

Koyo®



Needle Roller Bearings

JTEKT

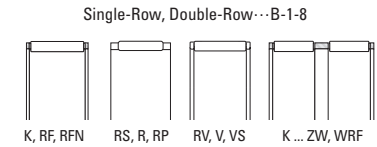
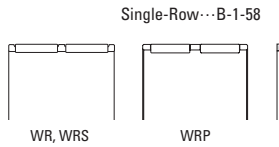
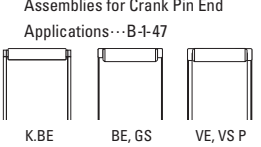
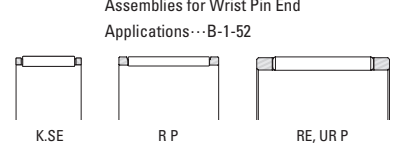
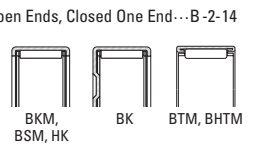
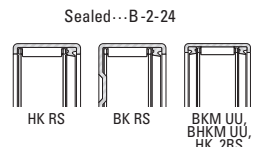
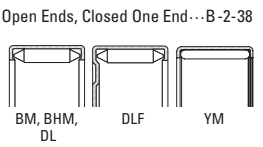
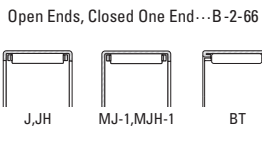
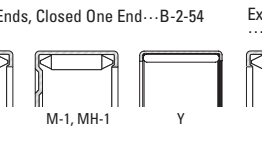
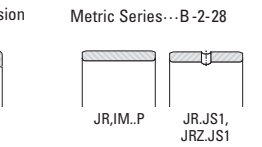
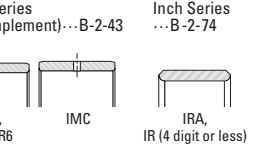



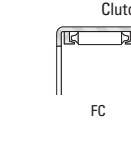
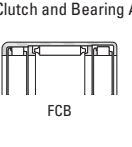
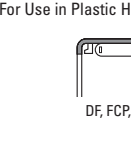
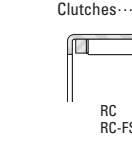
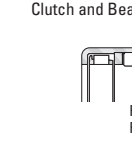
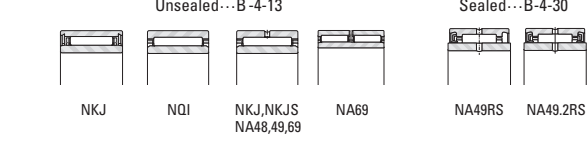
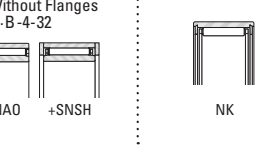
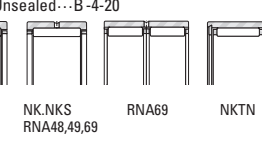
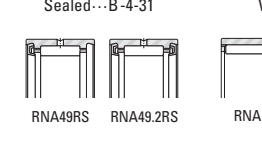
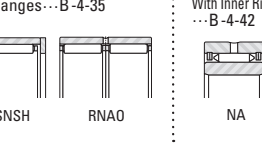
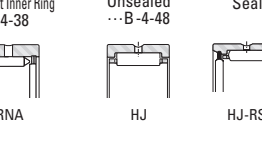
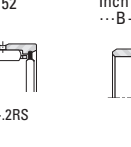
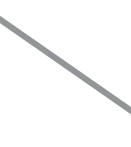



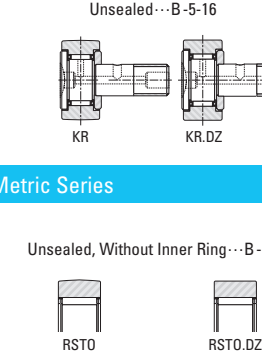
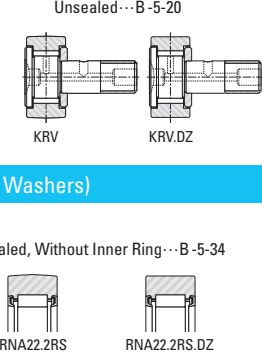
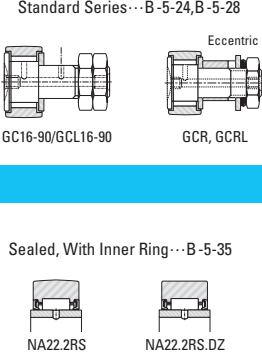
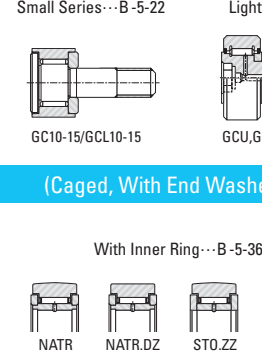

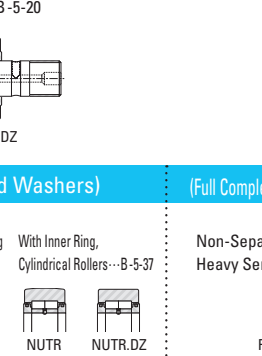
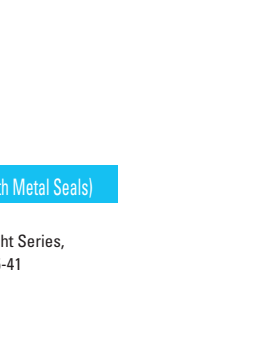
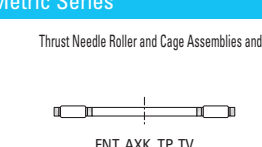
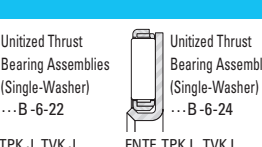
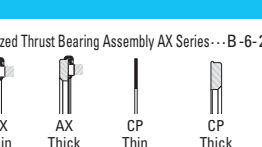
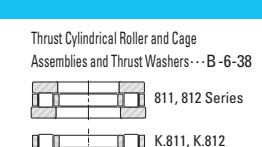
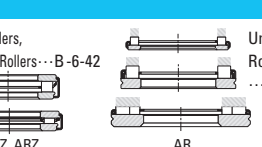

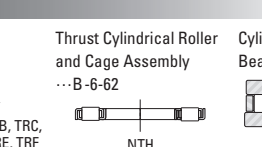
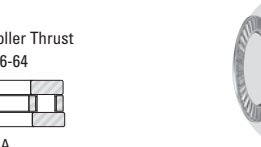



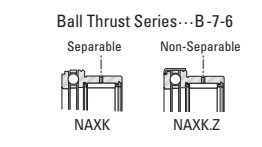
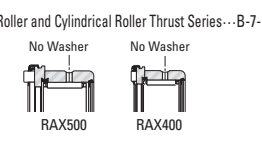
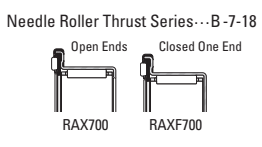

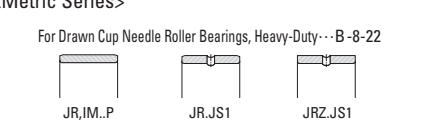
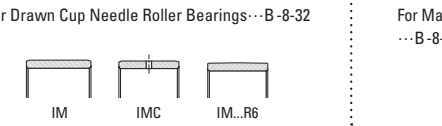
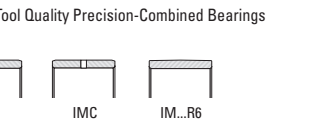
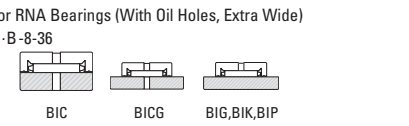

JTEKT CORPORATION

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CAT. NO. B2018E

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NEEDLE ROLLER BEARINGS

CAT. NO. B2018E

Value & Technology

	1866	1900	1930	1960	1990	2010	2013
Corporate History	<ul style="list-style-type: none"> •1866 Torrington is founded •1867 Dürkopp-Werke Bielefeld is founded 	<ul style="list-style-type: none"> •1921 Koyo Seiko Co., Ltd. is founded 	<ul style="list-style-type: none"> •1930 Nadella is founded 	<ul style="list-style-type: none"> •1962 FAG purchases Dürkopp-Werke AG •1962 Utsunomiya Kiki Co., Ltd. joins the group •1984 SNR (Nadella business partner) and Torrington commence joint venture •1993 Torrington purchases needle bearing business from FAG 	<ul style="list-style-type: none"> •2001 Torrington purchases Nadella business from SNR •2003 The Timken Company purchases Torrington •2006 JTEKT Corporation is born •2010 JTEKT purchases needle bearing business from The Timken Company 	<ul style="list-style-type: none"> •2013 JTEKT is integrated into the Koyo brand 	



1866
Foundation of Torrington

Founded as manufacturer of sewing machine needles and machinery to produce same

Early model swaging machine for uniform needle blanks

invention
No. U.S. 43,772 (1864)
Hopson & Brooks

IMPROVEMENT IN POINTING WIRE FOR PINS

This invention is the origin of the extra-precision rollers now produced by JTEKT.

1920
80% market share of automobile wire wheel parts

Cadillac put out its entire line on dressy wire wheels. Packard and a few other major producers followed suit, as eventually did most manufacturers (except Chevrolet). At the height of the trend, over 60% of U.S. passenger cars had wire wheels, and 80% of the spokes and nipples to build them were supplied by The Torrington Company. Effectively, every other passenger car made in America had Torrington spokes and nipples in the wheels.

More than 60% of automobiles, including those made by Cadillac, adopt wire wheels. Torrington acquires 80% market share of wire wheel spokes and nipples.

As a result, one in every two U.S.-manufactured automobiles use Torrington spokes and nipples.

Radial Needle Bearings

1932
Development of the world's first drawn cup needle bearing
< Space-saving and lightweight >

World's First invention
No. U.S. 2,038,474 (1932)
E. K. Brown

ANTIFRICTION BEARING AND METHOD OF MAKING THE SAME

1957
Development of caged drawn cup needle bearing
< Improved lubrication and support for higher speeds >

Increased lubricant retention capability
Separated rollers using cages

Thrust Needle Bearings

1955
Development of the world's first thrust needle bearing: contribution to the progress of AT development
< Lower torque and improved durability >

World's First invention
No. U.S. 2,724,625 (1955)
R. H. White

NEEDLE ROLLER THRUST BEARING

Development of the thrust needle bearing solved problems in early automatic transmissions.

Planetary Gear Shafts

1971
Development of induction-hardened planetary gear shaft

2001
Cold forging hole processing of planetary gear shaft
< Improved installation capability >

1968
Development of thick-wall drawn cup bearing
< High capacity >

Applications in axles, transmissions, pumps and motors

1996
Development of controlled stress thick-wall drawn cup needle bearing
< Longer life > Cup bore is profiled.

Reduced contact pressure on cup and shaft

< Higher speed, lower torque, and supports thin film lubricant >
Optimization of washer and cage shapes

2008
Development of thrust needle bearing for high-speed applications

Improved lubricity
Reduced roller end wear

2011
Development of noise-reduced thrust needle bearing
< Noise reduction >

Vibration-resistant
Custom-shaped resin is installed on the back side of the thrust washer.

2013
JTEKT is integrated into the Koyo brand

Regarding the Publishing of this Needle Roller Bearing Catalog

Thank you very much for your patronage of **Koyo** brand products.

In terms of environmental friendliness, there has been a rapidly increasing demand for smaller, lighter products, as well as lower friction, higher reliability, and higher functionality in many different industrial fields.

Our needle roller bearings are the optimal solution to all such requirements.

In 2010, as part of JTEKT's continual process for improvement in the needle roller bearing business, we integrated the technology of Torrington, a company with a long history in the United States and Europe, into the Koyo brand of traditional needle roller bearings.

In 2013, the Koyo brand will take the next step in this line of business to pursue stronger distribution and production structures and further technological development with the aim to accommodate our customers' needs on a global scale.

On this occasion, JTEKT has fully renewed its needle roller bearing catalog, which we present here.

We believe that this new catalog will prove useful in your selection and use of our needle roller bearings.

We look forward to your continued patronage.

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NEEDLE ROLLER BEARINGS

PRODUCT BREADTH

DRAWN CUP NEEDLE ROLLER BEARINGS, available in 3 mm to 139.7 mm bore ($1/8$ to $5\ 1/2$ in), are designed to support radial loads and reduce friction between rotating components. The low cross section of the drawn cup bearing provides maximum load-carrying capability with minimum space required.

DRAWN CUP ROLLER CLUTCHES AND BEARING ASSEMBLIES, available in 3 to 35 mm bore ($1/8$ to $1\ 3/8$ in), are designed to transmit torque between the shaft and housing in one direction and allow free overrun in the opposite direction. When transmitting torque, either the shaft or the housing can be the input member.

RADIAL NEEDLE ROLLER AND CAGE ASSEMBLIES, available in 3 mm to 165 mm bore ($1/8$ to $6\ 1/2$ in), consist of a complement of needle rollers held in place by a cage. With no inner or outer ring, the low cross section provides maximum load-carrying capability within the smallest envelope. The mating shaft and housing are normally used as inner and outer raceways.

NEEDLE ROLLER THRUST BEALINGS, available in 5 mm to 160 mm ($3/16$ to $6\ 1/4$ in) bore, consist of a complement of needle rollers held in place by a cage.

Needle roller thrust bealings are complements of small diameter needle rollers arranged in a spoke-like configuration. Needle rollers are equally spaced by means of a cage whose web section separates the rollers and provides guidance to keep them tracking in an orbital path. The purpose of these assemblies is to transmit a thrust load between two relatively rotating objects while greatly reducing friction.

Needle roller thrust bealings also can be unitized with lipped washers which service as raceway surfaces for the needle rollers. Washers can be supplied separately or can be mechanically unitized to the needle roller thrust assemblies for ease of handling.

HEAVY-DUTY NEEDLE ROLLER BEARINGS, available in 5 mm to 335 mm bore ($3/16$ to $13\ 3/16$ in), consist of a machined and ground channel-shaped outer ring with a complement of needle rollers retained and guided by a cage. The thick outer ring provides maximum load capacity and shock resistance with a relatively small radial cross section.

TRACK ROLLERS/CAM FOLLOWERS, available in 10 mm to 300 mm O.D. ($3/8$ to $11\ 13/16$ in), are characterized by their thick-walled outer rings that run directly on a track. The thick outer rings permit high load-carrying capability while minimizing distortion and bending stresses.

ENGINE BEARINGS include a full line of advanced bearing assemblies for automotive engine valve trains. These assemblies help reduce friction and optimize performance in both overhead valve and overhead cam engines. They include roller rocker arms for overhead valve (pushrod) engines, roller finger followers for overhead cam engines, valve lifter rollers for overhead valve and overhead cam engines.

PRECISION NEEDLE ROLLERS have multiple uses in a variety of industries including automotive, truck, farm and construction equipment, two-cycle engines, outboard engines and consumer durables. Needle rollers are mainly used as bearing rolling elements to transmit torque and reduce friction. They also can serve as precision shafts or as precision locating pins.

PLANETARY GEAR SHAFTS have multiple uses in a variety of industries including automotive, truck and farm and construction equipment. The shafts are used in planetary gear sets, differentials and engine valve trains.

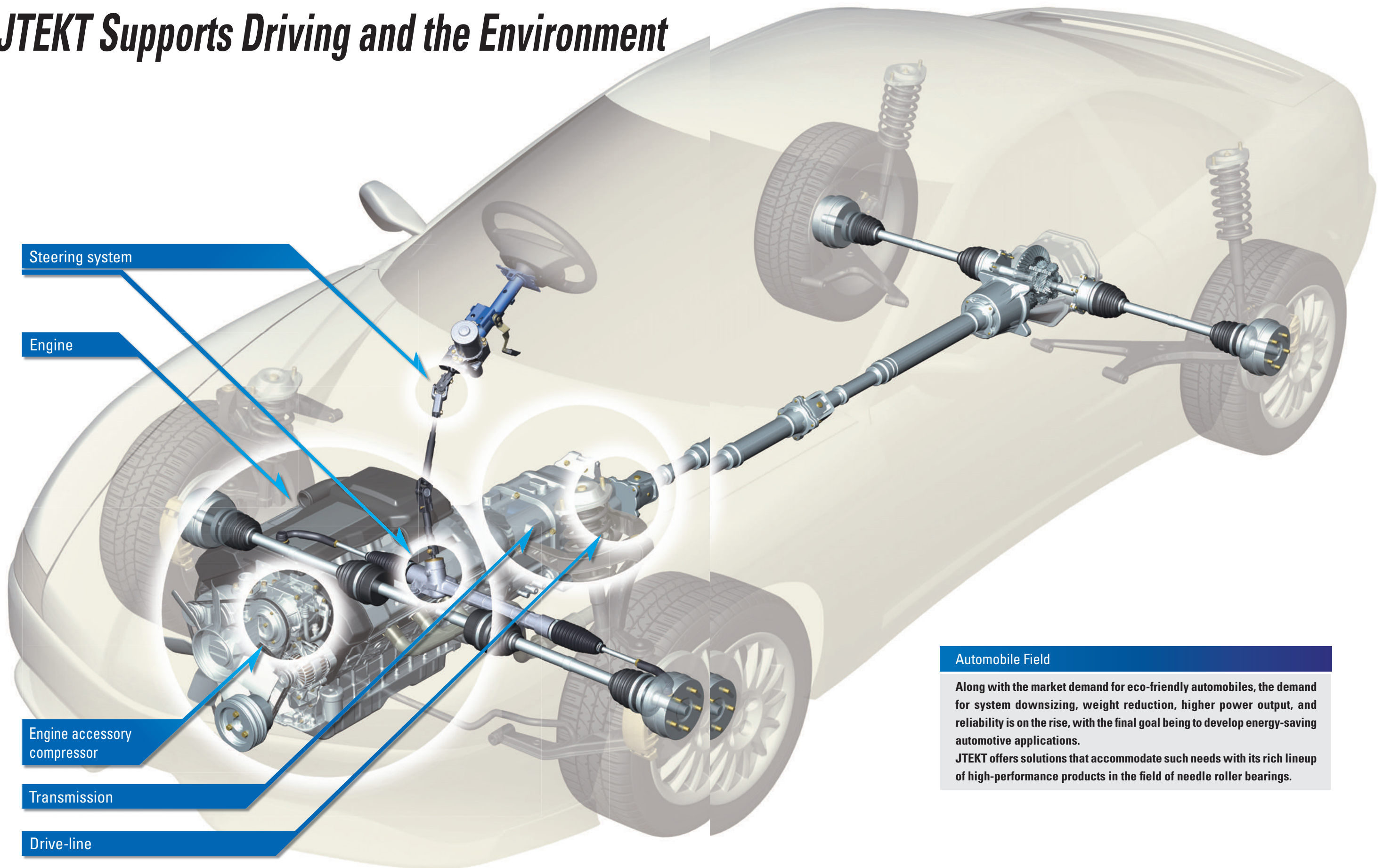
PRECISION PINS AND SHAFTS are crafted from the highest quality steel within a TS16949/ISO9000/AS9100-certified manufacturing facility. Pins and shafts come in a larger variety of configurations and materials and flexible product volumes. These pins and shafts are found in applications such as gasoline fuel systems components, diesel systems components, aerospace rollers and precision rollers (DFAR-compliant), planet pins, racing applications, rollers for bearing assemblies, gear shafts and steering column pins.

APPLICATIONS

NEEDLE ROLLER BEARING APPLICATIONS

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JTEKT Supports Driving and the Environment



Steering system

Engine

Engine accessory
compressor

Transmission

Drive-line

Automobile Field

Along with the market demand for eco-friendly automobiles, the demand for system downsizing, weight reduction, higher power output, and reliability is on the rise, with the final goal being to develop energy-saving automotive applications.

JTEKT offers solutions that accommodate such needs with its rich lineup of high-performance products in the field of needle roller bearings.

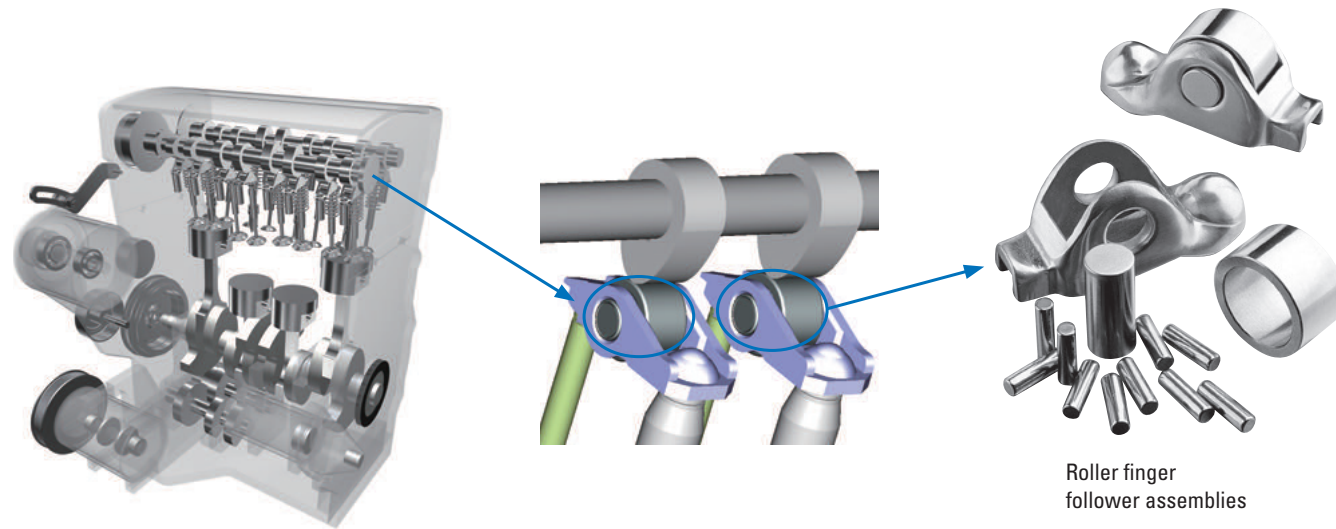
ENGINE

Valve Train Components

JTEKT's needle roller bearings for rocker arms contribute to reductions in energy used by engines and to improvements in engine reliability.

Bearing Features

- Low torque
- Wear resistance

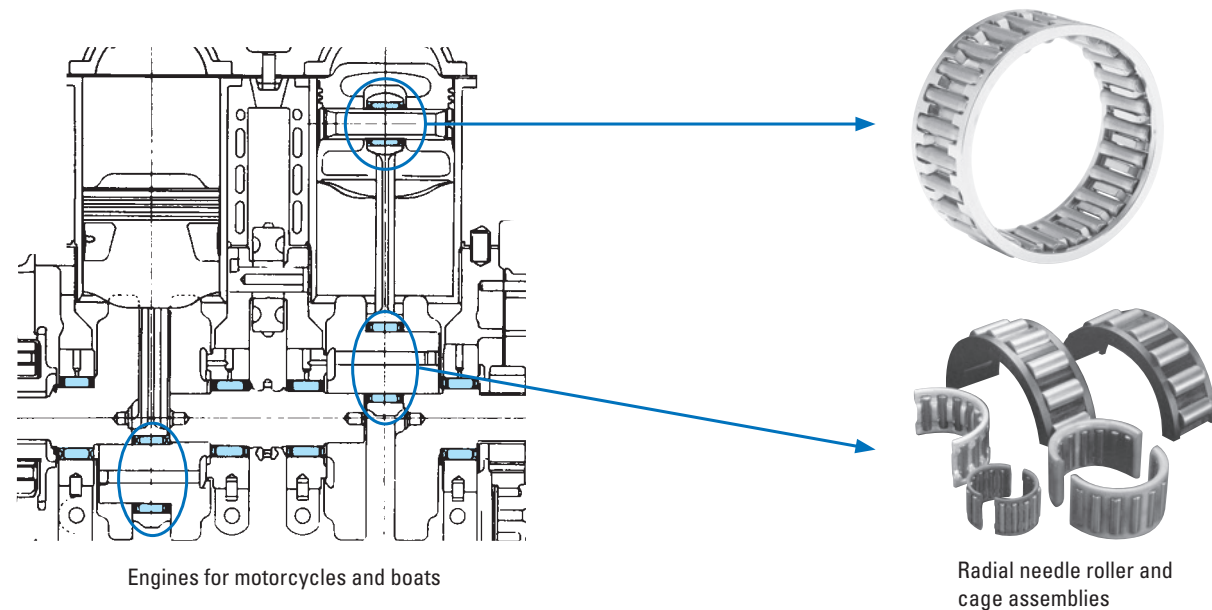


Piston and Crank Components

JTEKT's needle roller bearings for connecting rod applications respond to the need for reductions in energy used by engines and to demanding lubrication requirements, contributing to greater reliability.

Bearing Features

- Durability
- Improvement in seizure resistance
- Supports higher loads

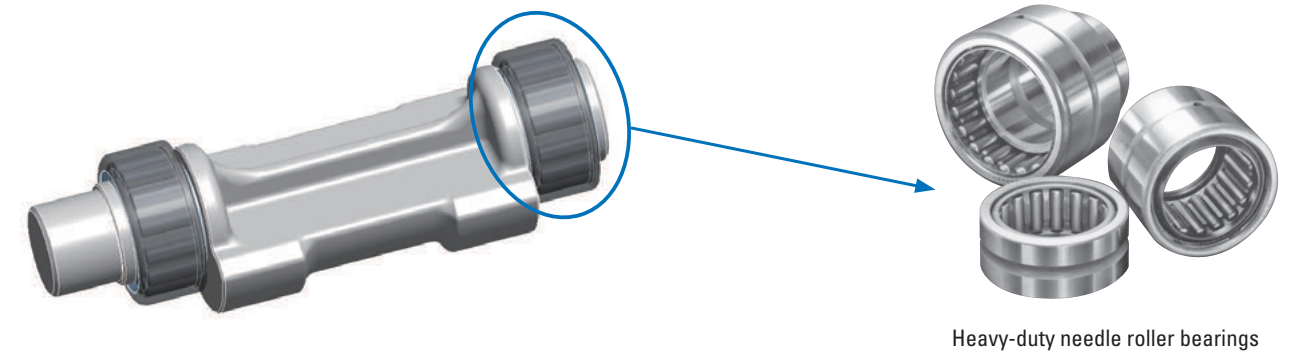


Balance Shaft Components

JTEKT's needle roller bearings for balance shafts contribute to improved lubrication methods, reduced friction, and improved reliability under vibration conditions.

Bearing Features

- High reliability
- Vibration resistance



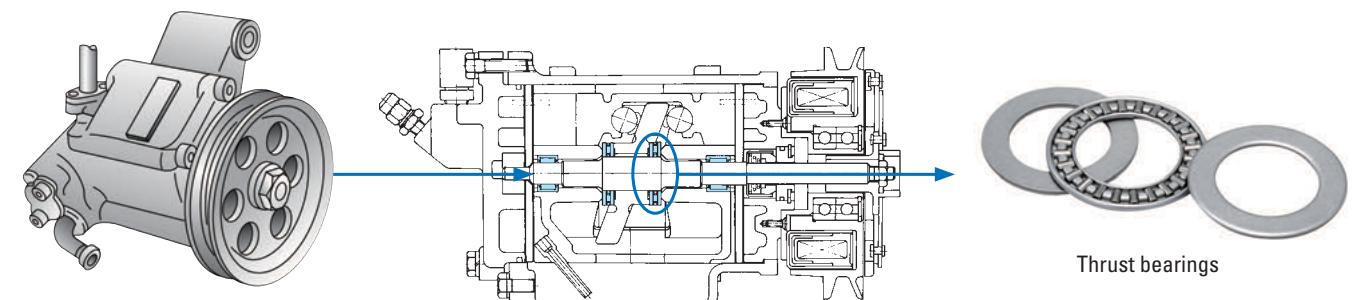
ENGINE ACCESSORIES

Compressor Components

JTEKT's needle roller bearings for compressors contribute to support for thin film lubricants, improved efficiency, and improved reliability.

Bearing Features

- Wear resistance
- Low torque
- Improved lubricity



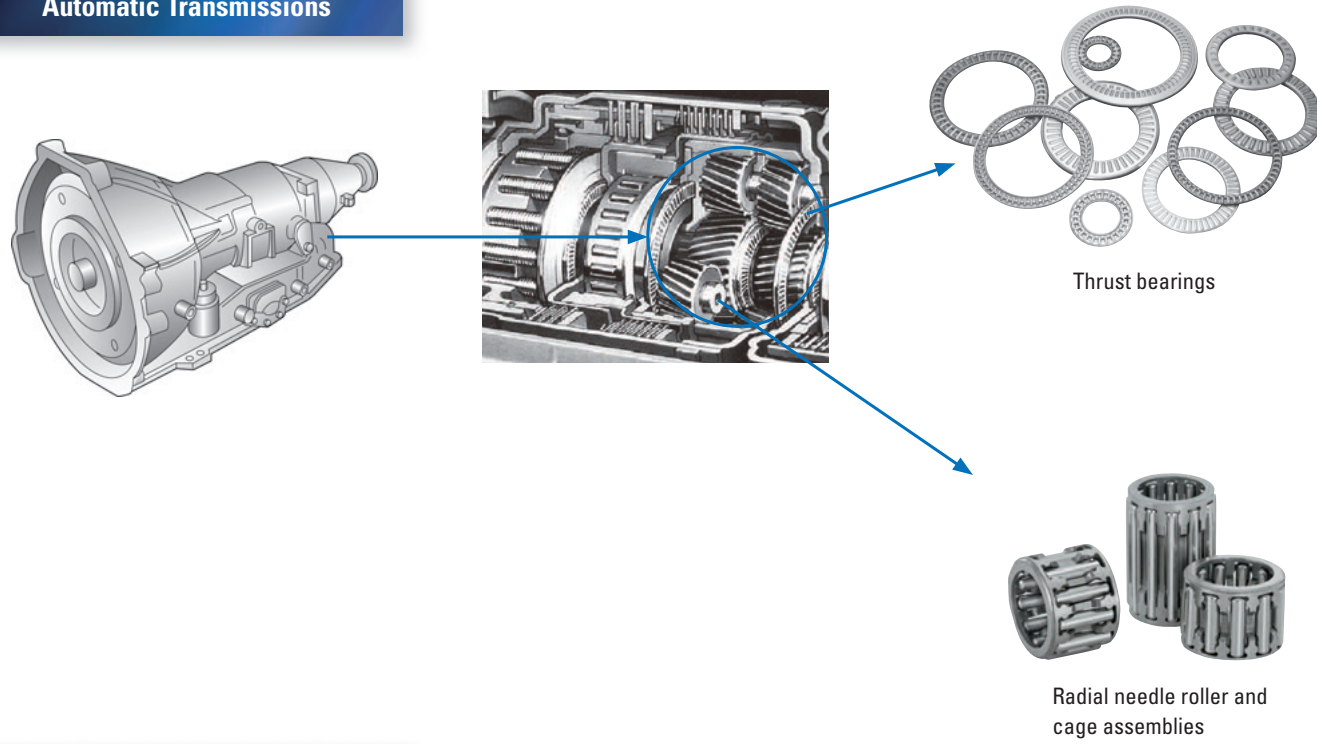
TRANSMISSION

JTEKT's needle roller bearings for transmissions contribute to reductions in the size and weight of the transmission, improved power and fuel efficiency, support for low-viscosity lubricants, and improved reliability.

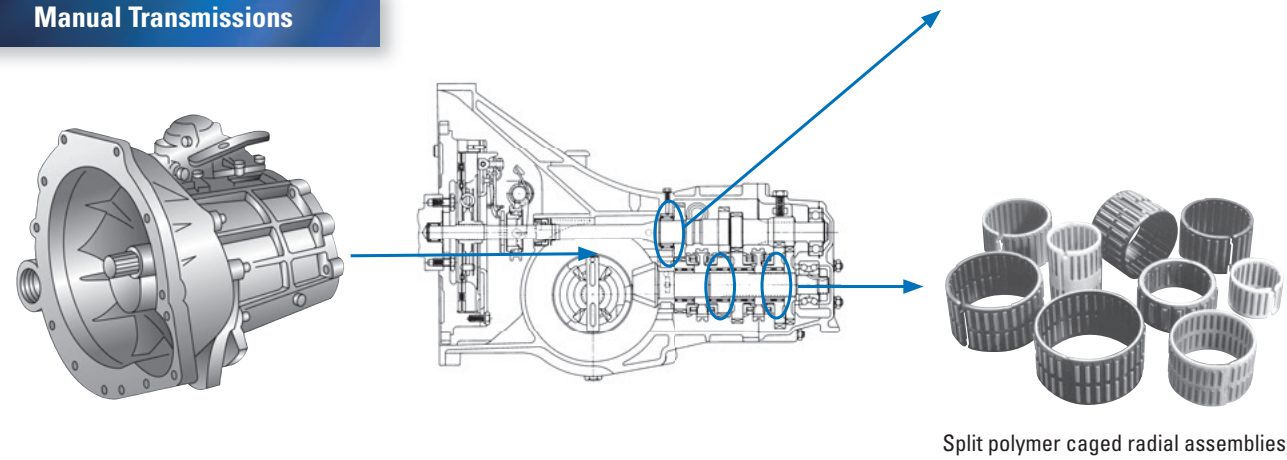
Bearing Features

- Supports higher loads
- Longer life in oil with foreign material
- Low torque

Automatic Transmissions



Manual Transmissions



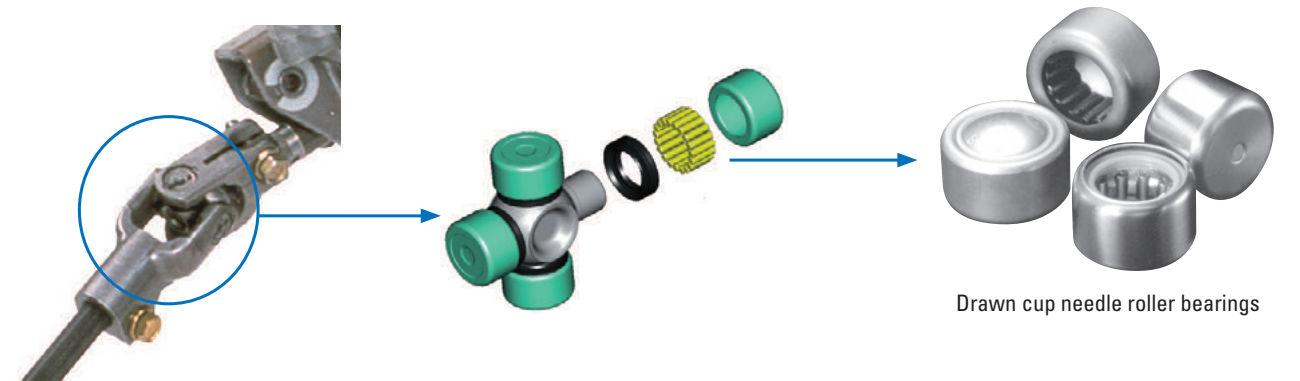
STEERING SYSTEMS

JTEKT's needle roller bearings for steering systems realize smooth steering capability with high reliability and quiet running by drawing on our experience in producing safe steering system components.

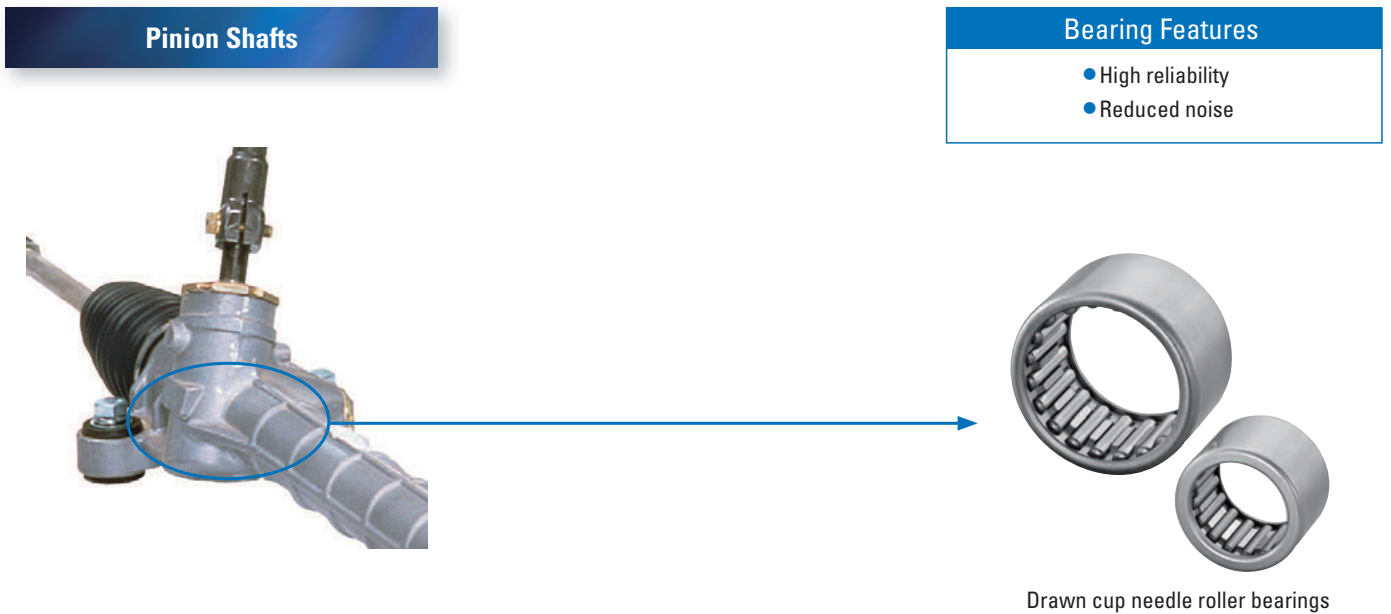
Bearing Features

- High reliability
- Reduced noise
- High rigidity

Intermediate Steering Shafts



Pinion Shafts



Bearing Features

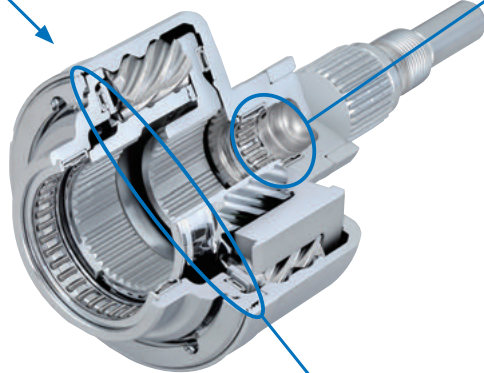
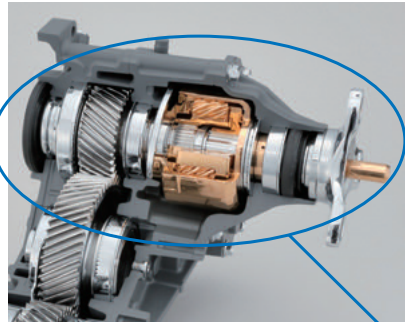
- High reliability
- Reduced noise

DRIVE-LINES

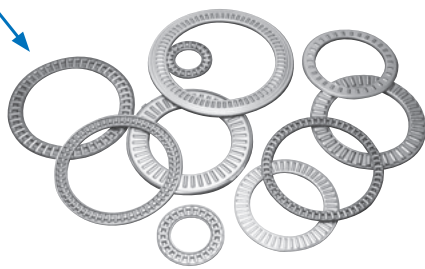
Torque Sensing LSD

JTEKT's needle roller bearings for torque sensing LSDs contribute to downsizing and weight reduction, higher efficiency, and improved reliability.

