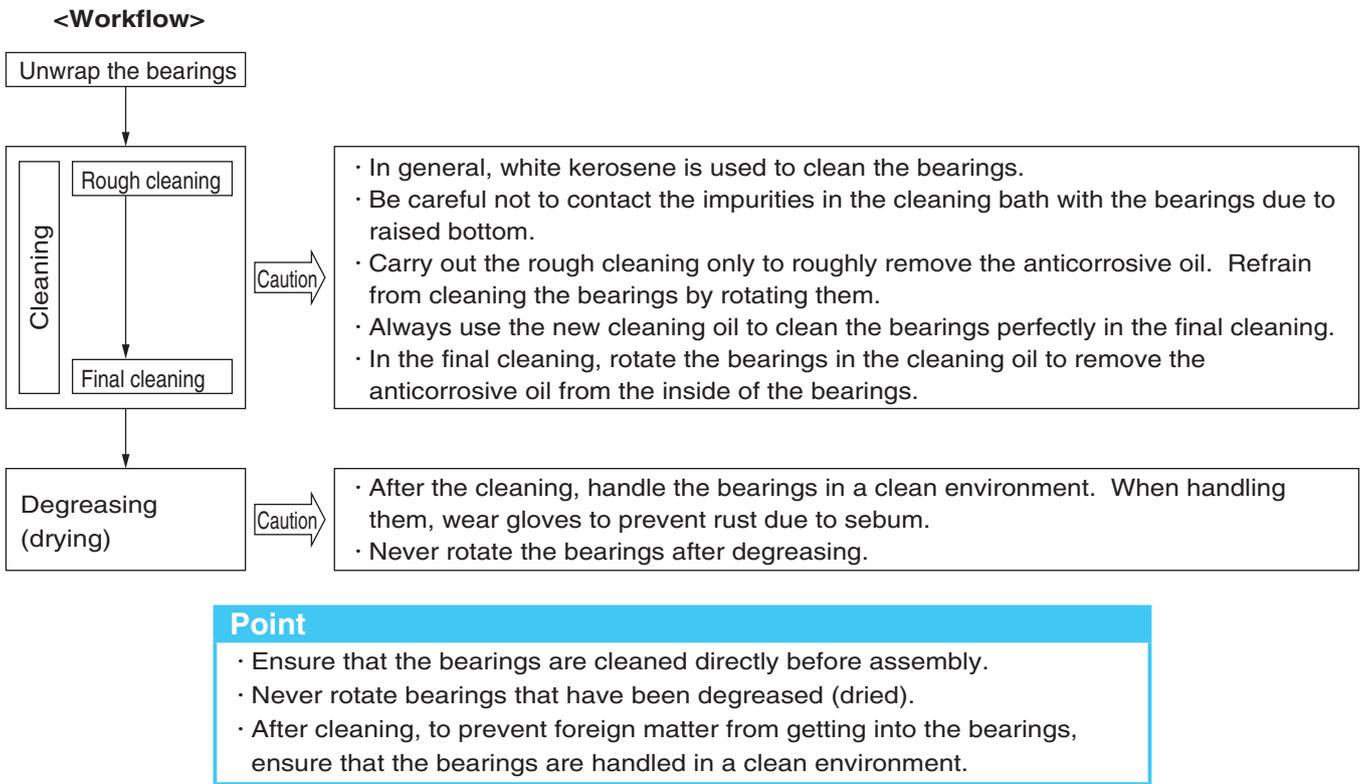


Fig. 1. 5 Cleaning workflow

1. 2. 3 Mounting bearings

The preparation before mounting the bearings varies depending on the bearing types and lubrication as shown in **Fig. 1. 6**.

For details, see **Fig. 1. 6** to mount the bearings.

In case of the angular contact ball bearings, the fitting mark is indicated on the outside surface of the bearing (see page 67). Mount the bearing in the correct direction referring to the fitting mark.

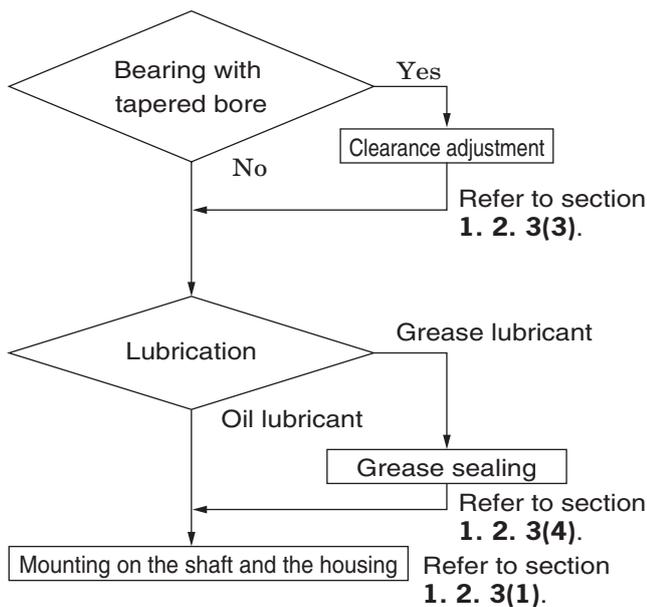


Fig. 1. 6 Preparation before mounting

1. 2. 3(1) Mounting on shaft and housing

① Bearing mounting

Mounting method of the bearings differs depending on types and fitting conditions.

In case of the bearings for machine tool spindles, the inner ring is usually rotated. Therefore, the interference fit is applied for the inner rings, and the clearance fit is applied for the outer rings.

As a method of interference fit, the shrinkage fit is usually applied for the cylindrical bore bearings. In case of the bearings with tapered bore, the inner ring is press fitted in the taper shaft. In this case, the bearing internal clearance needs to be adjusted as described in section **1.2.3(3)** beforehand, because it is necessary to control the radial internal clearance after fitting.

The clearance fit is used to fit the outer ring in the housing. To facilitate the mounting, the housing is heated to expand the bore diameter before mounting the bearing.

The bearing before mounting, which is used for oil lubrication, is very susceptible to flaws, because it is cleaned and degreased and is in metallic contact with a rolling element and raceway. To protect the raceway during the mounting, it is recommended to apply a small quantity of oil used for the machine to be mounted inside the bearing.

● Shrinkage fit

Heat the bearing assembly or inner ring on an induction heater or hot plate to induce expansion before mounting it onto a shaft.

If this method is used, no force is applied to the bearing and operation is carried out in a short time.

When a hot plate is used to heat up a bearing assembly, the use of a jig as shown in **Fig. 1. 7** enables efficient heating of the inner ring.

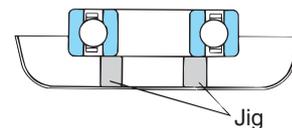


Fig. 1. 7 Inner ring heating jig

Specify the heating temperature of the bearing in accordance with the size and the required expansion, referring to **Fig. 1. 8**. Specify the temperature about 20 to 30°C higher than the required temperature, taking into consideration the temperature to be reduced during the operation.

However, never heat the bearing up to 120°C or more.

After mounting the bearing, shrinkage will occur in the width as the bearing cools off. Therefore, fit the inner ring and the shoulder firmly using a locknut to prevent clearance between them.

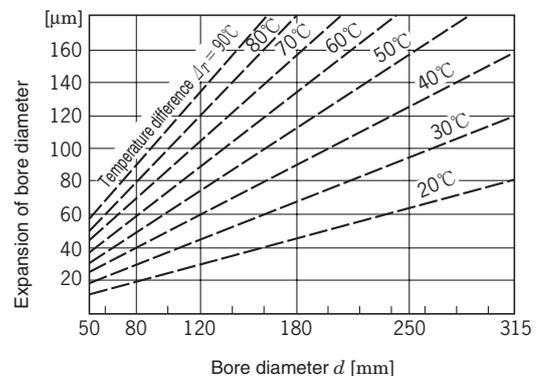


Fig. 1. 8 Heating temperature and expansion of inner rings

●Press fit

Be sure to use the specific jig to mount the inner ring to the shaft and the outer ring to the housing. When press fitting the inner ring and the outer ring, hold only the inner ring and the outer ring, respectively, and apply gently uniform pressure to the whole circumference surface.

Never mount the rings using hammer.

To facilitate the mounting, it is recommended to apply a small quantity of lubricant to the shaft or housing before press fitting.

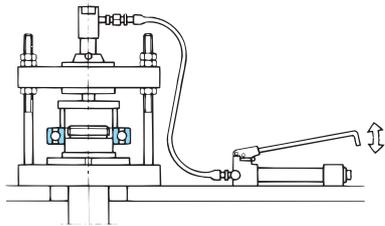


Fig. 1. 9 Press fitting by pressing machine

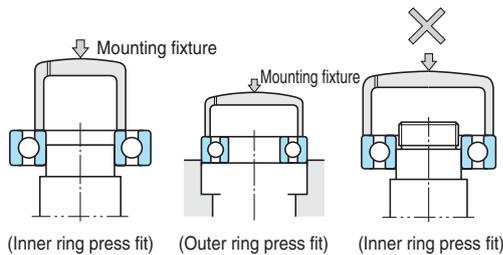
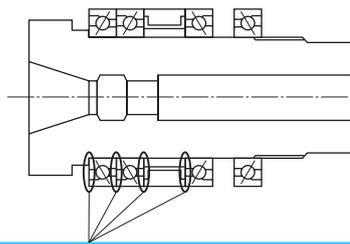


Fig. 1. 10 Example of press fitting jig



Point

- Ensure that contact is made for each mating surface.
- Take special care to ensure that no foreign matter or the like has been introduced.

Fig. 1. 11 Cautions for bearing assembly

[Reference] Force is necessary to press fit or remove bearings

The force necessary to press fit or remove inner rings of bearings differs depending on the finish of shafts and how much interference the bearings allow. The standard values can be obtained by using the following equations.

(In the case of solid shafts)

$$K_a = 9.8 f_k \cdot \Delta_{deff} \cdot B \left(1 - \frac{d^2}{D_i^2} \right) \times 10^3 \dots\dots\dots(1. 1)$$

(In the case of hollow shafts)

$$K_a = 9.8 f_k \cdot \Delta_{deff} \cdot B \frac{\left(1 - \frac{d^2}{D_i^2} \right) \left(1 - \frac{d_0^2}{d^2} \right)}{\left(1 - \frac{d_0^2}{D_i^2} \right)} \times 10^3 \dots\dots\dots(1. 2)$$

Where:

- K_a : force necessary for press fit or removal N
- Δ_{deff} : effective interference mm
- f_k : resistance coefficient
- (Coefficient taking into consideration friction between shafts and inner rings ... refer to the table below.)
- B : nominal inner ring width mm
- d : nominal inner ring bore diameter mm
- D_i : average outside diameter of inner ring mm
- d_0 : hollow shaft bore diameter mm

Value of resistance coefficient f_k

Conditions	f_k
· Press fitting bearings on to cylindrical shafts	4
· Removing bearings from cylindrical shafts	6
· Press fitting bearings on to tapered shafts or tapered sleeves	5.5
· Removing bearings from tapered shafts or tapered sleeves	4.5
· Press fitting tapered sleeves between shafts and bearings	10
· Removing tapered sleeves from the space between shafts and bearings	11

② Tightening of bearings

● Tightening of inner ring

As a way of fixing the inner ring to a shaft, a locknut is usually used. **Fig. 1. 12** shows an example of fixing an inner ring using a locknut.

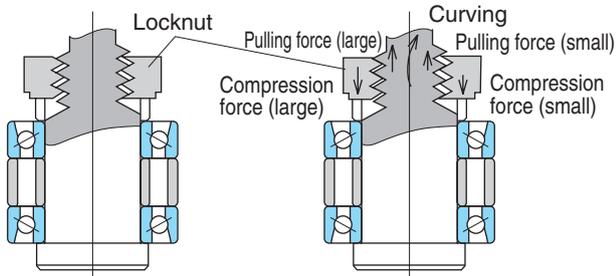


Fig. 1. 12 Example of fixing on inner ring using a locknut

As a clearance is present between thread of the locknut and that of the shaft, fixing the inner ring by using a locknut results in the center of the locknut deviating from the center of the shaft. This deviation in turn causes inclination of the inner ring or bending of the shaft.

As a result, the running accuracy of the shaft is decreased or an abnormal temperature increase is experienced due to the high load applied to the bearing (see **Fig. 1. 13**).

To settle this problem, positioning (centering) of the locknut is necessary after tightening.

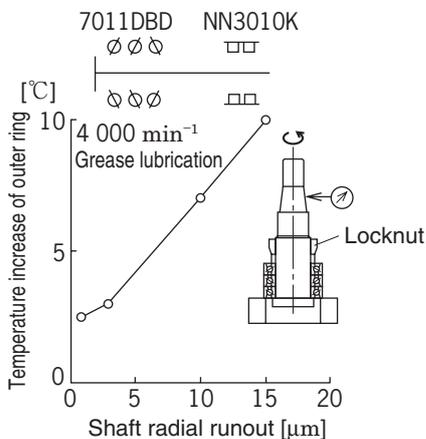


Fig. 1. 13 Relationship between shaft radial runout and temperature increase of the outer ring caused by the faulty positioning of the inner ring

Furthermore, the axial force generated by tightening the locknut leads to compressive strain of the inner ring and inner ring spacer, which in the case of position preloading, influence the amount of preload applied to the bearing.