- Bearing Features**
- Alleviates misalignment
 - Supports higher loads



Drawn cup needle roller bearings



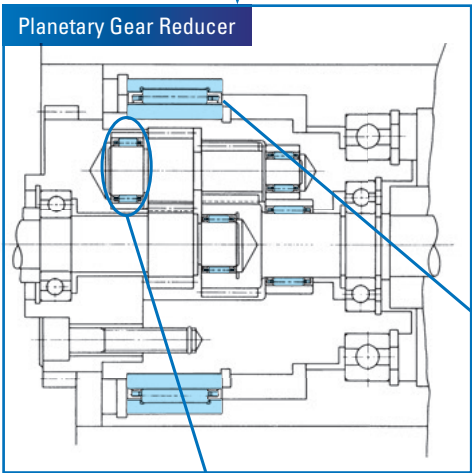
Thrust bearings

INDUSTRIAL MACHINERY FIELD

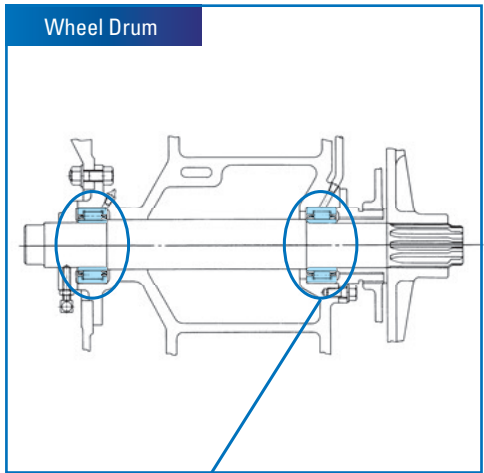
Construction equipment and agricultural machinery are used in demanding environments and therefore require high durability. JTEKT offers high-performance needle roller bearings that respond to energy-saving requirements and high reliability needs.

Construction Equipment

- Bearing Features**
- High reliability



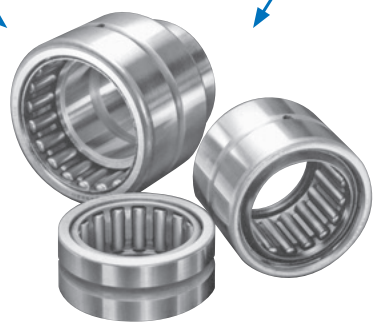
Planetary Gear Reducer



Wheel Drum

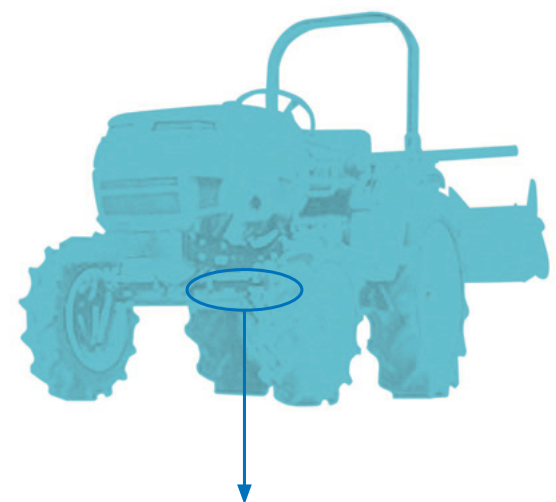


Radial needle roller and cage assemblies



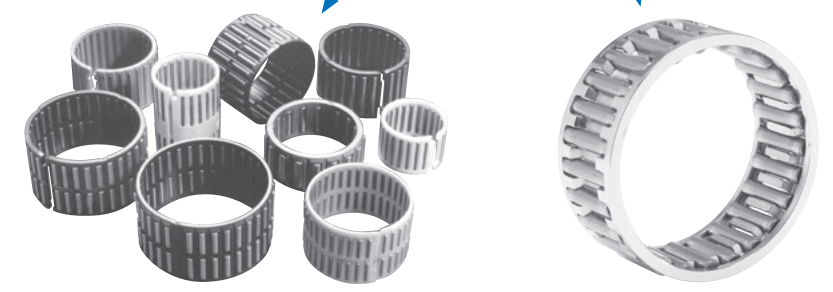
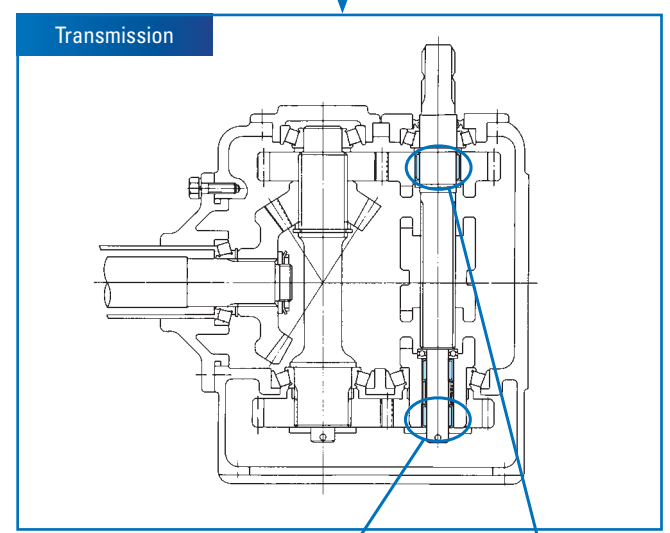
Heavy-duty needle roller bearings

Agricultural Machinery



Bearing Features

- High reliability

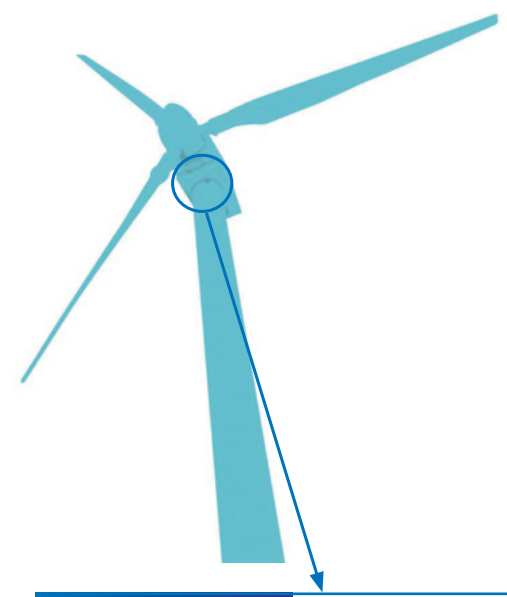


Radial needle roller and cage assemblies

WIND POWER GENERATION

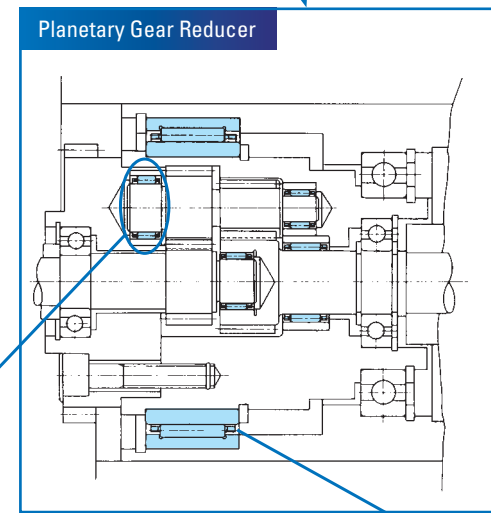
Bearings used in wind power generators require long service lives. JTEKT offers high-performance needle roller bearings that support high reliability and demanding environmental conditions.

Wind Power Generation



Bearing Features

- Long service life
- Reduced noise



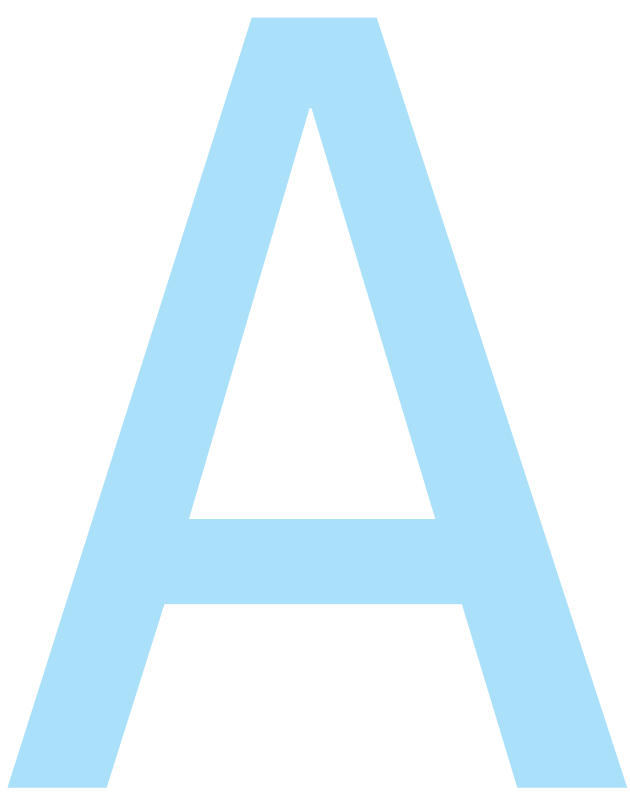
Radial needle roller and cage assemblies



Heavy-duty needle roller bearings



NOTES



ENGINEERING

A ENGINEERING

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A

ENGINEERING

A

BEARING TYPES

NEEDLE ROLLER BEARINGS

Needle roller bearings are an economical alternative for applications requiring minimal space to carry a given load at a desired speed. Needle roller bearings can be an ideal choice because of their ability to handle a given level of speed and load capacity, yet have the smallest cross section of all roller bearing types.

We offer both metric and inch nominal bearings in popular designs such as: radial caged needle rollers, drawn cup needle roller bearings, machined ring, track rollers, thrust bearings, combined bearings, and drawn cup roller clutches.

Most of these bearing types can be operated directly on a machined shaft of suitable quality, or with a matching inner ring where this requirement cannot be conventionally satisfied.

Radial Needle Roller and Cage Assemblies

Radial needle roller and cage assemblies have a steel cage that provides both inward and outward retention for the needle rollers. The designs provide maximum cage strength consistent with the inherently high load ratings of needle roller bearings. Accurate guidance of the needle rollers by the cage bars allows for operation at high speeds. Also available are needle roller and cage assemblies using molded, one-piece glass-reinforced engineered polymer cages. Needle roller and cage assemblies are manufactured with either one or two rows of needle rollers.

Drawn Cup Bearings

The outer ring in the form of a cup is accurately drawn and no subsequent machining is performed to build the outer raceway. Drawn cup needle roller bearings are available in open ends or single, closed-end designs. They also are available with one or two integral seals. Other options include a single lubricating hole and matching inner ring.

Heavy-Duty Needle Roller Bearings

These bearings are available in a wide range of inch and metric sizes plus an array of design features including: integral seals, side flanges (or separate end washers), inner rings, oil holes and single or double caged sets (or full complement) of rollers.

Track Rollers

Track rollers listed in this catalog are designed with outer rings of large radial cross section to withstand heavy rolling and shock loads on track-type or cam-controlled equipment. The outside diameters of the outer rings are either profiled or cylindrical. Profiled track rollers are designed to alleviate uneven bearing loading resulting from deflection, bending or misalignment in mounting. Stud-type track rollers are available with or without lip contact seals, or with shields. Yoke-type track rollers are designed for straddle mounting. Each yoke-type is available with either radial needle roller and cage assemblies, or with a single (or double) full complement row of cylindrical or needle rollers.

Thrust Bearing Assemblies And Washers

Thrust needle roller and cage assemblies are available in a variety of inch or metric sizes. All types have very small cross sections. If the back up surfaces cannot be used as raceways, hardened washers are available. Thrust bearings are available with needle rollers or heavier cylindrical rollers for high load-carrying capacity.

Combined (Radial and Thrust) Bearings

Combined bearings consist of a radial bearing (needle roller bearing) and a thrust bearing (ball or roller bearing). Some combined bearings are constructed similar to drawn cups, but with an added thrust bearing component. Like other needle roller bearings, these combined bearings can be matched with an optional inner ring or thrust washer as the opposing raceway.

NEEDLE ROLLER BEARING SELECTION

Because of the possible combinations of roller complement orientation, bearing cross section thickness and raceway construction needle roller bearings should be given extra

consideration for roller bearing applications selection. The table below should be used as a general guideline for the application of needle roller bearings.

Table A-1. Needle roller bearing capability comparison based on suitable oil lubrication

Bearing type/ design capability	Radial needle roller and cage assembly	Drawn cup needle roller bearing caged	Drawn cup roller bearing full complement	Needle roller bearing and inner ring	Track roller	Thrust needle roller and cage assembly	Needle rollers	Combination bearing radial/thrust
Radial load	High	Moderate	High	High	Moderate	None	Very high	High
Axial load	None	None	None	None	Low	Very high	None	High
Limiting speed	Very high	High	Moderate	Very high	Moderate	High	Moderate	Moderate
Slope tolerance	Moderate	Moderate	Very low	Moderate	Moderate ⁽¹⁾	Low	Very low	Low
Grease life	High	High	Low	High	Moderate	Low	Low	Low
Friction	Very low	Very low	High	Very low	Low ⁽²⁾	Moderate	High	Moderate
Precision	Very high	Moderate	Moderate	High	High	High	Very high	High
Cross section	Very low	Low	Low	Moderate	High	Very low	Very low	High
Cost	Low	Low	Low	High	High	Moderate	Very low	Very high

⁽¹⁾ "Moderate" for full complement track rollers

⁽²⁾ "Low" for full complement track rollers



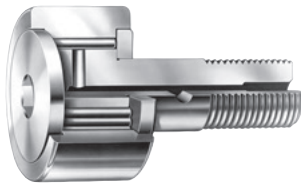
**Radial needle roller
and cage assembly**



Drawn cup needle roller



Heavy-duty needle roller



Track roller



**Thrust needle roller
and cage assembly**



Combined radial/thrust



Drawn cup roller clutch

BEARING REACTIONS, EQUIVALENT LOADS AND BEARING LIFE

DEFINITION OF LOAD RATINGS

Basic Dynamic Load Rating

The "basic dynamic load rating" (C_r) for a radial roller bearing is that calculated, constant, radial load, which a group of apparently identical bearings with stationary outer ring can theoretically endure for a rating life of one million revolutions of the inner ring. For a thrust roller bearing (C_a) is that calculated, constant, centric thrust load, which a group of apparently identical bearings can theoretically endure for a rating life of one million revolutions of one of the bearing washers. The basic dynamic load rating is a reference value only, the base value of one million revolutions has been chosen for ease of calculation. Since applied loading as great as the basic dynamic load tends to cause local plastic deformation of the rolling surfaces, it is not anticipated that such heavy loading would normally be applied.

Basic Static Load Rating

Basic static load rating for a radial roller bearing suitably manufactured from a good quality hardened alloy steel, the static radial load rating (C_{or}) is that uniformly distributed static radial bearing load, which produces a maximum contact stress of 4000 megapascals (580,000 psi) acting at the center of contact of the most heavily loaded rolling element. The static axial load rating (C_{oa}) is that uniformly distributed static centric axial load, which produces a maximum contact stress of 4000 megapascals (580,000 psi) acting at the center of contact of each rolling element.

Note: For a contact stress of 4000 megapascals (580,000 psi) a total permanent deformation of roller and raceway occurs, which is approximately 0.0001 of the roller diameter.

EQUIVALENT DYNAMIC RADIAL BEARING LOADS (P_r)

To calculate the L_{10} life, it is necessary to calculate a dynamic equivalent radial load, designated by P_r . The dynamic equivalent radial load is defined as a single radial load that, if applied to the bearing, will result in the same life as the combined loading under which the bearing operates.

$$P_r = XF_r + YF_a$$

Where:

- P_r = Dynamic equivalent radial load
- F_r = Applied radial load
- F_a = Applied axial load
- X = Radial load factor
- Y = Axial load factor

Radial needle roller bearings are designed to carry radial load with zero thrust load under normal conditions. With the thrust load equal to zero, equivalent radial load (P_r) is equal to the design radial load

(F_r). Your representative should be consulted on any applications where thrust load is involved (as the resulting increase in internal friction may require cooling to prevent increased operating temperatures).

STATIC RADIAL AND/OR AXIAL EQUIVALENT LOADS

The static equivalent radial and/or axial loading is dependent on the bearing type selected. For bearings designed to accommodate only radial or thrust loading, the static equivalent load is equal to the applied load.

For all bearings, the maximum contact stress can be approximated using the static equivalent load and the static rating.

For roller bearings:

$$\sigma_0 = 4000 \times \left(\frac{P_0}{C_0} \right)^{1/2} \text{ MPa}$$

$$\sigma_0 = 580 \times \left(\frac{P_0}{C_0} \right)^{1/2} \text{ ksi}$$

Because radial needle roller bearings are not designed to accept thrust loading, their equation to determine static radial equivalent load is:

$$P_{0r} = F_r$$

Thrust needle roller bearings are not designed to accept radial loading, so their equation to determine static thrust equivalent load is:

$$P_{0a} = F_a$$

The determination of the static load safety factor (f_0) serves to ascertain that a bearing with adequate static load rating has been selected.

$$f_0 = \frac{C_0}{P_0}$$

Where:

- f_0 = Static load safety factor
- C_0 = Basic static load rating (kN or lbf)
- P_0 = Maximum applied static load (kN or lbf)

f_0 is a safety factor against permanent deformation of the contact areas of the rolling elements and raceways. Higher f_0 values are required for particular smooth operation. The following values are generally suggested.

- $f_0 = 1.5 \dots 3.0$ for smooth operation
- $f_0 = 1.0 \dots 2.0$ for less smooth operation

For drawn cup needle roller bearings, f_0 should be ≥ 3 .

MINIMUM BEARING LOAD

Slippage can occur if loads are too light and, if accompanied by inadequate lubrication, can cause damage to the bearings. The minimum load for bearings with cage is $P/C = 0.02$, for full-complement bearings $P/C = 0.04$ (P is the dynamic load and C is the basic dynamic load rating).

Thrust needle roller bearings also have an added design requirement such that the minimum thrust load is satisfied to prevent the rollers from skidding on the raceway. The equation for the thrust loading force is different for needle rollers versus cylindrical rollers as noted:

(Needle rollers) $F_{a\ min} = C_0/2200\ kN$
 (Cylindrical rollers) $F_{a\ min} = 0.1C_0/2200\ kN$

MEAN DYNAMIC EQUIVALENT LOAD

When load magnitude or direction varies, it is necessary to calculate the mean dynamic equivalent load, which provides the same length of bearing service life as that under the actual load fluctuation. If the load and the rotational speed change in levels, as shown in Fig. A-1, the following equation can be used to calculate the mean dynamic equivalent load.

$$P_m = \sqrt[10/3]{\frac{P_1^{10/3} n_1 t_1 + P_2^{10/3} n_2 t_2 + \dots + P_n^{10/3} n_n t_n}{n_1 t_1 + n_2 t_2 + \dots + n_n t_n}}$$

In this equation,

- P_m : Mean dynamic equivalent load N
- P_1 : The load applied at rotational speed n_1 and for t_1 hours N
- ⋮
- P_n : The load applied at rotational speed n_n and for t_n hours N

What's more, the following equation can be used to calculate the mean rotational speed n_m .

$$n_m = \frac{n_1 t_1 + n_2 t_2 + \dots + n_n t_n}{t_1 + t_2 + \dots + t_n}$$

When the load changes steadily, as shown in Fig. A-2, the following equation can be used to calculate an approximation of the mean dynamic equivalent load.

$$P_m = \frac{P_{min} + 2 P_{max}}{3}$$

In this equation,

- P_{min} : The minimum dynamic equivalent load N
- P_{max} : The maximum dynamic equivalent load N

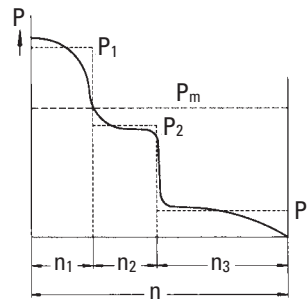


Fig. A-1

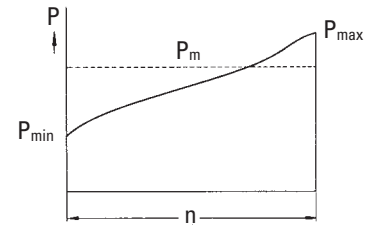


Fig. A-2

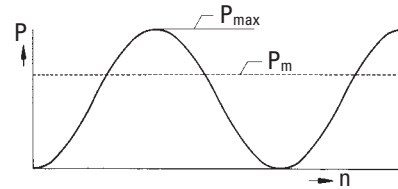


Fig. A-3

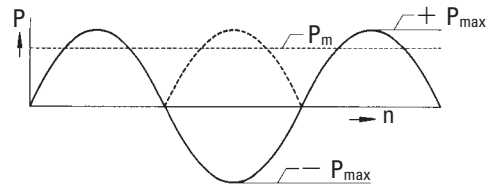


Fig. A-4

When the load changes like a sine wave between 0 and P_{max} , as shown in Fig. A-3, the following equation can be used to calculate an approximation of the mean dynamic equivalent load.

$$P_m \cong 0.68 P_{max}$$

When the load changes between 0 and P_{max} in only the upper half of the sine wave, as shown in Fig. A-4, the following equation can be used to calculate an approximation of the mean dynamic equivalent load.

$$P_m \cong 0.75 P_{max}$$



BEARING LIFE

Even if rolling bearings are rotated under ideal conditions, contact stress is continuously and repeatedly applied to the raceway surfaces of inner and outer rings or rolling contact surfaces of rolling elements, and material flakes from the raceway surfaces and rolling contact surfaces due to fatigue of material. The total number of bearing rotations (or total operating period at a constant speed) until flaking occurs is regarded as the bearing service life.

Even if bearings of the same dimensions, structure, material, and processing method are operated under the same rotating conditions, their service lives are considerably varied.

Since this phenomenon results from fatigue distribution in bearing materials themselves, differences in bearing service life should be statistically considered. When a group of identical bearings are rotated under the same conditions, the total number of revolutions until 90 % of the bearings are left without flaking (i.e. a service life of 90 % reliability) is defined as the basic rating life. Or in operating at a constant speed, it can be expressed by the total number of bearing rotations.

In practical service, however, a bearing fails not only because of fatigue, but other coefficients as well, such as wear, seizure, creep, fretting, brinelling, cracking etc. These bearing failures can be minimized by selecting the proper mounting method and lubricant, as well as the bearing most suitable for the application.

BEARING LIFE EQUATIONS

Basic Rating Life

Generally, the relationship between the basic dynamic load rating, dynamic equivalent load, and basic rating life of needle roller bearings is expressed as follows.

$$L_{10} = \left(\frac{C}{P} \right)^{10/3}$$

Where,

- L_{10} : Basic rating life 10⁶ rotations
- C : Basic dynamic load rating N
- P : Dynamic equivalent load N

It is common for the life being expressed in terms of time to be useful when the bearing is rotating at a constant speed.

In this situation, the life can be obtained with the following equation.

$$L_{10h} = \left(\frac{C}{P} \right)^{10/3} \frac{10^6}{60n}$$

Where,

- L_{10h} : Basic rating life h
- n : Rotational speed min⁻¹

Accordingly, where the dynamic equivalent load is P and rotational speed is n , the following equation can be used to calculate the basic dynamic load rating C , which is required to meet the design life. The bearing size most suitable for a specified purpose can then be selected by referring to the bearing specification table.

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

Corrected Rating Life

Generally, the basic rating life of a bearing (L_{10}) is regarded as a standard when its reliability is 90%, but certain applications require a service life whose reliability is more than 90%. The service life may be extended if special material is used, or it may be affected by operating conditions (installation, lubrication, dust prevention, and operating temperature). In such cases, the basic rating life (L_{10}) is corrected using the reliability coefficient (a_1), the bearing characteristic coefficient (a_2), and the operating condition coefficient (a_3). The corrected life is known as the corrected rating life (L_{na}) and can be expressed using the equation below.

$$L_{na} = a_1 \cdot a_2 \cdot a_3 \cdot L_{10}$$

Where,

- L_{na} : Corrected rating life 10⁶ rotations
(Estimated reliability (100 - n) %: the probability of failure is expressed by n with the bearing characteristics and operating conditions taken into consideration)
- L_{10} : Basic rating life 10⁶ rotations (estimated reliability 90%)
- a_1 : Reliability coefficient Refer to section (1)
- a_2 : Bearing characteristic coefficient Refer to section (2)
- a_3 : Operating condition coefficient Refer to section (3)

(1) Reliability coefficient (a_1)

Table A-2 describes the reliability coefficient a_1 , which is used to obtain the corrected rating life L_{na} for the reliability shown.

Table A-2. Reliability coefficient values a_1

Reliability, %	L_{na}	a_1
90	L_{10a}	1.00
95	L_{5a}	0.62
96	L_{4a}	0.53
97	L_{3a}	0.44
98	L_{2a}	0.33
99	L_{1a}	0.21

(2) Bearing characteristic coefficient (a_2)

The life may be affected by characteristics such as the bearing material (steel types and their quality), the production process, and the design.

In such cases, the bearing characteristic coefficient a_2 can be used to correct the bearing life calculation.

JTEKT employs vacuum-degassed bearing steel as our standard bearing material. This material has a significant affect on extending the bearing life, as verified though studies at the JTEKT research and development center. Vacuum-degassed steel bearings are listed in the bearing tables and use $a_2 = 1$.

For bearings made of special materials to extend the bearing's life, the bearing characteristic coefficient may be $a_2 > 1$.



(3) Operating condition coefficient (a_3)

Operating conditions, such as lubrication, affect the service life of bearings. Under normal lubrication, the calculation can be performed with $a_3 = 1$; and under exceptional lubrication, with $a_3 > 1$. When the lubricating condition is not adequate, such as when the lubricant has a low viscosity (20 mm²/s or less) or when the rotational speed is very slow (the product of the rotational speed in min⁻¹ and the rolling element pitch diameter in mm is 10,000 or less), the operating condition coefficient is treated as $a_3 < 1$.

If the lubricating condition is not adequate and $a_3 < 1$, the bearing character coefficient a_2 is usually less than 1.

Basic Dynamic Load Rating Correction Due to Temperature

During high-temperature operation, the bearing metal hardness deteriorates as the material compositions are altered. As a result, the basic dynamic load rating is diminished. Once altered, material composition does not recover, even if the operating temperature is returned to normal. Therefore, for bearings used in high temperature operations, the basic dynamic load rating used must be corrected by multiplying the basic dynamic load rating values specified in the bearing specification table by the temperature coefficient values in Table A-3.

Table A-3. Temperature coefficient values

Bearing temperature, °C	125	150	175	200	250
Temperature coefficient	1	1	0.95	0.90	0.75

MOUNTING DESIGNS

**METRIC SERIES NEEDLE ROLLER BEARINGS
(EXCEPT DRAWN CUP NEEDLE ROLLER
BEARINGS)**

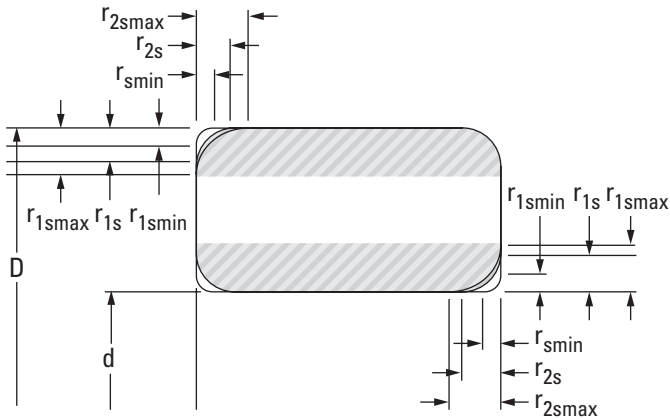
Metric series needle roller bearings are available with Radial Internal Clearance (RIC) designations per either of the following tables: per "ISO/ABMA 'C' Clearance." Non-standard values also are available by special request. Standard radial internal clearance values are listed in the following tables based on bore size. The clearance required for a given application depends on the desired operating precision, rotational speed of the bearing and the fitting practice used. Most applications use a normal or C0 (Standard) clearance. Typically, larger clearance reduces the operating zone of the bearing, increases the maximum roller load and reduces the bearing's expected life.

Table A-4. Metric series needle roller bearing radial internal clearance limits

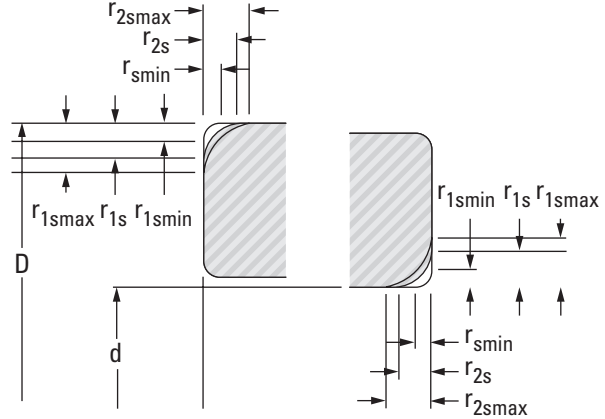
Bore		C2		C0 (Standard)		C3		C4	
		RIC							
over	incl.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
mm in	mm in	mm in	mm in	mm in	mm in	mm in	mm in	mm in	mm in
-	30.000 1.1811	0.025 0.0010	0.000 0.0000	0.045 0.0018	0.020 0.0008	0.060 0.0024	0.035 0.0014	0.075 0.0030	0.050 0.0020
30.000 1.1811	40.000 1.5748	0.030 0.0012	0.005 0.0002	0.050 0.0020	0.025 0.0010	0.070 0.0028	0.045 0.0018	0.085 0.0033	0.060 0.0024
40.000 1.5748	50.000 1.9685	0.035 0.0014	0.005 0.0002	0.060 0.0024	0.030 0.0012	0.080 0.0031	0.050 0.0020	0.100 0.0039	0.070 0.0028
50.000 1.9685	65.000 2.5591	0.040 0.0016	0.010 0.0004	0.070 0.0028	0.040 0.0016	0.090 0.0035	0.060 0.0024	0.110 0.0043	0.080 0.0031
65.000 2.5591	80.000 3.1496	0.045 0.0018	0.010 0.0004	0.075 0.0030	0.040 0.0016	0.100 0.0039	0.065 0.0026	0.125 0.0049	0.090 0.0035
80.000 3.1496	100.000 3.9370	0.050 0.0020	0.015 0.0006	0.085 0.0033	0.050 0.0020	0.110 0.0043	0.075 0.0030	0.140 0.0055	0.105 0.0041
100.000 3.9370	120.000 4.7244	0.055 0.0022	0.015 0.0006	0.090 0.0035	0.050 0.0020	0.125 0.0049	0.085 0.0033	0.165 0.0065	0.125 0.0049
120.000 4.7244	140.000 5.5118	0.060 0.0024	0.015 0.0006	0.105 0.0041	0.060 0.0024	0.145 0.0057	0.100 0.0039	0.190 0.0075	0.145 0.0057
140.000 5.5118	160.000 6.2992	0.070 0.0028	0.020 0.0008	0.120 0.0047	0.070 0.0028	0.165 0.0065	0.115 0.0045	0.215 0.0085	0.165 0.0065
160.000 6.2992	180.000 7.0866	0.075 0.0030	0.025 0.0010	0.125 0.0049	0.075 0.0030	0.170 0.0067	0.120 0.0047	0.220 0.0087	0.170 0.0067
180.000 7.0866	200.000 7.8740	0.090 0.0035	0.035 0.0014	0.145 0.0057	0.090 0.0035	0.195 0.0077	0.140 0.0055	0.250 0.0098	0.195 0.0077
200.000 7.8740	225.000 8.8583	0.105 0.0041	0.045 0.0018	0.165 0.0065	0.105 0.0041	0.220 0.0087	0.160 0.0063	0.280 0.0110	0.220 0.0087
225.000 8.8583	250.000 9.8425	0.110 0.0043	0.045 0.0018	0.175 0.0069	0.110 0.0043	0.235 0.0093	0.170 0.0067	0.300 0.0118	0.235 0.0093
250.000 9.8425	280.000 11.0236	0.125 0.0049	0.055 0.0022	0.195 0.0077	0.125 0.0049	0.260 0.0102	0.190 0.0075	0.330 0.0130	0.260 0.0102
280.000 11.0236	315.000 12.4016	0.130 0.0051	0.055 0.0022	0.205 0.0081	0.130 0.0051	0.275 0.0108	0.200 0.0079	0.350 0.0138	0.275 0.0108
315.000 12.4016	355.000 13.9764	0.145 0.0057	0.065 0.0026	0.225 0.0089	0.145 0.0057	0.305 0.0120	0.225 0.0089	0.385 0.0152	0.305 0.0120
355.000 13.9764	400.000 15.7480	0.190 0.0075	0.100 0.0039	0.280 0.0110	0.190 0.0075	0.370 0.0146	0.280 0.0110	0.460 0.0181	0.370 0.0146
400.000 15.7480	450.000 17.7165	0.210 0.0083	0.110 0.0043	0.310 0.0122	0.210 0.0083	0.410 0.0161	0.310 0.0122	0.510 0.0201	0.410 0.0161
450.000 17.7165	500.000 19.6850	0.220 0.0087	0.110 0.0043	0.330 0.0130	0.220 0.0087	0.440 0.0173	0.330 0.0130	0.550 0.0217	0.440 0.0173



METRIC SERIES BEARING CHAMFER DIMENSIONS



Radial Bearings



Thrust Bearings

Table A-5. Chamfer dimensions of radial bearings metric series

$r_{s \min}$	d		$r_{1s \max}$	$r_{2s \max}$
	Nominal bore dia.			
	>	≤		
mm in	mm in	mm in	mm in	mm in
0.150 0.0059	all all		0.300 0.0118	0.600 0.0236
0.200 0.0079	all all		0.500 0.0197	0.800 0.0315
0.300 0.0118	— 40.000 1.5748	40.000 1.5748 —	0.600 0.0236 0.800 0.0315	1.000 0.0394 1.000 0.0394
0.600 0.0236	— 40.000 1.5748	40.000 1.5748 —	1.000 0.0394 1.300 0.0512	2.000 0.0787 2.000 0.0787
1.000 0.0394	— 50.000 1.9685	50.000 1.9685 —	1.500 0.0591 1.900 0.0748	3.000 0.1181 3.000 0.1181
1.100 0.0433	— 120.000 4.7244	120.000 4.7244 —	2.000 0.0787 2.500 0.0984	3.500 0.1378 4.000 0.1575
1.500 0.0591	— 120.000 4.7244	120.000 4.7244 —	2.300 0.09055 3.000 0.1181	4.000 0.1575 5.000 0.19685
2.000 0.0787	— 80.000 3.1496 220.000 8.6614	80.000 3.1496 220.000 8.6614 —	3.000 0.1181 3.500 0.1378 3.800 0.1496	4.500 0.1772 5.000 0.19685 6.000 0.2362
2.100 0.0827	— 280.000 11.0236	280.000 11.0236 —	4.000 0.1575 4.500 0.1772	6.500 0.2559 7.000 0.2756

Table A-6. Chamfer dimensions of thrust bearings metric series

$r_{s \min}$	$r_{1s \max}$	$r_{2s \max}$
mm in	mm in	mm in
0.300 0.0118	0.800 0.0315	0.800 0.0315
0.600 0.0236	1.500 0.0591	1.500 0.0591
1.000 0.0394	2.200 0.0866	2.200 0.0866
1.100 0.0433	2.700 0.1063	2.700 0.1063
1.500 0.0591	3.500 0.1378	3.500 0.1378
2.000 0.0787	4.000 0.1575	4.000 0.1575

ABMA/ISO Symbols

- d Bearing bore diameter, nominal and shaft-piloted washer bore diameter, nominal.
- D Bearing outside diameter, nominal and housing-piloted washer outside diameter, nominal.
- $r_{s \min}$ Smallest permissible single chamfer dimension (minimum limit).
- $r_{1s \max}$ Largest permissible single chamfer dimension in a radial direction.
- $r_{2s \max}$ Largest permissible single chamfer dimension in an axial direction.

SHAFT DESIGNS

BEARINGS WITHOUT INNER RINGS

When the shaft is used as the inner raceway for needle roller bearings it must have a hardness of 58 HRC or higher and a wave-free finish in order to realize the full load-carrying capability of the bearing.