For those applications which are considerably affected by preload, such as a high-speed spindle, this compressive strain should be taken into consideration. Consideration to other types of bearing supports are the inclination of inner rings, bending of shafts, and axial forces. In cases where a interference fit sleeve is used to fix a bearing, the tolerance of the sleeve is of vital importance since positioning becomes difficult once the bearing is fitted.

Tightening forces (axial forces) and reference tightening torques of the locknuts or sleeves used to fix the inner rings are indicated as standard values in **Table 1. 1**.

Note that if the interference of inner ring is large and the number of bearing rows is large, the press fitting force also becomes large.

Table 1. 1 Nut axial force and reference nut tightening torque

0 series			9 series		
Nominal bore diameter (mm)	Nut axial force (N)	Reference nut tightening torque (N·m)	Nominal bore diameter (mm)	Nut axial force (N)	Reference nut tightening torque (N·m)
10	2 000	4	10	1 500	3
12	2 000	4	12	2 000	4
15	3 000	8	15	2 000	5
17	3 000	9	17	3 000	9
20	5 000	18	20	3 000	11
25	5 000	22	25	3 000	13
30	5 000	27	30	5 000	27
35	8 000	49	35	5 000	31
40	8 000	57	40	5 000	36
45	10 000	78	45	6 000	47
50	10 000	87	50	6 000	52
55	12 000	115	55	6 000	57
60	12 000	125	60	8 000	83
65	15 000	169	65	8 000	90
70	15 000	181	70	10 000	121
75	15 000	194	75	10 000	129
80	15 000	206	80	10 000	138
85	18 000	263	85	12 000	176
90	18 000	278	90	12 000	185
95	18 000	294	95	12 000	196
100	20 000	342	100	15 000	256
105	20 000	361	105	15 000	271
110	20 000	376	110	15 000	282
120	20 000	409	120	15 000	307
130	20 000	444	130	20 000	444
140	25 000	597	140	20 000	477
150	25 000	640	150	20 000	512
160	30 000	820	160	25 000	684
170	30 000	872	170	25 000	727
180	—	—	180	25 000	770
190	—	—	190	25 000	811

● Tightening of outer rings

Outer rings are fixed to the housing usually by means of a retaining plate.

The retaining plate is fastened to the housing with several bolts. Inadvertent fastening of the retaining plate, however, may result in an inclination and / or deformation of the outer ring.

If inclination and / or deformation occurs in the outer ring, the rolling elements and the cage cannot rotate properly, possibly causing unusual noise generation.

In order to prevent this, it is necessary to tighten the retaining plate fastening bolts with an even torque in diagonal sequence. The fastening bolts should not be fastened individually to the final torque, but in a step-by-step sequence (see **Fig. 1. 14**).

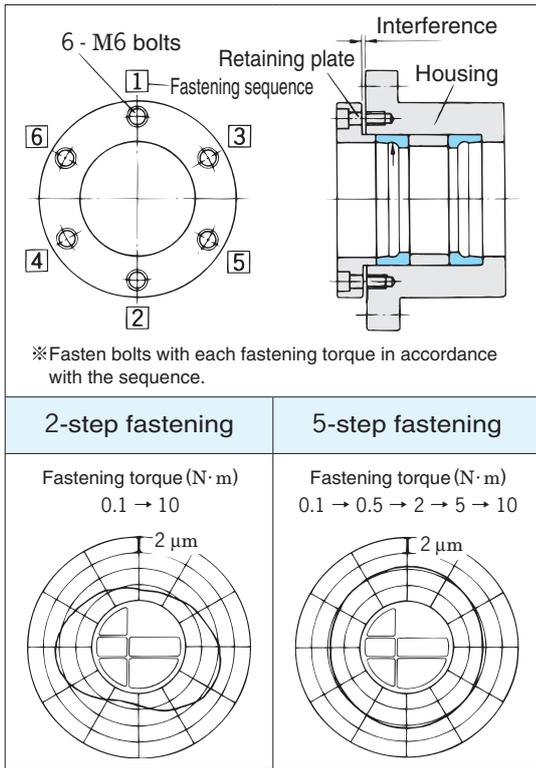


Fig. 1.14 Raceway roundness variations with respect to the various fastening method

A slight interference is provided between the housing and retaining plate to hold the outer ring firmly.

If variations on the interference exist on the circumference due to poor tolerance of the retaining plate or housing, fastening the retaining plate may cause inclination of the outer ring.

When securing the outer ring using the retaining plate, if the interference is excessive, the preload will become less than the set value, increasing the likelihood of the pressing force becoming uneven. In addition, if the interference is insufficient, the preload will become more than the set value, causing the pressing force to be insufficient, thus leading to creeping of the outer ring.

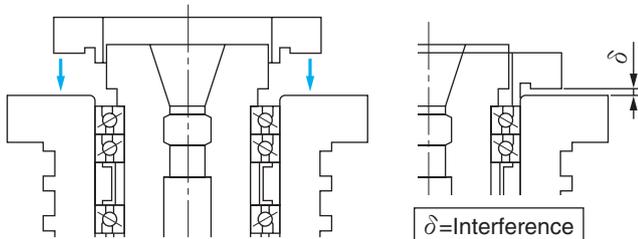


Fig. 1.15 Interference of retaining plate

Therefore, sufficient care should be taken to ensure tolerance of the retaining plate and housing.

For the interference between the housing and retaining plate as well as the reference tightening torque for the outer ring retaining plate bolts, see Tables 1.2 and 1.3.

Table 1.2 Interference of retaining plate

Nominal bore diameter (mm)	Interference of retaining plate (mm)
10~100	0.01~0.02
105~	0.02~0.04

Table 1.3 Tightening torque for outer ring retaining plate bolts

Nominal thread	Tightening torque (N·m)
M4×0.7	3.6
M5×0.8	7
M6×1	12.1
M8×1.25	29.3
M10×1.5	57.7
M12×1.75	99.2
M16×2	247
M20×2.5	496
M24×3	856

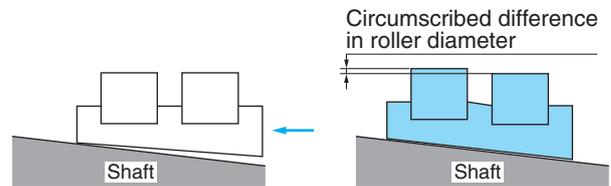
1.2.3(2) Management of spindle taper angle

When using cylindrical roller bearings with a tapered bore, the angle of the spindle taper and the angle of the bearing taper must be managed. Managing the taper angles ensures the high precision of the spindle.

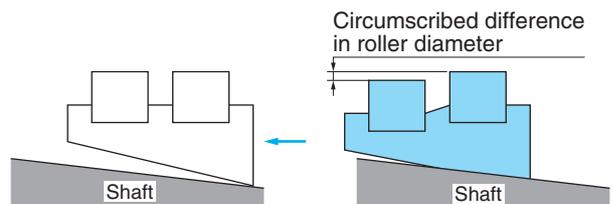
To manage the taper angle, apply a thin coating of blue paste to the bearing bore and check the contact locations with the spindle (Should be 80% or more).

A large difference in the angle between the spindle and the bearing bore will result in an increased difference in the circumscribed roller diameter between two rollers. This may lead to a failure.

- If bore taper angle of inner ring is less than shaft taper



- If shaft taper is less than bore taper angle of inner ring



Problem details: Increased difference between circumscribed diameter of rollers

Fig. 1.16 Example of poor accuracy for tapered hole

1. 2. 3(3) Adjusting of clearance

In case of the cylindrical roller bearing with tapered bore, it is necessary to adjust the dimension of the spacer to adjust the radial clearance of the bearing.

The adjustment is made as follows.

- (1) Lightly apply low-viscosity oil (kerosene, etc.) to the taper part of the shaft and fit slightly the inner ring of the cylindrical roller bearing into the shaft (**Fig. 1. 17**).

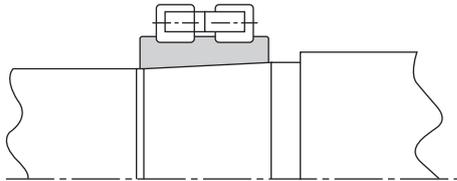


Fig. 1. 17 Temporary mounting of inner ring

- (2) Using a block gauge, measure the distance between the end face of the inner ring and that of the shoulder (**Fig. 1. 18**).

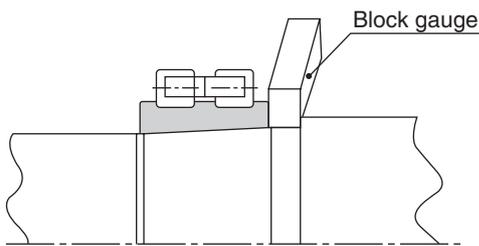


Fig. 1. 18 Width of spacer

- (3) Temporarily adjust the width of the spacer. Adjust the width of the spacer to the distance between the end face of the inner ring and that of the shoulder as measured in step (2). It is recommendable to make the outside diameter of the spacer larger than the diameter of the shaft shoulder to facilitate the pulling-out (Useful when pulling out the inner ring).

Point

- After machining, the parallelism of the lateral spacer sides must be 0.001 mm or less.
- Designing a spacer outer diameter larger than the diameter of the shaft shoulder will facilitate later work.

- (4) After degreasing the outside surface and the bore, fit the temporarily adjusted spacer and mount the inner ring onto the shaft.

Be careful not to make clearance between the end face of the spacer and that of the inner ring and clearance between the end face of the spacer and that of the shaft shoulder (**Fig. 1. 19**).

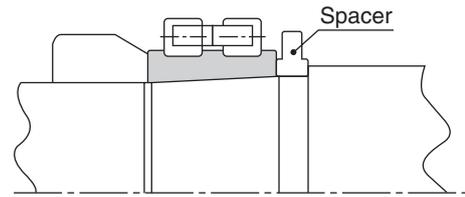


Fig. 1. 19 Mounting of spacer

- (5) Place the dial gauge on the outside surface of the outer ring, and move the outer ring upward and downward on the axial line of the dial gauge needle to measure the residual radial internal clearance (**Fig. 1. 20**).
- (6) After measurement, pull the bearing and the spacer out of the shaft. Never hit the bearing to pull it out (Hit gently the end face of the spacer of large outside diameter).
- (7) Based on the radial internal clearance measured in step (5), use the equation shown below to calculate the adjustment value of the inner ring to obtain the desired residual radial internal clearance.

In case of taper 1/12,

$$\text{Adjustment value } \Delta_A = (R_{sa} - R_{sb} - R_{sc}) \times 12/K$$

Where:

- R_{sa} : measured radial internal clearance the value measured in step (5)
- R_{sb} : desired radial internal clearance
- R_{sc} : contraction of the outer ring raceway due to fitting (0 in case of clearance fit)
- K : expansion coefficient of the inner ring raceway due to press fitting

Formula to calculate R_{sc}

$$R_{sc} = \Delta_{Deff} \frac{D_e}{D} \cdot \left(\frac{1 - \frac{D^2}{D_h^2}}{1 - \frac{D_e^2}{D_h^2}} \right)$$

Formula to calculate K

$$K = \frac{d}{D_i} \left(\frac{1 - \frac{d_0^2}{d^2}}{1 - \frac{d_0^2}{D_i^2}} \right)$$

Where:

- Δ_{Deff} : effective interference of outer ring
- D_h : outside diameter of housing
- D_e : outer ring raceway contact diameter
 - (ball bearing..... $D_e \doteq 0.2 (4D + d)$)
 - (roller bearing ... $D_e \doteq 0.25 (3D + d)$)
- D : nominal outer ring outside diameter
- d : nominal inner ring bore diameter (shaft diameter)
- d_0 : bore diameter of hollow shaft
- D_i : inner ring raceway contact diameter
 - (ball bearing..... $D_i \doteq 0.2 (D + 4d)$)
 - (roller bearing ... $D_i \doteq 0.25 (D + 3d)$)

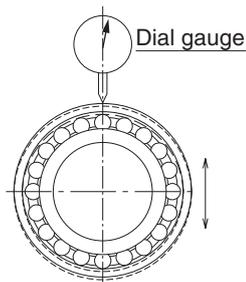


Fig. 1. 20 Measurement of residual radial clearance

Point

- Gently tap the spacer when pulling out the inner ring. Never tap the bearing under any circumstances!

(8) Adjust the width of the spacer.

The width of the spacer must be the value temporarily adjusted minus the adjustment value calculated in step (7).

Point

- After machining, the parallelism of the lateral spacer sides must be 0.001 mm or less.
- After machining, be sure to clean the spacer sufficiently.

(9) After cleaning, mount the bearing and the spacer onto the shaft.

Push inner ring sufficiently so that the end face of the spacer and that of the inner ring as well as the end face of the spacer and that of the shaft shoulder contact each other completely (**Fig. 1. 21**).

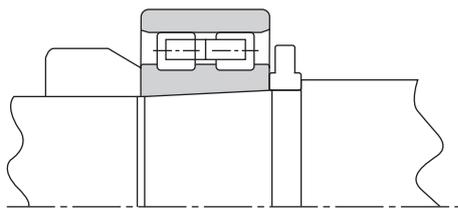


Fig. 1. 21 Mounting of bearing

(10) As in step (5), check the residual radial internal clearance of the bearing.

If the desired value of the radial internal clearance is not obtained, return to step (7) and make adjustment again.

(11) After checking that the desired value of the radial internal clearance is obtained in step (10), pull the bearing and spacer out of the shaft temporarily to clean and degrease them. In case of grease lubrication, seal them with the specified amount of grease, and then reassemble them.

Point

- Make sure that no temperature differences exist between components.
- Ensure proper fitting between the shaft and the bearing bore and between the housing and the bearing outer diameter.
- When using cylindrical roller bearings with a tapered bore, take note of the difference in taper angles of the shaft and the bearing bore.
- Be cautious of burrs and barbs on surfaces in contact with the bearing.
- * Pay special attention to accuracy upon reinstallation following a seizure.

1. 2. 3(4) Grease sealing

If the sealed amount of grease or the sealing method is not appropriate, overheating or instability (**Fig. 1. 22**) may result during breaking-in, and an extended time of breaking-in may become necessary.

Therefore, be sure to seal the bearing with an appropriate amount of grease in correct manner.

Sealing method of grease is described below.

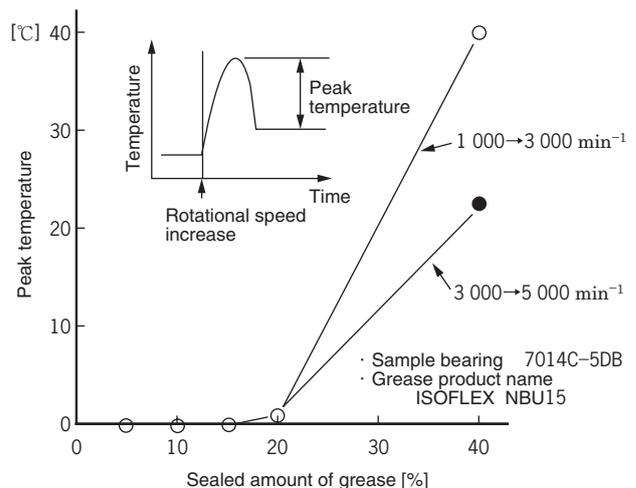


Fig. 1. 22 Relationship between sealed amount of grease and peak temperature

① Preparation before sealing

- Clean and degrease the bearing. And check that there is no stain of anticorrosive oil or foreign matter on the interspace and outer surfaces of the bearing.
- An appropriate amount of grease must be applied uniformly to the specified locations in the bearing. To apply grease, it is recommended to use a specific tool with measuring gauge, which has a nozzle tip.
- The tool used to apply grease also has to be cleaned off and degreased.
- Before applying grease, check the amount of grease to be sealed. The amount should be 10 to 15% of the space capacity of the bearing. (The space capacity of each bearing and the sealed amount of grease are shown in the bearing dimension table.)

② Method for grease sealing

Grease must be applied uniformly to the bearing raceway surface and the retainer guide as shown in **Fig. 1. 23**.

After applying grease, manually rotate the bearing to let the grease spread all over the inside of the bearing.

Also, after applying grease, be careful to prevent foreign matter and dust from adhering to the bearing.

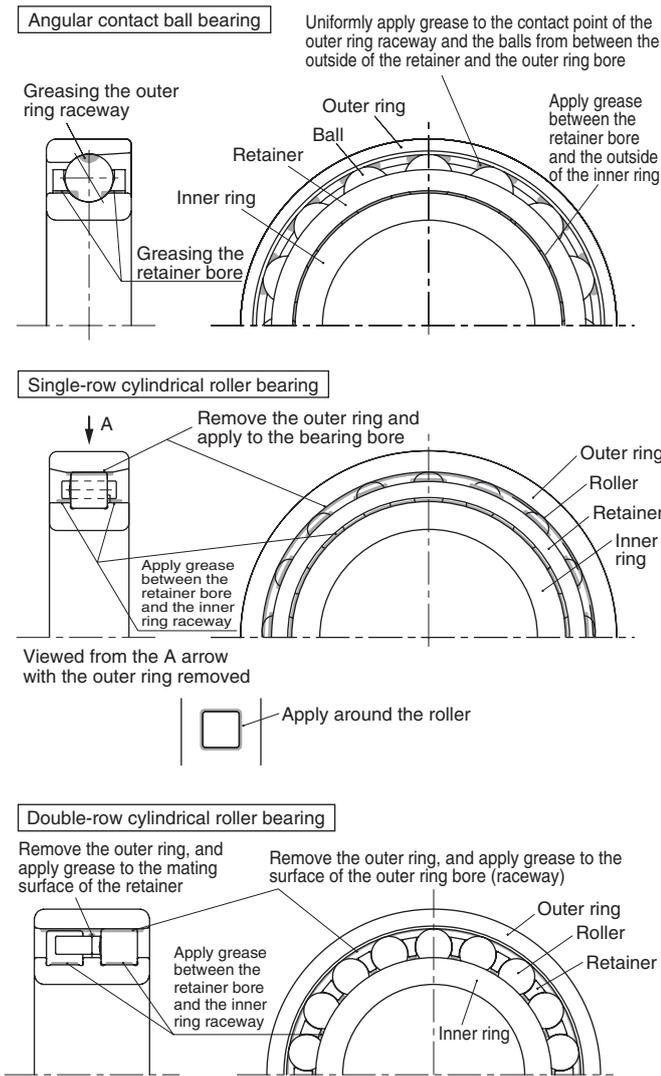


Fig. 1. 23 Grease sealing points

Point

- To apply grease, a tool with a nozzle-like tip similar to a syringe will facilitate work.
- Clean and dry the grease application tool before performing the work.
- Control the amount of grease according to capacity or amount.
- After applying grease, handle the bearing carefully as foreign matter will easily adhere to the bearing.
- Apply the grease evenly and little by little.

1. 2. 4 Mounting of ball screw support bearings

The methods for cleaning parts and applying grease are the same as for spindle bearings. Refer to sections **1. 2. 1 Checking dimensions of peripheral parts of bearings**, **1. 2. 2 Cleaning bearings**, and **1. 2. 3(4) Grease sealing** in **1. Handling and mounting of bearings**.

To use the ball screw support bearings, first create a housing assembly (unit) with the bearings already mounted in the housing.

Refer to "Tightening of outer rings" under **1. 2. 3(1) Mounting on shaft and housing** for how to mount the support bearing to the housing.

Be sure to wash the support bearing assembly part of the ball screw shaft.

The following section describes the procedure using a unit component as an example.

1. 2. 4(1) Mounting on shaft

The fitting of the inner ring of the ball screw support bearing is what's referred to as a "transition fit." Begin by heating the inner ring beforehand (**Fig. 1. 24**).

The inner ring can be heated by inserting a provisional shaft that has been heated into the bore of the inner ring or by directly heating the inner ring using a jig heated using a heater or the like.

When heating the inner ring directly, make sure the unit's oil seal lip does not touch the heating jig.

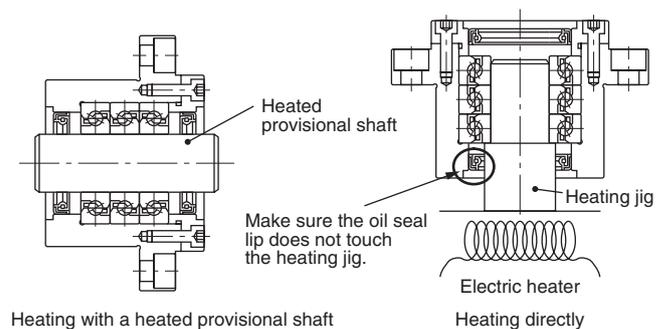


Fig. 1. 24 Heating the inner ring

1. 2. 4(2) Mounting on the machine body

Once the inner ring has been heated, mount the unit on the ball screw shaft as shown in **Fig. 1. 25**.

Make sure the ball screw shaft has been passed through the machine body beforehand.

To mount the unit, insert the inner collar onto the shaft with a clearance fit, and then insert the unit with a heated inner ring onto the shaft.

After inserting the unit onto the shaft, insert the other inner collar onto the shaft with a clearance fit.

Next, tighten the inner ring and the shaft with the shaft nut, and tighten the housing onto the machine body with the bolt.

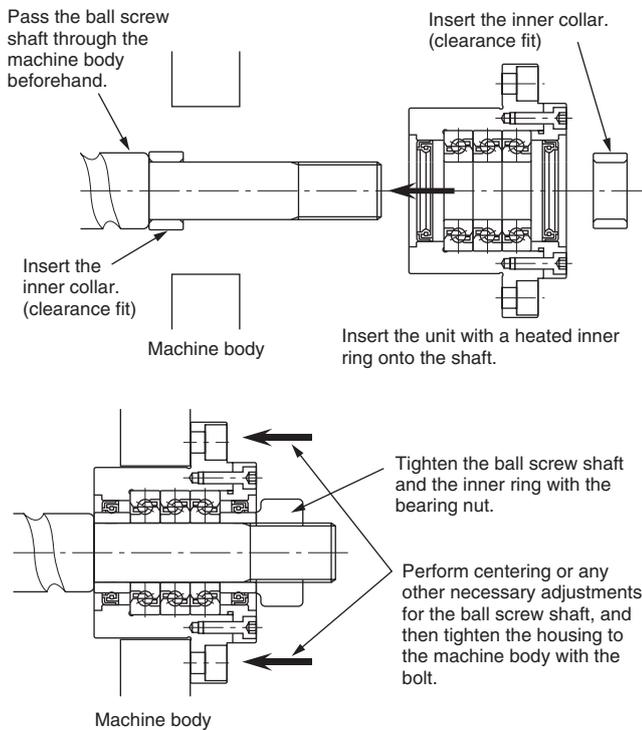


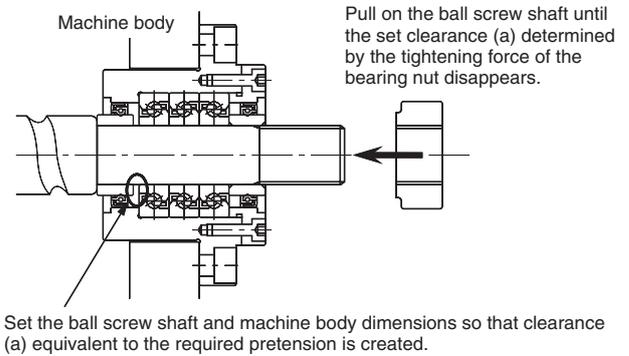
Fig. 1. 25 Mounting of the ball screw support unit

1. 2. 4(3) Applying pretension

The ball screw shaft can be used with pretension applied beforehand.

Fig. 1. 26 shows an example of this method.

After tightening one end of the ball screw, insert the unit at the other end onto the shaft. Set the dimensions of the ball screw and machine body in advance so that an axial clearance equivalent to the necessary pretension is created. When the inner ring and ball screw shaft are tightened using the shaft nut, the set clearance will disappear. The required pretension can be applied to the ball screw shaft by eliminating the clearance.



Point

- After tightening, make sure no residual clearance exists between the shaft shoulder and the inner collar and between the inner collar and the inner ring.

Fig. 1. 26 Applying pretension

1. 2. 5 Check after mounting bearings

1. 2. 5(1) Checking of preload

Preload of the bearing affects its rigidity and heat generation. If the preload is inadequate, not only the standard performance is not obtained, but also the life span is shortened and seizure results.

Therefore, it is important to check that the specified preload is applied to the bearing after completing the mounting of the bearing.

In this section, the following methods for checking the preload, which are generally used, are described.

① Check using the starting torque

If the preload of the bearing becomes large, the starting torque also tends to increase. Therefore, the preload can be checked by measuring the starting torque value.

Wind the thread on the shaft or the outer ring and fix it. By pulling the thread tangentially, measure the tension of the thread when the bearing starts to rotate using a tension gauge, etc. After obtaining the starting torque, the preload can be presumed referring to the correlation between the starting torque and the preload (Fig. 1. 27).

The starting torque can be measured easily. However, in case of the bearings used with low preload (e.g. angular contact ball bearing used as a spindle), the measurement error can be large because the starting torque is small. This method is recommendable when using the ball screw support bearings by applying heavy preload to them.

Note that it is necessary to standardize the sampling and measurement conditions because the condition of the lubricant and pulling speed affect the measurement result.