- 1. Metallurgy** – either case-hardening or through-hardening grades of good bearing-quality steel are satisfactory for raceways.

To realize full bearing capacity, the raceway area must be at least surface hard with a reasonable core strength. During the carburizing or induction-hardening of case hardened steel, not only must the surface hardness requirement of 58 HRC or higher be met, but the case depth to HV 550 (52.3 HRC) must be met in the range of $0.08D_w$ to $0.10D_w$ mm. (D_w : roller diameter)
(Conforms to JIS G0557 and ISO 2639.)

- 2. Strength** – the shaft must be of sufficient strength to keep the operating deflections within the limits outlined.
- 3. Tolerance** – the suggested shaft diameter tolerances for each type of needle roller bearing are indicated in the appropriate section of this catalog.
- 4. Variation of mean shaft diameter (taper)** – within the range of the bearing width, $5\ \mu\text{m}$ or less per 25 mm or one-half the diameter tolerance or less (whichever is smaller).
- 5. Deviation from circular form** – the radial deviation from true circular form of the raceway should not exceed $2.5\ \mu\text{m}$ for diameters up to and including 25 mm. For raceways greater than 25 mm, the allowable radial deviation should not exceed $2.5\ \mu\text{m}$ multiplied by a factor of the raceway diameter divided by 25.
- 6. High frequency lobing** – the lobing that occurs 10 or more times around the circumference of a shaft and exceeds $0.4\ \mu\text{m}$ from peak to valley is called chatter. Chatter usually causes undesirable noise and reduces fatigue life.
- 7. Shaft slope** – for shafts that are used as bearing raceways, the slant precision must be $13\ \mu\text{m}$ or less per 25 mm of raceway surface axial measurement length.
- 8. Surface finish** – In addition to a wave-free finish, the raceway surface roughness of $R_a \leq 0.2\ \mu\text{m}$ must be maintained for the bearing to utilize its full load rating. The raceway area also must be free of nicks, burrs, scratches and dents. Oil holes are permissible in the raceway area, but care must be taken to blend the edges gently into the raceway, and if possible, the hole should be located in the unloaded zone of the raceway.
Care also must be taken to prevent grind reliefs, fillets, etc., from extending into the raceway area. If the rollers overhang a grind relief or step on the shaft, there will be high stress concentration with resultant early damage.

- 9. End chamfer** – for the most effective assembly of the shaft into a bearing, the end of the shaft should have a large chamfer or rounding. This should help in preventing damage to the roller complement, scratching of the raceway surface, and nicking of the shaft end.

- 10. Sealing surface** – in some instances, bearings have integral or immediately adjacent seals that operate on the surface ground for the bearing raceway. Here, particular attention should be paid to the pattern of the shaft finish. In no instance should there be a “lead,” or spiral effect, as often occurs with through-feed centerless grinding. Such a “lead” may pump lubricant past the seal.

BEARINGS WITH INNER RINGS

When it is undesirable or impractical to prepare the shaft to be used as a raceway, inner rings are available as listed in the tabular pages. If the shaft is not used directly as a raceway, the following design specifications must be met:

- 1. Strength** – the shaft must be of sufficient strength to keep the operating deflections within the limits outlined.
- 2. Tolerance** – the suggested shaft diameter tolerances for each type of needle roller bearing are indicated in the appropriate section of the catalog.
- 3. Variation of mean shaft raceway diameter (taper) and deviation from circular form of the raceway** – should not exceed one-half the shaft diameter tolerance.
- 4. Surface finish** – the surface finish should not exceed a roughness of $R_a\ 0.8\ \mu\text{m}$.
- 5. Locating shoulders or steps** – locating shoulders or steps in the shaft must be held to close concentricity with the bearing seat to prevent imbalance and resultant vibrations.

HOUSING DESIGNS

BEARINGS WITH OUTER RINGS

For bearings with outer rings, the function of the housing is to locate and support the outer ring. The following specifications must be met:

- 1. Strength** – housings should be designed so that the radial loads placed on the bearings will cause a minimum of deflection or distortion of the housing.
- 2. Variation of mean housing diameter (taper)** – within the length of the outer ring, 13 μm or one-half the diameter tolerance (whichever is smaller) or less.
- 3. Deviation from circular form** – the housing bore should be round within one-half the housing bore tolerance.
- 4. Parallelism** – when possible, line bore housings that are common to one shaft to obtain parallelism of the housing bores and the shaft axis.
- 5. Surface finish** – The surface finish should not exceed R_a 1.6 μm .
- 6. End chamfer** – to permit easy introduction of the bearing into the housing, the end of the housing should have a generous chamfer.

Only heavy-duty needle roller bearings can be installed into housings with a transition fit or a clearance fit. The outer ring should be a transition fit in the housing when it rotates relative to the load. The outer ring may be a clearance fit in the housing when it is stationary relative to the load. In either case, locate the bearings by shoulders, or other locating devices, to prevent axial movement.

Since only the heavy-duty needle roller bearing does not require an interference fit in the housing to round and size it properly, a split housing may be used if desired. Dowels should be used to maintain proper register of the housing sections.

Drawn cup needle roller bearings have a thin case-hardened outer ring that is out-of-round from the hardening operation. For proper mounting it must **always** be pressed into the housing. Split housings will not round and size a drawn cup bearing. When split housings must be used, the bearing should first be mounted in a cylindrical sleeve.

The housing should be of sufficient tensile strength and section to round and size the bearing. It must be designed for minimum distortion under load. Steel or cast iron housings are preferred. Housing bores in low tensile strength materials such as aluminum, magnesium, phenolics, etc., should be reduced to provide more interference fit. Thin section cast iron and steel housings may also require reduced bores. Consult your representative for suggestions when working with these lower strength housings.

The housing should be through-bored if possible. When shouldered housing bores are unavoidable, the bearing should be located far enough from the shoulder to avoid the danger of crushing the end of the drawn cup during installation.

When the drawn cup bearing is mounted close to the housing face, care should be taken to mount the bearing at least 0.250 mm (0.0100 in) within the housing face to protect the bearing lip.

BEARINGS WITHOUT OUTER RINGS

In many cases, such as with gear bores, it is desirable to have the housing bore serve as the outer raceway for radial needle roller and cage assemblies or loose needle roller complements. In those instances, as for shafts used as raceways, the housing bore must have a hardness of 58 HRC or harder and a surface roughness $R_a \leq 0.2 \mu\text{m}$ so that the full load-carrying capacity of the bearing is realized.

- 1. Strength** – the housing must be of sufficient cross section to maintain proper roundness and running clearance under maximum load.
- 2. Metallurgical** – material selection, hardness and case depth should be consistent with the requirements for inner raceways given in the shaft design.
- 3. Variation of mean housing raceway diameter (taper)** – within the range of the bearing width, 5 μm or less per 25 mm or one-half the housing bore diameter tolerance or less (whichever is smaller). In addition, the bore diameter must never be smaller at both ends than in the center [sway-back].
- 4. Deviation from circular form** – the raceway out-of-roundness should not exceed one-half the bore tolerance.
- 5. Surface finish** – In addition to a wave-free finish, the raceway surface roughness of $R_a \leq 0.2 \mu\text{m}$ must be maintained for the bearing to utilize its full load rating. The raceway area also must be free of nicks, burrs, scratches and dents.
- 6. Grind reliefs** – care must be exercised to ensure that grind reliefs, fillets, etc., do not extend to the raceway. Oil holes in the raceway area are permissible, but the edges must be blended smoothly with the raceway and, if possible, the hole should be located in the unloaded zone of the raceway.



Table A-7. Accuracy and roughness of shafts and housings (needle roller and cage assemblies, drawn cup needle roller bearings, and machined ring needle roller bearings)

	Shaft		Housing bore	
	Raceway surface	Fitting surface	Raceway surface	Fitting surface
Out-of-roundness	Shaft diameter ≤ 25 mm: 2.5 μm or less Shaft diameter > 25 mm: 2.5 μm × (shaft diameter/25 mm) or less	One-half the shaft diameter tolerance or less	8 μm or one-half the bore tolerance or less	One-half the bore tolerance or less
Variation of mean diameter (taper)	Within the range of the bearing width, 5 μm or less per 25 mm or one-half the bearing tolerance or less (whichever is smaller)	One-half the shaft diameter tolerance or less	Within the range of the bearing width, 5 μm or less per 25 mm or one-half the bearing tolerance or less (whichever is smaller)	Within the length of the outer ring, 13 μm or one-half the diameter tolerance (whichever is smaller) or less.
Surface roughness	0.2 a or less	0.8 a or less	0.2 a or less	1.6 a or less
Hardness	58 HRC or harder ¹⁾	–	58 HRC or harder ¹⁾	–
Shaft slope	13 μm or less per 25 mm		–	

1) During the carburizing or induction-hardening of case hardened steel, not only must the surface hardness requirement specified above be met, but the case depth of HV 550 (52.3 HRC) must be met in the range of 0.08D_w to 0.10D_w mm. (D_w: roller diameter)

FITS

The purpose of fit is to securely fix the inner or outer ring to the shaft or housing, to preclude detrimental circumferential sliding on the fitting surface.

Such detrimental sliding (referred to as "creep") will cause abnormal heat generation, wear of the fitting surface, infiltration of abrasion metal particles into the bearing, vibration, and many other harmful effects, which cause a deterioration of bearing functions.

FIT SELECTION

In selecting the proper fit, careful consideration should be given to bearing operating conditions.

Major specific considerations are :

- Direction of load
- Load characteristics and magnitude
- Temperature distribution in operating
- Bearing internal clearance
- Surface finish, material and thickness of shaft and housing
- Mounting and dismounting methods
- Necessity to compensate for shaft thermal expansion at the fitting surface
- Bearing type and size

In view of these considerations, the following paragraphs explain the details of the important factors in fit selection.

1. Direction of load

Direction of load classified into three types : rotating inner ring load; rotating outer ring load and indeterminate direction load.

Table A-8 tabulates the relationship between these characteristics and fit.

Table A-8. Direction of Load and Fits

Direction of load		Rotating Ring		Type of load	Fit	
		Inner ring	outer ring		Inner ring	outer ring
Rotating inner ring load	Inner ring : Circumferential load Outer ring : Point load	Rotating	Stationary	Rotating load	Tight	Loose
Rotating outer ring load	Inner ring : Point load Outer ring : Circumferential load	Stationary	Rotating	Rotating load	Loose	Tight
Indeterminate direction load	Inner ring : Circumferential load Outer ring : Oscillating load	Rotating Stationary	Stationary Rotating	Stationary load > Rotating load Stationary load < Rotating load	Tight	Slightly tight
	Inner ring : Oscillating load Outer ring : Circumferential load	Rotating Stationary	Stationary Rotating	Stationary load > Rotating load Stationary load < Rotating load	Slightly tight	Tight

2. Effect of load characteristic and magnitude

When a radial load is applied, the inner ring will expand slightly. Since this expansion enlarges the circumference of the bore minutely, the initial interference is reduced.

The reduction can be calculated by the following equations :

$$\begin{aligned} & \text{[in the case of } F_r \leq 0.25 C_0] & \text{[in the case of } F_r > 0.25 C_0] \\ \Delta_{df} &= 0.08 \sqrt{\frac{d}{B}} \cdot F_r \times 10^{-3} & \Delta_{df} &= 0.02 \frac{F_r}{B} \times 10^{-3} \end{aligned}$$

where :

- Δ_{df} : Reduction of inner ring interference mm
- d : Nominal bore diameter of bearing mm
- B : Nominal inner ring width mm
- F_r : Radial load N
- C_0 : Basic static load rating N

When the radial load exceeds the C₀ value by 25%, greater interference is needed. When impact loads are expected, much greater interference is needed.

3. Effect of fitting surface roughness

The effective interference obtained after fitting differs from calculated interference due to plastic deformation of the ring fitting surface. When the inner ring is fitted, the effective interference, subject to the effect of the fitting surface finish, can be approximated by the following equations :

$$\begin{aligned} & \text{[In the case of a ground shaft]} & \text{[In the case of a turned shaft]} \\ \Delta_{deff} &\doteq \frac{d}{d+2} \Delta_d & \Delta_{deff} &\doteq \frac{d}{d+3} \Delta_d \end{aligned}$$

where :

- Δ_{deff} : Effective interference mm
- Δ_d : Calculated interference mm
- d : Nominal bore diameter of bearing mm



4. Effect of temperature

A bearing generally has an operating temperature that is higher than the ambient temperature. When the inner ring operates under load, its temperature generally becomes higher than that of the shaft and the effective interference decreases due to the greater thermal expansion of the inner ring.

If the temperature difference between the bearing inside and surrounding housing is Δt , the temperature difference between the fitting surfaces of the inner ring and shaft will be approximately $(0.10 \text{ to } 0.15) \times \Delta t$. The reduction of interference (Δdt) due to the temperature difference is then expressed as follows:

$$\Delta dt = (0.10 \sim 0.15) \Delta t \cdot \alpha \cdot d$$

$$\doteq 0.0015 \Delta t \cdot d \times 10^{-3}$$

In this equation,

- Δdt : Reduction of interference due to temperature difference mm
- Δt : Temperature difference between the inside of the bearing and the surrounding housing °C
- α : Linear expansion coefficient of bearing steel (approximately equal to 12.5×10^{-6}) 1/°C
- d : Nominal bore diameter of bearing mm

Consequently, when a bearing is higher in temperature than the shaft, greater interference is required.

However, a difference in temperature or in the coefficient of expansion may sometimes increase the interference between the outer ring and housing. Therefore, care should be taken when clearance is provided to accommodate shaft thermal expansion.

5. Maximum stress due to fit

When a bearing is fitted with interference, the bearing ring will expand or contract, generating internal stress.

Should this stress be excessive, the bearing ring may fracture.

The maximum bearing fitting-generated stress is determined by the equation in Table A-9.

In general, to avoid fracture, it is best to adjust the maximum interference to less than 1/1 000 of the shaft diameter, or the maximum stress (σ), determined by the equation in Table A-9, should be less than 120 MPa.

Table A-9 does not apply to drawn cup needle roller bearings.

Recommended Fits

Recommended fits are listed in each bearing section and within the tabular pages.

Table A-9. Maximum fitting-generated stress in bearings

Shaft & inner ring	Housing bore & outer ring
<p>(In the case of hollow shaft)</p> $\sigma = \frac{E}{2} \cdot \frac{\Delta_{deff}}{d} \cdot \frac{\left(1 - \frac{d_0^2}{d^2}\right) \left(1 + \frac{d^2}{D_i^2}\right)}{\left(1 - \frac{d_0^2}{D_i^2}\right)}$	<p>(In the case of $D_h \neq \infty$)</p> $\sigma = E \cdot \frac{\Delta_{Deff}}{D} \cdot \frac{\left(1 - \frac{D^2}{D_h^2}\right)}{\left(1 - \frac{D_e^2}{D_h^2}\right)}$
<p>(In the case of solid shaft)</p> $\sigma = \frac{E}{2} \cdot \frac{\Delta_{deff}}{d} \cdot \left(1 + \frac{d^2}{D_i^2}\right)$	<p>(In the case of $D_h = \infty$)</p> $\sigma = E \cdot \frac{\Delta_{Deff}}{D}$

where :

- | | | | |
|--|-----|---|-----|
| σ : Maximum stress | MPa | D_e : Raceway contact diameter of outer ring | mm |
| d : Nominal bore diameter (shaft diameter) | mm | roller bearing ... $De \doteq 0.25 (3D + d)$ | |
| D_i : Raceway contact diameter of inner ring | mm | D : Nominal outside diameter (bore diameter of housing) | mm |
| roller bearing ... $D_i \doteq 0.25 (D + 3d)$ | | Δ_{Deff} : Effective interference of outer ring | mm |
| Δ_{deff} : Effective interference of inner ring | mm | D_h : Outside diameter of housing | mm |
| d_0 : Bore diameter of hollow shaft | mm | E : Young's modulus = 2.08×10^5 | MPa |

[Remark] The above equations are applicable when the shaft and housing are steel.
When other materials are used, JTEKT should be consulted.



CLEARANCE

Bearing internal clearance is defined as the clearance between the bearing ring and the rolling elements. The total distance either inner or outer ring can be moved when the specified measuring load is applied to the ring in radial direction and the other ring is fixed is defined as radial internal clearance.

The term "residual clearance" is also defined as the original clearance decreased owing to expansion or contraction of a raceway due to fitting, when the bearing is mounted in the shaft and housing.

The term "effective clearance" is defined as the residual clearance decreased owing to dimensional change arising from temperature differentials within the bearing.

The term "operating clearance" is defined as the internal clearance present while a bearing mounted in a machine is rotating under a

certain load, or, the effective clearance increased due to elastic deformation arising from bearing loads.

The operating clearance is closely related to bearing performance and life. It is therefore desirable to select a clearance with a lower limit value on the positive side of zero.

When selecting the clearance, fitting conditions, temperature conditions, and tolerance of mounting dimensions must all be taken into account.

The operating clearance can be obtained from the equation in Table A-10.

These calculations can be used for machined ring needle roller bearings but not for drawn cup needle roller bearings.

For the drawn cup needle roller bearings refer to page B-2-7.

Table A-10. Operating clearance

Operating clearance (S)	$S = S_0 - (S_f + S_{t1} + S_{t2}) + S_w^*$		* $\left[S_w \text{ (increase of clearance due to load) is generally small, and thus may be ignored, although there is an equation for determining the value.} \right]$
Decrease of clearance due to fitting (S _f)	(In the case of hollow shaft)	$S_{fi} = \Delta_{deff} \frac{d}{D_i} \cdot \frac{\left(1 - \frac{d_0^2}{d^2}\right)}{\left(1 - \frac{d_0^2}{D_i^2}\right)}$	(In the case of D _h ≠∞)
	(In the case of solid shaft)	$S_{fi} = \Delta_{deff} \frac{d}{D_i}$	(In the case of D _h =∞)
Decrease of clearance due to temperature differentials between inner and outer rings (S _{t1})	The amount of decrease varies depending on the state of housing; however, generally the amount can be approximated by the following equation on the assumption that the outer ring will not expand:		where: D _e =D _r +2D _w Consequently, S _{t1} +S _{t2} will be determined by the following equation: S _{t1} +S _{t2} =α·D _i ·t ₁ +2α·D _w ·t ₂ Temperature differential between the inner and outer rings, t ₁ , can be expressed as follows: t ₁ =t _r -t _e Temperature differential between the rolling element and outer ring, t ₂ , can be expressed as follows: t ₂ =t _w -t _e
	$S_{t1} = \alpha \cdot (D_i \cdot t_r - D_e \cdot t_e)$		
Decrease of clearance due to temperature rise of rolling element (S _{t2})	$S_{t2} = 2\alpha \cdot D_w \cdot t_w$		

In Table A-10,

S : Operating clearance	mm	Δ_{Deff} : Effective interference of outer ring	mm
S ₀ : Clearance before mounting	mm	D _h : Outside diameter of housing	mm
S _f : Decrease of clearance due to fitting	mm	D _e : Outer ring raceway contact diameter	mm
S _{fi} : Expansion of inner ring raceway contact diameter	mm	roller bearing ... $D_e \doteq 0.25 (3D + d)$	
S _{fo} : Contraction of outer ring raceway contact diameter	mm	D : Nominal outside diameter	mm
S _{t1} : Decrease of clearance due to temperature differentials between inner and outer rings	mm	α : Linear expansion coefficient of bearing steel (12.5×10 ⁻⁶)	1/°C
S _{t2} : Decrease of clearance due to temperature rise of the rolling elements	mm	D _w : Average diameter of rolling elements	mm
S _w : Increase of clearance due to load	mm	roller bearing ... $D_w \doteq 0.25 (D - d)$	
Δ_{deff} : Effective interference of inner ring	mm	t ₁ : Temperature rise of the inner ring	°C
d : Nominal bore diameter (shaft diameter)	mm	t _e : Temperature rise of the outer ring	°C
d ₀ : Bore diameter of hollow shaft	mm	t _w : Temperature rise of rolling elements	°C
D _i : Inner ring raceway contact diameter	mm		
roller bearing ... $D_i \doteq 0.25 (D + 3d)$			

■ Bearings are sometimes used with a non-steel shaft or housing.

In the automotive industry, a statistical method is often incorporated for selection of clearance.

In these cases, or when other special operating conditions are involved, JTEKT should be consulted.

LUBRICATION

PURPOSE OF LUBRICATION

Lubrication is one of the most important factors determining bearing performance. Since the suitability of the lubricant and lubrication method have a dominant influence on bearing life, the most suitable lubricant should be selected according to operating conditions.

Functions of lubrication :

- To lubricate each part of the bearing, and to reduce friction and wear
- To carry away heat generated inside bearing due to friction and other causes
- To cover rolling contact surface with the proper oil film in order to prolong bearing fatigue life
- To prevent corrosion and contamination by dirt

Although the same general rules for ball bearings and roller bearings can also be applied to needle roller bearing lubrication, the following points should also be considered :

- The space in the bearing is very small; thus, only a little lubricant can be retained.
- The bearing is relatively wide, so circulating the lubricant through the bearing is difficult.
- In the case of full complement type sliding contact between rollers may arise.
- Rollers may skew during rotation.
- Often used in the application where oscillating motion is present.

Accordingly, these points must be given sufficient consideration when selecting the lubricant and method of lubrication.

LUBRICANT

Bearing lubrication is classified broadly into two categories : grease lubrication and oil lubrication. Table A-11 makes a general comparison between the two.

Table A-11. Comparison between grease and oil lubrication

Item	Grease	Oil
Sealing device	Easy	Slightly complicated and special care required for maintenance
Lubricating ability	Good	Excellent
Rotation speed	Low/medium speed	Applicable at high speed as well
Replacement of lubricant	Slightly troublesome	Easy
Life of lubricant	Relatively short	Long
Cooling effect	No cooling effect	Good (circulation is necessary)
Filtration of dirt	Difficult	Easy

GREASE LUBRICATION

Grease is made by mixing and dispersing a solid of high oil-affinity (called a thickener) with lubricant oil (as a base), and transforming it into a semi-solid state.

As well, a variety of additives can be added to improve specific performance.

Many types of grease are marketed in various combinations of thickener, base oil and additives according to the purposes. So, it is very important to select proper types of grease.

The characteristics of various greases are shown in Table A-12.

Table A-12. Characteristics of respective greases

	Lithium grease			Calcium grease (cup grease)	Sodium grease (fiber grease)	Complex base grease		Non-soap base grease		
	Mineral oil	Synthetic oil (diester oil)	Synthetic oil (silicon oil)	Mineral oil	Mineral oil	Lithium complex soap	Calcium complex soap	Bentone	Urea compounds	Fluorine compounds
Thickener	Lithium soap			Calcium soap	Sodium soap					
Base oil	Mineral oil	Synthetic oil (diester oil)	Synthetic oil (silicon oil)	Mineral oil	Mineral oil	Mineral oil	Mineral oil	Mineral oil	Mineral/synthetic oil	Synthetic oil
Dropping point (°C)	170 to 190	170 to 230	220 to 260	80 to 100	160 to 180	250 or higher	200 to 280	-	240 or higher	250 or higher
Operating temperature range (°C)	-30 to +120	-50 to +130	-50 to +180	-10 to +70	0 to +110	-30 to +150	-10 to +130	-10 to +150	-30 to +150	-40 to +250
Rotation speed range	Medium to high	High	Low to medium	Low to medium	Low to high	Low to high	Low to medium	Medium to high	Low to high	Low to medium
Mechanical stability	Excellent	Good to excellent	Good	Fair to good	Good to excellent	Good to excellent	Good	Good	Good to excellent	Good
Water resistance	Good	Good	Good	Good	Bad	Good to excellent	Good	Good	Good to excellent	Good
Pressure resistance	Good	Fair	Bad to fair	Fair	Good to excellent	Good	Good	Good to excellent	Good to excellent	Good
Remarks	Most widely usable for various rolling bearings.	Superior low temperature and friction characteristics.	Superior high and low temperature characteristics.	Suitable for applications at low rotation speed and under light load. Not applicable at high temperature.	Liable to emulsify in the presence of water. Used at relatively high temperature.	Superior mechanical stability and heat resistance. Used at relatively high temperature.	Superior pressure resistance when extreme pressure agent is added.	Suitable for applications at high temperature and under relatively heavy load.	Superior water resistance, oxidation stability, and heat stability. Suitable for applications at high temperature and high speed.	Superior chemical resistance and solvent resistance. Usable at up to 250 °C.

(1) Base oil

Mineral oil is usually used as the base oil for grease.

When low temperature fluidity, high temperature stability, or other special performance is required, diester oil, silicon oil, polyglycolic oil, fluorinated oil, or other synthetic oil is often used.

Generally, grease with a low viscosity base oil is suitable for applications at low temperature or high rotation speed; grease with high viscosity base oils are suitable for applications at high temperature or under heavy load.

(2) Thickener

Most greases use a metallic soap base such as lithium, sodium, or calcium as thickeners. For some applications, however, non-soap base thickeners (inorganic substances such as bentone, silica gel, and organic substances such as urea compounds, fluorine compounds) are also used.

In general, the mechanical stability, bearing operating temperature range, water resistance, and other characteristics of grease are determined by the thickener.

(Lithium soap base grease)

Superior in heat resistance, water resistance and mechanical stability.

(Calcium soap base grease)

Superior in water resistance; inferior in heat resistance.

(Sodium soap base grease)

Superior in heat resistance; inferior in water resistance.

(Non-soap base grease)

Superior in heat resistance.

(3) Additives

Various additives are selectively used to serve the respective purposes of grease applications.

- Extreme pressure agents
When bearings must tolerate heavy or impact loads.
- Oxidation inhibitors
When grease is not refilled for a long period.

Structure stabilizers, rust preventives, and corrosion inhibitors are also used.

(4) Consistency

Consistency, which indicates grease hardness, is expressed as a figure obtained, in accordance with ASTM (JIS), by multiplication by 10 the depth (in mm) to which the cone-shaped metallic plunger penetrates into the grease at 25 °C by deadweight in 5 seconds. The softer the grease, the higher the figure.

Table A-13 shows the relationships between the NLGI scales and ASTM (JIS) penetration indexes, service conditions of grease.

(NLGI : National Lubricating Grease Institute)

It is imperative that the bearing operating temperature is always within the temperature range specified for the grease used. Although softer greases provide better lubrication, they are more likely to be churned. Since grease churning tends to cause temperature rise and leakage, this characteristic should be taken into account when selecting grease consistency. For ordinary operating conditions, greases of NLGI No. 0 to 3 are commonly used. When the bearing operating speed is higher, a somewhat harder grease with high mechanical stability should be selected.

Table A-13. Grease consistency and service conditions

ASTM (JIS) penetration index (25 °C, 60 mixing operations)	NLGI scale	Service conditions/applications
355 - 385	0	For centralized lubricating
310 - 340	1	For centralized lubricating, at low temperature
265 - 295	2	For general use
220 - 250	3	For general use, at high temperature
175 - 205	4	For special applications

[Note] The larger the penetration index, the softer is the grease.

(5) Mixing of different greases

Since mixing of different greases changes their properties, greases of different brands should not be mixed.

If mixing cannot be avoided, greases containing the same thickener should be used. Even if the mixed greases contain the same thickener, however, mixing may still produce adverse effects, due to difference in additives or other factors.

Thus it is necessary to check the effects of a mixture in advance, through testing or other methods.

A

REPLENISHMENT/REPLACEMENT OF GREASE

The method of replenishing/replacing grease depends largely on the lubrication method. Whichever method may be utilized, care should be taken to use clean grease and to keep dirt or other foreign matter out of the housing.

When grease is refilled, new grease must be injected inside bearing.

In case of high speed operation or a small air space, because it is necessary to replenish grease often, a grease inlet should be provided as near the bearing as possible so that the deteriorated grease may be replaced by new grease.

Under normal operating conditions, grease life may be approximated by the graphs shown in Fig. A-5. It is recommended you use this diagram as a guide for replenishment and replacement of grease.

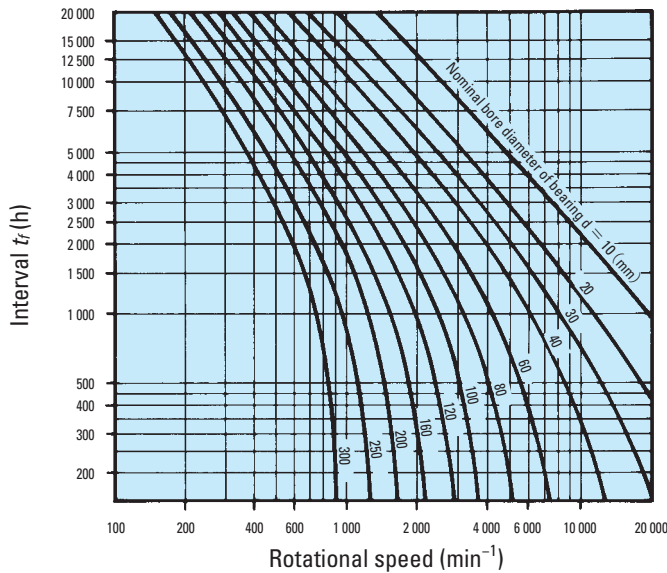


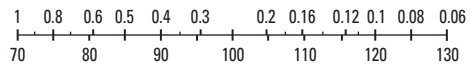
Fig. A-5 Grease feeding interval

■ Temperature correction

When the bearing operating temperature exceeds 70 °C, t_f' , obtained by multiplying t_f by correction coefficient a , found on the scale below, should be applied as the feeding interval.

$$t_f' = t_f \cdot a$$

Temperature correction coefficient a



Bearing operating temperature T °C

WARNING

Mixing grease types can cause the lubricant to become ineffective, which can result in equipment failure, creating a risk of serious bodily harm.



LUBRICATING OIL

The most commonly used bearing lubricating oil is super refined mineral oil, which has excellent oxidation stability and rust inhibition as well as high film strength. However, as bearings are being used in a variety of applications, a wide variety of synthetic oils are

being used. What's more, a variety of additives (such as oxidation inhibitors, rust inhibitors, and anti-foam agents) are being used to improve the specific properties of these synthetic oils. Table A-14 shows the properties of various lubricating oils.

Table A-14. Properties of various lubricating oils

Lubricating oil type	Super refined mineral oil	Major synthetic oils				
		Diester oil	Silicon oil	Polyglycolic oil	Polyphenyl ether oil	Fluorinated oil
Bearing operating temperature range (°C)	-40 to +220	-55 to +150	-70 to +350	-30 to +150	0 to +330	-20 to +300
Lubricating ability	Excellent	Excellent	Fair	Good	Good	Excellent
Oxidation stability	Good	Good	Fair	Fair	Excellent	Excellent
Radiation resistance	Bad	Bad	Bad to fair	Bad	Excellent	-

LUBRICATING OIL SELECTION

The most important thing to consider when selecting a lubricating oil is to select an oil that has a viscosity that is appropriate for the operating temperature of the bearing.

Use Table A-15 to select the proper kinematic viscosity for your bearing operating conditions. Use this value as a guideline.

If the viscosity of the lubricating oil is too low, an insufficient oil film will form. If the viscosity of the lubricating oil is too high, heat will

be generated due to viscous resistance.

Generally, the larger the load or the higher the operating temperature, the higher the viscosity of the used lubricating oil and the higher the rotational speed, the lower the viscosity of the used lubricating oil.

The relationship between the lubricating oil viscosity and temperature is shown in Fig. A-6.

Table A-15. Proper kinematic viscosities by bearing operating conditions

Operating temperature	$d_m n$ value	Proper kinematic viscosity (expressed in the ISO viscosity grade or the SAE No.)		
		Light/normal load		Heavy/impact load
-30 to 0°C	All rotation speeds	ISO VG 15, 22, 46	{ Refrigerating Machine oil }	—
0 to 60°C	300 000 or lower	ISO VG 46	{ Bearing oil Turbine oil }	ISO VG 68 SAE 30 { Bearing oil Turbine oil }
	300 000 to 600 000	ISO VG 32	{ Bearing oil Turbine oil }	ISO VG 68 { Bearing oil Turbine oil }
	600 000 or higher	ISO VG 7, 10, 22	{ Bearing oil }	—
60 to 100°C	300 000 or lower	ISO VG 68	{ Bearing oil }	ISO VG 68, 100 SAE 30 { Bearing oil }
	300 000 to 600 000	ISO VG 32, 46	{ Bearing oil Turbine oil }	ISO VG 68 { Bearing oil Turbine oil }
	600 000 or higher	ISO VG 22, 32, 46	{ Bearing oil Turbine oil Machine oil }	—
100 to 150°C	300 000 or lower	ISO VG 68, 100 SAE 30, 40	{ Bearing oil }	ISO VG 100 to 460 { Bearing oil Gear oil }
	300 000 to 600 000	ISO VG 68 SAE 30	{ Bearing oil Turbine oil }	ISO VG 68, 100 SAE 30, 40 { Bearing oil }

- [Remarks] 1. $d_m n = \frac{D+d}{2} \times n$ {D: nominal outside diameter (mm), d: nominal bore diameter (mm), n: rotational speed (min⁻¹)}
2. Please contact with JTEKT if the bearing operating temperature is under -30 °C or over 150 °C.

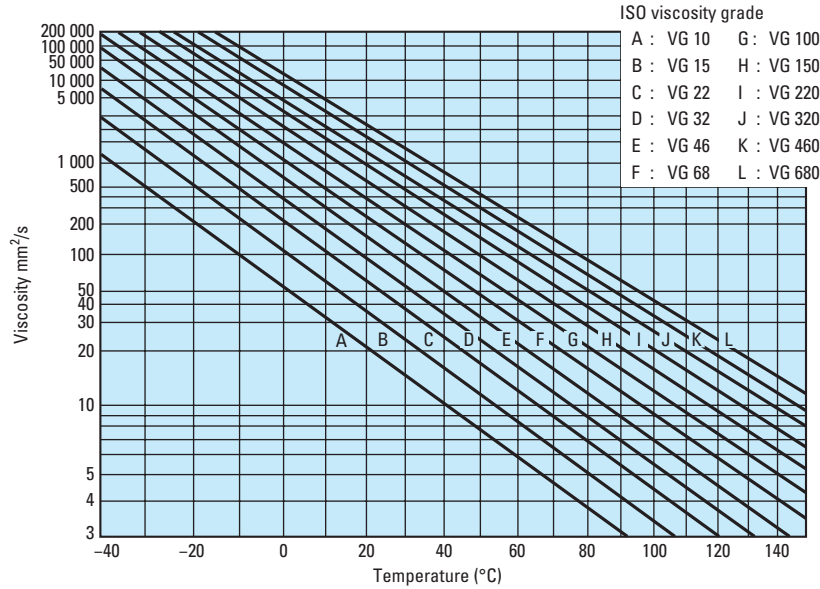


Fig. A-6. Relationship between lubricating oil viscosity and temperature (viscosity index : 100)

CLASSIFICATION

There are several classifications of oils based on viscosity grades. The most familiar are the Society of Automotive Engineers (SAE) classifications for automotive engine and gear oils. The American Society for Testing and Materials (ASTM) and the International Organization for Standardization (ISO) have adopted standard viscosity grades for industrial fluids. Fig. A-7 shows the viscosity comparisons of ISO/ASTM with SAE classification systems at 40°C (104°F).

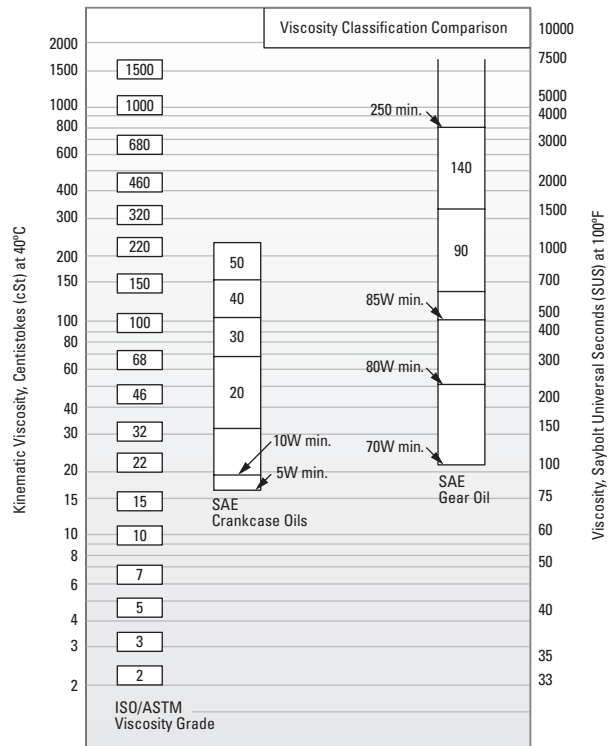


Fig. A-7. Viscosity classification comparison between ISO/ASTM grades (ISO 3448/ASTM D2442) and SAE grades (SAE J 300-80 for crankcase oils, SAE J 306-81 for axle and manual transmission oils)

OIL LUBRICATION METHOD

Oil lubrication is usable even with high speed rotation and at somewhat high temperatures and is effective in reducing bearing vibration and noise. Therefore, oil lubrication is used in many cases

where grease lubrication does not work.

The main types and methods of oil lubrication are shown in Table A-16.