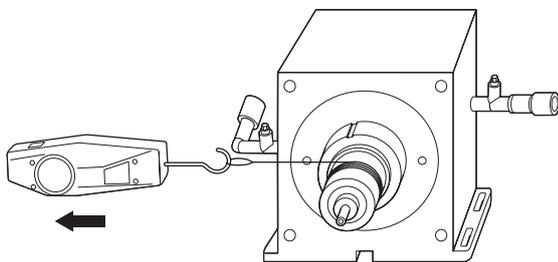


Fig. 1. 27 Measuring starting torque

② Check using the axial rigidity

The preload is confirmed referring to the correlation between the shaft end axial deviation measured by applying the axial load to the shaft end, and the axial rigidity and the preload (Fig. 1. 28).

This method is not recommendable when using a main shaft of high rigidity because the deviation is very small.

To use this method, a large-sized facility such as a load applying device is necessary. Also, it is necessary to standardize the sampling and measurement conditions because the parts other than the bearing have elastic deformability.

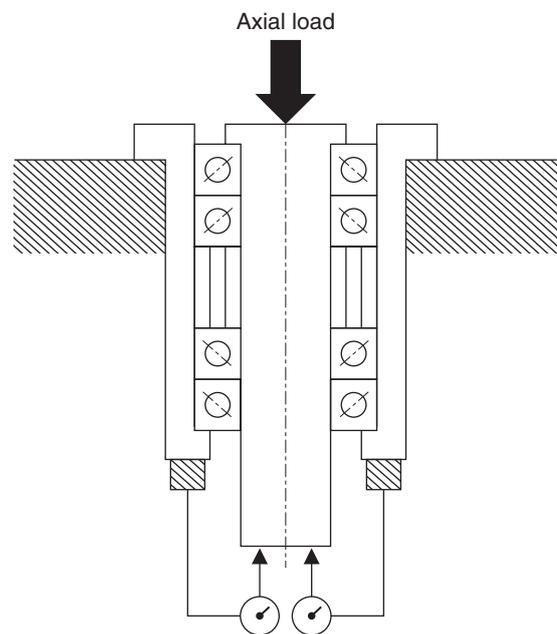


Fig. 1. 28 Measuring axial rigidity

③ Check using the proper vibrations

The preload is confirmed referring to the correlation between the spring constant of the bearing and the preload (Fig. 1. 29).

This method guarantees accuracy and repeatability of measured values.

However, the fixing method has to be meticulously inspected and standardized because the results are affected by the fixing method.

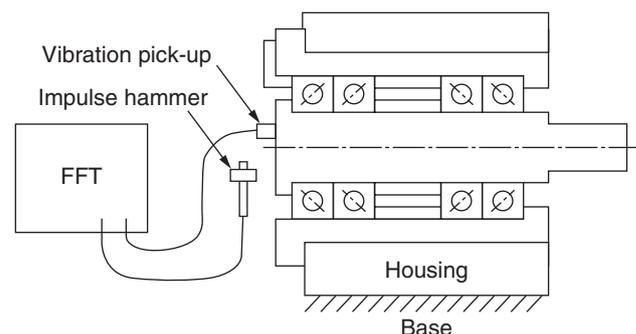


Fig. 1. 29 Measuring eigenfrequency

1. 2. 5(2) Breaking-in

In case of the bearings for grease lubrication, after installation of a bearing, problems are likely to occur due to rapid temperature rise caused by the immediate application of the maximum specified rotational speed. Therefore, breaking-in of the bearing is recommended, in which rotational speed is increased gradually.

Specifically, roller bearings require adequate breaking-in.

Fig. 1. 30 shows an example of breaking-in.

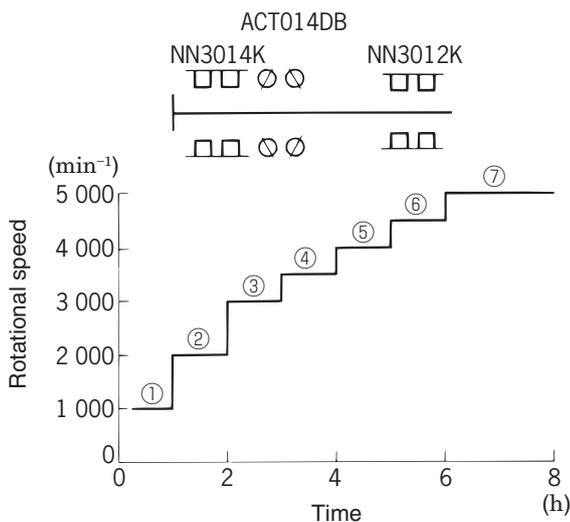


Fig. 1. 30 Example of breaking-in
(In case of 5 000 min⁻¹ max. speed)

If carrying out the break-in, after increasing the rotational speed, wait until the temperature of the bearing stops to increase or starts to decrease. Then, increase the rotational speed further. (Refer to Fig. 1. 31.)

Never increase the rotational speed when the temperature of the bearing is increasing.

The higher the temperature of the bearing becomes, the faster the grease deteriorates. Therefore, it is important to monitor the temperature during the breaking-in. When the temperature reaches a certain level, stop the operation temporarily. After the bearing cools off, resume the break-in starting from the rotational speed at which the operation was stopped or lower.

If the temperature is measured on the outside surface of the housing or retaining plate, the temperature at which the operation should be stopped is the room temperature plus 30 to 40°C (Supposing that the room temperature is 15 to 25°C).

The break-in is not required for the bearings lubricated with oil. However, if the bearings are used for the first time or after stored for an extended period of time, it is recommended to carry out the break-in because an abrupt increase of temperature may be expected due to the oil remaining in the lubrication duct and the inside of the bearing (excessive oil quantity).

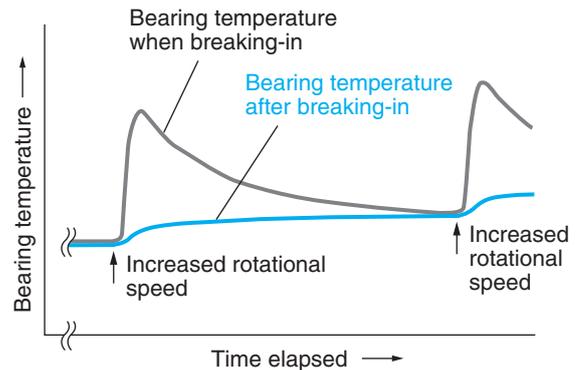


Fig. 1. 31 Bearing temperature increase before and after breaking-in

Point

- The breaking-in pattern should be based on a pattern of increased rotational speed ⇒ temperature equilibration ⇒ increased rotational speed.
- Set the amount of the rotational speed increase to be smaller than the maximum rotational speed of the vicinity.
- Even oil lubrication is affected by initial lubrication. Therefore, we recommend that you perform breaking-in.

1. 2. 5(3) Trial run and inspection

A trial run and inspection are carried out when bearings have been mounted, in order to check whether the mounting is adequate.

In the case of a small spindle, the rotation condition is examined initially by rotating it manually. After confirming that the below conditions do not exist, a further inspection is carried out by a powered run.

- Unsmoothness.....Possible causes include the insertion of foreign matter and flaws on the rolling surfaces. Grease used in grease lubrication may cause a phenomenon of unsmoothness at the initial stage. In such cases, unsmoothness disappears after breaking-in.
- Excessive torque.....Possible causes are friction in (heavy) the sealing device, insufficient clearance, etc.
- Uneven rotational.....Possible causes are defective torque mounting, and / or errors in mounting dimensions.

In the case of a large spindle that cannot be rotated manually, start it under unloaded condition and immediately after starting, turn the power off and allow to coast.

After verifying that the shaft is free of abnormal vibration or noise and rotates smoothly, proceed to powered run.

Powered run should be started with no load applied and at a low speed, before being increased gradually to a given condition.

Noise, temperature increase, and vibration are principal judging factors in powered run and inspection. If a faulty condition such as shown in **Tables 1. 4** and **1. 5** occurs, conduct a further inspection immediately.

In some cases, it is necessary to remove the bearing for inspection.

Table 1. 4 Bearing noises, causes, and countermeasures

Noise types		Causes	Countermeasures
Cyclic	Flaw noise (similar to noise when punching a rivet ¹⁾) Brinelling noise (unclear siren-line noise ¹⁾)	Flaw on raceway Brinelling on raceway	} Improve mounting procedure, cleaning method and rust preventive method. Replace bearing.
	Flaking noise (similar to a large hammering noise ¹⁾)	Flaking on raceway	
Not cyclic	Dirt noise (an irregular sandy noise ¹⁾)	Insertion of foreign matter	Improve cleaning method, sealing device. Use clean lubricant. Replace bearing.
	Flaw noise, flaking noise	Flaws and flaking on rolling elements	Replace bearing.
	Squeak noise (often heard in cylindrical roller bearing with grease lubrication, especially in winter or at low temperature)	If noise is caused by improper lubrication, a proper lubricant should be selected. In general, however, serious damage will not be caused by an improper lubricant if used continuously.	
Others	Abnormally large metallic sound	Abnormal load Incorrect mounting Insufficient amount of or improper lubricant	Review fitting, clearance. Adjust preload. Improve accuracy in processing and mounting shafts and housings. Improve sealing device. Refill lubricant. Select proper lubricant.

[Note] 1) In case of slow or medium rotation.

Table 1. 5 Causes and countermeasures for abnormal temperature rise

Causes	Countermeasures
Too much lubricant	Reduce lubricant amount
Insufficient lubricant	Refill lubricant
Improper lubricant	Select proper lubricant
Abnormal load	Review fitting and clearance conditions and adjust preload
Improper mounting (excessive friction)	Improve accuracy in processing and mounting shaft and housing. Review fitting. Improve sealing device.

Normally, listening rods are employed for bearing noise inspections. The device, which detects abnormalities through sound vibration, and the system, which utilizes acoustic emission for abnormality detection, are useful for more precise inspection.

In general, bearing temperature can be estimated from housing temperature, but the most accurate method is to measure the temperature of outer rings directly via lubrication holes.

Normally, bearing temperature begins to rise gradually when operation is just starting; and, unless the bearing has some abnormality, the temperature stabilizes within one or two hours.

Therefore, a rapid rise in temperature or unusually high temperature indicates some abnormality.

1. 2. 6 Dismounting of bearings

Dismounting a bearing for reuse or identification of causes of failure should be carried out in a careful manner similar to that of when mounted. Care should be taken to avoid damage to the bearing and other parts.

Specifically, when dismounting a bearing involving an interference, the dismounting process of the bearing should be taken into consideration at the designing stage of the shaft and housing.

It is recommended to make a jig for dismounting where appropriate.



IV . Examples of Bearing Failures

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1. Bearing failures, causes and countermeasures.....	200
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1. Bearing failures, causes and countermeasures

It is necessary to carry out the maintenance and inspection to use the machine equipment always in stable conditions.

The bearing is an important part of the machine installation. If the bearing is damaged, the machine may become nonoperating and other inadvertent effects may occur.

Rotation noise, vibrations, temperature and torque are important phenomena to determine the status of the bearing. If any abnormality is perceived in such phenomena, it is necessary to immediately find the cause of the problem and take appropriate measures.

In **Table 1. 1**, bearing failures, possible causes and countermeasures are shown.

Table 1. 1 Bearing failures, causes and countermeasures

Phenomena	Causes	Countermeasures	Notes	
Temperature rise	Excessive	Excessively small quantity of lubricant	<ul style="list-style-type: none"> • Check the quantity of the enclosed grease and the oil / air blow. • Check that there is no leakage in the oil / air pipe. 	<ul style="list-style-type: none"> • Usually this phenomenon is accompanied by metallic noise. • Grease may be deteriorated or leaking if this phenomenon occurs during normal operation in case of grease lubrication.
		Excessively large quantity of lubricant	<ul style="list-style-type: none"> • Check the quantity of the enclosed grease and the oil / air blow. 	<ul style="list-style-type: none"> • In case of grease lubrication, the breaking-in may be insufficient.
		Angular contact ball bearing: excessive preload Cylindrical roller bearing: excessive negative clearance	<ul style="list-style-type: none"> • Check the bearing axial clearance and mounting conditions. 	<ul style="list-style-type: none"> • Refer to case ① (page 201).
		Inadequate mounting precision	<ul style="list-style-type: none"> • Check that there is no misalignment. 	<ul style="list-style-type: none"> • If reinstalling the bearing, it is necessary to check the precision of the parts after dismounting it.
		Insufficient cooling	<ul style="list-style-type: none"> • Check the availability of the cooling capacity required. 	
		External factors	<ul style="list-style-type: none"> • Check that the belt tension is not excessive, the built-in motor is not heated excessively, and the coupling core is precisely placed. 	
		Deterioration of bearing	<ul style="list-style-type: none"> • Check operating conditions and bearing specifications. • Replace the bearing. 	<ul style="list-style-type: none"> • Usually this phenomenon is accompanied by torque rise.
	Instable	Oil / air lubrication: bad exhaust Grease lubrication: insufficient breaking-in	<ul style="list-style-type: none"> • Check the oil / air exhaust route. 	<ul style="list-style-type: none"> • In case of oil / air lubrication, if the oil blows intermittently (irregularly) from the exhaust port, the exhaust (oil drainage) is not carried out correctly.
Noise	Metallic noise	Excessively small quantity of lubricant	<ul style="list-style-type: none"> • Check the quantity of the enclosed grease and the oil / air blow. • Check that there is no leakage in the oil / air pipe. 	<ul style="list-style-type: none"> • This phenomenon is accompanied by excessive temperature rise. • Grease may be deteriorated or leaking if this phenomenon occurs during normal operation in case of grease lubrication.
	Continuous noise	Contact and interference between all rotating parts and all non-rotating parts	<ul style="list-style-type: none"> • Check the conditions of the mounted parts, including the labyrinth. 	<ul style="list-style-type: none"> • If this phenomenon occurs during normal operation, it may be the secondary phenomenon of a temporal failure.
		Unbalanced shaft and imprecise rotation	<ul style="list-style-type: none"> • Adjust the shaft balance. • Readjust the rotational accuracy. 	<ul style="list-style-type: none"> • This phenomenon is accompanied by buzzing noise. • If this phenomenon occurs during normal operation, it may be the secondary phenomenon of a temporal failure.
		Rough surface and brinelling of raceway	<ul style="list-style-type: none"> • Replace the bearing in the case of entry of foreign matter, flaking, or excessive load. 	<ul style="list-style-type: none"> • Refer to cases ② and ③ (page 201 and 202). • If there is no measure taken, this phenomenon may occur repeatedly.
	Intermittent noise	Noise of cages, and slippage because of preload leakage	<ul style="list-style-type: none"> • If the preload is excessively small, check the axial clearance and mounting conditions of the bearing. 	
Vibrations		Unbalanced shaft	<ul style="list-style-type: none"> • Adjust the shaft balance. • Readjust the rotational accuracy. 	
		Excessive radial clearance of cylindrical roller bearing	<ul style="list-style-type: none"> • Check the radial clearance of the bearing. Check the mounting conditions. 	<ul style="list-style-type: none"> • In case of the bearing with tapered bore, the shaft nut may be loose. • Also, the wear may have worsened.
		Rough surface and brinelling of raceway	<ul style="list-style-type: none"> • Replace the bearing in the case of entry of foreign matter, flaking, or excessive load. 	<ul style="list-style-type: none"> • Refer to cases ② and ③ (page 201 and 202).

Case ① Excessive bearing preload

Causes

1) Inadequate fitting

- Excessively large interference of the inner ring
⇒ Due to the increase of interference of the inner ring and the shaft, the diameter of the raceway expands and the preload increases.

- Excessively small clearance of outer ring fitting surface
⇒ If a temperature difference is generated between the outer ring and the housing, the outer ring is compressed and the diameter of the raceway shrinks, resulting in an increase in preload.

2) Inadequate tightening force of the bearing

- If the tightening force of the inner ring (nut shaft force etc.) is excessively large, the inner ring is deformed in axial direction and the preload increases.

3) Excessive cooling of the housing

- If the outer surface of the housing is excessively cooled, the second phenomenon described in item 1) is generated and the preload increases.

4) Failure in constant-pressure preloading and variable preloading system

- If the outer ring cannot be moved smoothly by the constant-pressure preloading and the preload variable spindle, the same phenomenon as in the case of the position preloading is generated, and the preload increases.

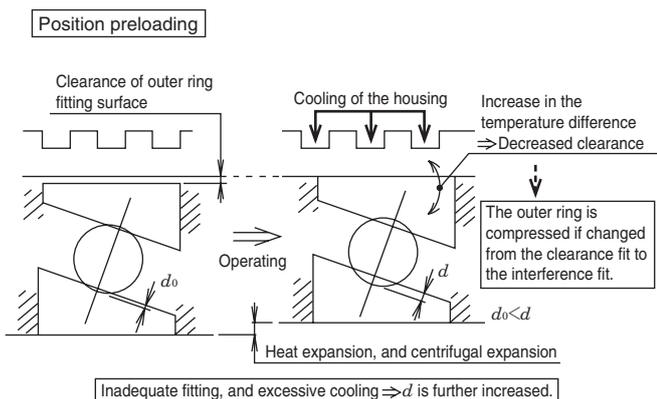


Fig. 1.1 Cause of increase in preload

Case ② Entry of foreign matter

Major types of foreign matter are as follows.

- Coolant
- Chippings
- Iron chips (housing material)

Causes

1) Poor sealing performance

If the labyrinth is not adequately configured for use conditions, the sufficient sealing effect is not obtained, and foreign matter including coolant, may be trapped in the bearing.

2) Part not cleaned sufficiently

If the parts are not cleaned sufficiently, foreign matter such as small burrs and barbs may exist. This foreign matter may fall into the inside of the bearing during the operation.

3) Dirty lubricant

If the oil lubricant is not completely washed out of the pipe, or if the environment for the enclosing grease is not adequate, foreign matter may be trapped in the lubricant and the bearing may be damaged.

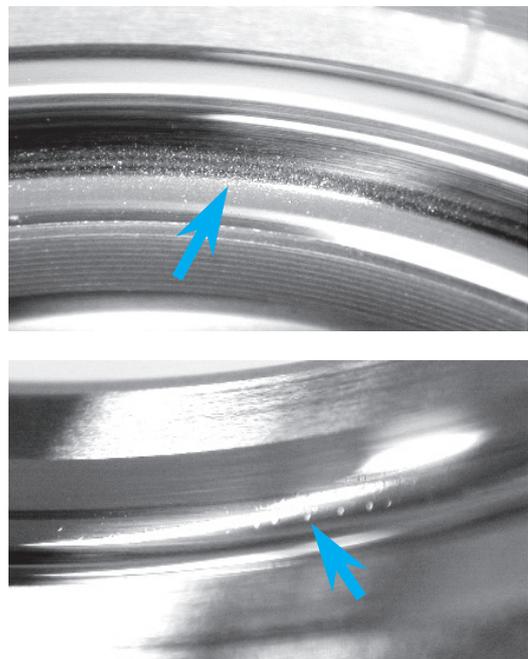


Fig. 1.2 Example of biting flaws formed in raceway because of entry of foreign matter

Case ③ Damage on the raceway surface (nick and flaking)

Causes

1) Nick

Nick may be produced on the raceway surface if the main shaft is hit, any excessive load is applied to the bearing because of the clamping and unclamping of the tool, or the bearing is not properly handled.

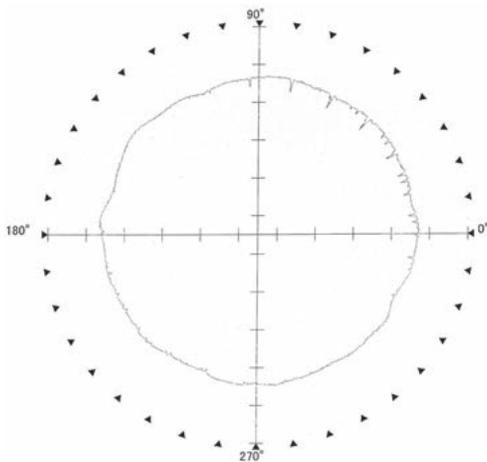


Fig. 1. 3 Example of nicks

2) Flaking

As the bearing becomes old, the flaking occurs if the load is applied repeatedly to the raceway surface.

However, even in case of a new bearing, the flaking may occur if an excessive load is applied to the bearing or the oil film is formed insufficiently.

Also, the flaking may be generated by the brinelling (nicks).

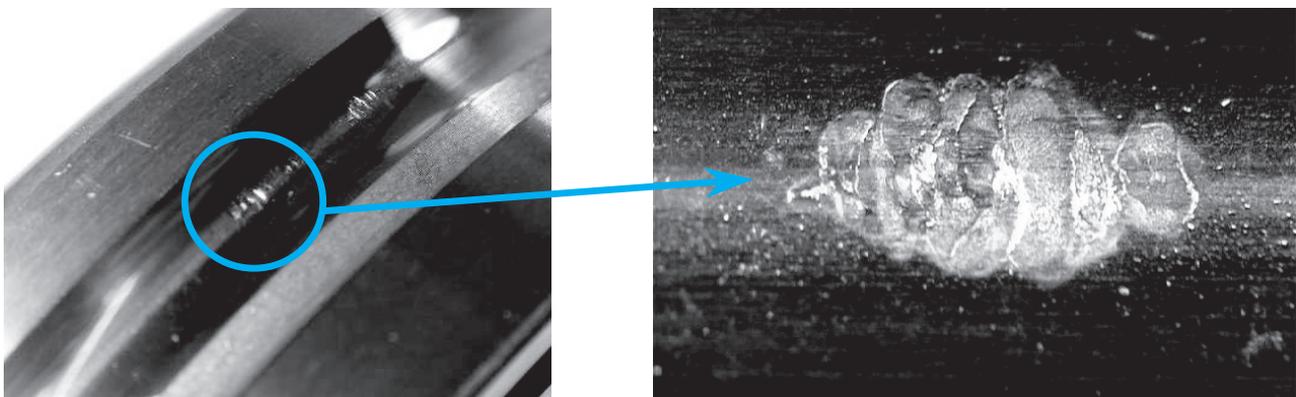


Fig. 1. 4 Example of flaking



V . Supplementary Tables

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Supplementary table 1 Shaft tolerances (deviation from nominal dimensions)