Table A-16. Types and methods of oil lubrication

Oil bath	<ul style="list-style-type: none"> • This is the simplest method. Bearings are soaked in oil before operation. • This method is applicable for low and medium rotational speeds. • Attaching an oil level gauge makes it possible to adjust the oil amount. • For horizontal shafts, approximately half of the rolling element in the lowest position is immersed. For vertical shafts, approximately 70 to 80% of the bearings are immersed. • Using magnetic lids is advantageous as it prevents iron powder generated by friction from being dispersed in the oil.
Oil drip	<ul style="list-style-type: none"> • An oiler is used to drip the oil, and the rotating parts are operated to fill the inside of the housing with an oil mist, which also has a cooling effect. • This method can be used with up to relatively high speeds and medium-sized loads. • The most common example of this method uses five to six drops of oil per minute. (It is difficult to adjust the amount of oil used to 1 mL/h or less.) • Ensure that oil does not accumulate in the bottom of the housing.
Oil splash	<ul style="list-style-type: none"> • A simple flinger or gears are attached to the shaft to supply the oil to its destination by means of flinging or splashing operations. This method can be used to supply oil even to bearings that are far away from the oil tank. • This method can be used with up to relatively high speeds. • The oil level must be maintained within a certain range. • Using magnetic lids is advantageous as it prevents iron powder generated by friction from being dispersed in the oil. What's more, to prevent the intrusion of foreign materials into the bearing, it is advisable to use a shield board or baffle.
Forced oil circulation	<ul style="list-style-type: none"> • This method uses an oil circulation system. After the supplied oil lubricates and cools the inside of the bearing, the oil passes through the oil return pipe to the tank. The oil is filtered and cooled and is then forcibly supplied once more by way of a pump. • This method is used a great deal under high rotational speed and high temperature conditions. • To prevent the lubricating oil from accumulating inside the housing, it is advisable to make the oil return pipe approximately twice as thick as the oil supply pipe.
Oil jet	<ul style="list-style-type: none"> • In this method, oil is sprayed from nozzles at a constant pressure (approximately 0.1 to 0.5 MPa). This method provides a large cooling effect. • This method is applicable for high rotational speeds and heavy loads. • Generally, the nozzle diameters are between 0.5 and 2 mm, and nozzles are installed in positions between 5 and 10 mm from the sides of the bearings. It is advisable to use between 2 and 4 nozzles for situations in which a large amount of heat is generated. • The oil jet method supplies a large quantity of oil, so it is advisable to use an oil discharge pump to forcibly discharge oil in order to prevent against the stagnation of unnecessary oil.
Oil mist lubrication (fog lubrication)	<ul style="list-style-type: none"> • In this method, dry mist (air that contains oil in mist form) obtained from an oil mist generator is continuously sent to the location where oil is to be applied to the bearing. The dry mist is then changed to wet mist (oil drops that can easily be affixed to a surface) by the nozzles attached to the housing or bearing, and the oil is then applied to the bearing. • This method forms and retains the minimum necessary oil film for lubrication, which provides benefits such as prevention of oil pollution, simplification of bearing maintenance, extension of bearing fatigue life, and reduction of oil consumption.
Oil and air lubrication	<ul style="list-style-type: none"> • In this method, a metering piston is used to eject a minuscule amount of oil, a mixing valve is used to mix the oil with compressed air, and the oil and air mixture is then applied to the bearing continuously and stably. • It's possible to perform metering management of the minuscule amount of oil, so new lubricating oil can always be supplied. Therefore, this method is applicable to usages with high rotational speeds such as machine tool main spindles. • The spindle's internal pressure rises because compressed air is supplied together with the lubricating oil. Therefore, this method is also effective at preventing the intrusion of external materials such as debris and cutting fluid. What's more, the lubricating oil flows through the oil supply pipe, so this method results in an extremely small amount of air pollution.

LIMITING SPEEDS

In addition to the bearing load ratings, the tabular pages also list the limiting speed values which are the maximum speeds at which the bearings may operate. These speeds have been calculated for unsealed and sealed bearings of conventional design, tolerances and internal clearances, properly mounted with low applied loads using normal splash, drip feed or other methods of lubrication which will provide adequate cooling of the bearings. A bearing may operate at a speed higher than the listed limiting speed with the use of a clean, good quality oil and after prior consultation with JTEKT's Engineering Department. With high speeds and high acceleration rates, the ratio of P/C should not fall below 0.02 to prevent skidding of the rolling elements.

Also the bearing should not be subjected to uneven stress distribution due to the effects of misalignment between the bearing housings, deformation of the shaft or housing.

Speeds Inadequate for Elastohydrodynamic Lubricating Film

International Standard **ISO 281** which covers calculation of dynamic load ratings and rating life states that at exceptionally low rotational speeds (i.e. the product of speed and pitch diameter (D_{pw}) in mm is less than 10000) the generated lubricant film is unlikely to be adequate to separate the rolling element/raceway contacts. At such operating conditions it may be inappropriate to calculate the bearing life although practical improvement in life, may be achieved with the use of lubricants of higher kinematic viscosity or containing EP additives.

BEARING TOLERANCES, INCH AND METRIC

TOLERANCES OF NEEDLE ROLLER BEARINGS

The tolerances given in the following table apply to the rings of needle roller radial bearing types whose rings are precision finished.

TOLERANCE TERMS, SYMBOLS AND DEFINITIONS Axes, planes etc.

Inner ring axis: Axis of the cylinder inscribed in a basically cylindrical bore. The inner ring axis is also the bearing axis.

Outer ring axis: Axis of the cylinder circumscribed around a basically cylindrical outside surface.

Radial plane: Plane perpendicular to the bearing or ring axis. It is, however, acceptable to consider radial planes referred to in the definitions as being parallel with the plane tangential to the reference face of a ring or the back face of a thrust bearing washer.

Radial direction: Direction through the bearing or ring axis in a radial plane.

Axial plane: Plane containing the bearing or ring axis.

Axial direction: Direction parallel with the bearing or ring axis. It is, however, acceptable to consider axial directions referred to in the definitions as being perpendicular to the plane tangential to the reference face of a ring or the back face of a thrust bearing washer.

Reference face: Face designated by the manufacturer of the bearings and that may be used as the reference face in measurements.

The reference face for measurement is generally taken as the unmarked face. In case of symmetrical rings, when it is not possible to identify the reference face, the tolerances are deemed to comply relative to either face, but not to both.

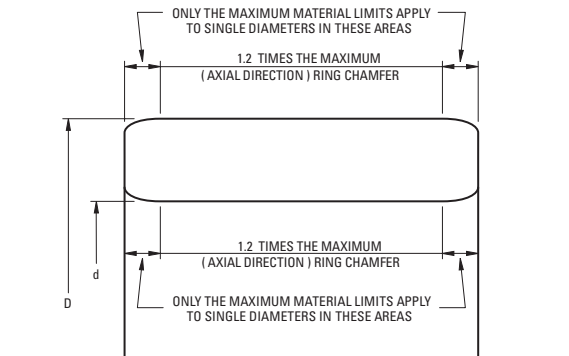
Outer ring flange back face: That side of an outer ring flange that is intended to support axial load.

Middle of raceway: Point or line on a raceway surface halfway between the two edges of the raceway.

Raceway contact diameter: Diameter of the theoretical circle through the nominal points of contact between the rolling elements and the raceway.

NOTE: For roller bearings, the nominal point of contact is generally at the middle of the roller.

Diameter deviation near ring faces: In radial planes, when nearer to the face of a ring than 1.2 times the maximum (axial direction) ring chamfer, only the maximum material limits apply.



ABMA / ISO Symbols - Inner Ring

Δd_{mp} Single plane mean bore diameter deviation from basic bore diameter, e.g., bore tolerance for a basically tapered bore, Δd_{mp} refers only to the theoretical small bore end of the bore.

V_{dsp} Difference between the largest and the smallest of the single bore diameters in a single radial plane.

V_{dmp} Difference between the largest and smallest of the mean bore diameters in a single radial plane of an individual ring.

ABMA / ISO Symbols - Outer Ring

ΔD_{mp} Single plane mean outside diameter deviation from basic outside diameter, e.g., O.D. tolerance.

V_{Dsp} Difference between the largest and smallest of the single outside diameters in a single radial plane.

The following tables provide standard ISO tolerance information. They are provided for general use and are referenced throughout this catalog.

ISO Tolerances for Holes – Metric													
Diameters mm		Deviations mm						Deviations mm					
>	≤	B10		B11		B12		C9		C10		C11	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
3	6	0.188	0.140	0.215	0.140	0.260	0.140	0.100	0.070	0.118	0.070	0.145	0.070
6	10	0.208	0.150	0.240	0.150	0.300	0.150	0.116	0.080	0.138	0.080	0.170	0.080
10	18	0.220	0.150	0.260	0.150	0.330	0.150	0.138	0.095	0.165	0.095	0.205	0.095
18	30	0.244	0.160	0.290	0.160	0.370	0.160	0.162	0.110	0.194	0.110	0.240	0.110
30	40	0.270	0.170	0.330	0.170	0.420	0.170	0.182	0.120	0.220	0.120	0.280	0.120
40	50	0.280	0.180	0.340	0.180	0.430	0.180	0.192	0.130	0.230	0.130	0.290	0.130
50	65	0.310	0.190	0.380	0.190	0.490	0.190	0.214	0.140	0.260	0.140	0.330	0.140
65	80	0.320	0.200	0.390	0.200	0.500	0.200	0.224	0.150	0.270	0.150	0.340	0.150
80	100	0.360	0.220	0.440	0.220	0.570	0.220	0.257	0.170	0.310	0.170	0.390	0.170
100	120	0.380	0.240	0.460	0.240	0.590	0.240	0.267	0.180	0.320	0.180	0.400	0.180
120	140	0.420	0.260	0.510	0.260	0.660	0.260	0.300	0.200	0.360	0.200	0.450	0.200
140	160	0.440	0.280	0.530	0.280	0.680	0.280	0.310	0.210	0.370	0.210	0.460	0.210
160	180	0.470	0.310	0.560	0.310	0.710	0.310	0.330	0.230	0.390	0.230	0.480	0.230
180	200	0.525	0.340	0.630	0.340	0.800	0.340	0.355	0.240	0.425	0.240	0.530	0.240
200	225	0.565	0.380	0.670	0.380	0.840	0.380	0.375	0.260	0.445	0.260	0.550	0.260
225	250	0.605	0.420	0.710	0.420	0.880	0.420	0.395	0.280	0.465	0.280	0.570	0.280
250	280	0.690	0.480	0.800	0.480	1.000	0.480	0.430	0.300	0.510	0.300	0.620	0.300
280	315	0.750	0.540	0.860	0.540	1.060	0.540	0.460	0.330	0.540	0.330	0.650	0.330
315	355	0.830	0.600	0.960	0.600	1.170	0.600	0.500	0.360	0.590	0.360	0.720	0.360
355	400	0.910	0.680	1.040	0.680	1.250	0.680	0.540	0.400	0.630	0.400	0.760	0.400
400	450	1.010	0.760	1.160	0.760	1.390	0.760	0.595	0.440	0.690	0.440	0.840	0.440
450	500	1.090	0.840	1.240	0.840	1.470	0.840	0.635	0.480	0.730	0.480	0.880	0.480

Diameters mm		Deviations mm									
>	≤	E9		E10		E11		E12		E13	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
3	6	0.050	0.020	0.068	0.020	0.095	0.020	0.140	0.020	0.200	0.020
6	10	0.061	0.025	0.083	0.025	0.115	0.025	0.175	0.025	0.245	0.025
10	18	0.075	0.032	0.102	0.032	0.142	0.032	0.212	0.032	0.302	0.032
18	30	0.092	0.040	0.124	0.040	0.170	0.040	0.250	0.040	0.370	0.040
30	50	0.112	0.050	0.150	0.050	0.210	0.050	0.300	0.050	0.440	0.050
50	80	0.134	0.060	0.180	0.060	0.250	0.060	0.360	0.060	0.520	0.060
80	120	0.159	0.072	0.212	0.072	0.292	0.072	0.422	0.072	0.612	0.072
120	180	0.185	0.085	0.245	0.085	0.335	0.085	0.485	0.085	0.715	0.085
180	250	0.215	0.100	0.285	0.100	0.390	0.100	0.560	0.100	0.820	0.100
250	315	0.240	0.110	0.320	0.110	0.430	0.110	0.630	0.110	0.920	0.110
315	400	0.265	0.125	0.355	0.125	0.485	0.125	0.695	0.125	1.015	0.125
400	500	0.290	0.135	0.385	0.135	0.535	0.135	0.765	0.135	1.105	0.135

Diameters mm		Deviations mm							
>	≤	F5		F6		F7		F8	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
3	6	0.015	0.010	0.018	0.010	0.022	0.010	0.028	0.010
6	10	0.019	0.013	0.022	0.013	0.028	0.013	0.035	0.013
10	18	0.024	0.016	0.027	0.016	0.034	0.016	0.043	0.016
18	30	0.029	0.020	0.033	0.020	0.041	0.020	0.053	0.020
30	50	0.036	0.025	0.041	0.025	0.050	0.025	0.064	0.025
50	80	0.043	0.030	0.049	0.030	0.060	0.030	0.076	0.030
80	120	0.051	0.036	0.058	0.036	0.071	0.036	0.090	0.036
120	180	0.061	0.043	0.068	0.043	0.083	0.043	0.106	0.043
180	250	0.070	0.050	0.079	0.050	0.096	0.050	0.122	0.050
250	315	0.079	0.056	0.088	0.056	0.108	0.056	0.137	0.056
315	400	0.087	0.062	0.098	0.062	0.119	0.062	0.151	0.062
400	500	0.095	0.068	0.108	0.068	0.131	0.068	0.165	0.068

ISO Tolerances for Holes – Metric							
Diameter mm		Deviations mm					
>	≤	G5		G6		G7	
		Max.	Min.	Max.	Min.	Max.	Min.
3	6	0.009	0.004	0.012	0.004	0.016	0.004
6	10	0.011	0.005	0.014	0.005	0.020	0.005
10	18	0.014	0.006	0.017	0.006	0.024	0.006
18	30	0.016	0.007	0.020	0.007	0.028	0.007
30	50	0.020	0.009	0.025	0.009	0.034	0.009
50	80	0.023	0.010	0.029	0.010	0.040	0.010
80	120	0.027	0.012	0.034	0.012	0.047	0.012
120	180	0.032	0.014	0.039	0.014	0.054	0.014
180	250	0.035	0.015	0.044	0.015	0.061	0.015
250	315	0.040	0.017	0.049	0.017	0.069	0.017
315	400	0.043	0.018	0.054	0.018	0.075	0.018
400	500	0.047	0.020	0.060	0.020	0.083	0.020

Diameters mm		Deviations mm									
>	≤	H4		H5		H6		H7		H8	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
3	6	0.004	0.000	0.005	0.000	0.008	0.000	0.012	0.000	0.018	0.000
6	10	0.004	0.000	0.006	0.000	0.009	0.000	0.015	0.000	0.022	0.000
10	18	0.005	0.000	0.008	0.000	0.011	0.000	0.018	0.000	0.027	0.000
18	30	0.006	0.000	0.009	0.000	0.013	0.000	0.021	0.000	0.033	0.000
30	50	0.007	0.000	0.011	0.000	0.016	0.000	0.025	0.000	0.039	0.000
50	80	0.008	0.000	0.013	0.000	0.019	0.000	0.030	0.000	0.046	0.000
80	120	0.010	0.000	0.015	0.000	0.022	0.000	0.035	0.000	0.054	0.000
120	180	0.012	0.000	0.018	0.000	0.025	0.000	0.040	0.000	0.063	0.000
180	250	0.014	0.000	0.020	0.000	0.029	0.000	0.046	0.000	0.072	0.000
250	315	0.016	0.000	0.023	0.000	0.032	0.000	0.052	0.000	0.081	0.000
315	400	0.018	0.000	0.025	0.000	0.036	0.000	0.057	0.000	0.089	0.000
400	500	0.020	0.000	0.027	0.000	0.040	0.000	0.063	0.000	0.097	0.000

Diameters mm		Deviations mm							
>	≤	H9		H10		H11		H12	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
3	6	0.030	0.000	0.048	0.000	0.075	0.000	0.120	0.000
6	10	0.036	0.000	0.058	0.000	0.090	0.000	0.150	0.000
10	18	0.043	0.000	0.070	0.000	0.110	0.000	0.180	0.000
18	30	0.052	0.000	0.084	0.000	0.130	0.000	0.210	0.000
30	50	0.062	0.000	0.100	0.000	0.160	0.000	0.250	0.000
50	80	0.074	0.000	0.120	0.000	0.190	0.000	0.300	0.000
80	120	0.087	0.000	0.140	0.000	0.220	0.000	0.350	0.000
120	180	0.100	0.000	0.160	0.000	0.250	0.000	0.400	0.000
180	250	0.115	0.000	0.185	0.000	0.290	0.000	0.460	0.000
250	315	0.130	0.000	0.210	0.000	0.320	0.000	0.520	0.000
315	400	0.140	0.000	0.230	0.000	0.360	0.000	0.570	0.000
400	500	0.155	0.000	0.250	0.000	0.400	0.000	0.630	0.000



ISO Tolerances for Holes – Metric

Diameters mm		Deviations mm						Deviations mm					
>	≤	J6		J7		J8		K6		K7		K8	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
3	6	0.005	-0.003	0.006	-0.006	0.010	-0.008	0.002	-0.006	0.003	-0.009	0.005	-0.013
6	10	0.005	-0.004	0.008	-0.007	0.012	-0.010	0.002	-0.007	0.005	-0.010	0.006	-0.016
10	18	0.006	-0.005	0.010	-0.008	0.015	-0.012	0.002	-0.009	0.006	-0.012	0.008	-0.019
18	30	0.008	-0.005	0.012	-0.009	0.020	-0.013	0.002	-0.011	0.006	-0.015	0.010	-0.023
30	50	0.010	-0.006	0.014	-0.011	0.024	-0.015	0.003	-0.013	0.007	-0.018	0.012	-0.027
50	80	0.013	-0.006	0.018	-0.012	0.028	-0.018	0.004	-0.015	0.009	-0.021	0.014	-0.032
80	120	0.016	-0.006	0.022	-0.013	0.034	-0.020	0.004	-0.018	0.010	-0.025	0.016	-0.038
120	180	0.018	-0.007	0.026	-0.014	0.041	-0.022	0.004	-0.021	0.012	-0.028	0.020	-0.043
180	250	0.022	-0.007	0.030	-0.016	0.047	-0.025	0.005	-0.024	0.013	-0.033	0.022	-0.050
250	315	0.025	-0.007	0.036	-0.016	0.055	-0.026	0.005	-0.027	0.016	-0.036	0.025	-0.056
315	400	0.029	-0.007	0.039	-0.018	0.060	-0.029	0.007	-0.029	0.017	-0.040	0.028	-0.061
400	500	0.033	-0.007	0.043	-0.020	0.066	-0.031	0.008	-0.032	0.018	-0.045	0.029	-0.068

Diameters mm		Deviations mm						Deviations mm					
>	≤	M5		M6		M7		N6		N7		N8	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
3	6	-0.003	-0.008	-0.001	-0.009	0.000	-0.012	-0.005	-0.013	-0.004	-0.016	-0.002	-0.020
6	10	-0.004	-0.010	-0.003	-0.012	0.000	-0.015	-0.007	-0.016	-0.004	-0.019	-0.003	-0.025
10	18	-0.004	-0.012	-0.004	-0.015	0.000	-0.018	-0.009	-0.020	-0.005	-0.023	-0.003	-0.030
18	30	-0.005	-0.014	-0.004	-0.017	0.000	-0.021	-0.011	-0.024	-0.007	-0.028	-0.003	-0.036
30	50	-0.005	-0.016	-0.004	-0.020	0.000	-0.025	-0.012	-0.028	-0.008	-0.033	-0.003	-0.042
50	80	-0.006	-0.019	-0.005	-0.024	0.000	-0.030	-0.014	-0.033	-0.009	-0.039	-0.004	-0.050
80	120	-0.008	-0.023	-0.006	-0.028	0.000	-0.035	-0.016	-0.038	-0.010	-0.045	-0.004	-0.058
120	180	-0.009	-0.027	-0.008	-0.033	0.000	-0.040	-0.020	-0.045	-0.012	-0.052	-0.004	-0.067
180	250	-0.011	-0.031	-0.008	-0.037	0.000	-0.046	-0.022	-0.051	-0.014	-0.060	-0.005	-0.077
250	315	-0.013	-0.036	-0.009	-0.041	0.000	-0.052	-0.025	-0.057	-0.014	-0.066	-0.005	-0.086
315	400	-0.014	-0.039	-0.010	-0.046	0.000	-0.057	-0.026	-0.062	-0.016	-0.073	-0.005	-0.094
400	500	-0.016	-0.043	-0.010	-0.050	0.000	-0.063	-0.027	-0.067	-0.017	-0.080	-0.006	-0.103

Diameters mm		Deviations mm				Deviations mm				Deviations mm	
>	≤	P6		P7		R6		R7		R8	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
3	6	-0.009	-0.017	-0.008	-0.020	-0.012	-0.020	-0.011	-0.023	-0.015	-0.033
6	10	-0.012	-0.021	-0.009	-0.024	-0.016	-0.025	-0.013	-0.028	-0.019	-0.041
10	18	-0.015	-0.026	-0.011	-0.029	-0.020	-0.031	-0.016	-0.034	-0.023	-0.050
18	30	-0.018	-0.031	-0.014	-0.035	-0.024	-0.037	-0.020	-0.041	-0.028	-0.061
30	50	-0.021	-0.037	-0.017	-0.042	-0.029	-0.045	-0.025	-0.050	-0.034	-0.073
50	65	-0.026	-0.045	-0.021	-0.051	-0.035	-0.054	-0.030	-0.060	-0.041	-0.087
65	80	-0.026	-0.045	-0.021	-0.051	-0.037	-0.056	-0.032	-0.062	-0.043	-0.089
80	100	-0.030	-0.052	-0.024	-0.059	-0.044	-0.066	-0.038	-0.073	-0.051	-0.105
100	120	-0.030	-0.052	-0.024	-0.059	-0.047	-0.069	-0.041	-0.076	-0.054	-0.108
120	140	-0.037	-0.061	-0.028	-0.068	-0.056	-0.081	-0.048	-0.088	-0.063	-0.126
140	160	-0.036	-0.061	-0.028	-0.068	-0.058	-0.083	-0.050	-0.090	-0.065	-0.128
160	180	-0.036	-0.061	-0.028	-0.068	-0.061	-0.086	-0.053	-0.093	-0.068	-0.131
180	200	-0.041	-0.070	-0.033	-0.079	-0.068	-0.097	-0.060	-0.106	-0.077	-0.149
200	225	-0.041	-0.070	-0.033	-0.079	-0.071	-0.100	-0.063	-0.109	-0.080	-0.152
225	250	-0.041	-0.070	-0.033	-0.079	-0.075	-0.104	-0.067	-0.113	-0.084	-0.156
250	280	-0.047	-0.079	-0.036	-0.088	-0.085	-0.117	-0.074	-0.126	-0.094	-0.175
280	315	-0.047	-0.079	-0.036	-0.088	-0.089	-0.121	-0.078	-0.130	-0.098	-0.179
315	355	-0.051	-0.087	-0.041	-0.098	-0.097	-0.133	-0.087	-0.144	-0.108	-0.197
355	400	-0.051	-0.087	-0.041	-0.098	-0.103	-0.139	-0.093	-0.150	-0.114	-0.203
400	450	-0.055	-0.095	-0.045	-0.108	-0.113	-0.153	-0.103	-0.166	-0.126	-0.223
450	500	-0.055	-0.095	-0.045	-0.108	-0.119	-0.159	-0.109	-0.172	-0.132	-0.229

ISO Tolerances for Shafts – Metric

Diameters mm		Deviations mm							
>	≤	a10		a11		a12		a13	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
—	3	-0.270	-0.310	-0.270	-0.330	-0.270	-0.370	-0.270	-0.410
3	6	-0.270	-0.318	-0.270	-0.345	-0.270	-0.390	-0.270	-0.450
6	10	-0.280	-0.338	-0.280	-0.370	-0.280	-0.430	-0.280	-0.500
10	18	-0.290	-0.360	-0.290	-0.400	-0.290	-0.470	-0.290	-0.560
18	30	-0.300	-0.384	-0.300	-0.430	-0.300	-0.510	-0.300	-0.630
30	40	-0.310	-0.410	-0.310	-0.470	-0.310	-0.560	-0.310	-0.700
40	50	-0.320	-0.420	-0.320	-0.480	-0.320	-0.570	-0.320	-0.710
50	65	-0.340	-0.460	-0.340	-0.530	-0.340	-0.640	-0.340	-0.800
65	80	-0.360	-0.480	-0.360	-0.550	-0.360	-0.660	-0.360	-0.820
80	100	-0.380	-0.520	-0.380	-0.600	-0.380	-0.730	-0.380	-0.920
100	120	-0.410	-0.550	-0.410	-0.630	-0.410	-0.760	-0.410	-0.950
120	140	-0.460	-0.620	-0.460	-0.710	-0.460	-0.860	-0.460	-1.090
140	160	-0.520	-0.680	-0.520	-0.770	-0.520	-0.920	-0.520	-1.150
160	180	-0.580	-0.740	-0.580	-0.830	-0.580	-0.980	-0.580	-1.210
180	200	-0.660	-0.845	-0.660	-0.950	-0.660	-1.120	-0.660	-1.380
200	225	-0.740	-0.925	-0.740	-1.030	-0.740	-1.200	-0.740	-1.460
225	250	-0.820	-1.005	-0.820	-1.110	-0.820	-1.280	-0.820	-1.540
250	280	-0.920	-1.130	-0.920	-1.240	-0.920	-1.440	-0.920	-1.730
280	315	-1.050	-1.260	-1.050	-1.370	-1.050	-1.570	-1.050	-1.860
315	355	-1.200	-1.430	-1.200	-1.560	-1.200	-1.770	-1.200	-2.090
355	400	-1.350	-1.580	-1.350	-1.710	-1.350	-1.920	-1.350	-2.240

Diameters mm		Deviations mm						Deviations mm					
>	≤	c11		c12		c13		e11		e12		e13	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
—	3	-0.060	-0.120	-0.060	-0.160	-0.060	-0.200	-0.014	-0.074	-0.014	-0.114	-0.014	-0.154
3	6	-0.070	-0.145	-0.070	-0.190	-0.070	-0.250	-0.020	-0.095	-0.020	-0.140	-0.020	-0.200
6	10	-0.080	-0.170	-0.080	-0.230	-0.080	-0.300	-0.025	-0.115	-0.025	-0.175	-0.025	-0.245
10	18	-0.095	-0.205	-0.095	-0.275	-0.095	-0.365	-0.032	-0.142	-0.032	-0.212	-0.032	-0.302
18	30	-0.110	-0.240	-0.110	-0.320	-0.110	-0.440	-0.040	-0.170	-0.040	-0.250	-0.040	-0.370
30	40	-0.120	-0.280	-0.120	-0.370	-0.120	-0.510	-0.050	-0.210	-0.050	-0.300	-0.050	-0.440
40	50	-0.130	-0.290	-0.130	-0.380	-0.130	-0.520	-0.050	-0.210	-0.050	-0.300	-0.050	-0.440
50	65	-0.140	-0.330	-0.140	-0.440	-0.140	-0.600	-0.060	-0.250	-0.060	-0.360	-0.060	-0.520
65	80	-0.150	-0.340	-0.150	-0.450	-0.150	-0.610	-0.060	-0.250	-0.060	-0.360	-0.060	-0.520
80	100	-0.170	-0.390	-0.170	-0.520	-0.170	-0.710	-0.072	-0.292	-0.072	-0.422	-0.072	-0.612
100	120	-0.180	-0.400	-0.180	-0.530	-0.180	-0.720	-0.072	-0.292	-0.072	-0.422	-0.072	-0.612
120	140	-0.200	-0.450	-0.200	-0.600	-0.200	-0.830	-0.085	-0.335	-0.085	-0.485	-0.085	-0.715
140	160	-0.210	-0.460	-0.210	-0.610	-0.210	-0.840	-0.085	-0.335	-0.085	-0.485	-0.085	-0.715
160	180	-0.230	-0.480	-0.230	-0.630	-0.230	-0.860	-0.085	-0.335	-0.085	-0.485	-0.085	-0.715
180	200	-0.240	-0.530	-0.240	-0.700	-0.240	-0.960	-0.100	-0.390	-0.100	-0.560	-0.100	-0.820
200	225	-0.260	-0.550	-0.260	-0.720	-0.260	-0.980	-0.100	-0.390	-0.100	-0.560	-0.100	-0.820
225	250	-0.280	-0.570	-0.280	-0.740	-0.280	-1.000	-0.100	-0.390	-0.100	-0.560	-0.100	-0.820
250	280	-0.300	-0.620	-0.300	-0.820	-0.300	-1.110	-0.110	-0.430	-0.110	-0.630	-0.110	-0.920
280	315	-0.330	-0.650	-0.330	-0.850	-0.330	-1.140	-0.110	-0.430	-0.110	-0.630	-0.110	-0.920
315	355	-0.360	-0.720	-0.360	-0.930	-0.360	-1.250	-0.125	-0.485	-0.125	-0.695	-0.125	-1.015
355	400	-0.400	-0.760	-0.400	-0.970	-0.400	-1.290	-0.125	-0.485	-0.125	-0.695	-0.125	-1.015



ISO Tolerances for Shafts – Metric

Diameters mm		Deviations mm						Deviations mm					
>	≤	f5		f6		f7		g5		g6		g7	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
—	3	-0.006	-0.010	-0.006	-0.012	-0.006	-0.016	-0.002	-0.006	-0.002	-0.008	-0.002	-0.012
3	6	-0.010	-0.015	-0.010	-0.018	-0.010	-0.022	-0.004	-0.009	-0.004	-0.012	-0.004	-0.016
6	10	-0.013	-0.019	-0.013	-0.022	-0.013	-0.028	-0.005	-0.011	-0.005	-0.014	-0.005	-0.020
10	18	-0.016	-0.024	-0.016	-0.027	-0.016	-0.034	-0.006	-0.014	-0.006	-0.017	-0.006	-0.024
18	30	-0.020	-0.029	-0.020	-0.033	-0.020	-0.041	-0.007	-0.016	-0.007	-0.020	-0.007	-0.028
30	50	-0.025	-0.036	-0.025	-0.041	-0.025	-0.050	-0.009	-0.020	-0.009	-0.025	-0.009	-0.034
50	80	-0.030	-0.043	-0.030	-0.049	-0.030	-0.060	-0.010	-0.023	-0.010	-0.029	-0.010	-0.040
80	120	-0.036	-0.051	-0.036	-0.058	-0.036	-0.071	-0.012	-0.027	-0.012	-0.034	-0.012	-0.047
120	180	-0.043	-0.061	-0.043	-0.068	-0.043	-0.083	-0.014	-0.032	-0.014	-0.039	-0.014	-0.054
180	250	-0.050	-0.070	-0.050	-0.079	-0.050	-0.096	-0.015	-0.035	-0.015	-0.044	-0.015	-0.061
250	315	-0.056	-0.079	-0.056	-0.088	-0.056	-0.108	-0.017	-0.040	-0.017	-0.049	-0.017	-0.069
315	400	-0.062	-0.087	-0.062	-0.098	-0.062	-0.119	-0.018	-0.043	-0.018	-0.054	-0.018	-0.075

Diameters mm		Deviations mm									
>	≤	h4		h5		h6		h7		h8	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
—	3	0.000	-0.003	0.000	-0.004	0.000	-0.006	0.000	-0.010	0.000	-0.014
3	6	0.000	-0.004	0.000	-0.005	0.000	-0.008	0.000	-0.012	0.000	-0.018
6	10	0.000	-0.004	0.000	-0.006	0.000	-0.009	0.000	-0.015	0.000	-0.022
10	18	0.000	-0.005	0.000	-0.008	0.000	-0.011	0.000	-0.018	0.000	-0.027
18	30	0.000	-0.006	0.000	-0.009	0.000	-0.013	0.000	-0.021	0.000	-0.033
30	50	0.000	-0.007	0.000	-0.011	0.000	-0.016	0.000	-0.025	0.000	-0.039
50	80	0.000	-0.008	0.000	-0.013	0.000	-0.019	0.000	-0.030	0.000	-0.046
80	120	0.000	-0.010	0.000	-0.015	0.000	-0.022	0.000	-0.035	0.000	-0.054
120	180	0.000	-0.012	0.000	-0.018	0.000	-0.025	0.000	-0.040	0.000	-0.063
180	250	0.000	-0.014	0.000	-0.020	0.000	-0.029	0.000	-0.046	0.000	-0.072
250	315	0.000	-0.016	0.000	-0.023	0.000	-0.032	0.000	-0.052	0.000	-0.081
315	400	0.000	-0.018	0.000	-0.025	0.000	-0.036	0.000	-0.057	0.000	-0.089

Diameters mm		Deviations mm									
>	≤	h9		h10		h11		h12		h13	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
—	3	0.000	-0.025	0.000	-0.040	0.000	-0.060	0.000	-0.100	0.000	-0.140
3	6	0.000	-0.030	0.000	-0.048	0.000	-0.075	0.000	-0.120	0.000	-0.180
6	10	0.000	-0.036	0.000	-0.058	0.000	-0.090	0.000	-0.150	0.000	-0.220
10	18	0.000	-0.043	0.000	-0.070	0.000	-0.110	0.000	-0.180	0.000	-0.270
18	30	0.000	-0.052	0.000	-0.084	0.000	-0.130	0.000	-0.210	0.000	-0.330
30	50	0.000	-0.062	0.000	-0.100	0.000	-0.160	0.000	-0.250	0.000	-0.390
50	80	0.000	-0.074	0.000	-0.120	0.000	-0.190	0.000	-0.300	0.000	-0.460
80	120	0.000	-0.087	0.000	-0.140	0.000	-0.220	0.000	-0.350	0.000	-0.540
120	180	0.000	-0.100	0.000	-0.160	0.000	-0.250	0.000	-0.400	0.000	-0.630
180	250	0.000	-0.115	0.000	-0.185	0.000	-0.290	0.000	-0.460	0.000	-0.720
250	315	0.000	-0.130	0.000	-0.210	0.000	-0.320	0.000	-0.520	0.000	-0.810
315	400	0.000	-0.140	0.000	-0.230	0.000	-0.360	0.000	-0.570	0.000	-0.890



ISO Tolerances for Shafts – Metric

Diameter mm		Deviations mm						Deviations mm					
>	≤	j5		j6		j7		k5		k6		k7	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
—	3	0.002	-0.002	0.004	-0.002	0.006	-0.004	0.004	0.000	0.006	0.000	0.010	0.000
3	6	0.003	-0.002	0.006	-0.002	0.008	-0.004	0.006	0.001	0.009	0.001	0.013	0.001
6	10	0.004	-0.002	0.007	-0.002	0.010	-0.005	0.007	0.001	0.010	0.001	0.016	0.001
10	18	0.005	-0.003	0.008	-0.003	0.012	-0.006	0.009	0.001	0.012	0.001	0.019	0.001
18	30	0.005	-0.004	0.009	-0.004	0.013	-0.008	0.011	0.002	0.015	0.002	0.023	0.002
30	50	0.006	-0.005	0.011	-0.005	0.015	-0.010	0.013	0.002	0.018	0.002	0.027	0.002
50	80	0.006	-0.007	0.012	-0.007	0.018	-0.012	0.015	0.002	0.021	0.002	0.032	0.002
80	120	0.006	-0.009	0.013	-0.009	0.020	-0.015	0.018	0.003	0.025	0.003	0.038	0.003
120	180	0.007	-0.011	0.014	-0.011	0.022	-0.018	0.021	0.003	0.028	0.003	0.043	0.003
180	250	0.007	-0.013	0.016	-0.013	0.025	-0.021	0.024	0.004	0.033	0.004	0.050	0.004
250	315	0.007	-0.016	0.016	-0.016	0.026	-0.026	0.027	0.004	0.036	0.004	0.056	0.004
315	400	0.007	-0.018	0.018	-0.018	0.029	-0.028	0.029	0.004	0.040	0.004	0.061	0.004

Diameter mm		Deviations mm						Deviations mm					
>	≤	m5		m6		m7		n5		n6		n7	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
—	3	0.006	0.002	0.008	0.002	0.012	0.002	0.008	0.004	0.010	0.004	0.014	0.004
3	6	0.009	0.004	0.012	0.004	0.016	0.004	0.013	0.008	0.016	0.008	0.020	0.008
6	10	0.012	0.006	0.015	0.006	0.021	0.006	0.016	0.010	0.019	0.010	0.025	0.010
10	18	0.015	0.007	0.018	0.007	0.025	0.007	0.020	0.012	0.023	0.012	0.030	0.012
18	30	0.017	0.008	0.021	0.008	0.029	0.008	0.024	0.015	0.028	0.015	0.036	0.015
30	50	0.020	0.009	0.025	0.009	0.034	0.009	0.028	0.017	0.033	0.017	0.042	0.017
50	80	0.024	0.011	0.030	0.011	0.041	0.011	0.033	0.020	0.039	0.020	0.050	0.020
80	120	0.028	0.013	0.035	0.013	0.048	0.013	0.038	0.023	0.045	0.023	0.058	0.023
120	180	0.033	0.015	0.040	0.015	0.055	0.015	0.045	0.027	0.052	0.027	0.067	0.027
180	250	0.037	0.017	0.046	0.017	0.063	0.017	0.051	0.031	0.060	0.031	0.077	0.031
250	315	0.043	0.020	0.052	0.020	0.072	0.020	0.057	0.034	0.066	0.034	0.086	0.034
315	400	0.046	0.021	0.057	0.021	0.078	0.021	0.062	0.037	0.073	0.037	0.094	0.037

Diameter mm		Deviations mm					
>	≤	p6		r6		r7	
		Max.	Min.	Max.	Min.	Max.	Min.
80	100	0.059	0.037	-	-	-	-
100	120	0.059	0.037	-	-	-	-
120	140	0.068	0.043	0.090	0.065	-	-
140	160	0.068	0.043	0.090	0.065	-	-
160	180	0.068	0.043	0.090	0.065	-	-
180	200	0.079	0.050	0.106	0.077	-	-
200	225	0.079	0.050	0.109	0.080	0.126	0.080
225	250	0.079	0.050	0.113	0.084	0.130	0.084
250	280	0.088	0.056	0.126	0.094	0.146	0.094
280	315	0.088	0.056	0.130	0.098	0.150	0.098
315	355	0.098	0.062	0.144	0.108	0.165	0.108
355	400	0.098	0.062	0.150	0.114	0.171	0.114
400	450	0.108	0.068	0.166	0.126	0.189	0.126
450	500	0.108	0.068	0.172	0.132	0.195	0.132