Unit : μm

Nominal shaft dia. (mm)		Deviation classes of shaft diameter																								Nominal shaft dia. (mm)									
over	up to	g4	g5	g6	h4	h5	h6	h7	js3	js4	js5	js6	js7	j5	j6	j7	k3	k4	k5	k6	k7	m4	m5	m6	m7	n4	n5	n6	p6	r5	r6	r7	over	up to	
3	6	-4	-4	-4	0	0	0	0	± 1.2	± 2	± 2.5	± 4	± 6	+3	+6	+8	+2.5	+5	+6	+9	+13	+8	+9	+12	+16	+12	+13	+16	+20	+20	+23	+27	3	6	
		-8	-9	-12	-4	-5	-8	-12						-2	-2	-4	0	+1	+1	+1	+1	+4	+4	+4	+4	+8	+8	+8	+12	+15	+15	+15			
6	10	-5	-5	-5	0	0	0	0	± 1.2	± 2	± 3	± 4.5	± 7.5	+4	+7	+10	+2.5	+5	+7	+10	+16	+10	+12	+15	+21	+14	+16	+19	+24	+25	+28	+34	6	10	
		-9	-11	-14	-4	-6	-9	-15						-2	-2	-5	0	+1	+1	+1	+1	+6	+6	+6	+6	+10	+10	+10	+15	+19	+19	+19			
10	18	-6	-6	-6	0	0	0	0	± 1.5	± 2.5	± 4	± 5.5	± 9	+5	+8	+12	+3	+6	+9	+12	+19	+12	+15	+18	+25	+17	+20	+23	+29	+31	+34	+41	10	18	
		-11	-14	-17	-5	-8	-11	-18						-3	-3	-6	0	+1	+1	+1	+1	+7	+7	+7	+7	+12	+12	+12	+18	+23	+23	+23			
18	30	-7	-7	-7	0	0	0	0	± 2	± 3	± 4.5	± 6.5	± 10.5	+5	+9	+13	+4	+8	+11	+15	+23	+14	+17	+21	+29	+21	+24	+28	+35	+37	+41	+49	18	30	
		-13	-16	-20	-6	-9	-13	-21						-4	-4	-8	0	+2	+2	+2	+2	+8	+8	+8	+8	+15	+15	+15	+22	+28	+28	+28			
30	50	-9	-9	-9	0	0	0	0	± 2	± 3.5	± 5.5	± 8	± 12.5	+6	+11	+15	+4	+9	+13	+18	+27	+16	+20	+25	+34	+24	+28	+33	+42	+45	+50	+59	30	50	
		-16	-20	-25	-7	-11	-16	-25						-5	-5	-10	0	+2	+2	+2	+2	+9	+9	+9	+9	+17	+17	+17	+26	+34	+34	+34			
50	80	-10	-10	-10	0	0	0	0	± 2.5	± 4	± 6.5	± 9.5	± 15	+6	+12	+18	+5	+10	+15	+21	+32	+19	+24	+30	+41	+28	+33	+39	+51	+54	+60	+71	50	65	
		-18	-23	-29	-8	-13	-19	-30						-7	-7	-12	0	+2	+2	+2	+2	+11	+11	+11	+11	+20	+20	+20	+32	+41	+41	+41			
80	120	-12	-12	-12	0	0	0	0	± 3	± 5	± 7.5	± 11	± 17.5	+6	+13	+20	+6	+13	+18	+25	+38	+23	+28	+35	+48	+33	+38	+45	+59	+66	+73	+86	80	100	
		-22	-27	-34	-10	-15	-22	-35						-9	-9	-15	0	+3	+3	+3	+3	+13	+13	+13	+13	+23	+23	+23	+37	+45	+51	+51			
120	180	-14	-14	-14	0	0	0	0	± 4	± 6	± 9	± 12.5	± 20	+7	+14	+22	+8	+15	+21	+28	+43	+27	+33	+40	+55	+39	+45	+52	+68	+81	+88	+103	120	140	
		-26	-32	-39	-12	-18	-25	-40						-11	-11	-18	0	+3	+3	+3	+3	+15	+15	+15	+15	+27	+27	+27	+43	+51	+55	+65			
180	250	-15	-15	-15	0	0	0	0	± 5	± 7	± 10	± 14.5	± 23	+7	+16	+25	+10	+18	+24	+33	+50	+31	+37	+46	+63	+45	+51	+60	+79	+97	+106	+123	180	200	
		-29	-35	-44	-14	-20	-29	-46						-13	-13	-21	0	+4	+4	+4	+4	+17	+17	+17	+17	+31	+31	+31	+50	+60	+77	+77			
250	315	-17	-17	-17	0	0	0	0	± 6	± 8	± 11.5	± 16	± 26	+7	+16	+26	+12	+20	+27	+36	+56	+36	+43	+52	+72	+50	+57	+66	+88	+117	+126	+146	250	280	
		-33	-40	-49	-16	-23	-32	-52						-16	-16	-26	0	+4	+4	+4	+4	+20	+20	+20	+20	+34	+34	+34	+56	+66	+88	+94	+94		
315	400	-18	-18	-18	0	0	0	0	± 6.5	± 9	± 12.5	± 18	± 28.5	+7	+18	+29	+13	+22	+29	+40	+61	+39	+46	+57	+78	+55	+62	+73	+98	+133	+144	+165	315	355	
		-36	-43	-54	-18	-25	-36	-57						-18	-18	-28	0	+4	+4	+4	+4	+21	+21	+21	+21	+37	+37	+37	+62	+73	+98	+108	+108		
400	500	-20	-20	-20	0	0	0	0	± 7.5	± 10	± 13.5	± 20	± 31.5	+7	+20	+31	+15	+25	+32	+45	+68	+43	+50	+63	+86	+60	+67	+80	+108	+153	+166	+189	400	450	
		-40	-47	-60	-20	-27	-40	-63						-20	-20	-32	0	+5	+5	+5	+5	+23	+23	+23	+23	+40	+40	+40	+68	+80	+108	+126	+126		
500	630	-22	-22	-22	0	0	0	0	± 8	± 11	± 16	± 22	± 35	—	—	—	+16	+22	+32	+44	+70	+48	+58	+70	+96	+66	+76	+88	+122	+182	+194	+220	500	560	
		-44	-54	-66	-22	-32	-44	-70						—	—	—	0	0	0	0	0	+26	+26	+26	+26	+44	+44	+44	+78	+150	+150	+150			
630	800	-24	-24	-24	0	0	0	0	± 9	± 12.5	± 18	± 25	± 40	—	—	—	+18	+25	+36	+50	+80	+55	+66	+80	+110	+75	+86	+100	+138	+211	+225	+255	630	710	
		-49	-60	-74	-25	-36	-50	-80						—	—	—	0	0	0	0	0	+30	+30	+30	+30	+50	+50	+50	+88	+175	+175	+175			
800	1 000	-26	-26	-26	0	0	0	0	± 10.5	± 14	± 20	± 28	± 45	—	—	—	+21	+28	+40	+56	+90	+62	+74	+90	+124	+84	+96	+112	+156	+250	+266	+300	800	900	
		-54	-66	-82	-28	-40	-56	-90						—	—	—	0	0	0	0	0	+34	+34	+34	+34	+56	+56	+56	+100	+210	+210	+210			
																	0	0	0	0	0									+260	+276	+310	900	1 000	
																														+220	+220	+220			

Supplementary table 2 Housing bore tolerances (deviation from nominal dimensions)

Unit : μm

Nominal bore dia. (mm)		Deviation classes of housing bore diameter																								Nominal bore dia. (mm)						
over	up to	G5	G6	G7	H4	H5	H6	H7	H8	JS4	JS5	JS6	JS7	J6	J7	K4	K5	K6	K7	M4	M5	M6	M7	N4	N5	N6	N7	P5	P6	P7	over	up to
10	18	+14 + 6	+17 + 6	+ 24 + 6	+ 5 0	+ 8 0	+11 0	+18 0	+27 0	± 2.5	± 4	± 5.5	± 9	+ 6 - 5	+10 - 8	+ 1 - 4	+ 2 - 6	+ 2 - 9	+ 6 -12	- 5 -10	- 4 -12	- 4 -15	0 -18	-10 -15	- 9 -17	- 9 -20	- 5 -23	-15 -23	-15 -26	-11 -29	10	18
18	30	+16 + 7	+20 + 7	+ 28 + 7	+ 6 0	+ 9 0	+13 0	+21 0	+33 0	± 3	± 4.5	± 6.5	± 10.5	+ 8 - 5	+12 - 9	0 - 6	+ 1 - 8	+ 2 -11	+ 6 -15	- 6 -12	- 5 -14	- 4 -17	0 -21	-13 -19	-12 -21	-11 -24	- 7 -28	-19 -28	-18 -31	-14 -35	18	30
30	50	+20 + 9	+25 + 9	+ 34 + 9	+ 7 0	+11 0	+16 0	+25 0	+39 0	± 3.5	± 5.5	± 8	± 12.5	+10 - 6	+14 -11	+ 1 - 6	+ 2 - 9	+ 3 -13	+ 7 -18	- 6 -13	- 5 -16	- 4 -20	0 -25	-14 -21	-13 -24	-12 -28	- 8 -33	-22 -33	-21 -37	-17 -42	30	50
50	80	+23 +10	+29 +10	+ 40 + 10	+ 8 0	+13 0	+19 0	+30 0	+46 0	± 4	± 6.5	± 9.5	± 15	+13 - 6	+18 -12	+ 1 - 7	+ 3 -10	+ 4 -15	+ 9 -21	- 8 -16	- 6 -19	- 5 -24	0 -30	-17 -25	-15 -28	-14 -33	- 9 -39	-27 -40	-26 -45	-21 -51	50	65
																																65
80	120	+27 +12	+34 +12	+ 47 + 12	+10 0	+15 0	+22 0	+35 0	+54 0	± 5	± 7.5	± 11	± 17.5	+16 - 6	+22 -13	+ 1 - 9	+ 2 -13	+ 4 -18	+10 -25	- 9 -19	- 8 -23	- 6 -28	0 -35	-19 -29	-18 -33	-16 -38	-10 -45	-32 -47	-30 -52	-24 -59	80	100
120	180	+32 +14	+39 +14	+ 54 + 14	+12 0	+18 0	+25 0	+40 0	+63 0	± 6	± 9	± 12.5	± 20	+18 - 7	+26 -14	+ 1 -11	+ 3 -15	+ 4 -21	+12 -28	-11 -23	- 9 -27	- 8 -33	0 -40	-23 -35	-21 -39	-20 -45	-12 -52	-37 -55	-36 -61	-28 -68	120	140
180	250	+35 +15	+44 +15	+ 61 + 15	+14 0	+20 0	+29 0	+46 0	+72 0	± 7	± 10	± 14.5	± 23	+22 - 7	+30 -16	0 -14	+ 2 -18	+ 5 -24	+13 -33	-13 -27	-11 -31	- 8 -37	0 -46	-27 -41	-25 -45	-22 -51	-14 -60	-44 -64	-41 -70	-33 -79	180	200
250	315	+40 +17	+49 +17	+ 69 + 17	+16 0	+23 0	+32 0	+52 0	+81 0	± 8	± 11.5	± 16	± 26	+25 - 7	+36 -16	0 -16	+ 3 -20	+ 5 -27	+16 -36	-16 -32	-13 -36	- 9 -41	0 -52	-30 -46	-27 -50	-25 -57	-14 -66	-49 -72	-47 -79	-36 -88	250	280
315	400	+43 +18	+54 +18	+ 75 + 18	+18 0	+25 0	+36 0	+57 0	+89 0	± 9	± 12.5	± 18	± 28.5	+29 - 7	+39 -18	+ 1 -17	+ 3 -22	+ 7 -29	+17 -40	-16 -34	-14 -39	-10 -46	0 -57	-32 -50	-30 -55	-26 -62	-16 -73	-55 -80	-51 -87	-41 -98	315	355
400	500	+47 +20	+60 +20	+ 83 + 20	+20 0	+27 0	+40 0	+63 0	+97 0	± 10	± 13.5	± 20	± 31.5	+33 - 7	+43 -20	0 -20	+ 2 -25	+ 8 -32	+18 -45	-18 -38	-16 -43	-10 -50	0 -63	-35 -55	-33 -60	-27 -67	-17 -80	-61 -88	-55 -95	-45 -108	400	450
500	630	+54 +22	+66 +22	+ 92 + 22	+22 0	+32 0	+44 0	+70 0	+110 0	± 11	± 16	± 22	± 35	—	—	0 -22	0 -32	0 -44	0 -70	-26 -48	-26 -58	-26 -70	-26 -96	-44 -66	-44 -76	-44 -88	-44 -114	- 78 -110	- 78 -122	- 78 -148	500	560
630	800	+60 +24	+74 +24	+104 + 24	+25 0	+36 0	+50 0	+80 0	+125 0	± 12.5	± 18	± 25	± 40	—	—	0 -25	0 -36	0 -50	0 -80	-30 -55	-30 -66	-30 -80	-30 -110	-50 -75	-50 -86	-50 -100	-50 -130	- 88 -124	- 88 -138	- 88 -168	630	710
800	1 000	+66 +26	+82 +26	+116 + 26	+28 0	+40 0	+56 0	+90 0	+140 0	± 14	± 20	± 28	± 45	—	—	0 -28	0 -40	0 -56	0 -90	-34 -62	-34 -74	-34 -90	-34 -124	-56 -84	-56 -96	-56 -112	-56 -146	-100 -140	-100 -156	-100 -190	800	900
1 000	1 250	+75 +28	+94 +28	+133 + 28	+33 0	+47 0	+66 0	+105 0	+165 0	± 16.5	± 23.5	± 33	± 52.5	—	—	0 -33	0 -47	0 -66	0 -105	-40 -73	-40 -87	-40 -106	-40 -145	-66 -99	-66 -113	-66 -132	-66 -171	-120 -167	-120 -186	-120 -225	1 000	1 120

Supplementary table 3 Numerical values for standard tolerance grades IT (ISO 286-1)

Basic size (mm)		Standard tolerance grades (IT)																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14 ¹⁾	15 ¹⁾	16 ¹⁾	17 ¹⁾	18 ¹⁾
over	up to	Tolerances (µm)											Tolerances (mm)						
—	3	0.8	1.2	2	3	4	6	10	14	25	40	60	0.10	0.14	0.26	0.40	0.60	1.00	1.40
3	6	1	1.5	2.5	4	5	8	12	18	30	48	75	0.12	0.18	0.30	0.48	0.75	1.20	1.80
6	10	1	1.5	2.5	4	6	9	15	22	36	58	90	0.15	0.22	0.36	0.58	0.90	1.50	2.20
10	18	1.2	2	3	5	8	11	18	27	43	70	110	0.18	0.27	0.43	0.70	1.10	1.80	2.70
18	30	1.5	2.5	4	6	9	13	21	33	52	84	130	0.21	0.33	0.52	0.84	1.30	2.10	3.30
30	50	1.5	2.5	4	7	11	16	25	39	62	100	160	0.25	0.39	0.62	1.00	1.60	2.50	3.90
50	80	2	3	5	8	13	19	30	46	74	120	190	0.30	0.46	0.74	1.20	1.90	3.00	4.60
80	120	2.5	4	6	10	15	22	35	54	87	140	220	0.35	0.54	0.87	1.40	2.20	3.50	5.40
120	180	3.5	5	8	12	18	25	40	63	100	160	250	0.40	0.63	1.00	1.60	2.50	4.00	6.30
180	250	4.5	7	10	14	20	29	46	72	115	185	290	0.46	0.72	1.15	1.85	2.90	4.60	7.20
250	315	6	8	12	16	23	32	52	81	130	210	320	0.52	0.81	1.30	2.10	3.20	5.20	8.10
315	400	7	9	13	18	25	36	57	89	140	230	360	0.57	0.89	1.40	2.30	3.60	5.70	8.90
400	500	8	10	15	20	27	40	63	97	155	250	400	0.63	0.97	1.55	2.50	4.00	6.30	9.70
500	630	—	—	—	—	—	44	70	110	175	280	440	0.70	1.10	1.75	2.80	4.40	7.00	11.00
630	800	—	—	—	—	—	50	80	125	200	320	500	0.80	1.25	2.00	3.20	5.00	8.00	12.50
800	1 000	—	—	—	—	—	56	90	140	230	360	560	0.90	1.40	2.30	3.60	5.60	9.00	14.00
1 000	1 250	—	—	—	—	—	66	105	165	260	420	660	1.05	1.65	2.60	4.20	6.60	10.50	16.50
1 250	1 600	—	—	—	—	—	78	125	195	310	500	780	1.25	1.95	3.10	5.00	7.80	12.50	19.50
1 600	2 000	—	—	—	—	—	92	150	230	370	600	920	1.50	2.30	3.70	6.00	9.20	15.00	23.00
2 000	2 500	—	—	—	—	—	110	175	280	440	700	1 100	1.75	2.80	4.40	7.00	11.00	17.50	28.00
2 500	3 150	—	—	—	—	—	135	210	330	540	860	1 350	2.10	3.30	5.40	8.60	13.50	21.00	33.00

[Note] 1) Standard tolerance grades IT 14 to IT 18 (incl.) shall not be used for basic sizes less than or equal to 1 mm.

Supplementary table 4 Steel hardness conversion

Rockwell C-scale 1 471.0 N(150 kgf)	Vicker's	Brinell		Rockwell		Shore
		Standard ball	Tungsten carbide ball	A-scale 588.4 N(60 kgf)	B-scale 980.7 N(100 kgf)	
68	940			85.6		97
67	900			85.0		95
66	865			84.5		92
65	832		739	83.9		91
64	800		722	83.4		88
63	772		705	82.8		87
62	746		688	82.3		85
61	720		670	81.8		83
60	697		654	81.2		81
59	674		634	80.7		80
58	653		615	80.1		78
57	633		595	79.6		76
56	613		577	79.0		75
55	595	—	560	78.5		74
54	577	—	543	78.0		72
53	560	—	525	77.4		71
52	544	500	512	76.8		69
51	528	487	496	76.3		68
50	513	475	481	75.9		67
49	498	464	469	75.2		66
48	484	451	455	74.7		64
47	471	442	443	74.1		63
46	458		432	73.6		62
45	446		421	73.1		60
44	434		409	72.5		58
43	423		400	72.0		57
42	412		390	71.5		56
41	402		381	70.9		55
40	392		371	70.4	—	54
39	382		362	69.9	—	52
38	372		353	69.4	—	51
37	363		344	68.9	—	50
36	354		336	68.4	(109.0)	49
35	345		327	67.9	(108.5)	48
34	336		319	67.4	(108.0)	47
33	327		311	66.8	(107.5)	46
32	318		301	66.3	(107.0)	44
31	310		294	65.8	(106.0)	43
30	302		286	65.3	(105.5)	42
29	294		279	64.7	(104.5)	41
28	286		271	64.3	(104.0)	41
27	279		264	63.8	(103.0)	40
26	272		258	63.3	(102.5)	38
25	266		253	62.8	(101.5)	38
24	260		247	62.4	(101.0)	37
23	254		243	62.0	100.0	36
22	248		237	61.5	99.0	35
21	243		231	61.0	98.5	35
20	238		226	60.5	97.8	34
(18)	230		219	—	96.7	33
(16)	222		212	—	95.5	32
(14)	213		203	—	93.9	31
(12)	204		194	—	92.3	29
(10)	196		187		90.7	28
(8)	188		179		89.5	27
(6)	180		171		87.1	26
(4)	173		165		85.5	25
(2)	166		158		83.5	24
(0)	160		152		81.7	24

Supplementary table 5(1) SI units and conversion factors

Mass	SI units	Other units ¹⁾	Conversion into SI units	Conversion from SI units
Angle	rad [radian(s)]	° [degree(s)] * ' [minute(s)] * " [second(s)] *	1° = π /180 rad 1' = π /10 800 rad 1" = π /648 000 rad	1 rad = 57.295 78°
Length	m [meter(s)]	Å [Angstrom unit] μ [micron(s)] in [inch(es)] ft [foot(feet)] yd [yard(s)] mile [mile(s)]	1Å = 10 ⁻¹⁰ m = 0.1 nm = 100 pm 1μ = 1 μm 1in = 25.4 mm 1ft = 12 in = 0.304 8 m 1yd = 3 ft = 0.914 4 m 1mile = 5 280 ft = 1 609.344 m	1m = 10 ¹⁰ Å 1m = 39.37 in 1m = 3.280 8 ft 1m = 1.093 6 yd 1km = 0.621 4 mile
Area	m ²	a [are(s)] ha [hectare(s)] acre [acre(s)]	1a = 100 m ² 1ha = 10 ⁴ m ² 1acre = 4 840 yd ² = 4 046.86 m ²	1km ² = 247.1 acre
Volume	m ³	ℓ , L [liter(s)] * cc [cubic centimeters] gal(US) [gallon(s)] floz(US) [fluid ounce(s)] barrel(US) [barrels(US)]	1 ℓ = 1 dm ³ = 10 ⁻³ m ³ 1cc = 1 cm ³ = 10 ⁻⁶ m ³ 1gal(US) = 231 in ³ = 3.785 41 dm ³ 1floz(US) = 29.573 5 cm ³ 1barrel(US) = 158.987 dm ³	1m ³ = 10 ³ ℓ 1m ³ = 10 ⁶ cc 1m ³ = 264.17 gal 1m ³ = 33 814 floz 1m ³ = 6.289 8 barrel
Time	s [second(s)]	min [minute(s)] * h [hour(s)] * d [day(s)] *		
Angular velocity	rad / s			
Velocity	m / s	kn [knot(s)] * m / h *	1kn = 1 852 m / h	1km / h = 0.539 96 kn
Acceleration	m / s ²	G	1G = 9.806 65 m / s ²	1m / s ² = 0.101 97 G
Frequency	Hz [hertz]	c / s [cycle(s)/second]	1c / s = 1s ⁻¹ = 1 Hz	
Rotational frequency	s ⁻¹	rpm [revolutions per minute] * min ⁻¹ * r / min	1rpm = 1 / 60 s ⁻¹	1s ⁻¹ = 60 rpm
Mass	kg [kilogram(s)]	t [ton(s)] * lb [pound(s)] gr [grain(s)] oz [ounce(s)] ton (UK) [ton(s) (UK)] ton (US) [ton(s) (US)] car [carat(s)]	1t = 10 ³ kg 1lb = 0.453 592 37 kg 1gr = 64.798 91 mg 1oz = 1/16 lb = 28.349 5 g 1ton(UK) = 1 016.05 kg 1ton(US) = 907.185 kg 1car = 200 mg	1kg = 2.204 6 lb 1g = 15.432 4 gr 1kg = 35.274 0 oz 1t = 0.984 2 ton (UK) 1t = 1.102 3 ton (US) 1g = 5 car

[Notes] 1) * : Unit can be used as an SI unit.
No asterisk : Unit cannot be used.

Supplementary table 5(2) SI units and conversion factors

Mass	SI units	Other units ¹⁾	Conversion into SI units	Conversion from SI units
Density	kg / m ³			
Linear density	kg / m			
Momentum	kg·m / s			
Moment of momentum, angular momentum	} kg·m ² / s			
Moment of inertia		kg·m ²		
Force	N [newton(s)]	dyn [dyne(s)] kgf [kilogram-force] gf [gram-force] tf [ton-force] lbf [pound-force]	1dyn = 10 ⁻⁵ N 1kgf = 9.806 65 N 1gf = 9.806 65×10 ⁻³ N 1tf = 9.806 65×10 ³ N 1lbf = 4.448 22 N	1N = 10 ⁵ dyn 1N = 0.101 97 kgf 1N = 0.224 809 lbf
Moment of force	N·m [Newton meter(s)]	gf·cm kgf·cm kgf·m tf·m lbf·ft	1gf·cm = 9.806 65×10 ⁻⁵ N·m 1kgf·cm = 9.806 65×10 ⁻² N·m 1kgf·m = 9.806 65 N·m 1tf·m = 9.806 65×10 ³ N·m 1lbf·ft = 1.355 82 N·m	1N·m = 0.101 97 kgf·m 1N·m = 0.737 56 lbf·ft
Pressure, Normal stress	Pa [Pascal(s)] or N / m ² {1 Pa = 1 N / m ² }	gf / cm ² kgf / mm ² kgf / m ² lbf / in ² bar [bar(s)] at [engineering air pressure] mH ₂ O, mAq [meter water column] atm [atmosphere] mHg [meter mercury column] Torr [torr]	1gf / cm ² = 9.806 65×10 Pa 1kgf / mm ² = 9.806 65×10 ⁵ Pa 1kgf / m ² = 9.806 65 Pa 1lbf / in ² = 6 894.76 Pa 1bar = 10 ⁵ Pa 1at = 1kgf / cm ² = 9.806 65×10 ⁴ Pa 1mH ₂ O = 9.806 65×10 ³ Pa 1atm = 101 325 Pa 1mHg = $\frac{101\ 325}{0.76}$ Pa 1Torr = 1 mmHg = 133.322 Pa	1MPa = 0.101 97 kgf / mm ² 1Pa = 0.101 97 kgf / m ² 1Pa = 0.145×10 ⁻³ lbf / in ² 1Pa = 10 ⁻² mbar 1Pa = 7.500 6×10 ⁻³ Torr
Viscosity	Pa·s [pascal second]	P [poise] kgf·s / m ²	10 ⁻² P = 1 cP = 1 mPa·s 1kgf·s / m ² = 9.806 65 Pa·s	1Pa·s = 0.101 97 kgf·s / m ²
Kinematic viscosity	m ² / s	St [stokes]	10 ⁻² St = 1 cSt = 1 mm ² / s	
Surface tension	N / m			

Supplementary table 5(3) SI units and conversion factors

Mass	SI units	Other units ¹⁾	Conversion into SI units	Conversion from SI units
Work, energy	J [joule(s)] {1 J = 1 N·m}	eV [electron volt(s)] * erg [erg(s)] kgf·m lbf·ft	1 eV = (1.602 189 2±0.000 004 6)×10 ⁻¹⁹ J 1 erg = 10 ⁻⁷ J 1 kgf·m = 9.806 65 J 1 lbf·ft = 1.355 82 J	1 J = 10 ⁷ erg 1 J = 0.101 97 kgf·m 1 J = 0.737 56 lbf·ft
Power	W [watt(s)]	erg / s [ergs per second] kgf·m / s PS [French horse-power] HP [horse-power (British)] lbf·ft / s	1 erg / s = 10 ⁻⁷ W 1 kgf·m / s = 9.806 65 W 1 PS = 75 kgf·m / s = 735.5 W 1 HP = 550 lbf·ft / s = 745.7 W 1 lbf·ft / s = 1.355 82 W	1 W = 0.101 97 kgf·m / s 1 W = 0.001 36 PS 1 W = 0.001 34 HP
Thermo-dynamic temperature	K [kelvin(s)]			
Celsius temperature	°C [Celsius(s)] {t°C = (t+273.15)K}	°F [degree(s) Fahrenheit]	t °F = $\frac{5}{9} (t-32)°C$	t °C = $(\frac{9}{5} t+32)°F$
Linear expansion coefficient	K ⁻¹	°C ⁻¹ [per degree]		
Heat	J [joule(s)] {1 J = 1 N·m}	erg [erg(s)] kgf·m cal _{IT} [I. T. calories]	1 erg = 10 ⁻⁷ J 1 cal _{IT} = 4.186 8 J 1 Mcal _{IT} = 1.163 kW·h	1 J = 10 ⁷ erg 1 J = 0.238 85 cal _{IT} 1 kW·h = 0.86×10 ⁶ cal _{IT}
Thermal conductivity	W / (m·K)	W / (m·°C) cal / (s·m·°C)	1 W / (m·°C) = 1 W / (m·K) 1 cal / (s·m·°C) = 4.186 05 W / (m·K)	
Coefficient of heat transfer	W / (m ² ·K)	W / (m ² ·°C) cal / (s·m ² ·°C)	1 W / (m ² ·°C) = 1 W / (m ² ·K) 1 cal / (s·m ² ·°C) = 4.186 05 W / (m ² ·K)	
Heat capacity	J / K	J / °C	1 J / °C = 1 J / K	
Massic heat capacity	J / (kg·K)	J / (kg·°C)		

[Notes] 1) * : Unit can be used as an SI unit.
No asterisk : Unit cannot be used.