ISO Tolerances for Holes – inch

Diameter in		Deviations in						Deviations in					
>	≤	B10		B11		B12		C9		C10		C11	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
0.1181	0.2362	+0.0074	+0.0055	+0.0085	+0.0055	+0.0102	+0.0055	+0.0039	+0.0028	+0.0046	+0.0028	+0.0057	+0.0028
0.2362	0.3937	+0.0082	+0.0059	+0.0094	+0.0059	+0.0118	+0.0059	+0.0046	+0.0031	+0.0054	+0.0031	+0.0067	+0.0031
0.3937	0.7087	+0.0087	+0.0059	+0.0102	+0.0059	+0.0130	+0.0059	+0.0054	+0.0037	+0.0065	+0.0037	+0.0081	+0.0037
0.7087	1.1811	+0.0096	+0.0063	+0.0114	+0.0063	+0.0146	+0.0063	+0.0064	+0.0043	+0.0076	+0.0043	+0.0094	+0.0043
1.1811	1.5748	+0.0106	+0.0067	+0.0130	+0.0067	+0.0165	+0.0067	+0.0072	+0.0047	+0.0087	+0.0047	+0.0110	+0.0047
1.5748	1.9685	+0.0110	+0.0071	+0.0134	+0.0071	+0.0169	+0.0071	+0.0076	+0.0051	+0.0091	+0.0051	+0.0114	+0.0051
1.9685	2.5591	+0.0122	+0.0075	+0.0150	+0.0075	+0.0193	+0.0075	+0.0084	+0.0055	+0.0102	+0.0055	+0.0120	+0.0055
2.5591	3.1496	+0.0126	+0.0079	+0.0154	+0.0079	+0.0197	+0.0079	+0.0088	+0.0059	+0.0106	+0.0059	+0.0134	+0.0059
3.1496	3.9370	+0.0142	+0.0087	+0.0173	+0.0087	+0.0224	+0.0087	+0.0101	+0.0067	+0.0122	+0.0067	+0.0154	+0.0067
3.9370	4.7244	+0.0150	+0.0094	+0.0181	+0.0094	+0.0232	+0.0094	+0.0105	+0.0071	+0.0126	+0.0071	+0.0157	+0.0071
4.7244	5.5118	+0.0165	+0.0102	+0.0201	+0.0102	+0.0260	+0.0102	+0.0118	+0.0079	+0.0142	+0.0079	+0.0177	+0.0079
5.5118	6.2992	+0.0173	+0.0110	+0.0209	+0.0110	+0.0268	+0.0110	+0.0122	+0.0083	+0.0146	+0.0083	+0.0181	+0.0083
6.2992	7.0866	+0.0185	+0.0122	+0.0220	+0.0122	+0.0280	+0.0122	+0.0130	+0.0091	+0.0154	+0.0091	+0.0189	+0.0091
7.0866	7.8740	+0.0207	+0.0134	+0.0248	+0.0134	+0.0315	+0.0134	+0.0140	+0.0094	+0.0167	+0.0094	+0.0209	+0.0094
7.8740	8.8583	+0.0222	+0.0150	+0.0264	+0.0150	+0.0331	+0.0150	+0.0148	+0.0102	+0.0175	+0.0102	+0.0217	+0.0102
8.8583	9.8425	+0.0238	+0.0165	+0.0280	+0.0165	+0.0346	+0.0165	+0.0156	+0.0110	+0.0183	+0.0110	+0.0224	+0.0110
9.8425	11.0236	+0.0272	+0.0189	+0.0315	+0.0189	+0.0394	+0.0189	+0.0169	+0.0118	+0.0201	+0.0118	+0.0244	+0.0118
11.0236	12.4016	+0.0295	+0.0213	+0.0339	+0.0213	+0.0417	+0.0213	+0.0181	+0.0130	+0.0213	+0.0130	+0.0256	+0.0130
12.4016	13.9764	+0.0327	+0.0236	+0.0378	+0.0236	+0.0461	+0.0236	+0.0197	+0.0142	+0.0232	+0.0142	+0.0283	+0.0142
13.9764	15.7480	+0.0358	+0.0268	+0.0409	+0.0268	+0.0492	+0.0268	+0.0213	+0.0157	+0.0248	+0.0157	+0.0299	+0.0157
15.7480	17.7165	+0.0398	+0.0299	+0.0457	+0.0299	+0.0547	+0.0299	+0.0234	+0.0173	+0.0272	+0.0173	+0.0331	+0.0173
17.7165	19.6850	+0.0429	+0.0331	+0.0488	+0.0331	+0.0579	+0.0331	+0.0250	+0.0189	+0.0287	+0.0189	+0.0346	+0.0189

Diameter in		Deviations in									
>	≤	E9		E10		E11		E12		E13	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
0.1181	0.2362	+0.0020	+0.0008	+0.0027	+0.0008	+0.0037	+0.0008	+0.0055	+0.0008	+0.0079	+0.0008
0.2362	0.3937	+0.0024	+0.0010	+0.0033	+0.0010	+0.0045	+0.0010	+0.0069	+0.0010	+0.0096	+0.0010
0.3937	0.7087	+0.0030	+0.0013	+0.0040	+0.0013	+0.0056	+0.0013	+0.0083	+0.0013	+0.0119	+0.0013
0.7087	1.1811	+0.0036	+0.0016	+0.0049	+0.0016	+0.0067	+0.0016	+0.0098	+0.0016	+0.0146	+0.0016
1.1811	1.9685	+0.0044	+0.0020	+0.0059	+0.0020	+0.0083	+0.0020	+0.0118	+0.0020	+0.0173	+0.0020
1.9685	3.1496	+0.0053	+0.0024	+0.0071	+0.0024	+0.0098	+0.0024	+0.0142	+0.0024	+0.0205	+0.0024
3.1496	4.7244	+0.0063	+0.0028	+0.0083	+0.0028	+0.0115	+0.0028	+0.0166	+0.0028	+0.0241	+0.0028
4.7244	7.0866	+0.0073	+0.0033	+0.0096	+0.0033	+0.0132	+0.0033	+0.0191	+0.0033	+0.0281	+0.0033
7.0866	9.8425	+0.0085	+0.0039	+0.0112	+0.0039	+0.0154	+0.0039	+0.0220	+0.0039	+0.0323	+0.0039
9.8425	12.4016	+0.0094	+0.0043	+0.0126	+0.0043	+0.0169	+0.0043	+0.0248	+0.0043	+0.0362	+0.0043
12.4016	15.7480	+0.0104	+0.0049	+0.0140	+0.0049	+0.0191	+0.0049	+0.0274	+0.0049	+0.0400	+0.0049
15.7480	19.6850	+0.0114	+0.0053	+0.0152	+0.0053	+0.0211	+0.0053	+0.0301	+0.0053	+0.0435	+0.0053

Diameter in		Deviations in							
>	≤	F5		F6		F7		F8	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
0.1181	0.2362	+0.0006	+0.0004	+0.0007	+0.0004	+0.0009	+0.0004	+0.0011	+0.0004
0.2362	0.3937	+0.0007	+0.0005	+0.0009	+0.0005	+0.0011	+0.0005	+0.0014	+0.0005
0.3937	0.7087	+0.0009	+0.0006	+0.0011	+0.0006	+0.0013	+0.0006	+0.0017	+0.0006
0.7087	1.1811	+0.0011	+0.0008	+0.0013	+0.0008	+0.0016	+0.0008	+0.0021	+0.0008
1.1811	1.9685	+0.0014	+0.0010	+0.0016	+0.0010	+0.0020	+0.0010	+0.0025	+0.0010
1.9685	3.1496	+0.0017	+0.0012	+0.0019	+0.0012	+0.0024	+0.0012	+0.0030	+0.0012
3.1496	4.7244	+0.0020	+0.0014	+0.0023	+0.0014	+0.0028	+0.0014	+0.0035	+0.0014
4.7244	7.0866	+0.0024	+0.0017	+0.0027	+0.0017	+0.0033	+0.0017	+0.0042	+0.0017
7.0866	9.8425	+0.0028	+0.0020	+0.0031	+0.0020	+0.0038	+0.0020	+0.0048	+0.0020
9.8425	12.4016	+0.0031	+0.0022	+0.0035	+0.0022	+0.0043	+0.0022	+0.0054	+0.0022
12.4016	15.7480	+0.0034	+0.0024	+0.0039	+0.0024	+0.0047	+0.0024	+0.0059	+0.0024
15.7480	19.6850	+0.0037	+0.0027	+0.0043	+0.0027	+0.0052	+0.0027	+0.0065	+0.0027



ISO Tolerances for Holes – inch							
Diameter in		Deviations in					
>	≤	G5		G6		G7	
		Max.	Min.	Max.	Min.	Max.	Min.
0.1181	0.2362	+0.0004	+0.0002	+0.0005	+0.0002	+0.0006	+0.0002
0.2362	0.3937	+0.0004	+0.0002	+0.0006	+0.0002	+0.0008	+0.0002
0.3937	0.7087	+0.0006	+0.0002	+0.0007	+0.0002	+0.0009	+0.0002
0.7087	1.1811	+0.0006	+0.0003	+0.0008	+0.0003	+0.0011	+0.0003
1.1811	1.9685	+0.0008	+0.0004	+0.0010	+0.0004	+0.0013	+0.0004
1.9685	3.1496	+0.0009	+0.0004	+0.0011	+0.0004	+0.0016	+0.0004
3.1496	4.7244	+0.0011	+0.0005	+0.0013	+0.0005	+0.0019	+0.0005
4.7244	7.0866	+0.0013	+0.0006	+0.0015	+0.0006	+0.0021	+0.0006
7.0866	9.8425	+0.0014	+0.0006	+0.0017	+0.0006	+0.0024	+0.0006
9.8425	12.4016	+0.0016	+0.0007	+0.0019	+0.0007	+0.0027	+0.0007
12.4016	15.7480	+0.0017	+0.0007	+0.0021	+0.0007	+0.0030	+0.0007
15.7480	19.6850	+0.0019	+0.0008	+0.0024	+0.0008	+0.0033	+0.0008

Diameter in		Deviations in									
>	≤	H4		H5		H6		H7		H8	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
0.1181	0.2362	+0.0002	0	+0.0002	0	+0.0003	0	+0.0005	0	+0.0007	0
0.2362	0.3937	+0.0002	0	+0.0002	0	+0.0004	0	+0.0006	0	+0.0009	0
0.3937	0.7087	+0.0002	0	+0.0003	0	+0.0004	0	+0.0007	0	+0.0011	0
0.7087	1.1811	+0.0002	0	+0.0004	0	+0.0005	0	+0.0008	0	+0.0013	0
1.1811	1.9685	+0.0003	0	+0.0004	0	+0.0006	0	+0.0010	0	+0.0015	0
1.9685	3.1496	+0.0003	0	+0.0005	0	+0.0007	0	+0.0012	0	+0.0018	0
3.1496	4.7244	+0.0004	0	+0.0006	0	+0.0009	0	+0.0014	0	+0.0021	0
4.7244	7.0866	+0.0005	0	+0.0007	0	+0.0010	0	+0.0016	0	+0.0025	0
7.0866	9.8425	+0.0006	0	+0.0008	0	+0.0011	0	+0.0018	0	+0.0028	0
9.8425	12.4016	+0.0006	0	+0.0009	0	+0.0013	0	+0.0020	0	+0.0032	0
12.4016	15.7480	+0.0007	0	+0.0010	0	+0.0014	0	+0.0022	0	+0.0035	0
15.7480	19.6850	+0.0008	0	+0.0011	0	+0.0016	0	+0.0025	0	+0.0038	0

Diameter in		Deviations in							
>	≤	H9		H10		H11		H12	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
0.1181	0.2362	+0.0012	0	+0.0019	0	+0.0030	0	+0.0047	0
0.2362	0.3937	+0.0014	0	+0.0023	0	+0.0035	0	+0.0059	0
0.3937	0.7087	+0.0017	0	+0.0028	0	+0.0043	0	+0.0071	0
0.7087	1.1811	+0.0020	0	+0.0033	0	+0.0051	0	+0.0083	0
1.1811	1.9685	+0.0024	0	+0.0039	0	+0.0063	0	+0.0098	0
1.9685	3.1496	+0.0029	0	+0.0047	0	+0.0075	0	+0.0118	0
3.1496	4.7244	+0.0034	0	+0.0055	0	+0.0087	0	+0.0138	0
4.7244	7.0866	+0.0039	0	+0.0063	0	+0.0098	0	+0.0157	0
7.0866	9.8425	+0.0045	0	+0.0073	0	+0.0114	0	+0.0181	0
9.8425	12.4016	+0.0051	0	+0.0083	0	+0.0126	0	+0.0205	0
12.4016	15.7480	+0.0055	0	+0.0091	0	+0.0142	0	+0.0224	0
15.7480	19.6850	+0.0061	0	+0.0098	0	+0.0157	0	+0.0248	0



ISO Tolerances for Holes – inch

Diameter in		Deviations in						Deviations in					
>	≤	J6		J7		J8		K6		K7		K8	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
0.1181	0.2362	+0.00020	-0.00012	+0.00024	-0.00024	+0.00039	-0.00031	+0.00008	-0.00024	+0.00012	-0.00035	+0.00020	-0.00051
0.2362	0.3937	+0.00020	-0.00016	+0.00031	-0.00028	+0.00047	-0.00039	+0.00008	-0.00028	+0.00020	-0.00039	+0.00024	-0.00063
0.3937	0.7087	+0.00024	-0.00020	+0.00039	-0.00031	+0.00059	-0.00047	+0.00008	-0.00035	+0.00024	-0.00047	+0.00031	-0.00075
0.7087	1.1811	+0.00031	-0.00020	+0.00047	-0.00035	+0.00079	-0.00051	+0.00008	-0.00043	+0.00024	-0.00059	+0.00039	-0.00091
1.1811	1.9685	+0.00039	-0.00024	+0.00055	-0.00043	+0.00094	-0.00059	+0.00012	-0.00051	+0.00028	-0.00071	+0.00047	-0.00106
1.9685	3.1496	+0.00051	-0.00024	+0.00071	-0.00047	+0.00110	-0.00071	+0.00016	-0.00059	+0.00035	-0.00083	+0.00055	-0.00126
3.1496	4.7244	+0.00063	-0.00024	+0.00087	-0.00051	+0.00134	-0.00079	+0.00016	-0.00071	+0.00039	-0.00098	+0.00063	-0.00150
4.7244	7.0866	+0.00071	-0.00028	+0.00102	-0.00055	+0.00161	-0.00087	+0.00016	-0.00083	+0.00047	-0.00110	+0.00079	-0.00169
7.0866	9.8425	+0.00087	-0.00028	+0.00118	-0.00063	+0.00185	-0.00098	+0.00020	-0.00094	+0.00051	-0.00130	+0.00087	-0.00197
9.8425	12.4016	+0.00098	-0.00028	+0.00142	-0.00063	+0.00217	-0.00102	+0.00020	-0.00106	+0.00063	-0.00142	+0.00098	-0.00220
12.4016	15.7480	+0.00114	-0.00028	+0.00154	-0.00071	+0.00236	-0.00114	+0.00028	-0.00114	+0.00067	-0.00157	+0.00110	-0.00240
15.7480	19.6850	+0.00130	-0.00028	+0.00169	-0.00079	+0.00259	-0.00122	+0.00031	-0.00126	+0.00071	-0.00177	+0.00114	-0.00268

Diameter in		Deviations in						Deviations in					
>	≤	M5		M6		M7		N6		N7		N8	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
0.1181	0.2362	-0.00012	-0.00031	-0.00004	-0.00035	0	-0.00047	-0.0002	-0.0005	-0.0002	-0.0006	-0.0001	-0.0008
0.2362	0.3937	-0.00016	-0.00039	-0.00012	-0.00047	0	-0.00059	-0.0003	-0.0006	-0.0002	-0.0007	-0.0001	-0.0010
0.3937	0.7087	-0.00016	-0.00047	-0.00016	-0.00059	0	-0.00071	-0.0004	-0.0008	-0.0002	-0.0009	-0.0001	-0.0012
0.7087	1.1811	-0.00020	-0.00055	-0.00016	-0.00067	0	-0.00083	-0.0004	-0.0009	-0.0003	-0.0011	-0.0001	-0.0014
1.1811	1.9685	-0.00020	-0.00063	-0.00016	-0.00079	0	-0.00098	-0.0005	-0.0011	-0.0003	-0.0013	-0.0001	-0.0017
1.9685	3.1496	-0.00024	-0.00075	-0.00020	-0.00094	0	-0.00118	-0.0006	-0.0013	-0.0004	-0.0015	-0.0002	-0.0020
3.1496	4.7244	-0.00031	-0.00091	-0.00024	-0.00110	0	-0.00138	-0.0006	-0.0015	-0.0004	-0.0018	-0.0002	-0.0023
4.7244	7.0866	-0.00035	-0.00106	-0.00031	-0.00130	0	-0.00157	-0.0008	-0.0018	-0.0005	-0.0020	-0.0002	-0.0026
7.0866	9.8425	-0.00043	-0.00122	-0.00031	-0.00146	0	-0.00181	-0.0009	-0.0020	-0.0006	-0.0024	-0.0002	-0.0030
9.8425	12.4016	-0.00051	-0.00142	-0.00035	-0.00161	0	-0.00205	-0.0009	-0.0022	-0.0006	-0.0026	-0.0002	-0.0034
12.4016	15.7480	-0.00055	-0.00154	-0.00039	-0.00181	0	-0.00224	-0.0010	-0.0024	-0.0006	-0.0029	-0.0002	-0.0037
15.7480	19.6850	-0.00063	-0.00169	-0.00039	-0.00197	0	-0.00248	-0.0011	-0.0026	-0.0007	-0.0031	-0.0002	-0.0041

Diameter in		Deviations in				Deviations in					
>	≤	P6		P7		R6		R7		R8	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
0.1181	0.2362	-0.0004	-0.0007	-0.0003	-0.0008	-0.0005	-0.0008	-0.0004	-0.0009	-0.0006	-0.0013
0.2362	0.3937	-0.0005	-0.0008	-0.0004	-0.0009	-0.0006	-0.0010	-0.0005	-0.0011	-0.0007	-0.0016
0.3937	0.7087	-0.0006	-0.0010	-0.0004	-0.0011	-0.0008	-0.0012	-0.0006	-0.0013	-0.0009	-0.0020
0.7087	1.1811	-0.0007	-0.0012	-0.0006	-0.0014	-0.0009	-0.0015	-0.0008	-0.0016	-0.0011	-0.0024
1.1811	1.9685	-0.0008	-0.0015	-0.0007	-0.0017	-0.0011	-0.0018	-0.0010	-0.0020	-0.0013	-0.0029
1.9685	2.5591	-0.0010	-0.0018	-0.0008	-0.0020	-0.0014	-0.0021	-0.0012	-0.0024	-0.0016	-0.0034
2.5591	3.1496	-0.0010	-0.0018	-0.0008	-0.0020	-0.0015	-0.0022	-0.0013	-0.0024	-0.0017	-0.0035
3.1496	3.9370	-0.0012	-0.0020	-0.0009	-0.0023	-0.0017	-0.0026	-0.0015	-0.0029	-0.0020	-0.0041
3.9370	4.7244	-0.0012	-0.0020	-0.0009	-0.0023	-0.0019	-0.0027	-0.0016	-0.0030	-0.0021	-0.0043
4.7244	5.5118	-0.0014	-0.0024	-0.0011	-0.0027	-0.0022	-0.0032	-0.0019	-0.0035	-0.0025	-0.0050
5.5118	6.2992	-0.0014	-0.0024	-0.0011	-0.0027	-0.0023	-0.0033	-0.0020	-0.0035	-0.0026	-0.0050
6.2992	7.0866	-0.0014	-0.0024	-0.0011	-0.0027	0.0024	-0.0034	-0.0021	-0.0037	-0.0027	-0.0052
7.0866	7.8740	-0.0016	-0.0028	-0.0013	-0.0031	-0.0027	-0.0038	-0.0024	-0.0042	-0.0030	-0.0059
7.8740	8.8583	-0.0016	-0.0028	-0.0013	-0.0031	0.0028	-0.0039	-0.0025	-0.0043	-0.0031	-0.0060
8.8583	9.8425	-0.0016	-0.0028	-0.0013	-0.0031	-0.0030	-0.0041	-0.0026	-0.0044	-0.0033	-0.0061
9.8425	11.0236	-0.0019	-0.0031	-0.0014	-0.0035	-0.0033	-0.0046	-0.0029	-0.0050	-0.0037	-0.0069
11.0236	12.4016	-0.0019	-0.0031	-0.0014	-0.0035	-0.0035	-0.0048	-0.0031	-0.0051	-0.0039	-0.0070
12.4016	13.9764	-0.0020	-0.0034	-0.0016	-0.0039	-0.0038	-0.0052	-0.0034	-0.0057	-0.0043	-0.0078
13.9764	15.7480	-0.0020	-0.0034	-0.0016	-0.0039	-0.0041	-0.0055	-0.0037	-0.0059	-0.0045	-0.0080
15.7480	17.7165	-0.0022	-0.0037	-0.0018	-0.0043	-0.0044	-0.0060	-0.0041	-0.0065	-0.0050	-0.0088
17.7165	19.6850	-0.0022	-0.0037	-0.0018	-0.0043	-0.0047	-0.0063	-0.0043	-0.0068	-0.0052	-0.0090

A

ISO Tolerances for Shafts – inch									
Diameter in		Deviations in							
>	≤	a10		a11		a12		a13	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
—	0.1181	-0.0106	-0.0122	-0.0106	-0.0130	-0.0106	-0.0146	-0.0106	-0.0161
0.1181	0.2362	-0.0106	-0.0125	-0.0106	-0.0136	-0.0106	-0.0154	-0.0106	-0.0177
0.2362	0.3937	-0.0110	-0.0133	-0.0110	-0.0146	-0.0110	-0.0169	-0.0110	-0.0197
0.3937	0.7087	-0.0114	-0.0142	-0.0114	-0.0157	-0.0114	-0.0185	-0.0114	-0.0220
0.7087	1.1811	-0.0118	-0.0151	-0.0118	-0.0169	-0.0118	-0.0201	-0.0118	-0.0248
1.1811	1.5748	-0.0122	-0.0161	-0.0122	-0.0185	-0.0122	-0.0220	-0.0122	-0.0276
1.5748	1.9685	-0.0126	-0.0165	-0.0126	-0.0189	-0.0126	-0.0224	-0.0126	-0.0280
1.9685	2.5591	-0.0134	-0.0181	-0.0134	-0.0209	-0.0134	-0.0252	-0.0134	-0.0315
2.5591	3.1496	-0.0142	-0.0189	-0.0142	-0.0217	-0.0142	-0.0260	-0.0142	-0.0323
3.1496	3.9370	-0.0150	-0.0205	-0.0150	-0.0236	-0.0150	-0.0287	-0.0150	-0.0362
3.9370	4.7244	-0.0161	-0.0217	-0.0161	-0.0248	-0.0161	-0.0299	-0.0161	-0.0374
4.7244	5.5118	-0.0181	-0.0244	-0.0181	-0.0280	-0.0181	-0.0339	-0.0181	-0.0429
5.5118	6.2992	-0.0205	-0.0268	-0.0205	-0.0303	-0.0205	-0.0362	-0.0205	-0.0453
6.2992	7.0866	-0.0228	-0.0291	-0.0228	-0.0327	-0.0228	-0.0386	-0.0228	-0.0476
7.0866	7.8740	-0.0260	-0.0333	-0.0260	-0.0374	-0.0260	-0.0441	-0.0260	-0.0543
7.8740	8.8583	-0.0291	-0.0364	-0.0291	-0.0406	-0.0291	-0.0472	-0.0291	-0.0575
8.8583	9.8425	-0.0323	-0.0396	-0.0323	-0.0437	-0.0323	-0.0504	-0.0323	-0.0606
9.8425	11.0236	-0.0362	-0.0445	-0.0362	-0.0488	-0.0362	-0.0567	-0.0362	-0.0681
11.0236	12.4016	-0.0413	-0.0496	-0.0413	-0.0539	-0.0413	-0.0618	-0.0413	-0.0732
12.4016	13.9764	-0.0472	-0.0563	-0.0472	-0.0614	-0.0472	-0.0697	-0.0472	-0.0823
13.9764	15.7480	-0.0531	-0.0622	-0.0531	-0.0673	-0.0531	-0.0756	-0.0531	-0.0882

Diameter in		Deviations in						Deviations in					
>	≤	c11		c12		c13		e11		e12		e13	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
—	0.1181	-0.0024	-0.0047	-0.0024	-0.0063	-0.0024	-0.0079	-0.0006	-0.0029	-0.0006	-0.0045	-0.0006	-0.0061
0.1181	0.2362	-0.0028	-0.0057	-0.0028	-0.0075	-0.0028	-0.0098	-0.0008	-0.0037	-0.0008	-0.0055	-0.0008	-0.0079
0.2362	0.3937	-0.0031	-0.0067	-0.0031	-0.0091	-0.0031	-0.0118	-0.0010	-0.0045	-0.0010	-0.0069	-0.0010	-0.0096
0.3937	0.7087	-0.0037	-0.0081	-0.0037	-0.0108	-0.0037	-0.0144	-0.0013	-0.0056	-0.0013	-0.0083	-0.0013	-0.0119
0.7087	1.1811	-0.0043	-0.0094	-0.0043	-0.0126	-0.0043	-0.0173	-0.0016	-0.0067	-0.0016	-0.0098	-0.0016	-0.0146
1.1811	1.5748	-0.0047	-0.0110	-0.0047	-0.0146	-0.0047	-0.0201	-0.0020	-0.0083	-0.0020	-0.0118	-0.0020	-0.0173
1.5748	1.9685	-0.0051	-0.0114	-0.0051	-0.0150	-0.0051	-0.0205	-0.0020	-0.0083	-0.0020	-0.0118	-0.0020	-0.0173
1.9685	2.5591	-0.0055	-0.0130	-0.0055	-0.0173	-0.0055	-0.0236	-0.0024	-0.0098	-0.0024	-0.0142	-0.0024	-0.0205
2.5591	3.1496	-0.0059	-0.0134	-0.0059	-0.0177	-0.0059	-0.0240	-0.0024	-0.0098	-0.0024	-0.0142	-0.0024	-0.0205
3.1496	3.9370	-0.0067	-0.0154	-0.0067	-0.0205	-0.0067	-0.0280	-0.0028	-0.0115	-0.0028	-0.0166	-0.0028	-0.0241
3.9370	4.7244	-0.0071	-0.0157	-0.0071	-0.0209	-0.0071	-0.0283	-0.0028	-0.0115	-0.0028	-0.0166	-0.0028	-0.0241
4.7244	5.5118	-0.0079	-0.0177	-0.0079	-0.0236	-0.0079	-0.0327	-0.0033	-0.0132	-0.0033	-0.0191	-0.0033	-0.0281
5.5118	6.2992	-0.0083	-0.0181	-0.0083	-0.0240	-0.0083	-0.0331	-0.0033	-0.0132	-0.0033	-0.0191	-0.0033	-0.0281
6.2992	7.0866	-0.0091	-0.0189	-0.0091	-0.0248	-0.0091	-0.0339	-0.0033	-0.0132	-0.0033	-0.0191	-0.0033	-0.0281
7.0866	7.8740	-0.0094	-0.0209	-0.0094	-0.0276	-0.0094	-0.0378	-0.0039	-0.0154	-0.0039	-0.0220	-0.0039	-0.0323
7.8740	8.8583	-0.0102	-0.0217	-0.0102	-0.0283	-0.0102	-0.0386	-0.0039	-0.0154	-0.0039	-0.0220	-0.0039	-0.0323
8.8583	9.8425	-0.0110	-0.0224	-0.0110	-0.0291	-0.0110	-0.0394	-0.0039	-0.0154	-0.0039	-0.0220	-0.0039	-0.0323
9.8425	11.0236	-0.0118	-0.0244	-0.0118	-0.0323	-0.0118	-0.0437	-0.0043	-0.0169	-0.0043	-0.0248	-0.0043	-0.0362
11.0236	12.4016	-0.0130	-0.0256	-0.0130	-0.0335	-0.0130	-0.0449	-0.0043	-0.0169	-0.0043	-0.0248	-0.0043	-0.0362
12.4016	13.9764	-0.0142	-0.0283	-0.0142	-0.0366	-0.0142	-0.0492	-0.0049	-0.0191	-0.0049	-0.0274	-0.0049	-0.0400
13.9764	15.7480	-0.0157	-0.0299	-0.0157	-0.0382	-0.0157	-0.0508	-0.0049	-0.0191	-0.0049	-0.0274	-0.0049	-0.0400



ISO Tolerances for Shafts – inch

Diameter in		Deviations in						Deviations in					
>	≤	f5		f6		f7		g5		g6		g7	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
—	0.1181	-0.0002	-0.0004	-0.0002	-0.0005	-0.0002	-0.0006	-0.0001	-0.0002	-0.0001	-0.0003	-0.0001	-0.0005
0.1181	0.2362	-0.0004	-0.0006	-0.0004	-0.0007	-0.0004	-0.0009	-0.0002	-0.0004	-0.0002	-0.0005	-0.0002	-0.0006
0.2362	0.3937	-0.0005	-0.0007	-0.0005	-0.0009	-0.0005	-0.0011	-0.0002	-0.0004	-0.0002	-0.0006	-0.0002	-0.0008
0.3937	0.7087	-0.0006	-0.0009	-0.0006	-0.0011	-0.0006	-0.0013	-0.0002	-0.0006	-0.0002	-0.0007	-0.0002	-0.0009
0.7087	1.1811	-0.0008	-0.0011	-0.0008	-0.0013	-0.0008	-0.0016	-0.0003	-0.0006	-0.0003	-0.0008	-0.0003	-0.0011
1.1811	1.9685	-0.0010	-0.0014	-0.0010	-0.0016	-0.0010	-0.0020	-0.0004	-0.0008	-0.0004	-0.0010	-0.0004	-0.0013
1.9685	3.1496	-0.0012	-0.0017	-0.0012	-0.0019	-0.0012	-0.0024	-0.0004	-0.0009	-0.0004	-0.0011	-0.0004	-0.0016
3.1496	4.7244	-0.0014	-0.0020	-0.0014	-0.0023	-0.0014	-0.0028	-0.0005	-0.0011	-0.0005	-0.0013	-0.0005	-0.0019
4.7244	7.0866	-0.0017	-0.0024	-0.0017	-0.0027	-0.0017	-0.0033	-0.0006	-0.0013	-0.0006	-0.0015	-0.0006	-0.0021
7.0866	9.8425	-0.0020	-0.0028	-0.0020	-0.0031	-0.0020	-0.0038	-0.0006	-0.0014	-0.0006	-0.0017	-0.0006	-0.0024
9.8425	12.4016	-0.0022	-0.0031	-0.0022	-0.0035	-0.0022	-0.0043	-0.0007	-0.0016	-0.0007	-0.0019	-0.0007	-0.0027
12.4016	15.7480	-0.0024	-0.0034	-0.0024	-0.0039	-0.0024	-0.0047	-0.0007	-0.0017	-0.0007	-0.0021	-0.0007	-0.0030

Diameter in		Deviations in									
>	≤	h4		h5		h6		h7		h8	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
—	0.1181	0	-0.00012	0	-0.00016	0	-0.00024	0	-0.0004	0	-0.0006
0.1181	0.2362	0	-0.00016	0	-0.00020	0	-0.00031	0	-0.0005	0	-0.0007
0.2362	0.3937	0	-0.0002	0	-0.00024	0	-0.0004	0	-0.0006	0	-0.0009
0.3937	0.7087	0	-0.0002	0	-0.00031	0	-0.0004	0	-0.0007	0	-0.0011
0.7087	1.1811	0	-0.0002	0	-0.0004	0	-0.0005	0	-0.0008	0	-0.0013
1.1811	1.9685	0	-0.0003	0	-0.0004	0	-0.0006	0	-0.0010	0	-0.0015
1.9685	3.1496	0	-0.0003	0	-0.0005	0	-0.0007	0	-0.0012	0	-0.0018
3.1496	4.7244	0	-0.0004	0	-0.0006	0	-0.0009	0	-0.0014	0	-0.0021
4.7244	7.0866	0	-0.0005	0	-0.0007	0	-0.0010	0	-0.0016	0	-0.0025
7.0866	9.8425	0	-0.0006	0	-0.0008	0	-0.0011	0	-0.0018	0	-0.0028
9.8425	12.4016	0	-0.0006	0	-0.0009	0	-0.0013	0	-0.0020	0	-0.0032
12.4016	15.7480	0	-0.0007	0	-0.0010	0	-0.0014	0	-0.0022	0	-0.0035

Diameter in		Deviations in									
>	≤	h9		h10		h11		h12		h13	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
—	0.1181	0	-0.0010	0	-0.0016	0	-0.0024	0	-0.0039	0	-0.0055
0.1181	0.2362	0	-0.0012	0	-0.0019	0	-0.0030	0	-0.0047	0	-0.0071
0.2362	0.3937	0	-0.0014	0	-0.0023	0	-0.0035	0	-0.0059	0	-0.0087
0.3937	0.7087	0	-0.0017	0	-0.0028	0	-0.0043	0	-0.0071	0	-0.0106
0.7087	1.1811	0	-0.0020	0	-0.0033	0	-0.0051	0	-0.0083	0	-0.0130
1.1811	1.9685	0	-0.0024	0	-0.0039	0	-0.0063	0	-0.0098	0	-0.0154
1.9685	3.1496	0	-0.0029	0	-0.0047	0	-0.0075	0	-0.0118	0	-0.0181
3.1496	4.7244	0	-0.0034	0	-0.0055	0	-0.0087	0	-0.0138	0	-0.0213
4.7244	7.0866	0	-0.0039	0	-0.0063	0	-0.0098	0	-0.0157	0	-0.0248
7.0866	9.8425	0	-0.0045	0	-0.0073	0	-0.0114	0	-0.0181	0	-0.0283
9.8425	12.4016	0	-0.0051	0	-0.0083	0	-0.0126	0	-0.0205	0	-0.0319
12.4016	15.7480	0	-0.0055	0	-0.0091	0	-0.0142	0	-0.0224	0	-0.0350

A

ISO Tolerances for Shafts – inch

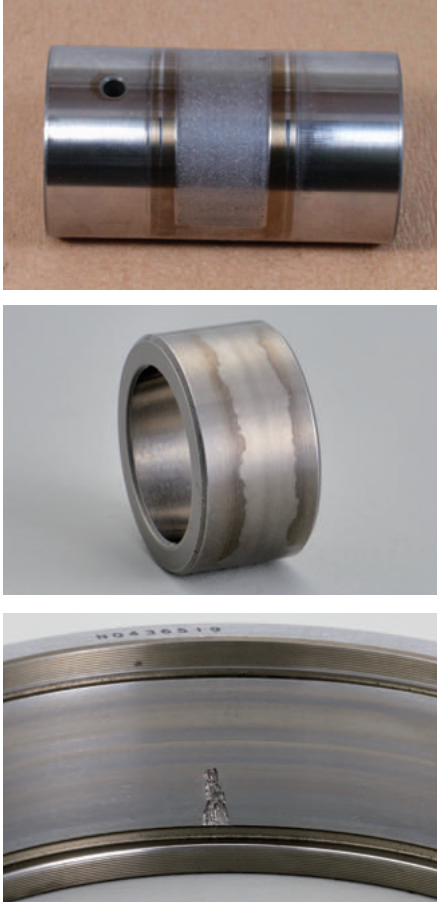
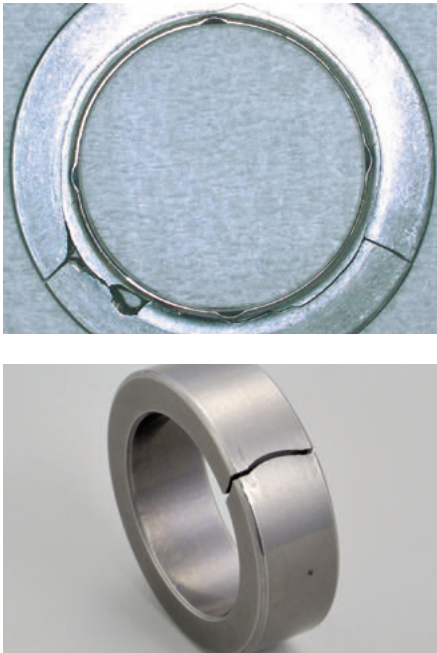
Diameter in		Deviations in						Deviations in					
>	≤	j5		j6		j7		k5		k6		k7	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
—	0.1181	+0.00008	-0.00008	+0.00016	-0.00008	+0.00024	-0.00016	+0.00016	0	+0.00024	0	+0.00039	0
0.1181	0.2362	+0.00012	-0.00008	+0.00024	-0.00008	+0.00031	-0.00016	+0.00024	+0.00004	+0.00035	+0.00004	+0.00051	+0.00004
0.2362	0.3937	+0.00016	-0.00008	+0.00028	-0.00008	+0.00039	-0.00020	+0.00028	+0.00004	+0.00039	+0.00004	+0.00063	+0.00004
0.3937	0.7087	+0.00020	-0.00012	+0.00031	-0.00012	+0.00047	-0.00024	+0.00035	+0.00004	+0.00047	+0.00004	+0.00075	+0.00004
0.7087	1.1811	+0.00020	-0.00016	+0.00035	-0.00016	+0.00051	-0.00031	+0.00043	+0.00008	+0.00059	+0.00008	+0.00091	+0.00008
1.1811	1.9685	+0.00024	-0.00020	+0.00043	-0.00020	+0.00059	-0.00039	+0.00051	+0.00008	+0.00071	+0.00008	+0.00106	+0.00008
1.9685	3.1496	+0.00024	-0.00028	+0.00047	-0.00028	+0.00071	-0.00047	+0.00059	+0.00008	+0.00083	+0.00008	+0.00126	+0.00008
3.1496	4.7244	+0.00024	-0.00035	+0.00051	-0.00035	+0.00079	-0.00059	+0.00071	+0.00012	+0.00098	+0.00012	+0.00150	+0.00012
4.7244	7.0866	+0.00028	-0.00043	+0.00055	-0.00043	+0.00087	-0.00071	+0.00083	+0.00012	+0.00110	+0.00012	+0.00169	+0.00012
7.0866	9.8425	+0.00028	-0.00051	+0.00063	-0.00051	+0.00098	-0.00083	+0.00094	+0.00016	+0.00130	+0.00016	+0.00197	+0.00016
9.8425	12.4016	+0.00028	-0.00063	+0.00063	-0.00063	+0.00102	-0.00102	+0.00106	+0.00016	+0.00142	+0.00016	+0.00220	+0.00016
12.4016	15.7480	+0.00028	-0.00071	+0.00071	-0.00071	+0.00114	-0.00110	+0.00114	+0.00016	+0.00157	+0.00016	+0.00240	+0.00016