Supplementary table 5(4) SI units and conversion factors

Mass	SI units	Other units ¹⁾	Conversion into SI units	Conversion from SI units
Electric current	A [ampere(s)]			
Electric charge, quantity of electricity	C [coulomb(s)] {1 C = 1 A·s}	A·h *	1 A·h = 3.6 kC	
Tension, electric potential	V [volt(s)] {1 V = 1 W / A}			
Capacitance	F [farad(s)] {1 F = 1 C / V}			
Magnetic field strength	A / m	Oe [oersted(s)]	$1 \text{ Oe} = \frac{10^3}{4\pi} \text{ A / m}$	$1 \text{ A / m} = 4\pi \times 10^{-3} \text{ Oe}$
Magnetic flux density	T [tesla(s)] { $1 \text{ T} = 1 \text{ N} / (\text{A} \cdot \text{m})$ $= 1 \text{ Wb} / \text{m}^2$ $= 1 \text{ V} \cdot \text{s} / \text{m}^2$ }	Gs [gauss(es)] γ [gamma(s)]	$1 \text{ Gs} = 10^{-4} \text{ T}$ $1 \gamma = 10^{-9} \text{ T}$	$1 \text{ T} = 10^4 \text{ Gs}$ $1 \text{ T} = 10^9 \gamma$
Magnetic flux	Wb [weber(s)] {1 Wb = 1 V·s}	Mx [maxwell(s)]	$1 \text{ Mx} = 10^{-8} \text{ Wb}$	$1 \text{ Wb} = 10^8 \text{ Mx}$
Self inductance	H [henry(-ries)] {1 H = 1 Wb / A}			
Resistance (to direct current)	Ω [ohm(s)] {1 Ω = 1 V / A}			
Conductance (to direct current)	S [siemens] {1 S = 1 A / V}			
Active power	W { $1 \text{ W} = 1 \text{ J} / \text{s}$ $= 1 \text{ A} \cdot \text{V}$ }			

[Refer.] Principal units conversion table

Force

N	dyn	kgf
1	1×10^5	$1.019\ 72 \times 10^{-1}$
1×10^{-5}	1	$1.019\ 72 \times 10^{-6}$
9.806 65	$9.806\ 65 \times 10^5$	1

Torque

N·m	mN·m	$\mu\text{N}\cdot\text{m}$	kgf·m	kgf·cm	gf·cm
1	1×10^3	1×10^6	$1.019\ 72 \times 10^{-1}$	$1.019\ 72 \times 10$	$1.019\ 72 \times 10^4$
1×10^{-3}	1	1×10^3	$1.019\ 72 \times 10^{-4}$	$1.019\ 72 \times 10^{-2}$	$1.019\ 72 \times 10$
1×10^{-6}	1×10^{-3}	1	$1.019\ 72 \times 10^{-7}$	$1.019\ 72 \times 10^{-5}$	$1.019\ 72 \times 10^{-2}$
9.806 65	$9.806\ 65 \times 10^3$	$9.806\ 65 \times 10^6$	1	1×10^2	1×10^5
$9.806\ 65 \times 10^{-2}$	$9.806\ 65 \times 10$	$9.806\ 65 \times 10^4$	1×10^{-2}	1	1×10^3
$9.806\ 65 \times 10^{-5}$	$9.806\ 65 \times 10^{-2}$	$9.806\ 65 \times 10$	1×10^{-5}	1×10^{-3}	1

Stress

Pa or N/m ²	MPa or N/mm ²	kgf/mm ²	kgf/cm ²
1	1×10^{-6}	$1.019\ 72 \times 10^{-7}$	$1.019\ 72 \times 10^{-5}$
1×10^6	1	$1.019\ 72 \times 10^{-1}$	$1.019\ 72 \times 10$
$9.806\ 65 \times 10^6$	9.806 65	1	1×10^2
$9.806\ 65 \times 10^4$	$9.806\ 65 \times 10^{-2}$	1×10^{-2}	1

[Note] 1 Pa=1 N/m², 1 MPa=1 N/mm²

Pressure

Pa	kPa	MPa	bar	kgf/cm ²	atm	mmH ₂ O	mmHg or Torr
1	1×10^{-3}	1×10^{-6}	1×10^{-5}	$1.019\ 72 \times 10^{-5}$	$9.869\ 23 \times 10^{-6}$	$1.019\ 72 \times 10^{-1}$	$7.500\ 62 \times 10^{-3}$
1×10^3	1	1×10^{-3}	1×10^{-2}	$1.019\ 72 \times 10^{-2}$	$9.869\ 23 \times 10^{-3}$	$1.019\ 72 \times 10^2$	7.500 62
1×10^6	1×10^3	1	1×10	$1.019\ 72 \times 10$	9.869 23	$1.019\ 72 \times 10^5$	$7.500\ 62 \times 10^3$
1×10^5	1×10^2	1×10^{-1}	1	1.019 72	$9.869\ 23 \times 10^{-1}$	$1.019\ 72 \times 10^4$	$7.500\ 62 \times 10^2$
$9.806\ 65 \times 10^4$	$9.806\ 65 \times 10$	$9.806\ 65 \times 10^{-2}$	$9.806\ 65 \times 10^{-1}$	1	$9.678\ 41 \times 10^{-1}$	1×10^4	$7.355\ 59 \times 10^2$
$1.013\ 25 \times 10^5$	$1.013\ 25 \times 10^2$	$1.013\ 25 \times 10^{-1}$	1.013 25	1.033 23	1	$1.033\ 23 \times 10^4$	$7.600\ 00 \times 10^2$
9.806 65	$9.806\ 65 \times 10^{-3}$	$9.806\ 65 \times 10^{-6}$	$9.806\ 65 \times 10^{-5}$	1×10^{-4}	$9.678\ 41 \times 10^{-5}$	1	$7.355\ 59 \times 10^{-2}$
$1.333\ 22 \times 10^2$	$1.333\ 22 \times 10^{-1}$	$1.333\ 22 \times 10^{-4}$	$1.333\ 22 \times 10^{-3}$	$1.359\ 51 \times 10^{-3}$	$1.315\ 79 \times 10^{-3}$	$1.359\ 51 \times 10$	1

[Note] 1 Pa=1 N/m²

Kinematic viscosity

m ² /s	cSt	St
1	1×10^6	1×10^4
1×10^{-6}	1	1×10^{-2}
1×10^{-4}	1×10^2	1

[Note] 1 cSt=1 mm²/s, 1 St=1 cm²/s

Supplementary table 6 Lubrication (discharge) intervals of the oil / air

Preloading method	Material of rolling element	Oil viscosity	d_{mn} value ($\times 10^4$)														
			over	—	70	85	100	125	150	175	200	225	250				
			up to	70	85	100	125	150	175	200	225	250					
Position preloading	Bearing steel (SUJ2)	ISO VG10	Standard	5-10 Minute	3-8 Minute		2-6 Minute		Consult JTEKT.								
			High Ability	5-10 Minute		3-8 Minute		2-6 Minute									
		ISO VG22	Standard	6-12 Minute	4-10 Minute		3-6 Minute										
			High Ability	6-12 Minute		4-10 Minute		3-6 Minute									
		ISO VG32	Standard	10-18 Minute	6-15 Minute		4-12 Minute										
			High Ability	10-18 Minute		6-15 Minute		4-12 Minute									
	Ceramics (Si ₃ N ₄)	ISO VG10	Standard	4-10 Minute		2-8 Minute		1-5 Minute									
			High Ability	4-10 Minute		2-8 Minute		1-5 Minute									
		ISO VG22	Standard	6-12 Minute		4-10 Minute		3-6 Minute									
			High Ability	6-12 Minute		4-10 Minute		3-6 Minute									
		ISO VG32	Standard	10-18 Minute		6-15 Minute		4-12 Minute									
			High Ability	10-18 Minute		6-15 Minute		4-12 Minute									
Constant-pressure preloading	Bearing steel (SUJ2)	ISO VG10	Standard	4-10 Minute		2-8 Minute		Consult JTEKT.									
			High Ability	4-10 Minute		2-8 Minute											
		ISO VG22	Standard	6-12 Minute		3-10 Minute											
			High Ability	6-12 Minute		3-10 Minute											
		ISO VG32	Standard	10-18 Minute		6-15 Minute											
			High Ability	10-18 Minute		6-15 Minute											
	Ceramics (Si ₃ N ₄)	ISO VG10	Standard	4-10 Minute		2-8 Minute							1-5 Minute	1-3 Minute	Consult JTEKT.		
			High Ability	4-10 Minute		2-8 Minute							1-5 Minute	1-3 Minute			
		ISO VG22	Standard	6-12 Minute		3-10 Minute							2-6 Minute	2-4 Minute			1-3 Minute
			High Ability	6-12 Minute		3-10 Minute							2-6 Minute	2-4 Minute			1-3 Minute
		ISO VG32	Standard	10-18 Minute		6-15 Minute							3-10 Minute	2-6 Minute			2-5 Minute
			High Ability	10-18 Minute		6-15 Minute							3-10 Minute	2-6 Minute			2-5 Minute

- [Remarks]**
- The discharge intervals indicated are reference values supposing that the oil quantity of one discharge is 0.03ml in case of the angular contact ball bearing.
 - If the cylindrical roller bearing is used, suppose that the discharge interval is the same, and the oil quantity of one discharge is 0.01ml.
 - Select the optimal value of the required oil quantity by carrying out the test on the machine referring to the table above, because the optimal value varies depending on the type of the bearing, environment and use conditions.
 - ISO VG22 or VG32 is recommended in case of the main shaft driven by the built-in motor.

Supplementary table 7 Specification report of bearing for main shaft of machine tool

Examination certificate No. _____

Please fill in the space provided [].

* Please attach the drawings, which show the configuration of the main shaft, dimensions, external load and loading position and direction.

No	Item	Details
1	Machine used	Name
	<input type="checkbox"/> Newly developed <input type="checkbox"/> Improved <input type="checkbox"/> Existing <input type="checkbox"/> Additional machine consideration	Type
		Mounting direction of main shaft
	Weight of rotating part	① Other than the built-in type Weight of rotating part : _____ N ② The built-in type Rotating unit weight (Not including rotor) : _____ N Rotor weight : _____ N
Conditions	<input type="checkbox"/> Load acting on bearings during tool unclamping (when using a machining center) _____ kN	
2	Bearing used	Bearing number
		Matching
		Spacer
		Dimension and location
		<input type="checkbox"/> Not available <input type="checkbox"/> Available Dimension and location (_____The number of row is counted from the left.) Row No. _____ -Row No. _____ : _____ mm Row No. _____ -Row No. _____ : _____ mm
		Manufacture <input type="checkbox"/> Manufactured by JTEKT <input type="checkbox"/> Supplied <input type="checkbox"/> Manufactured by you (JTEKT supplies only the bearings.) <input type="checkbox"/> Others
		Shape <input type="checkbox"/> Standard design by JTEKT <input type="checkbox"/> Specified by you (Description must be attached.)
3	Maximum velocity	_____ min ⁻¹
4	Main shaft bore	① _____ mm ② _____ mm (Main shaft bore in the mounting part of the bearing)
5	Lubrication method	<input type="checkbox"/> Grease <input type="checkbox"/> Oil / air <input type="checkbox"/> Oil mist <input type="checkbox"/> Jet <input type="checkbox"/> Others (_____)
6	Preloading method * After examination, other methods may be recommended.	<input type="checkbox"/> Position preloading <input type="checkbox"/> Constant-pressure preloading <input type="checkbox"/> Preload change (position preloading ↔ position preloading) Change rotation velocity _____ min ⁻¹ <input type="checkbox"/> Preload change (position preloading ↔ constant-pressure preloading) Change rotation velocity _____ min ⁻¹ <input type="checkbox"/> Others (_____) (Desired preload amount _____ N/ _____ min ⁻¹ hour)
7	Driving method	<input type="checkbox"/> Built-in motor <input type="checkbox"/> Coupling <input type="checkbox"/> Others (_____) <input type="checkbox"/> Gear <input type="checkbox"/> Belt * When consideration of the gear and belt loads is necessary, please contact us with the load and position.
8	Cooling	<input type="checkbox"/> Not available <input type="checkbox"/> Available Cooled part : <input type="checkbox"/> Housing (including bearing outer cylinder) <input type="checkbox"/> Housing (no cooling of the bearing outer cylinder) <input type="checkbox"/> Shaft <input type="checkbox"/> Others (_____)
9	Requirements	<input type="checkbox"/> None <input type="checkbox"/> Available <input type="checkbox"/> Service life <input type="checkbox"/> Max. rotation with no load <input type="checkbox"/> Machining load: _____ hours * For machining load, machining cycle, and other detailed conditions, contact us.
		<input type="checkbox"/> Rigidity <input type="checkbox"/> Rotational frequency : <input type="checkbox"/> At mounting <input type="checkbox"/> At (_____) min ⁻¹ <input type="checkbox"/> Spindle orientation : <input type="checkbox"/> Horizontal <input type="checkbox"/> Vertical downward <input type="checkbox"/> Vertical downward
		<input type="checkbox"/> Bearing stiffness * Contact us for single row or total value specifications. <input type="checkbox"/> Single row <input type="checkbox"/> Total value <input type="checkbox"/> Shaft head rigidity * Contact us for specific loads.
		<input type="checkbox"/> Axial rigidity : _____ N/μm (When the Axial load = _____ N) <input type="checkbox"/> Ra rigidity : _____ N/μm (When the Ra load = _____ N)
10	Examination item	
11	Remarks * Other requests or comments	

JTEKT Corporation WEB site

<https://www.jtekt.co.jp/e/>



JTEKT Bearing WEB site

<https://koyo.jtekt.co.jp/en/>



JTEKT Overseas hubs

<https://www.jtekt.co.jp/e/company/global.html>



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