Diameter in		Deviations in						Deviations in					
>	≤	m5		m6		m7		n5		n6		n7	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
—	0.1181	+0.00024	+0.00008	+0.00031	+0.00008	+0.00047	+0.00008	+0.0003	+0.0002	+0.0004	+0.0002	+0.0006	+0.0002
0.1181	0.2362	+0.00035	+0.00016	+0.00047	+0.00016	+0.00063	+0.00016	+0.0005	+0.0003	+0.0006	+0.0003	+0.0008	+0.0003
0.2362	0.3937	+0.00047	+0.00024	+0.00059	+0.00024	+0.00083	+0.00024	+0.0006	+0.0004	+0.0007	+0.0004	+0.0010	+0.0004
0.3937	0.7087	+0.00059	+0.00028	+0.00071	+0.00028	+0.00098	+0.00028	+0.0008	+0.0005	+0.0009	+0.0005	+0.0012	+0.0005
0.7087	1.1811	+0.00067	+0.00031	+0.00083	+0.00031	+0.00114	+0.00031	+0.0009	+0.0006	+0.0011	+0.0006	+0.0014	+0.0006
1.1811	1.9685	+0.00079	+0.00035	+0.00098	+0.00035	+0.00134	+0.00035	+0.0011	+0.0007	+0.0013	+0.0007	+0.0017	+0.0007
1.9685	3.1496	+0.00094	+0.00043	+0.00118	+0.00043	+0.00161	+0.00043	+0.0013	+0.0008	+0.0015	+0.0008	+0.0020	+0.0008
3.1496	4.7244	+0.00110	+0.00051	+0.00138	+0.00051	+0.00189	+0.00051	+0.0015	+0.0009	+0.0018	+0.0009	+0.0023	+0.0009
4.7244	7.0866	+0.00130	+0.00059	+0.00157	+0.00059	+0.00217	+0.00059	+0.0018	+0.0011	+0.0020	+0.0011	+0.0026	+0.0011
7.0866	9.8425	+0.00146	+0.00067	+0.00181	+0.00067	+0.00248	+0.00067	+0.0020	+0.0012	+0.0024	+0.0012	+0.0030	+0.0012
9.8425	12.4016	+0.00169	+0.00079	+0.00205	+0.00079	+0.00283	+0.00079	+0.0022	+0.0013	+0.0026	+0.0013	+0.0034	+0.0013
12.4016	15.7480	+0.00181	+0.00083	+0.00224	+0.00083	+0.00307	+0.00083	+0.0024	+0.0015	+0.0029	+0.0015	+0.0037	+0.0015



Diameter in		Deviations in					
>	≤	p6		r6		r7	
		Max.	Min.	Max.	Min.	Max.	Min.
3.1496	3.9370	+0.0023	+0.0015	-	-	-	-
3.9370	4.7244	+0.0023	+0.0015	-	-	-	-
4.7244	5.5118	+0.0027	+0.0017	+0.0035	+0.0026	-	-
5.5118	6.2992	+0.0027	+0.0017	+0.0035	+0.0026	-	-
6.2992	7.0866	+0.0027	+0.0017	+0.0035	+0.0026	-	-
7.0866	7.8740	+0.0031	+0.0020	+0.0042	+0.0030	-	-
7.8740	8.8583	+0.0031	+0.0020	+0.0043	+0.0031	+0.0050	+0.0031
8.8583	9.8425	+0.0031	+0.0020	+0.0044	+0.0033	+0.0051	+0.0033
9.8425	11.0236	+0.0035	+0.0022	+0.0050	+0.0037	+0.0057	+0.0037
11.0236	12.4016	+0.0035	+0.0022	+0.0051	+0.0039	+0.0059	+0.0039
12.4016	13.9764	+0.0039	+0.0024	+0.0057	+0.0043	+0.0065	+0.0043
13.9764	15.7480	+0.0039	+0.0024	+0.0059	+0.0045	+0.0067	+0.0045
15.7480	17.7165	+0.0043	+0.0027	+0.0065	+0.0050	+0.0074	+0.0050
17.7165	19.6850	+0.0043	+0.0027	+0.0068	+0.0052	+0.0077	+0.0052

EXAMPLES OF BEARING FAILURES



A

Failures	Characteristics
<p>(1) Flaking</p>	 <p>Flaking is a phenomenon that material is removed in flakes from a surface layer of the bearing raceways or rolling elements due to rolling fatigue. This phenomenon is generally attributed to the approaching end of bearing service life. However, if flaking occurs at early stages of bearing service life, it is necessary to determine causes and adopt countermeasures, since there is a possibility of abnormality in this case.</p> <p>Pitting Pitting is another type of failure caused by rolling fatigue, in which minute holes of approx. 0.1 mm in depth are generated on the raceway surface.</p> <p>Peeling (shown in middle figure) Peeling is a phenomenon in which the lubricant film separation is insufficient for complete surface separation (0.02 mm or less) of the rolling surfaces causing fatigue and peeling due to concentrated stress acting on microscopic peaks of surface roughness.</p>
<p>(2) Cracking Chipping</p>	 <p>Cracking is mainly triggered by debris initiated defects due to wear of other system components, partial shape defects, and concentrated stress and overload caused by edge load. It may occur on bearing rings due to fatigue caused by repeated bend stress.</p>

Damages	Causes	Countermeasures
Flaking occurring at an incipient stage	<ul style="list-style-type: none"> · Too small internal clearance · Improper or insufficient lubricant · Load too high · Rust 	<ul style="list-style-type: none"> · Provide proper internal clearance. · Select proper lubricating method or lubricant.
Symmetrical flaking along circumference of raceway	<ul style="list-style-type: none"> · Inaccurate housing roundness 	<ul style="list-style-type: none"> · Correct processing accuracy of housing bore. Especially for split housings, care should be taken to ensure processing accuracy.
Flaking occurring near the edge of the raceway or rolling contact surface	<ul style="list-style-type: none"> · Improper mounting · Shaft deflection · Inaccuracy of the shaft and housing 	<ul style="list-style-type: none"> · Correct centering. · Correct squareness of shaft or housing shoulder.
Flaking on the raceway surface at the same interval as rolling element spacing	<ul style="list-style-type: none"> · Heavy impact load during mounting · A flaw caused during mounting · Rust generated while out of operation 	<ul style="list-style-type: none"> · Improve mounting procedure. · Provide rust prevention treatment before long cessation of operation.
Cracking in outer ring, inner ring or race	<ul style="list-style-type: none"> · Excessive interference · Excessive fillet on shaft or housing · Heavy impact load · Advanced flaking or seizure · Impact on race during mounting 	<ul style="list-style-type: none"> · Select proper fit. · Adjust fillet in the shaft or in the housing to smaller than that of the bearing chamfer dimension. · Re-examine load conditions. · Improve mounting procedures.
Cracking on rolling elements	<ul style="list-style-type: none"> · Heavy impact load · Advanced flaking 	<ul style="list-style-type: none"> · Improve mounting and handling procedures. · Re-examine load conditions.

Failures	Characteristics	
(3) Brinelling Nicks	<ul style="list-style-type: none"> · Brinelling is a small surface indentation generated either on the raceway through plastic deformation at the contact point between the raceway and rolling elements, or on the rolling surfaces from insertion of foreign matter, when heavy load is applied while the bearing is stationary or rotating at a low rotation speed. · Nicks are indentations produced directly by rough handling such as hammering. 	
(4) Wear		<p>Normally, wear of bearing is observed on sliding contact surfaces such as roller end faces and rib faces, cage pockets, the guide surface of cages and cage riding lands.</p> <p>Wear is not directly related to material fatigue.</p> <p>Wear caused by foreign matter and corrosion can affect not only sliding surfaces but rolling surfaces.</p>
(5) Fretting		<p>Fretting occurs to bearings which are subject to vibration while in stationary condition or which are exposed to minute vibrations. It is characterized by rust-colored wear particles.</p> <p>Since fretting on the raceways often appears similar to brinelling, it is sometimes called "false brinelling".</p>
(6) Creeping	<p>Creeping is a phenomenon in which bearing rings move relative to the shaft or housing during operation.</p>	

Damages	Causes	Countermeasures
Brinelling on the raceway or rolling contact surface	· Entry of foreign matter	· Clean bearing and its peripheral parts. · Improve sealing devices.
Brinelling on the raceway surface at the same interval as the rolling element spacing	· Impact load during mounting · Excessive load applied while bearing is stationary	· Improve mounting procedure. · Improve machine handling.
Nicks on the raceway or rolling contact surface	· Careless handling	· Improve mounting and handling procedure.
Wear on the contact surfaces (cage pockets, cage riding land)	· Improper or insufficient lubricant	· Select proper lubricating method or lubricant. · Improve sealing device. · Clean the bearing and its peripheral parts.
Wear on raceways and rolling contact surfaces	· Entry of foreign matter · Improper or insufficient lubricant	
Rust-colored wear particles generated on the fitting surface (fretting corrosion)	· Insufficient interference	· Provide greater interference. · Apply lubricant to the fitting surface.
Brinelling on the raceway surface at the same interval as rolling element spacing (false brinelling)	· Vibration and oscillation when bearings are stationary.	· Improve fixing method of the shaft and housing.
Wear, discoloration, and scuffing caused by slipping on the fitting surfaces	· Insufficient interference · Insufficient tightening of sleeve	· Provide greater interference. · Proper tightening of sleeve.

Failures	Characteristics
<p>(7) Damage to Cages</p>	 <p>Since cages are made of low hardness materials, external pressure and contact with other parts can easily produce flaws and distortion. In some cases, these are aggravated and become chips and cracks. Large chips and cracks are often accompanied by deformation, which may reduce the accuracy of the cage itself and may hinder the smooth movement of rolling elements.</p>
<p>(8) Seizing</p>	 <p>A phenomenon caused by abnormal heating in bearings due to various reasons</p>

Damages	Causes	Countermeasures
<p>Flaws, distortion, chipping, cracking and excessive wear in cages.</p>	<ul style="list-style-type: none"> · Extraordinary vibration, impact, moment · Improper or insufficient lubricant · Dents made during mounting 	<ul style="list-style-type: none"> · Re-examine load conditions. · Select proper lubricating method or lubricant. · Re-examine cage types. · Improve mounting.
<p>Discoloration, distortion, and melting together due to heating in bearings</p>	<ul style="list-style-type: none"> · Too small internal clearance · Improper or insufficient lubricant · Excessive load · Aggravated by other bearing flaws 	<ul style="list-style-type: none"> · Provide proper internal clearance. · Select proper lubricating method or lubricant. · Re-examine bearing type. · Earlier discovery of bearing flaws



NOTES



NEEDLE ROLLER BEARINGS

B

B

B NEEDLE ROLLER BEARINGS

<i>Radial Needle Roller and Cage Assemblies</i>	B-1-1
<i>Drawn Cup Needle Roller Bearings</i>	B-2-1
<i>Drawn Cup Roller Clutches</i>	B-3-1
<i>Heavy-Duty Needle Roller Bearings</i>	B-4-1
<i>Track Rollers</i>	B-5-1
<i>Thrust Bearings, Assemblies, Washers</i>	B-6-1
<i>Combined Needle Roller Bearings</i>	B-7-1
<i>Needle Rollers, Accessories</i>	B-8-1

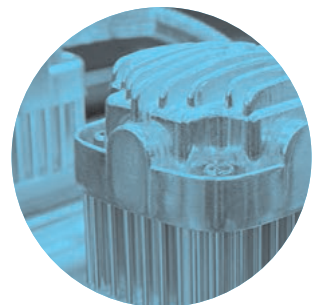
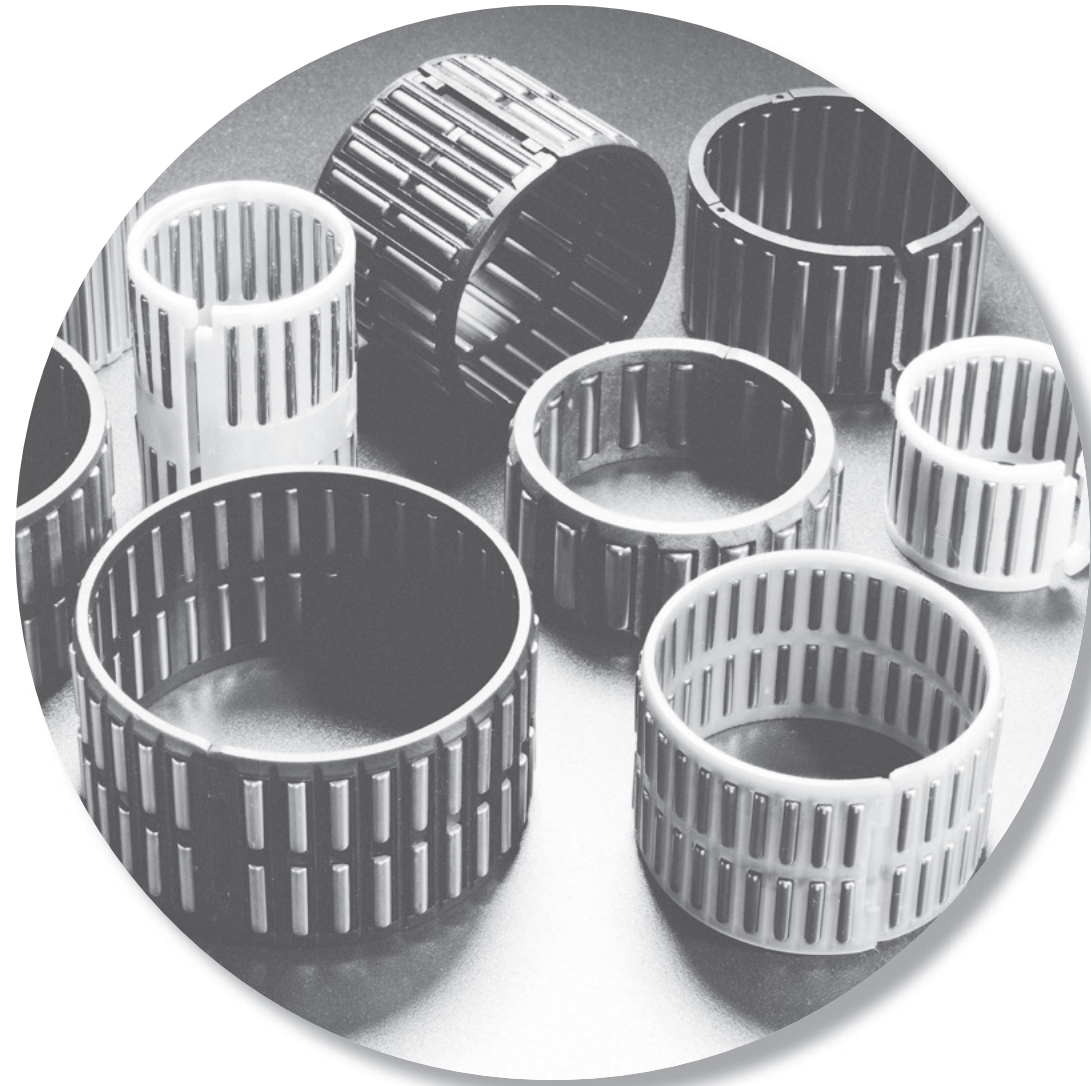
NEEDLE ROLLER BEARINGS

B

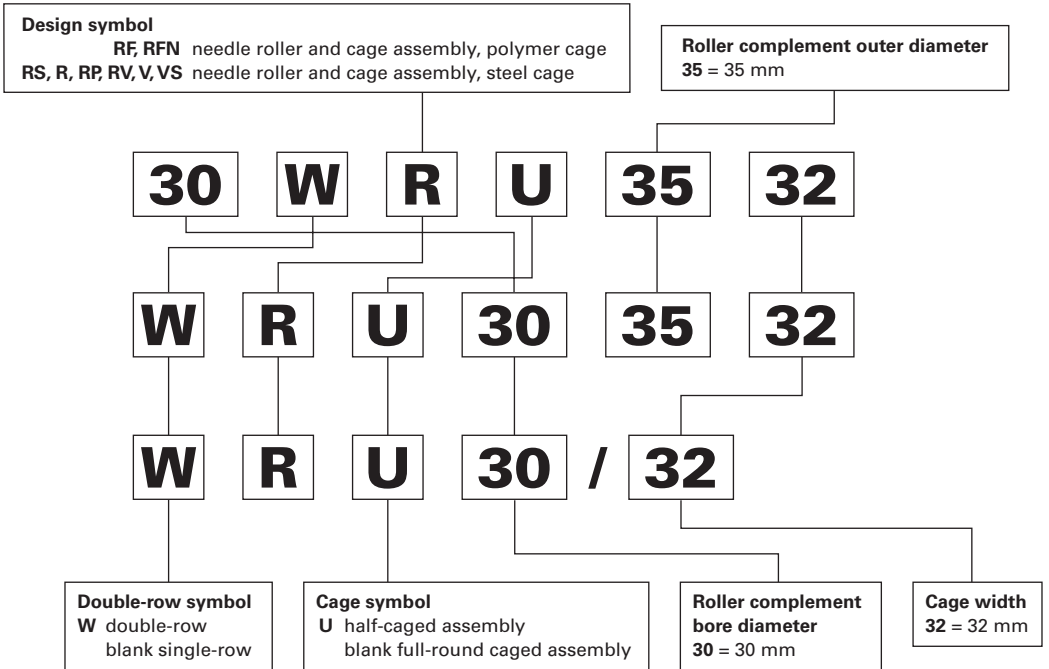
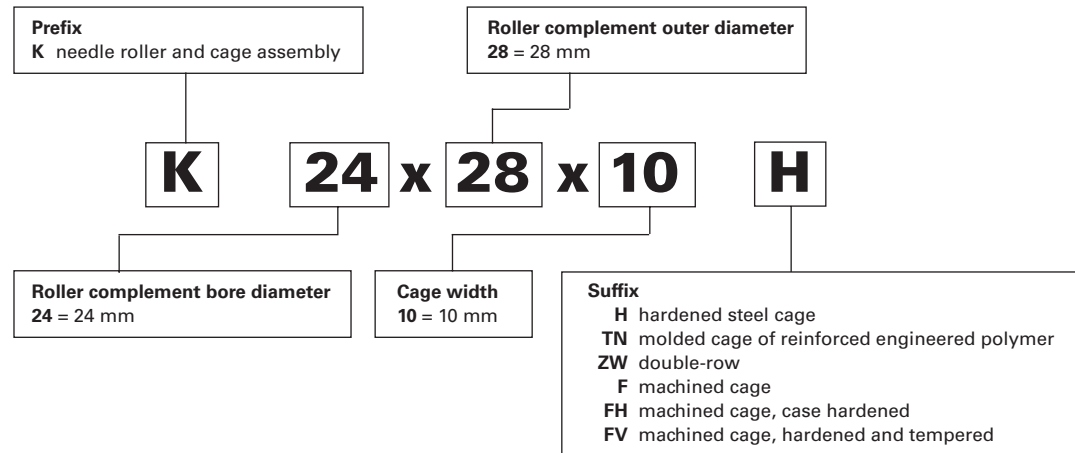
RADIAL NEEDLE ROLLER AND CAGE ASSEMBLIES

Overview: Needle roller and cage assemblies feature a complement of needles held in place by a cage with no inner or outer ring. The minimal cross section provides maximum load-carrying capability within the smallest envelope.

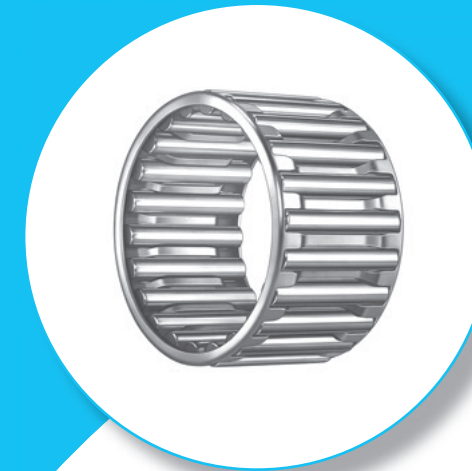
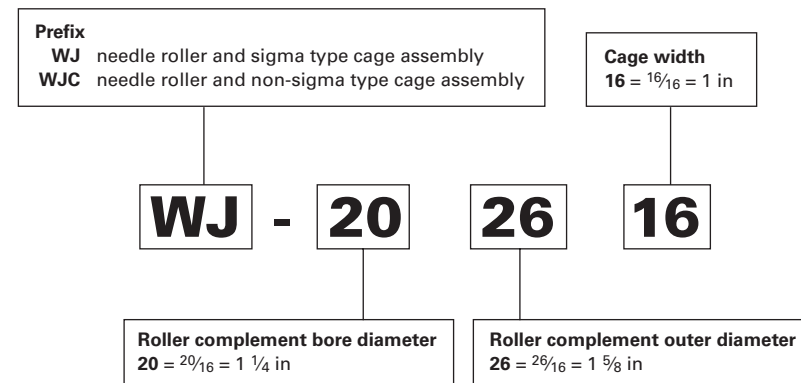
- **Catalogue range:** 3 mm – 127 mm (0.1181 in – 5.0000 in) bore.
- **Markets:** Automotive and truck transmissions, agricultural and construction equipment, two-cycle engines, pumps and compressors.
- **Features and Benefits:**
 - Unitized design simplifies handling and installation while allowing for increased lube flow.
 - Split and segmented designs allow mounting at difficult positions on crankshafts and gear shafts.
 - Controlled contour rollers optimize contact stress distribution.
 - Special manufacturing processes help increase roller fatigue resistance and minimize axial drift effects in critical applications.
 - Optimized cage piloting geometry minimizes pressure velocity effects.
 - Steel or polymer cages are available to suit your application requirements.
 - Coatings are available to help avoid corrosion and improve wear resistance.



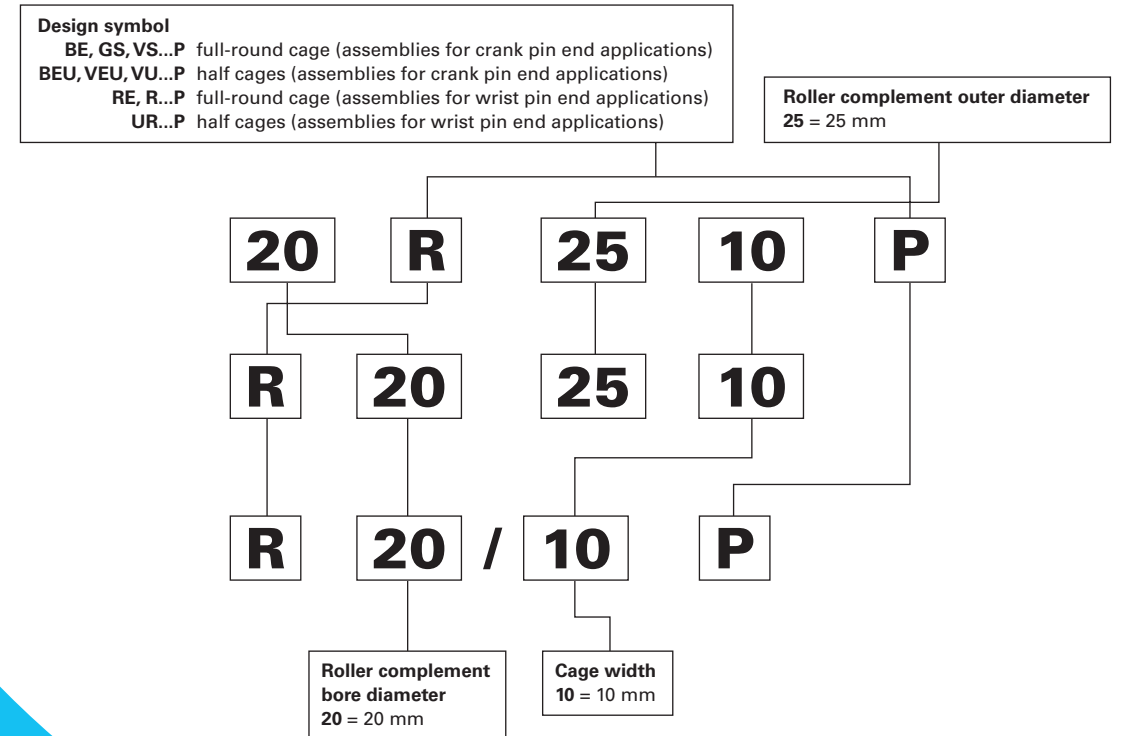
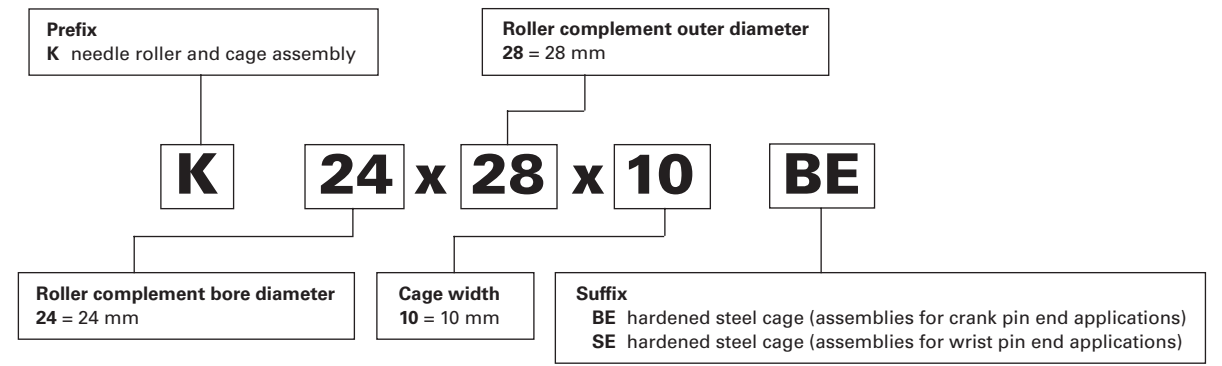
Radial Needle Roller and Cage Assemblies – Metric Nominal Dimensions



Inch Nominal Dimensions



Radial Needle Roller and Cage Assemblies for Connecting Rod Applications – Nominal Dimensions





Radial Needle Roller and Cage Assemblies

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K SE Series	B-1-51
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RADIAL NEEDLE ROLLER AND CAGE ASSEMBLIES

METRIC SERIES

Metric series radial needle roller and cage assemblies are available in a variety of sizes and designs. This catalog includes the most popular, standardized designs.

REFERENCE STANDARDS ARE:

- **ISO 3030** – needle roller bearings – radial needle roller and cage assemblies – boundary dimensions and tolerances.
- **DIN 5405 Part 1** – rolling bearings – needle roller bearings – radial needle roller and cage assemblies.
- **ANSI/ABMA 18.1** – needle roller bearings – radial, metric design.
- **JIS B 1536** – roller bearings – boundary dimensions and tolerances of needle roller bearings.

Before selecting specific metric series radial needle roller and cage assemblies, the engineering section should be reviewed.

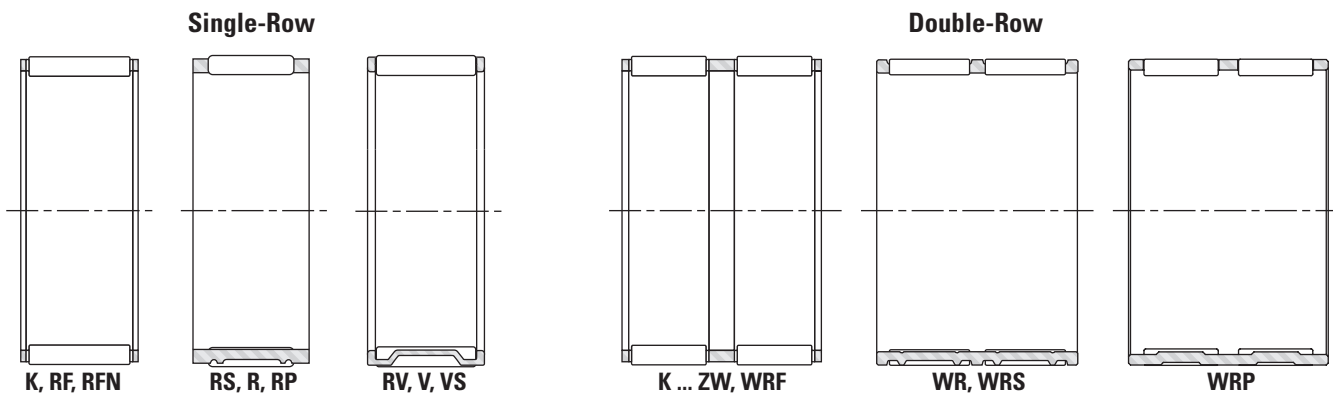


Fig. B1-1. Types of Metric Series Radial Needle Roller and Cage Assemblies

CONSTRUCTION

Radial needle roller and cage assemblies have a steel cage that provides both inward and outward retention for the needle rollers. The designs provide maximum cage strength consistent with the inherent high load-ratings of needle roller bearings. Accurate guidance of the needle rollers by the cage bars allows for operation at high speeds. Needle roller and cage assemblies have either one or two rows of needle rollers.

Also listed are metric series needle roller and cage assemblies using molded, one-piece glass-reinforced engineered polymer cages. These operate well at temperatures up to 120° C (250° F) over extended periods. However, care should be exercised when these assemblies are lubricated with oils containing additives as service life may be reduced if the operating temperature exceeds 100° C (212° F). At such high temperatures oil can deteriorate with time and it is suggested that oil change intervals are observed.

Needle rollers with relieved ends used in these assemblies are made of high-carbon chrome steel, through-hardened, ground and lapped to close tolerances for diameter and roundness. See the engineering section for further discussion of relieved end rollers.

DIMENSIONAL ACCURACY

NEEDLE ROLLER GROUPS (GAGES)

Applicable: K, K.. ZW series

Metric series radial needle roller and cage assemblies are supplied with needle roller complements subdivided into groups (gages) shown in Table B1-1. This is in accordance with Grade G2 specified in ISO 3096 standard (see needle rollers, page B8-13). The group limits of the needle rollers are indicated on the package. Labels of identifying colors show the group limits of the needle rollers. The needle roller and cage assemblies of one shipment usually contain needle rollers with group limits of between 0.000 to -0.002 mm (0.0000 to -0.00008 in) and -0.005 to -0.007 mm (-0.0002 to -0.0003 in) [colors red, blue and white]. For additional information on needle roller and cage assemblies with needle rollers of different group limits contact your representative.

Applicable: RF, RFN, RS, R, RP, RV, V, VS, WRF, WR, WRS, WRP series
The purchased group is 0.000 to -0.006 mm.

AXIAL GUIDANCE REQUIREMENTS

Radial needle roller and cage assembly must be axially guided by shoulders or other suitable means. The end guiding surfaces should be hardened to minimize wear and must provide sufficient axial clearance to prevent end-locking of the assembly. Length tolerance H11 is suggested.

If end guidance is provided by a housing shoulder at one end and by a shaft shoulder at the other end, the shaft must be axially positioned to prevent end-locking of needle roller and cage assembly. The housing and shaft shoulder heights should be 70 percent to 90 percent of the needle roller diameter to provide proper axial guidance.

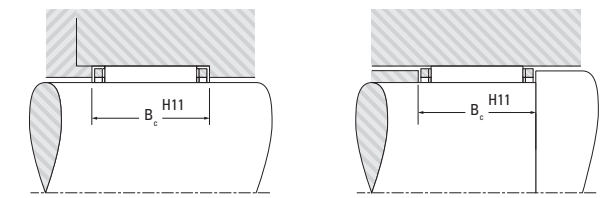


Fig. B1-2. Axial guidance requirements

Table B1-1. Needle roller group limits (Grade G2)

Group tolerance		Marking gage	Identifying color on label or on package
mm in	mm in		
0.000 0.0000	-0.002 -0.00008	P0M2	Red
-0.001 -0.00004	-0.003 -0.00012	M1M3	Red
-0.002 -0.00008	-0.004 -0.0002	M2M4	Blue
-0.003 -0.00012	-0.005 -0.0002	M3M5	Blue
-0.004 -0.0002	-0.006 -0.0002	M4M6	White (gray)
-0.005 -0.0002	-0.007 -0.0003	M5M7	White (gray)
-0.006 -0.0002	-0.008 -0.0003	M6M8	Green
-0.007 -0.0003	-0.009 -0.0004	M7M9	Green
-0.008 -0.0003	-0.010 -0.0004	M8M10	Yellow
-0.009 -0.0004	-0.011 -0.0004	M9M11	Yellow

In the marking of the gages, P identifies zero (0) or plus (+), M identifies minus (-).

MOUNTING DIMENSIONS

DESIGN OF RACEWAYS

Radial needle roller and cage assemblies use the housing bore as the outer raceway and the shaft as the inner raceway. To realize full bearing load rating and life, the housing bore and the shaft raceways must have the correct geometric and metallurgical characteristics. The housing should be of sufficient cross section to maintain adequate roundness and running clearance under load. Additional design details for housings and shafts used as outer and inner raceways can be found in the engineering section. The only limit to precision of the radial clearance of a mounted assembly is the capability of the user to hold close tolerances on the inner and outer raceways. The suggested shaft tolerances listed in Table B1-2 are based on housing bore tolerance G6 and apply to metric series needle roller bearing and cage assemblies.

Table B1-2. Suggested shaft tolerances for housing bores machined to G6

Condition	Tolerance zone class		Housing hole
	Axis		
Radial clearance	Fw ≤ 50 mm	Fw > 50 mm	G6
Smaller than normal	j5	h5	
Normal	h5	g5	
Larger than normal	g6	f6	

MOUNTING IN SETS

Radial needle roller and cage assemblies that are mounted side by side must have needle rollers of the same group limits to ensure uniform load distribution.

LUBRICATION

Oil is the preferred lubricant for most applications. In critical applications involving high speeds, ample oil flow must be provided. Where assemblies are subjected to high centrifugal forces – such as in epicyclic gearing, or inertia forces, as in the small end of a connecting rod – the contact pressure between the cage and the raceway guiding surface becomes critical. The allowable contact pressure depends on a combination of the induced force and the relative velocity between the cage and raceway and the rate of lubricant flow. Consult your representative when cages will be subjected to high induced forces.

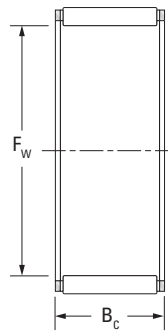
SPECIAL DESIGNS

Radial needle roller and cage assemblies made to special dimensions or configurations – such as those which are split to assemble around a one-piece crankshaft – can be made available on special order. Special coated or plated cages to enhance life, under conditions of marginal lubrication and high induced forces, also can be made available.

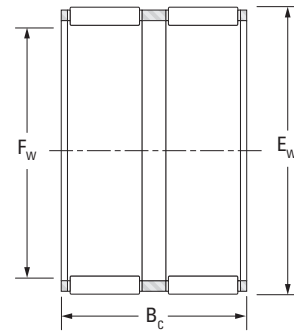


SINGLE-ROW, DOUBLE-ROW ASSEMBLIES

METRIC SERIES K, K ZW SERIES



K



K ZW

Table with columns for Shaft Dia., Fw, Ew, Bc, Assembly Designation, Load Ratings (Dynamic, Static), Speed Rating (Grease, Oil), Approx. Wt., and Mounting Dimension (S, H). Rows include bearings like K3X5X7TN, K4X7X7TN, K5X8X8TN, etc.

(1) Cage material: P: polymer cage, S: steel cage

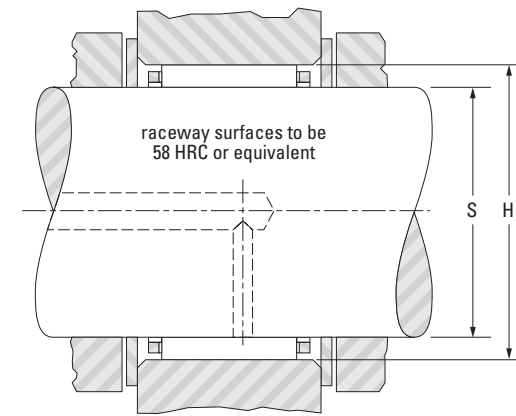


Table with columns for Shaft Dia., Fw, Ew, Bc, Assembly Designation, Load Ratings (Dynamic, Static), Speed Rating (Grease, Oil), Approx. Wt., and Mounting Dimension (S, H). Rows include bearings like K8X11X13H, K9X12X10FH, K9X12X10FV, etc.

Continued on next page.



SINGLE-ROW, DOUBLE-ROW ASSEMBLIES

METRIC SERIES K, K ZW SERIES

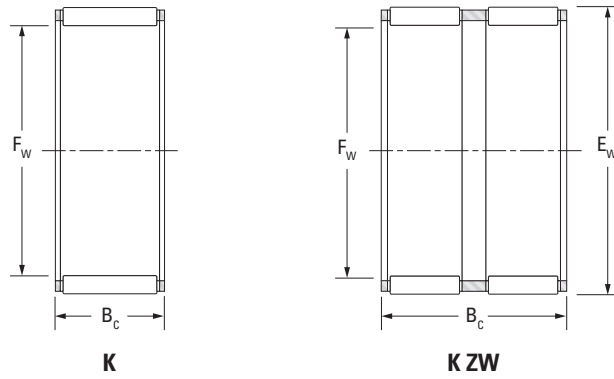


Table with columns: Shaft Dia., Fw, Ew, Bc, Assembly Designation, Load Ratings (Dynamic, Static), Cage material, Speed Rating (Grease, Oil), Approx. Wt., Mounting Dimension (S, H). Rows include various bearing models like K12X17X13, K12X18X12H, etc.

(1) Cage material: P: polymer cage, S: steel cage

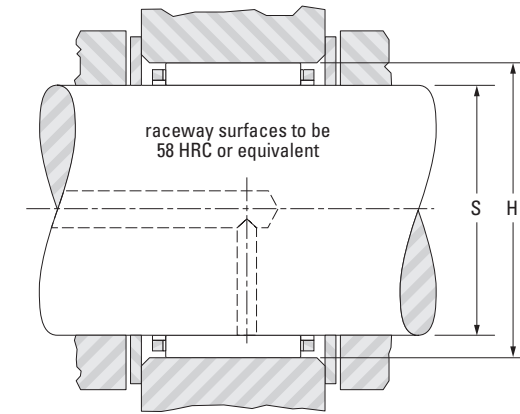


Table with columns: Shaft Dia., Fw, Ew, Bc, Assembly Designation, Load Ratings (Dynamic, Static), Cage material, Speed Rating (Grease, Oil), Approx. Wt., Mounting Dimension (S, H). Rows include various bearing models like K15X19X17H, K15X19X22ZW, etc.

Continued on next page.



SINGLE-ROW, DOUBLE-ROW ASSEMBLIES

METRIC SERIES K, K ZW SERIES

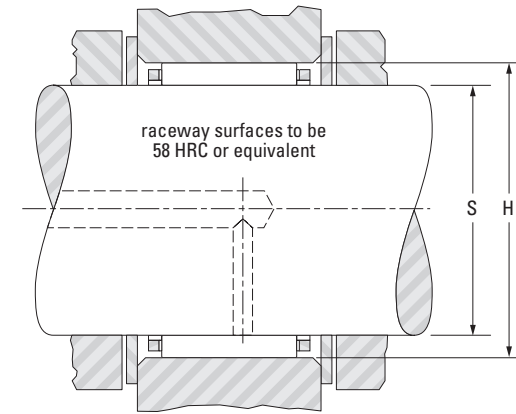
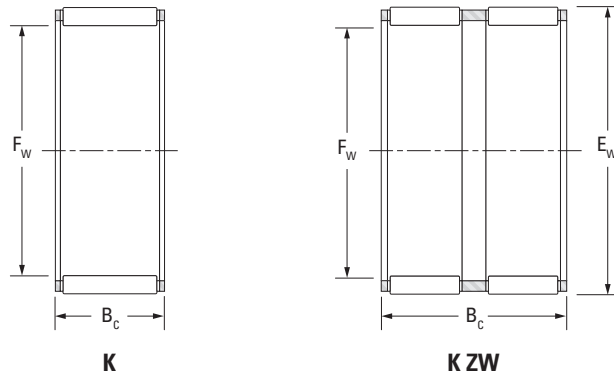


Table with 13 columns: Shaft Dia., Fw, Ew, Bc, Assembly Designation, Load Ratings (Dynamic, Static), Cage material, Speed Rating (Grease, Oil), Approx. Wt., Mounting Dimension (S, H).

(1) Cage material: P: polymer cage, S: steel cage

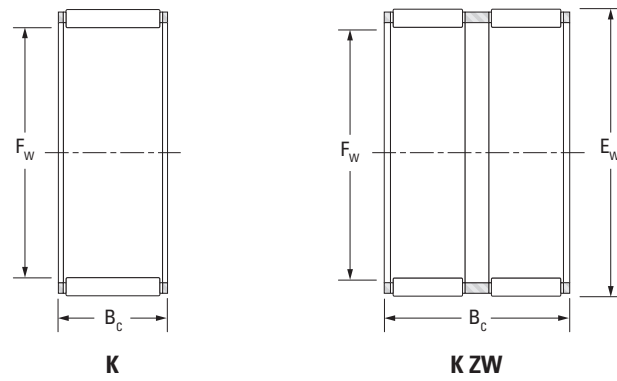
Table with 13 columns: Shaft Dia., Fw, Ew, Bc, Assembly Designation, Load Ratings (Dynamic, Static), Cage material, Speed Rating (Grease, Oil), Approx. Wt., Mounting Dimension (S, H).

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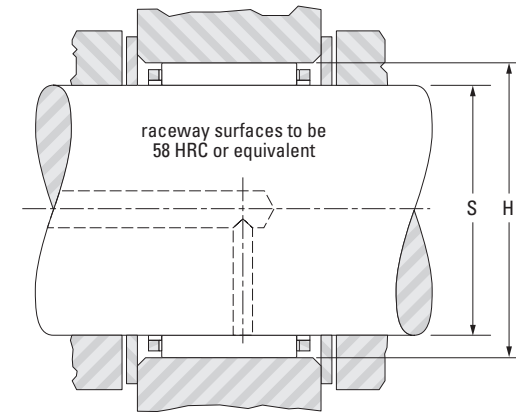
SINGLE-ROW,
DOUBLE-ROW
ASSEMBLIES

METRIC SERIES
K, K ZW SERIES



Shaft Dia.	F_w	E_w	B_c	Assembly Designation	Load Ratings		Cage material ⁽¹⁾ P/S	Speed Rating		Approx. Wt.	Mounting Dimension			
					Dynamic	Static		Grease	Oil		S		H	
											C	C_0	Max.	Min.
mm in	mm in	mm in	mm in		kN lbf			min ⁻¹	kg lbs	mm in	mm in	mm in	mm in	
							S							

(1) Cage material: P: polymer cage, S: steel cage



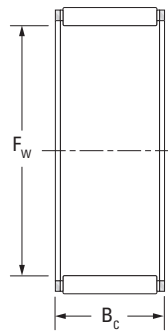
Shaft Dia.	F_w	E_w	B_c	Assembly Designation	Load Ratings		Cage material ⁽¹⁾ P/S	Speed Rating		Approx. Wt.	Mounting Dimension			
					Dynamic	Static		Grease	Oil		S		H	
											C	C_0	Max.	Min.
mm in	mm in	mm in	mm in		kN lbf			min ⁻¹	kg lbs	mm in	mm in	mm in	mm in	
							S							

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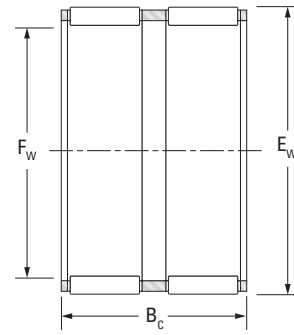


SINGLE-ROW,
DOUBLE-ROW
ASSEMBLIES

METRIC SERIES
K, K ZW SERIES



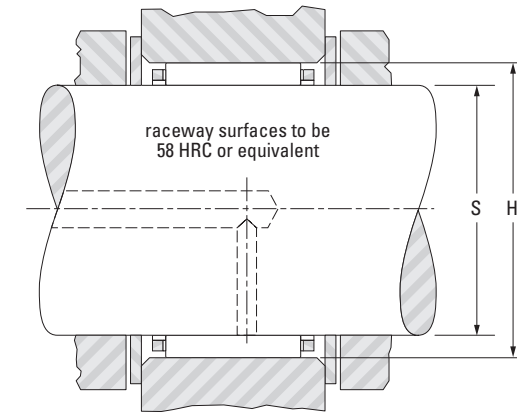
K



K ZW

Shaft Dia.	F _w	E _w	B _c	Assembly Designation	Load Ratings		Cage material ⁽¹⁾ P/S	Speed Rating		Approx. Wt.	Mounting Dimension			
					Dynamic	Static		Grease	Oil		S		H	
					C	C ₀					Max.	Min.	Max.	Min.
mm in	mm in	mm in	mm in		kN lbf			min ⁻¹	kg lbs	mm in	mm in	mm in	mm in	
75 2.9528	75 2.9528	83 3.2677	30 1.181	K75X83X30FH	60.9 13700	138 31000	S	3600	5600	0.141 0.311	75.000 2.9528	74.987 2.9522	83.034 3.2691	83.012 3.2682
80 3.1496	80 3.1496	86 3.3858	20 0.787	K80X86X20H	38.6 8680	96.7 21700	S	3400	5200	0.072 0.159	80.000 3.1496	79.987 3.1491	86.034 3.3872	86.012 3.3863
	80 3.1496	88 3.4646	25 0.984	K80X88X25FV1	54.0 12100	121 27200	S	3400	5200	0.134 0.295	80.000 3.1496	79.987 3.1491	88.034 3.4659	88.012 3.4650
	80 3.1496	88 3.4646	30 1.181	K80X88X30	67.5 15200	161 36200	S	3400	5200	0.153 0.337	80.000 3.1496	79.987 3.1491	88.034 3.4659	88.012 3.4650
85 3.3465	85 3.3465	92 3.622	20 0.787	K85X92X20H	39.9 8970	91.7 20600	S	3200	4900	0.085 0.187	84.988 3.3460	84.973 3.3454	92.034 3.6234	92.012 3.6225
	85 3.3465	93 3.6614	25 0.984	K85X93X25F	58.8 13219	138 31024	S	3200	4900	0.000 0.000	84.988 3.3460	84.973 3.3454	93.034 3.6628	93.012 3.6619
	85 3.3465	93 3.6614	30 1.181	K85X93X30H	31024 15600	3200 38200	S	4900	4900	0.166 0.366	84.988 3.3460	84.973 3.3454	93.034 3.6628	93.012 3.6619
90 3.5433	90 3.5433	97 3.8189	20 0.787	K90X97X20	46.3 10400	114 25600	S	3000	4600	0.095 0.209	89.988 3.5428	89.973 3.5422	97.034 3.8202	97.012 3.8194
	90 3.5433	98 3.8583	25 0.984	K90X98X25F	54.8 12300	128 28800	S	3000	4600	0.134 0.295	89.988 3.5428	89.973 3.5422	98.034 3.8596	98.012 3.8587
	90 3.5433	98 3.8583	30 1.181	K90X98X30	63.6 14300	155 34800	S	3000	4600	0.168 0.370	89.988 3.5428	89.973 3.5422	98.034 3.8596	98.012 3.8587
95 3.7402	95 3.7402	103 4.0551	20 0.787	K95X103X20	49.3 11100	114 25600	S	2800	4400	0.130 0.287	94.988 3.7397	94.973 3.7391	103.034 4.0565	103.012 4.0556
	95 3.7402	103 4.0551	30 1.181	K95X103X30F	71.0 16000	183 41100	S	2800	4400	0.180 0.39	94.988 3.7397	94.973 3.7391	103.034 4.0565	103.012 4.0556
100 3.9370	100 3.937	108 4.252	30 1.181	K100X108X30	72.4 16300	191 42900	S	2700	4200	0.210 0.463	99.988 3.9365	99.973 3.9359	108.034 4.2533	108.012 4.2524
110 4.3307	110 4.3307	118 4.6457	24 0.945	K110X118X24	64.0 14400	168 37800	S	2400	3800	0.165 0.364	109.988 4.3302	109.973 4.3296	118.034 4.6470	118.012 4.6461
	110 4.3307	118 4.6457	30 1.181	K110X118X30H	75.3 16900	207 46500	S	2400	3800	0.200 0.441	109.988 4.3302	109.973 4.3296	118.034 4.6470	118.012 4.6461

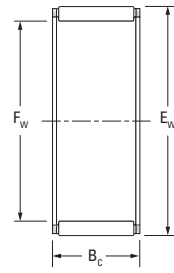
(1) Cage material: P: polymer cage, S: steel cage



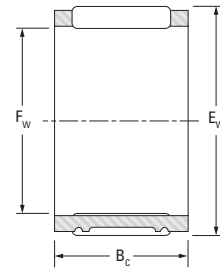


SINGLE-ROW,
DOUBLE-ROW
ASSEMBLIES

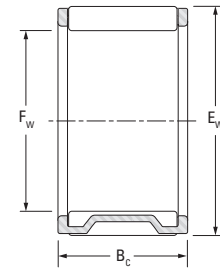
METRIC SERIES
R, RF, RFN, RP, RS, RV,
V, VS, WR, WRF, WRP,
WRS SERIES



RF, RFN



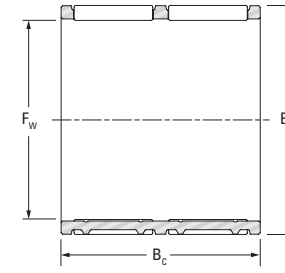
RS, R, RP



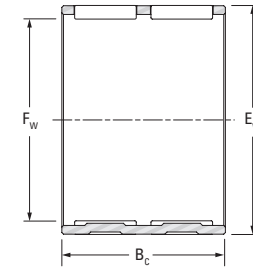
RV, V, VS

Shaft Dia.	F _w	E _w	B _c	Assembly Designation	Load Ratings		Cage material ⁽¹⁾ P/S	Speed Rating		Approx. Wt.	Mounting Dimension			
					Dynamic	Static		Grease	Oil		S		H	
					C	C ₀					Max.	Min.	Max.	Min.
12 0.4724	12	16	20	12R1620A	9.8	11.9	S	20000	30000	0.010	12.000	11.992	16.017	16.006
	12	17	11.5	RV121712A-2	8.25	8.4	S	16000	25000	0.007	12.000	11.992	17.017	17.006
13 0.5118	13	17	10	RS131710-2	5.85	6.35	S	23000	29000	0.006	13.000	12.992	17.017	17.006
	13	17	12	RS131712	7.25	8.35	S	23000	29000	0.007	13.000	12.992	17.017	17.006
15 0.5906	15	19	10	R15/10-1	6.75	7.9	S	18000	28000	0.006	15.000	14.992	19.02	19.007
	15	19	20	R15/20	13	18.4	S	18000	28000	0.012	15.000	14.992	19.02	19.007
	15	21	9	RV152109-4	7.65	7.15	S	14000	21000	0.008	15.000	14.992	21.02	21.007
17 0.6693	17	21	13	R17/13	9.4	12.6	S	17000	26000	0.009	17.000	16.992	21.02	21.007
	17	23	13	RS17/13	11.4	12.4	S	18000	27000	0.014	17.000	16.992	23.02	23.007
18 0.7087	18	22	16	R18/16-8	11.6	16.8	S	16000	24000	0.011	18.000	17.992	22.02	22.007
	18	22	17	R18/17	12.4	18.2	S	16000	24000	0.012	18.000	17.992	22.02	22.007
	18	24	17	RS182417	15.1	17.9	S	16000	25000	0.019	18.000	17.992	24.02	24.007
	18	26	21.9	RF182622A-1	19.1	20.3	P	17000	26000	0.019	18.000	17.992	26.02	26.007
	18	26	21.9	RV182622A-2	22.7	25.5	S	17000	26000	0.031	18.000	17.992	26.02	26.007
	18	27	11	RF182711-1	15.5	14.6	P	18000	27000	0.014	18.000	17.992	27.02	27.007
20 0.7874	20	24	10	R20/10	7.75	10.3	S	14000	22000	0.008	20.000	19.991	24.02	24.007
	20	25	25	RF202525	19.1	28.2	P	14000	22000	0.014	20.000	19.991	25.02	25.007

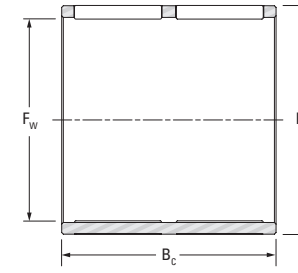
(1) Cage material: P: polymer cage, S: steel cage



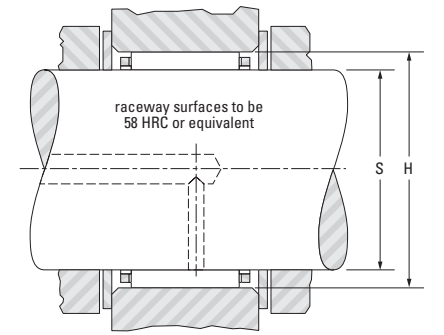
WR, WRS



WRP



WRF



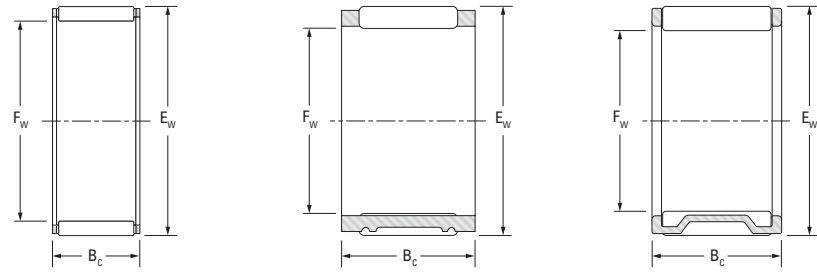
Shaft Dia.	F _w	E _w	B _c	Assembly Designation	Load Ratings		Cage material ⁽¹⁾ P/S	Speed Rating		Approx. Wt.	Mounting Dimension			
					Dynamic	Static		Grease	Oil		S		H	
					C	C ₀					Max.	Min.	Max.	Min.
20 0.7874	20	25	26	20WR2526	17.1	24.4	S	14000	22000	0.027	20.000	19.991	25.02	25.007
	20	26	11.6	20VS2612	10.8	11.9	S	15000	23000	0.012	20.000	19.991	26.02	26.007
	20	26	12	RV202612-4	13.1	15.4	S	15000	23000	0.014	20.000	19.992	26.02	26.007
	20	27	15	20V2715	17.4	20.1	S	15000	23000	0.019	20.000	19.991	27.02	27.007
	20	28	20	RP202820	24.3	28.5	S	15000	23000	0.028	20.000	19.992	28.02	28.007
22 0.8661	22	26	17	R22/17	13.5	21.7	S	13000	20000	0.014	22.000	21.991	26.02	26.007
	22	28	17	RS22/17	17.1	22.3	S	13000	20000	0.022	22.000	21.991	28.02	28.007
	22	28	23	VS22/23B	25.2	36.8	S	13000	20000	0.025	22.000	21.991	28.02	28.007
	22	30	20	RV223020-1	24.2	29	S	14000	21000	0.031	22.000	21.991	30.02	30.007
	22	32	11	RF223211-1	19.5	19.3	P	14000	22000	0.019	22.000	21.991	32.025	32.009
	22	32	15	RV223215	21.8	22.1	S	14000	22000	0.032	22.000	21.991	32.025	32.009
	22	32	16	RV223216	21.8	22.1	S	14000	22000	0.035	22.000	21.991	32.025	32.009
23 0.9055	23	33	20	23V3320-1	27.6	30.2	S	13000	20000	0.044	23.000	22.991	33.025	33.009
24 0.9449	24	28	13	RS242813-1	11.2	17.6	S	12000	18000	0.012	24.000	23.991	28.02	28.007
	24	28	17	R24/17A	14.2	23.9	S	12000	18000	0.016	24.000	23.991	28.02	28.007
	24	28	34	WR24/34	22	41.6	S	12000	18000	0.031	24.000	23.991	28.02	28.007
	24	32	15	RV243215-4	20.2	23.4	S	12000	19000	0.027	24.000	23.991	32.025	32.009

Continued on next page.



SINGLE-ROW,
DOUBLE-ROW
ASSEMBLIES

METRIC SERIES
R, RF, RFN, RP, RS, RV,
V, VS, WR, WRF, WRP,
WRS SERIES



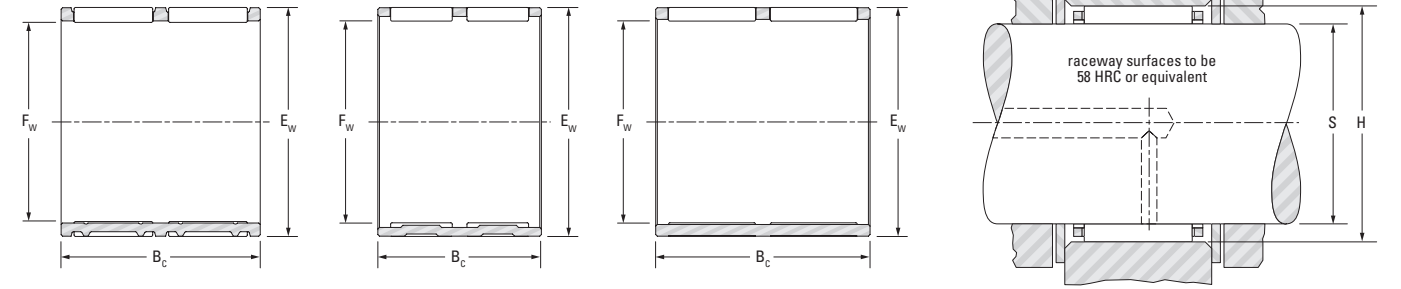
RF, RFN

RS, R, RP

RV, V, VS

Shaft Dia.	F _w	E _w	B _c	Assembly Designation	Load Ratings		Cage material ⁽¹⁾ P/S	Speed Rating		Approx. Wt.	Mounting Dimension			
					Dynamic	Static		Grease	Oil		S		H	
					C	C ₀					Max.	Min.	Max.	Min.
mm in	mm in	mm in	mm in		kN lbf			min ⁻¹	kg lbs	mm in	mm in	mm in	mm in	
24.9 0.9803	24.9	29.9	26.8	RFU253027A	20.3	32.3	P	12000	18000	0.017	24.900	24.891	29.92	29.907
25 0.9843	25	29	9.9	R25/10A	7.25	10.1	S	11000	17000	0.010	25.000	24.991	29.02	29.007
	25	29	16.8	RF252917	14	23.7	P	11000	17000	0.009	25.000	24.991	29.02	29.007
	25	29	22	WR25/22	17	30.5	S	11000	17000	0.022	25.000	24.991	29.02	29.007
	25	30	12	25R3012	11.4	15.6	S	11000	17000	0.015	25.000	24.991	30.02	30.007
	25	30	20	RFU253020	17.7	27.4	P	11000	17000	0.014	25.000	24.991	30.02	30.007
	25	30	26	25WR3026	22.4	37.2	S	11000	17000	0.032	25.000	24.991	30.02	30.007
	25	31	24	25R3124	26	39.7	S	12000	18000	0.035	25.000	24.991	31.025	31.009
	25	32	16	25V3216	19.5	24.7	S	12000	18000	0.025	25.000	24.991	32.025	32.009
	25	32	32	RV253232	40	62.5	S	12000	18000	0.049	25.000	24.991	32.025	32.009
	25	33	23.8	25R3324B-1	31.9	42.8	S	12000	18000	0.048	25.000	24.991	33.025	33.009
	25	33	30	RF253330	38.7	54.8	P	12000	18000	0.041	25.000	24.991	33.025	33.009
	25	34	32	RV253432	46.1	63.9	S	12000	18000	0.066	25.000	24.991	34.025	34.009
	25	35	25	25R3525	34.7	41.4	S	12000	19000	0.065	25.000	24.991	35.025	35.009
	25	37	24	25V3724	34.4	36.6	S	12000	19000	0.072	25.000	24.991	37.025	37.009
	25	37	25	25V3725A	38.9	43.1	S	12000	19000	0.077	25.000	24.991	37.025	37.009
	25	37	33	RV253733	48.2	56.7	S	12000	19000	0.100	25.000	24.991	37.025	37.009

(1) Cage material: P: polymer cage, S: steel cage



WR, WRS

WRP

WRF

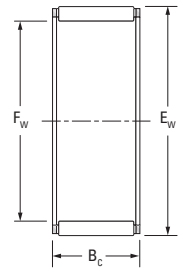
Shaft Dia.	F _w	E _w	B _c	Assembly Designation	Load Ratings		Cage material ⁽¹⁾ P/S	Speed Rating		Approx. Wt.	Mounting Dimension			
					Dynamic	Static		Grease	Oil		S		H	
					C	C ₀					Max.	Min.	Max.	Min.
mm in	mm in	mm in	mm in		kN lbf			min ⁻¹	kg lbs	mm in	mm in	mm in	mm in	
26 1.0236	26	30	16.8	RFU263017	13.9	23.7	P	10000	16000	0.009	26.000	25.991	30.02	30.007
	26	30	20	RS263020	17.1	31.1	S	10000	16000	0.020	26.000	25.991	30.02	30.007
	26	30	22	RS263022A	16.9	30.4	S	10000	16000	0.022	26.000	25.991	30.02	30.007
	26	31	24	26WR3124-2	22.2	37.1	S	11000	17000	0.030	26.000	25.991	31.025	31.009
	26	33	34	RPV263334F	30.7	44.3	S	11000	17000	0.043	26.000	25.991	33.025	33.009
27 1.0630	27	31	23.8	WRS273124A	19.1	36.2	S	10000	16000	0.025	27.000	26.991	31.025	31.009
28 1.1024	28	32	26	28R3226	17.1	31.5	S	10000	15000	0.027	28.000	27.991	32.025	32.009
	28	32	26.8	RF283227	22	43.9	P	10000	15000	0.017	28.000	27.991	32.025	32.009
	28	33	17	28R3317	18.8	30.7	S	10000	15000	0.022	28.000	27.991	33.025	33.009
	28	33	19.8	RF283320	19.5	32.2	P	10000	15000	0.016	28.000	27.991	33.025	33.009
	28	33	27	R28/27	25.8	46.2	S	10000	15000	0.036	28.000	27.991	33.025	33.009
	28	34	19.8	RFU283420	20.2	29.6	P	10000	16000	0.018	28.000	27.991	34.025	34.009
	28	35	37.5	RPV283538A	37	57.9	S	10000	16000	0.048	28.000	27.991	35.025	35.009
	28	38	20	28VU3820	23.7	25.8	S	10000	16000	0.048	28.000	27.991	38.025	38.009
	28	38	24	RS283824	31.7	37.9	S	10000	16000	0.070	28.000	27.991	38.025	38.009
	28	41	25	RV284125	40.9	44.6	S	11000	17000	0.088	28.000	27.991	41.025	41.009
	28	42	50.5	RF284251A	89.5	118	P	11000	17000	0.182	28.000	27.991	42.025	42.009

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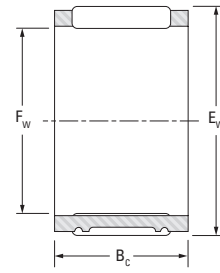


SINGLE-ROW, DOUBLE-ROW ASSEMBLIES

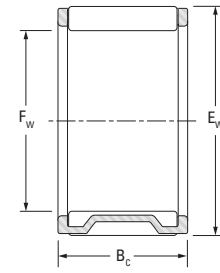
METRIC SERIES R, RF, RFN, RP, RS, RV, V, VS, WR, WRF, WRP, WRS SERIES



RF, RFN



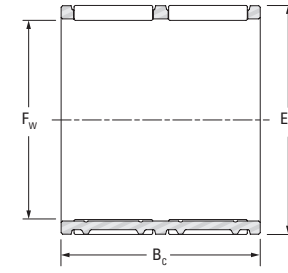
RS, R, RP



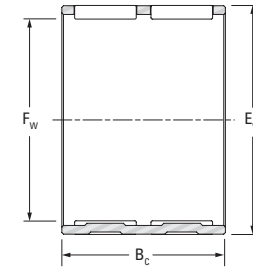
RV, V, VS

Table with columns: Shaft Dia., Fw, Ew, Bc, Assembly Designation, Load Ratings (Dynamic, Static), Cage material, Speed Rating (Grease, Oil), Approx. Wt., Mounting Dimension (S, H).

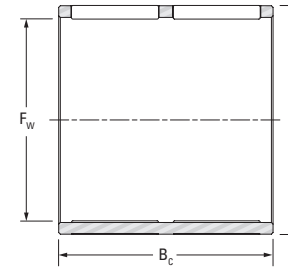
(1) Cage material: P: polymer cage, S: steel cage



WR, WRS



WRP



WRF

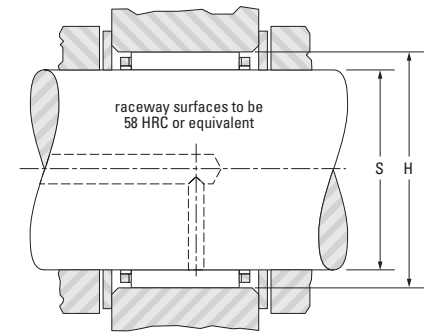


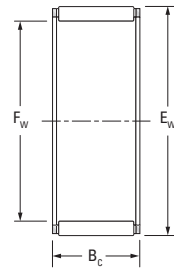
Table with columns: Shaft Dia., Fw, Ew, Bc, Assembly Designation, Load Ratings (Dynamic, Static), Cage material, Speed Rating (Grease, Oil), Approx. Wt., Mounting Dimension (S, H).

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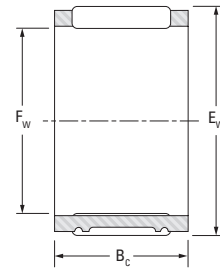


SINGLE-ROW,
DOUBLE-ROW
ASSEMBLIES

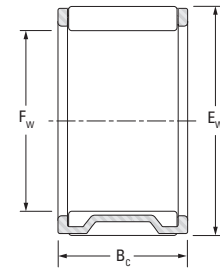
METRIC SERIES
R, RF, RFN, RP, RS, RV,
V, VS, WR, WRF, WRP,
WRS SERIES



RF, RFN



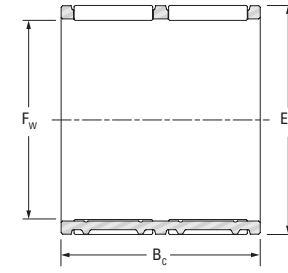
RS, R, RP



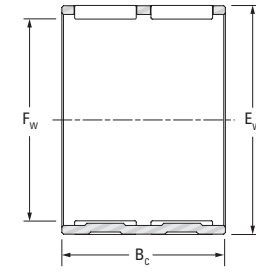
RV, V, VS

Shaft Dia.	F _w	E _w	B _c	Assembly Designation	Load Ratings		Cage material ⁽¹⁾ P/S	Speed Rating		Approx. Wt.	Mounting Dimension			
					Dynamic	Static		Grease	Oil		S		H	
					C	C ₀					Max.	Min.	Max.	Min.
35 1.3780	35	40	31	RP354031	30.8	62.1	S	7800	12000	0.037	35.000	34.989	40.025	40.009
	35	40	33	RP354033-1	31.3	63.8	S	7800	12000	0.040	35.000	34.989	40.025	40.009
	35	40	35	RF354035	31.8	64.9	P	7800	12000	0.032	35.000	34.989	40.025	40.009
	35	42	20	VS35/20	27.5	42.6	S	7800	12000	0.042	35.000	34.989	42.025	42.009
	35	48	17.5	RF354818A-1	42.5	50	P	8500	13000	0.061	35.000	34.989	48.025	48.009
	35	48	17.5	RV354818A-4	38.7	44.1	S	8500	13000	0.081	35.000	34.989	48.025	48.009
36 1.4173	36	41	20	RS364120	22	40.9	S	7800	12000	0.034	36.000	35.989	41.025	41.009
	36	42	17	RS364217-K	20.5	32.8	S	7800	12000	0.035	36.000	35.989	42.025	42.009
	36	43	22.4	RFU364322A	27.4	42.4	P	7800	12000	0.029	36.000	35.989	43.025	43.009
37 1.4567	37	42	22	37R4222	25	48.5	S	7200	11000	0.038	37.000	36.989	42.025	42.009
	37	42	23	RF374223-1	24.1	46.1	P	7200	11000	0.022	37.000	36.989	42.025	42.009
38 1.4961	38	43	17	R38/17-1	18.6	33.6	S	7200	11000	0.032	38.000	37.989	43.025	43.009
	38	44	26	RF384426	28.9	51.7	P	7200	11000	0.031	38.000	37.989	44.025	44.009
	38	44	33	RP384433	38.1	74	S	7200	11000	0.055	38.000	37.989	44.025	44.009
	38	44	39.8	RP384440A	43.9	88.7	S	7200	11000	0.064	38.000	37.989	44.025	44.009
	38	44	40	WRPU384440F	44.1	89.3	S	7200	11000	0.075	38.000	37.989	44.025	44.009
	38	46	26	RS384626	36.8	57.8	S	7800	12000	0.077	38.000	37.989	46.025	46.009

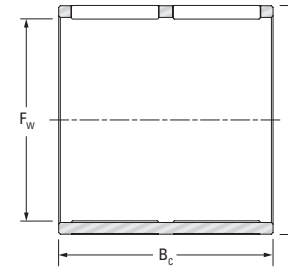
(1) Cage material: P: polymer cage, S: steel cage



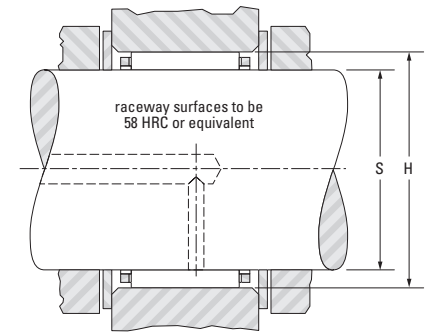
WR, WRS



WRP



WRF



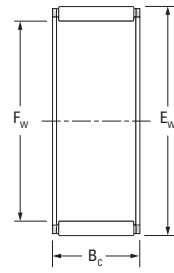
Shaft Dia.	F _w	E _w	B _c	Assembly Designation	Load Ratings		Cage material ⁽¹⁾ P/S	Speed Rating		Approx. Wt.	Mounting Dimension			
					Dynamic	Static		Grease	Oil		S		H	
					C	C ₀					Max.	Min.	Max.	Min.
39 1.5354	39	44	43	WRS394443	41.3	94.3	S	7200	11000	0.075	39.000	38.989	44.025	44.009
	39	44	43.8	39WR4444	42.6	98	S	7200	11000	0.080	39.000	38.989	44.025	44.009
	39	46	32.8	39R4633	43.9	80.2	S	7200	11000	0.086	39.000	38.989	46.025	46.009
	39	46	37.8	RSU394638A	46.2	85.4	S	7200	11000	0.096	39.000	38.989	46.025	46.009
	39	46	44.3	WRP394644A	54.9	107	S	7200	11000	0.102	39.000	38.989	46.025	46.009
	39	55	20.5	RF395521A	56.1	64.2	P	7800	12000	0.098	39.000	38.989	55.029	55.01
40 1.5748	40	45	27	RS404527	30.3	63.6	S	7200	11000	0.049	40.000	39.989	45.025	45.009
	40	45	30	R40/30	30.8	64.9	S	7200	11000	0.055	40.000	39.989	45.025	45.009
	40	45	32	R40/32A	14.7	24	S	7200	11000	0.053	40.000	39.989	45.025	45.009
	40	47	20	RS40/20	29.3	48.2	S	7200	11000	0.054	40.000	39.989	47.025	47.009
	40	48	34	40V4834	52.2	92.2	S	7200	11000	0.087	40.000	39.989	48.025	48.009
	40	55	27.5	RF405528A-1	68.8	87.1	P	7800	12000	0.121	40.000	39.989	55.029	55.01
	40	55	30	RF405530	73.6	94.9	P	7800	12000	0.132	40.000	39.989	55.029	55.01
	40	56	20	RV405620-4	51.9	58.3	S	7800	12000	0.130	40.000	39.989	56.029	56.01
	40	60	31.5	RF406032A	95.2	112	P	7800	12000	0.214	40.000	39.989	60.029	60.01
41.3 1.6260	41.3	47.3	23.6	RFU414724A	27.9	50.8	P	6500	10000	0.030	41.300	41.289	47.325	47.309
42 1.6535	42	47	30.8	RSU424730F	32.3	70.4	S	6500	10000	0.058	42.000	41.989	47.025	47.009

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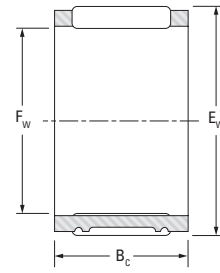


**SINGLE-ROW,
DOUBLE-ROW
ASSEMBLIES**

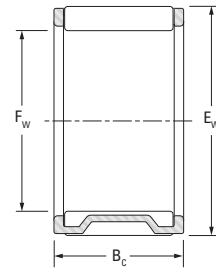
**METRIC SERIES
R, RF, RFN, RP, RS, RV,
V, VS, WR, WRF, WRP,
WRS SERIES**



RF, RFN



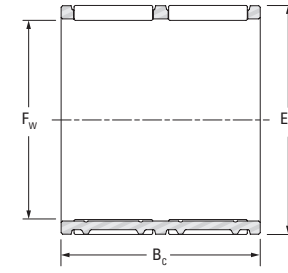
RS, R, RP



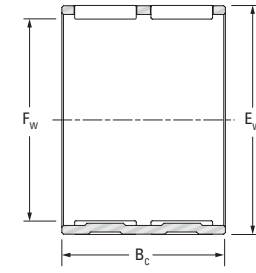
RV, V, VS

Shaft Dia.	F _w	E _w	B _c	Assembly Designation	Load Ratings		Cage material ⁽¹⁾ P/S	Speed Rating		Approx. Wt.	Mounting Dimension			
					Dynamic	Static		Grease	Oil		S		H	
					C	C ₀					Max.	Min.	Max.	Min.
mm in	mm in	mm in	mm in		kN lbf		min⁻¹	kg lbs	mm in	mm in	mm in	mm in		
42 1.6535	42	49	22	RF424922	29.7	49.7	P	6500	10000	0.035	42.000	41.989	49.025	49.009
43.5 1.7126	43.5	50.5	33.8	RF445134A	46.5	89.6	P	6500	10000	0.059	43.500	43.489	50.529	50.51
44 1.7323	44	50	27.5	44RFN5028	37.3	75.4	S	6500	10000	0.041	44.000	43.989	50.025	50.009
	44	50	39	RP445039	46.8	101	S	6500	10000	0.070	44.000	43.989	50.025	50.009
44.5 1.7520	44.5	51.5	36	RP455236A	49.1	96.6	S	6500	10000	0.075	44.500	44.489	51.529	51.51
	44.5	51.5	41.6	RP455242A	54	109	S	6500	10000	0.086	44.500	44.489	51.529	51.51
45 1.7717	45	49	25	RFU454925	25.3	61.5	P	6000	9300	0.023	45.000	44.989	49.025	49.009
	45	50	17	RS455017	23.1	46.8	S	6100	9400	0.035	45.000	44.989	50.025	50.009
	45	50	19	R45/19	25.2	52.4	S	6100	9400	0.039	45.000	44.989	50.025	50.009
	45	50	24	RS455024	30.4	66.6	S	6100	9400	0.050	45.000	44.989	50.025	50.009
	45	50	33	R45/33	38	88.7	S	6100	9400	0.068	45.000	44.989	50.025	50.009
	45	52	22	RS455222	35.4	63.9	S	6200	9500	0.066	45.000	44.989	52.029	52.01
	45	64	23	RV456423-7	65.2	72.1	S	6500	10000	0.191	45.000	44.989	64.029	64.01
46 1.8110	46	53	42.6	RPU465343A	48.3	95	S	6000	9300	0.084	46.000	45.989	53.029	53.01
47 1.8504	47	52	30	R47/30H	37.4	88.1	S	5800	8900	0.062	47.000	46.989	52.029	52.01
	47	53	28.8	RP475329A	35.6	72.7	S	5900	9000	0.054	47.000	46.989	53.029	53.01
	47	53	36	RP475336	47.4	105	S	5900	9000	0.068	47.000	46.989	53.029	53.01

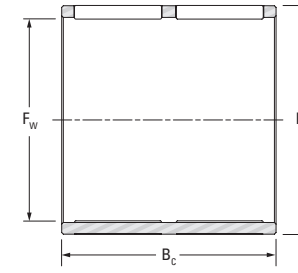
(1) Cage material: P: polymer cage, S: steel cage



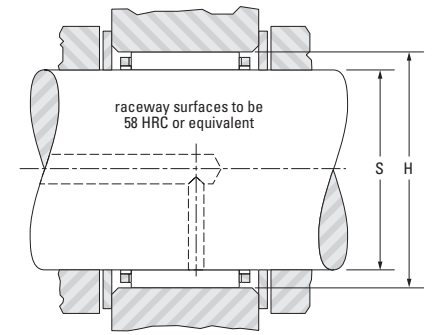
WR, WRS



WRP



WRF



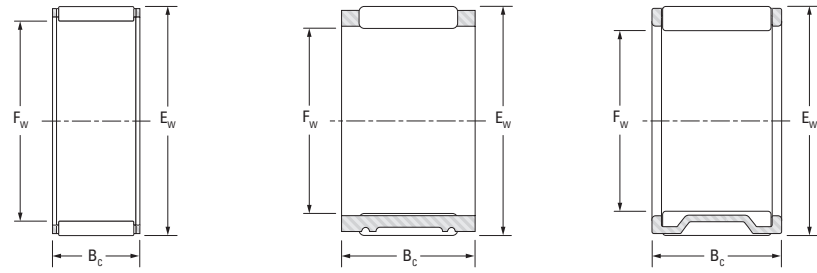
Shaft Dia.	F _w	E _w	B _c	Assembly Designation	Load Ratings		Cage material ⁽¹⁾ P/S	Speed Rating		Approx. Wt.	Mounting Dimension			
					Dynamic	Static		Grease	Oil		S		H	
					C	C ₀					Max.	Min.	Max.	Min.
mm in	mm in	mm in	mm in		kN lbf		min⁻¹	kg lbs	mm in	mm in	mm in	mm in		
47 1.8504	47	54	38.6	WRP475439A	49.1	98.4	S	5900	9100	0.107	47.000	46.989	54.029	54.01
47.9 1.8858	47.9	52.9	25	RF485325A-1	31.2	70.4	P	5700	8800	0.033	47.900	47.889	52.929	52.91
	47.9	52.9	33.8	RF485334A-1	23.7	48.3	P	5700	8800	0.030	47.900	47.889	52.929	52.91
48 1.8898	48	53	28	48R5328	35.2	82.1	S	5700	8700	0.060	48.000	47.989	53.029	53.01
	48	54	20	48R5420-1	30.8	60.9	S	5700	8800	0.054	48.000	47.989	54.029	54.01
	48	54	39	48R5439	48.5	109	S	5700	8800	0.106	48.000	47.989	54.029	54.01
49 1.9291	49	56	44.6	RF495645A	61.2	133	P	5700	8700	0.087	49.000	48.989	56.029	56.01
50 1.9685	50	55	27	R50/27A	11.9	19.6	S	5500	8400	0.056	50.000	49.989	55.029	55.01
	50	56	30	RF505630	41.2	89.6	S	5500	8500	0.050	50.000	49.989	56.029	56.01
	50	56	40	50WR5640	53.7	126	S	5500	8500	0.110	50.000	49.989	56.029	56.01
	50	57	33.5	RP505734A	48.1	97.9	S	5500	8500	0.080	50.000	49.989	57.029	57.01
	50	57	38.9	RS505739A	58.4	126	S	5500	8500	0.142	50.000	49.989	57.029	57.01
	50	58	25	RF505825	38.5	66.9	P	5600	8600	0.054	50.000	49.989	58.029	58.01
	50	70	36	RF507036	115	149	P	6000	9300	0.277	50.000	49.989	70.029	70.01
50.8 2.0000	50.8	64.8	50	RF516550A	124	207	P	5700	8800	0.258	50.800	50.787	64.829	64.81
	50.8	64.8	60	RV516560	138	237	S	5700	8800	0.369	50.800	50.787	64.829	64.81
53 2.0866	53	58	25	RF535825	33.3	79	P	5100	7900	0.035	53.000	52.987	58.029	58.01

Continued on next page.



SINGLE-ROW,
DOUBLE-ROW
ASSEMBLIES

METRIC SERIES
R, RF, RFN, RP, RS, RV,
V, VS, WR, WRF, WRP,
WRS SERIES



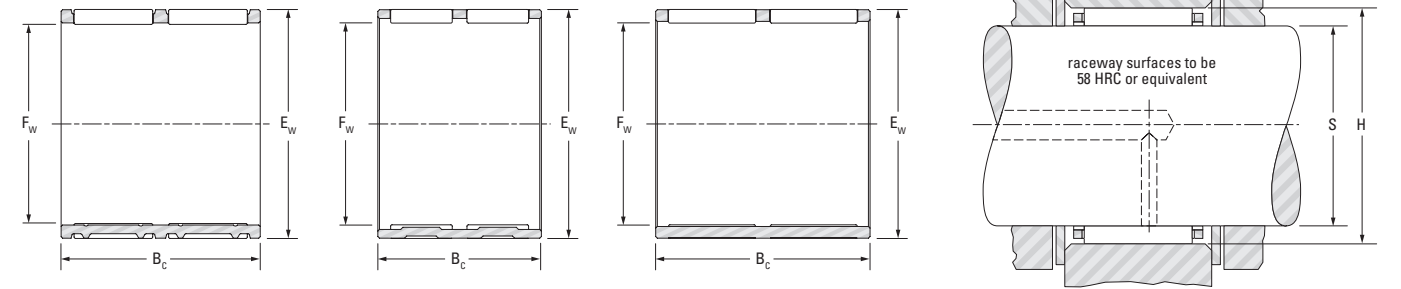
RF, RFN

RS, R, RP

RV, V, VS

Shaft Dia.	F _w	E _w	B _c	Assembly Designation	Load Ratings		Cage material ⁽¹⁾ P/S	Speed Rating		Approx. Wt.	Mounting Dimension			
					Dynamic	Static		Grease	Oil		S		H	
			C		C ₀	Max.	Min.			Max.	Min.			
54 2.1260	54	60	-0.20 -0.008 -0.55 -0.022	RP546036	46	105	S	5100	7800	0.000	54.000	53.987	60.029	60.01
	54	61		RFU546136A	53.2	114	P	5100	7900	0.075	54.000	53.987	61.029	61.01
	54	61		RF546141A	63.5	143	P	5100	7900	0.092	54.000	53.987	61.029	61.01
55 2.1654	55	59		55RFN5913A	11.4	23.3	S	4900	7500	0.011	55.000	54.987	59.029	59.01
55.5 2.185	55.5	61.5		RF525828A	40.9	89.9	P	5300	8100	0.050	55.500	55.487	61.529	61.51
	55.5	61.5		RF525835A	28.2	54.3	P	5300	8100	0.041	55.500	55.487	61.529	61.51
56 2.2047	56	61		R56/34	43.6	114	S	4800	7400	0.084	56.000	55.987	61.029	61.01
	56	63		RPU566347	60	135	S	4900	7600	0.119	56.000	55.987	63.029	63.01
58 2.2835	58	65		58R6526	44.1	92	S	4700	7300	0.099	58.000	57.987	65.029	65.01
	58	65		58RFN6537A	57.6	130	S	4700	7300	0.081	58.000	57.987	65.029	65.01
	58	65		RS586537A-2	56.7	127	S	4700	7300	0.157	58.000	57.987	65.029	65.01
	58	65		WRP586543A	60.1	137	S	4700	7300	0.144	58.000	57.987	65.029	65.01
	58	80		RV588072	233	361	S	5200	8000	0.889	58.000	57.987	80.029	80.01
60 2.3622	60	65		R60/30	41.1	108	S	4500	6900	0.081	60.000	59.987	65.029	65.01
	60	82		RF608230	120	155	P	5000	7700	0.340	60.000	59.987	82.034	82.012
63 2.4803	63	68		R63/30	42.1	113	S	4300	6600	0.083	63.000	62.987	68.029	68.01
	63	75		RV637538-1	121	240	S	4500	6900	0.270	63.000	62.987	75.029	75.01

(1) Cage material: P: polymer cage, S: steel cage



WR, WRS

WRP

WRF

Shaft Dia.	F _w	E _w	B _c	Assembly Designation	Load Ratings		Cage material ⁽¹⁾ P/S	Speed Rating		Approx. Wt.	Mounting Dimension			
					Dynamic	Static		Grease	Oil		S		H	
			C		C ₀	Max.	Min.			Max.	Min.			
65 2.5591	65	70	-0.20 -0.008 -0.55 -0.022	R65/20A	12.3	22.6	S	4200	6400	0.057	65.000	64.987	70.029	70.01
	65	70		R65/24A	12.9	23.9	S	4200	6400	0.067	65.000	64.987	70.029	70.01
68 2.6772	68	73		WRS687332A	45.7	129	S	4000	6100	0.095	68.000	67.987	73.029	73.01
70 2.7559	70	76		70R7620	36.6	86.2	S	3800	5900	0.077	70.000	69.987	76.029	76.01
	70	80		70WR8055	108	242	S	4000	6100	0.351	70.000	69.987	80.029	80.01
71 2.7953	71	79		71V7930B	64	145	S	3800	5900	0.135	71.000	70.987	79.029	79.01
73 2.8740	73	79		R73/20	38.1	92.2	S	3700	5700	0.084	73.000	72.987	79.029	79.01
76.2 3.0000	76.2	85.5		76V8632A	76.3	167	S	3600	5600	0.177	76.200	76.187	85.534	85.512
	76.2	85.5		RV768633A	78.5	173	S	3600	5600	0.187	76.200	76.187	85.534	85.512
	76.2	85.5		RV768644A-2	95.6	222	S	3600	5600	0.235	76.200	76.187	85.534	85.512
	76.2	88		RV768834A	91.1	177	S	3600	5600	0.250	76.200	76.187	88.034	88.012



RADIAL NEEDLE ROLLER AND CAGE ASSEMBLIES FOR CONNECTING ROD APPLICATIONS

METRIC SERIES

Connecting rods have two bearing positions: the crank pin or big end, and the wrist pin or small end.

In the crank pin position there may be severe operating conditions due to centrifugal forces, internal forces, accelerations and high rotational speeds, requiring the use of special radial needle roller and cage assemblies.

Similarly, in the wrist pin position the reciprocating inertia loads and high oscillating speeds dictate the use of special cage designs.

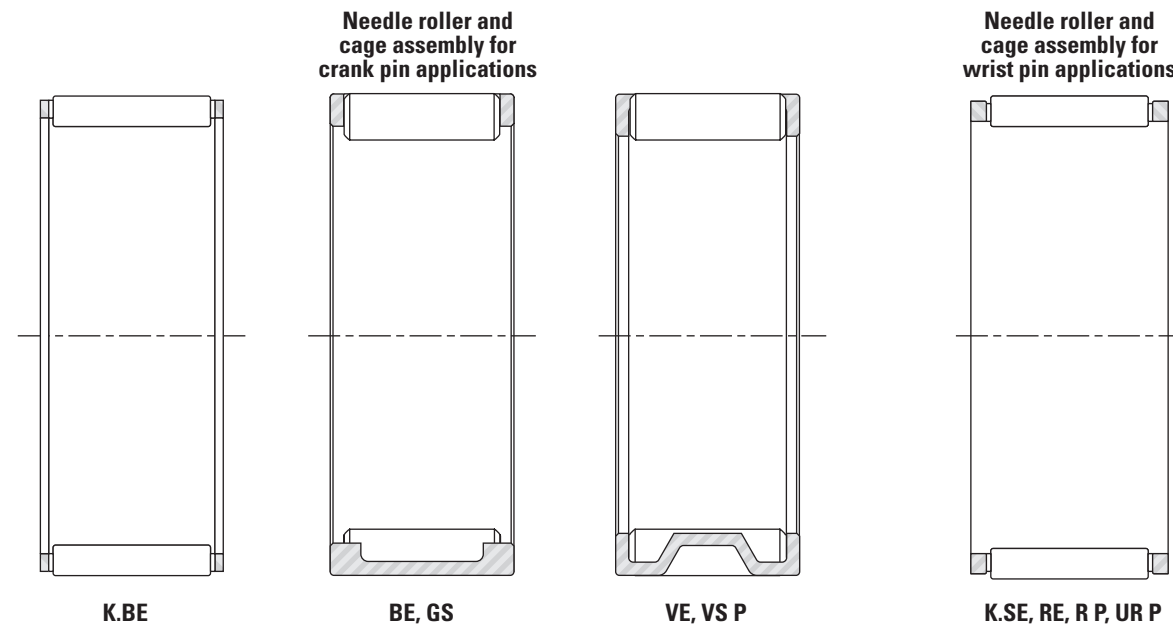


Fig. B1-3. Types of metric series radial needle roller and cage assemblies

CONSTRUCTION

METRIC SERIES RADIAL NEEDLE ROLLER AND CAGE ASSEMBLIES FOR CRANK PIN POSITIONS

Needle roller and cage assemblies for use in crank pin positions have cages with a large outside cylindrical surface to ensure optimum radial guidance in the connecting rod bore. Due to the inherent low weight and strength of the heat-treated cages, the needle roller and cage assemblies are well-suited for high-speed engine applications. When necessary, silver plating and copper plating can be applied for optimum performance during operation at high speeds.

METRIC SERIES RADIAL NEEDLE ROLLER AND CAGE ASSEMBLIES FOR WRIST PIN POSITIONS

Reciprocating inertia loads and oscillating speeds require the cages used in the wrist pin positions to be heat-treated and to guide on the wrist pin.

These cages are available in a variety of widths to allow the selection of a needle roller and cage assembly with the length of needle rollers to match the connecting rod width.

SIZE SELECTION

In most instances, selection of a suitable size of a needle roller and cage assembly for typical connecting rod positions may be based on the cylinder displacement of the engine which in turn, dictates the crank pin and wrist pin diameters.

Suggestions, based on engine displacements, are listed in the following table.

Table B1-3. Crank pin and wrist pin diameters, determined by the cylinder displacement of the engine

		Cylinder displacement in cm ³						
Cylinder	>	40	60	100	150	200	300	
Displacement	≤	40	60	100	150	200	300	
		Diameter						
		mm in	mm in	mm in	mm in	mm in	mm in	mm in
Crank pin		12/14 0.4724/0.5512	15/16/18 0.5906/0.6299/0.7087	18/20 0.7087/0.7874	18/20/22 0.7087/0.7874/0.8661	24/25/28 0.9449/0.9843/1.1024	28/30 1.1024/1.1811	35/40 1.3780/1.5748
Wrist pin		10/11 0.3937/0.4331	12/13 0.4724/0.5118	14/15 0.5512/0.5906	15/16 0.5906/0.6299	18 0.7087	20 0.7874	20 0.7874



CONNECTING ROD GUIDANCE ARRANGEMENTS

End guidance of a connecting rod can be provided either at the crank pin or at the wrist pin end. Connecting-rod guidance is achieved at the crank pin end using a small clearance between the crank counterweights. Guidance at the wrist pin end is controlled by a small clearance between the piston bosses.

CRANK PIN END GUIDANCE

With crank pin end guidance, care must be taken that an adequate amount of lubricant is supplied to the crank pin bearing and the surfaces that guide the connecting rod. For this purpose, grooves in the connecting rod end faces, or slots in the connecting rod bore aligned with the incoming lubrication path, should be provided. Occasionally, bronze or hardened steel washers may be used for end guidance of the connecting rod.

At the wrist pin end, the needle roller and cage assembly is located axially between the piston bosses. It may be both economical and effective to machine the connecting rod at the wrist pin end and at the crank pin end to the same width. It is suggested that, at the wrist

pin end, the needle roller length does not overhang the connecting rod width. Otherwise, the load rating of the needle roller and cage assembly will be reduced.

WRIST PIN END GUIDANCE

Wrist pin end will get the most effective axial guidance between the piston bosses. Grooves in the bottom of the piston bosses and a chamfer of small angle – on each side of the upper portion of the connecting rod small end – can improve the oil flow to the needle roller and cage assembly and its guiding surfaces.

The length of the needle roller and cage assembly and the connecting rod width at the crank pin end should be identical to ensure best possible radial piloting of cage in the bore of the connecting rod. The crank counterweights are recessed to allow proper axial alignment of the connecting rod. As a rule, it is not necessary to have an additional supply of lubricant. Only in engines with sparse lubrication should consideration be given to provide lubricating slots in the connecting rod bores as with crank pin end guidance.

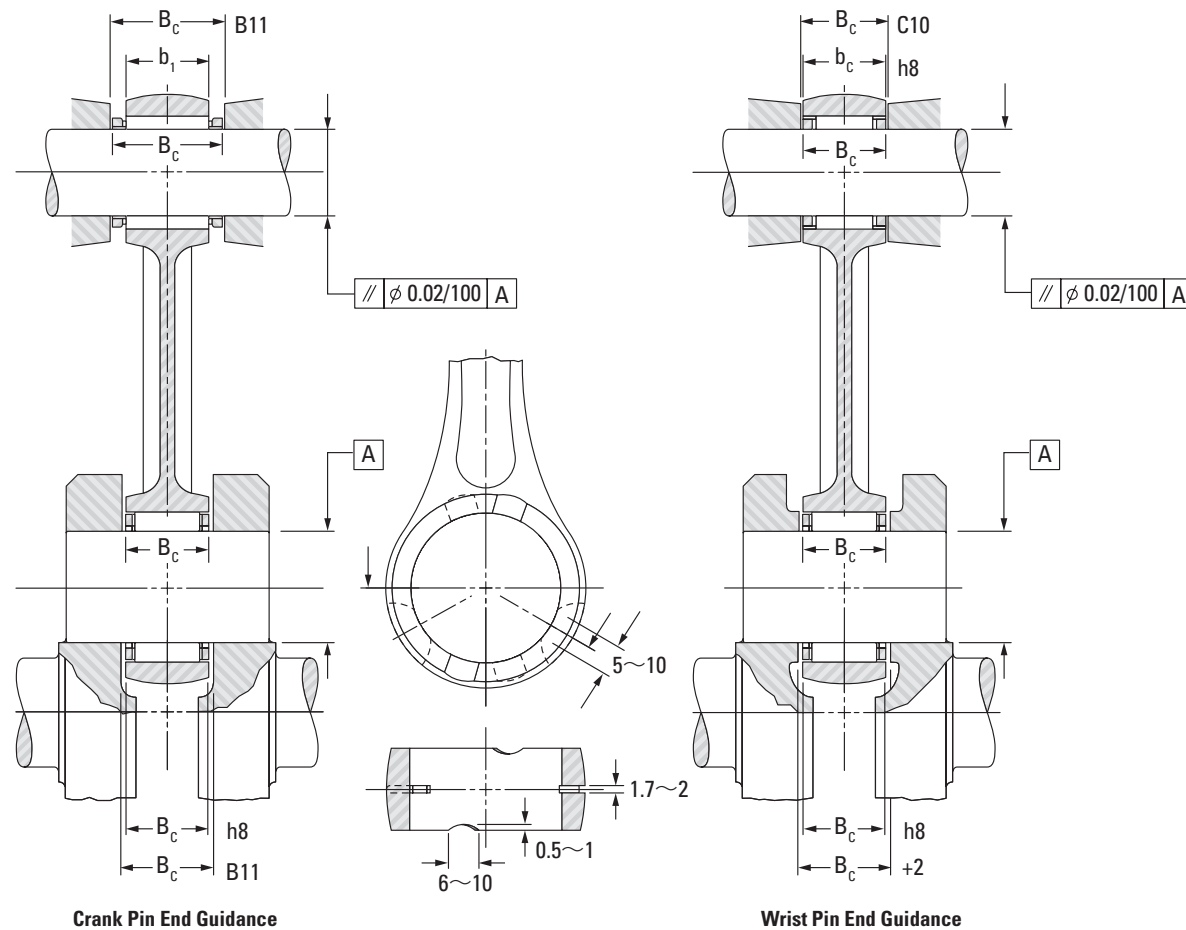


Fig. B1-4. Crank pin and wrist pin end guidance

SUITABLE MATERIALS AND HEAT TREATMENT

Connecting rod crank pin end and wrist pin end bores that serve as raceways:

a case-hardening steel such as SNCM 420, 15 CrNi 6, 17 MnCr 5, or ALSL 8620.

Crank pins:

a case-hardening steel such as SCM 415, 15 Cr 3, AISI 8620, or AISI 1018; a through-hardening steel such as SUJ 2m, 100 Cr 6, or AISI 52100; or a similar substance.

Wrist pins:

a case-hardening steel such as SCr 420, Cr 15, or 15 Cr 3; a through-hardening steel such as SUJ 2, 100 Cr 6, or ALSL 52100; or a similar substance.

See Table B1-4 for the effective case depths of the raceways.

After hardening, the connecting rods must be stress-relieved.

FORM TOLERANCES

The recommended mounting specifications for crank pins, wrist pins, and connecting rods are listed in Table B1-4.

Table B1-4. Form tolerances

Classification		Connecting rod crank pin end and wrist pin end holes	Crank pin and wrist pin outer diameters
Surface roughness (Ra)		0.16 a or less	0.1 a or less
Hardness		60 – 64 HRC	
Hardening layer depth (mm) (depth to 550 HV)		0.6 – 1.2 mm	
Out-of-roundness (μm)	Greater than 9 and less than or equal to 18	1.5	1
	Greater than 18 and less than or equal to 30	2	1.5
	Greater than 30 and less than or equal to 40	2.5	2
Taper (μm)	Greater than 9 and less than or equal to 18	2	1
	Greater than 18 and less than or equal to 30	3	2
	Greater than 30 and less than or equal to 42	4	3
Parallelism		0.02 mm or less per 100 mm	

RADIAL CLEARANCE

METRIC SERIES CRANK PIN BEARINGS

The high speeds of modern production engines dictate the need for crank pin bearings with a relatively large radial clearance. As an approximation, the minimum clearance can be taken as the crank pin diameter/1000. The maximum radial clearance would be a result of the sorting plan shown in Table B1-6(1) on page B1-46.

As shown in the example of the matching scheme, the suggested mounting diameters for the crank pin position are G6 for the connecting rod bore diameters and h5 for the crank pin diameters. Axial location of the cage is shown on the crank pin end guidance arrangement.

Racing and sport engines operate at even higher speeds than production engines, requiring 50 percent larger radial clearances in the crank pin bearings. The larger radial clearances also should be used in bores of split connecting rods to avoid the danger of distortion – resulting from the unavoidable connecting rod deformation occurring in operation. Consult your representative for advice on such applications.

METRIC SERIES WRIST PIN BEARINGS

The radial clearance in wrist pin bearings should be held as small as possible. The minimum clearance should be aimed at 2 μm with the maximum clearance resulting from the proposed sorting plan in Table B1-6(2) on page B1-46. The maximum clearance should be held as close as possible to 12 μm for all wrist pin bearings based on sorting wrist pins made to a tolerance h5, small end bore diameter tolerance of K6 and needle roller grades as shown in Table B1-6(2) on page B1-46.

The recommended radial clearances for prefix BE, GS, VE, VSP, RE, RP, and URP bearings are shown in Table B1-5.

Table B1-5. Recommended radial clearances

Diameter classification		Crank pin end		Wrist pin end	
Over	Or less	Minimum	Maximum	Minimum	Maximum
mm		μm		μm	
–	10	9	25	3	14
10	18	9	25	3	14
18	30	10	25	5	17
30	40	18	33	–	–



METRIC SERIES RADIAL NEEDLE ROLLER AND CAGE ASSEMBLIES FOR CONNECTING ROD APPLICATIONS

MATCHING SCHEME FOR A CRANK PIN BEARING ARRANGEMENT
(three diameter ranges are specified for the connecting rod and crank pin)

Example: Satisfy conditions of Radial clearance 20 µm – 33 µm
 Crank pin diameter 20 mm, tolerance h5
 Connecting rod bore diameter 26 mm, tolerance G6
 Needle roller and cage assembly K20x26x12BE

Table B1-6(1). Radial clearance

		Connecting Rod Crank Pin End Bore Diameter 26 mm Tolerance range					
		+7 – +12		+12 – +16		+16 – +20	
		Needle Roller Tolerance	Radial Clearance	Needle Roller Tolerance	Radial Clearance	Needle Roller Tolerance	Radial Clearance
Crank Pin Diameter 20 mm Tolerance range	-3 – 0	-9 – -7	21 – 33	-6 – -4 -7 – -5	20 – 31 22 – 33	-4 – -2 -5 – -3	20 – 31 22 – 33
	-6 – -3	-7 – -5	20 – 32	-5 – -3	21 – 32	-3 – -1	21 – 32
	-9 – -6	-6 – -4	21 – 33	-3 – -1 -4 – -2	20 – 31 22 – 33	-2 – 0	22 – 33

MATCHING SCHEME FOR A WRIST PIN BEARING ARRANGEMENT
(three diameter ranges are specified for the connecting rod and wrist pin)

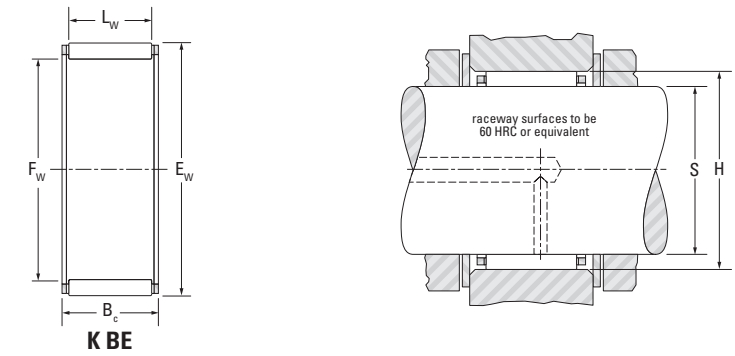
Example: Satisfy conditions of Radial clearance 2 µm – 16 µm
 Wrist pin diameter 16 mm, tolerance h5
 Connecting rod bore diameter 20 mm, tolerance K6
 Needle roller and cage assembly K16x20x20SE

Table B1-6(2). Radial clearance

		Wrist Pin End Bore Diameter 20 mm Tolerance range					
		-11 – -6		-6 – -2		-2 – +2	
		Needle Roller Tolerance	Radial Clearance	Needle Roller Tolerance	Radial Clearance	Needle Roller Tolerance	Radial Clearance
Wrist Pin Diameter 16 mm Tolerance range	-3 – 0			-6 – -4 -7 – -5	2 – 13 4 – 15	-4 – -2 -5 – -3	2 – 13 4 – 15
	-6 – -3	-7 – -5	2 – 14	-5 – -3 -6 – -4	3 – 14 5 – 16	-3 – -1 -4 – -2	3 – 14 5 – 16
	-8 – -6	-6 – -4 -7 – -5	3 – 14 5 – 16	-3 – -1 -4 – -2	2 – 12 4 – 14	-2 – 0	4 – 10

ASSEMBLIES FOR CRANK PIN END APPLICATIONS

METRIC SERIES K BE SERIES



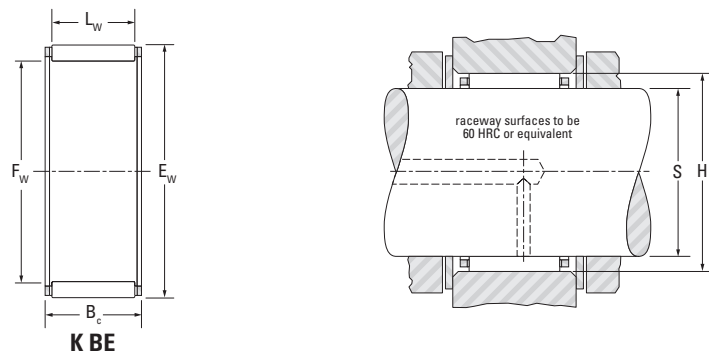
Shaft Dia.	F _w	E _w	B _c		L _w	Assembly Designation	Load Ratings		Approx. Wt.	Mounting Dimensions (non-high performance engines)			
			-0.20 -0.008 -0.55 -0.022	mm in			C	C ₀		S		H	
										mm in	mm in	mm in	mm in
12 0.4724	12 0.4724	16 0.6299	10 0.394	7.8 0.307	K12X16X10BE	6.21 1400	6.70 1510	0.004 0.009	12.000 0.4724	11.992 0.4721	16.017 0.6306	16.006 0.6302	
	12 0.4724	17 0.6693	10 0.394	7.8 0.307	K12X17X10BE	7.32 1650	7.21 1620	0.005 0.011	12.000 0.4724	11.992 0.4721	17.017 0.6700	17.006 0.6695	
14 0.5512	14 0.5512	18 0.7087	10 0.394	7.8 0.307	K14X18X10BE	6.89 1550	7.98 1790	0.005 0.011	14.000 0.5512	13.992 0.5509	18.017 0.7093	18.006 0.7089	
	14 0.5512	20 0.7874	10 0.394	7.8 0.307	K14X20X10BE	8.90 2000	8.61 1940	0.007 0.015	14.000 0.5512	13.992 0.5509	20.020 0.7882	20.007 0.7877	
	14 0.5512	20 0.7874	12 0.472	9.5 0.374	K14X20X12BE	10.50 2360	10.60 2380	0.009 0.020	14.000 0.5512	13.992 0.5509	20.020 0.7882	20.007 0.7877	
16 0.6299	16 0.6299	21 0.8268	10 0.394	7.8 0.307	K16X21X10BE	8.17 1840	8.90 2000	0.007 0.015	16.000 0.6299	15.992 0.6296	21.020 0.8276	21.007 0.8270	
	16 0.6299	22 0.8661	12 0.472	9.5 0.374	K16X22X12BE	11.20 2520	11.90 2680	0.011 0.024	16.000 0.6299	15.992 0.6296	22.020 0.8669	22.007 0.8664	
18 0.7087	18 0.7087	24 0.9449	12 0.472	9.5 0.374	K18X24X12BE	11.80 2650	13.10 2940	0.011 0.024	18.000 0.7087	17.992 0.7083	24.020 0.9457	24.007 0.9452	
	18 0.7087	24 0.9449	13 0.512	10.5 0.413	WK18X24X13BE	12.80 2880	14.60 3280	0.011 0.024	18.000 0.7087	17.992 0.7083	24.020 0.9457	24.007 0.9452	
	18 0.7087	24 0.9449	15 0.591	11.8 0.465	K18X24X15BE	13.30 2990	15.20 3420	0.014 0.031	18.000 0.7087	17.992 0.7083	24.020 0.9457	24.007 0.9452	
19 0.748	19 0.748	25 0.9843	15 0.591	12.5 0.492	K19X25X15BE	14.70 3300	17.60 3960	0.014 0.031	19.000 0.7480	18.991 0.7477	25.020 0.9850	25.007 0.9845	
20 0.7874	20 0.7874	26 1.0236	12 0.472	9.8 0.386	K20X26X12BE	13.30 2990	15.80 3550	0.013 0.029	20.000 0.7874	19.991 0.7870	26.020 1.0244	26.007 1.0239	
	20 0.7874	26 1.0236	17 0.669	13.8 0.543	K20X26X17BE	14.90 3350	18.20 4090	0.017 0.037	20.000 0.7874	19.991 0.7870	26.020 1.0244	26.007 1.0239	
22 0.8661	22 0.8661	28 1.1024	13 0.512	9.8 0.386	K22X28X13BE	13.90 3120	17.10 3840	0.015 0.033	22.000 0.8661	21.991 0.8658	28.020 1.1031	28.007 1.1026	
	22 0.8661	29 1.1417	16 0.63	12.8 0.504	K22X29X16BE	18.50 4160	22.30 5010	0.021 0.046	22.000 0.8661	21.991 0.8658	29.020 1.1425	29.007 1.1420	
24 0.9449	24 0.9449	30 1.1811	13 0.512	9.8 0.386	K24X30X13BE	14.40 3240	18.40 4140	0.016 0.035	24.000 0.9449	23.991 0.9445	30.020 1.1819	30.007 1.1814	
	24 0.9449	30 1.1811	15 0.591	11.8 0.465	K24X30X15BE	15.30 3440	19.70 4430	0.018 0.040	24.000 0.9449	23.991 0.9445	30.020 1.1819	30.007 1.1814	

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ASSEMBLIES FOR CRANK PIN END APPLICATIONS

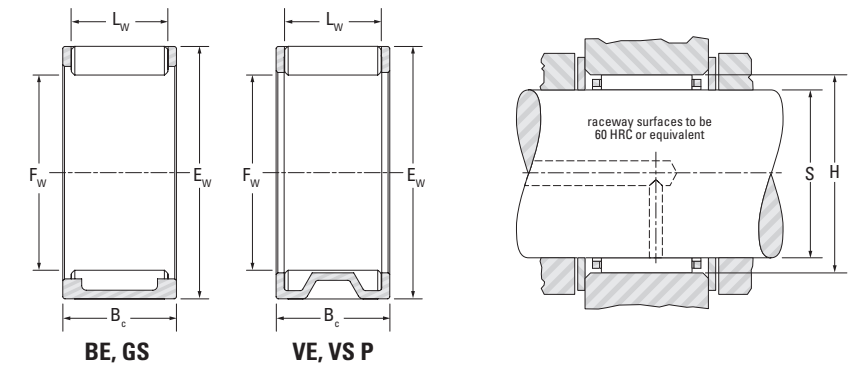
METRIC SERIES
K BE SERIES



Shaft Dia.	F _w	E _w	B _c		L _w	Assembly Designation	Load Ratings		Approx. Wt.	Mounting Dimensions (non-high performance engines)			
			-0.20 -0.008	-0.55 -0.022			Dynamic	Static		S		H	
			C	C ₀						Max.	Min.	Max.	Min.
24 0.9449	24 0.9449	30 1.1811	17 0.669	13.8 0.543	K24X30X17BE	19.00 4270	26.30 5910	0.021 0.040	24.000 0.9449	23.991 0.9445	30.020 1.1819	30.007 1.1814	
25 0.9843	25 0.9843	31 1.2205	19.8 0.78	17.8 0.701	WK25X31X20BE	23.30 5240	34.50 7760	0.024 0.053	25.000 0.9843	24.991 0.9839	31.025 1.2215	31.009 1.2208	
	25 0.9843	32 1.2598	16 0.63	12.8 0.504	K25X32X16BE	19.20 4320	24.30 5460	0.022 0.049	25.000 0.9843	24.991 0.9839	32.025 1.2608	32.009 1.2602	
	25 0.9843	32 1.2598	24 0.945	19.8 0.780	K25X32X24BE	27.50 6180	38.50 8660	0.035 0.077	25.000 0.9843	24.991 0.9839	32.025 1.2608	32.009 1.2602	
30 1.1811	30 1.1811	37 1.4567	16 0.63	12.8 0.504	K30X37X16BE	21.60 4860	29.80 6700	0.029 0.064	30.000 1.1811	29.991 1.1807	37.025 1.4577	37.009 1.4570	
35 1.378	35 1.378	42 1.6535	20 0.787	16.8 0.661	K35X42X20BE	29.70 6680	47.00 10600	0.039 0.086	35.000 1.3780	34.989 1.3775	42.025 1.6545	42.009 1.6539	

ASSEMBLIES FOR CRANK PIN END APPLICATIONS

METRIC SERIES
BE, GS, VE, VS P SERIES



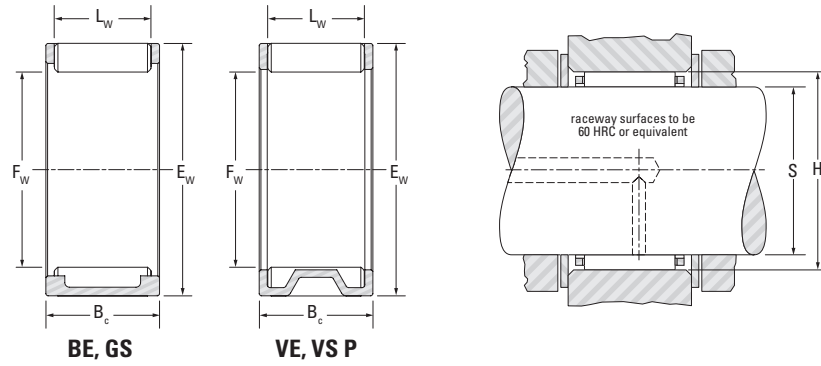
Shaft Dia.	F _w	E _w	B _c		L _w	Assembly Designation	Load Ratings		Approx. Wt.	Mounting Dimensions (non-high performance engines)			
			-0.20 -0.008	-0.55 -0.022			Dynamic	Static		S		H	
			C	C ₀						Max.	Min.	Max.	Min.
12 0.4724	12	16	10	7.4	12VS1610P-1	5.95	6.35	0.004					
16 0.6299	16	22	12	8.8	VE162212AB1-2	9.65	9.8	0.011					
	16	22	13.2	9.8	VE162213ASB1	10.6	11	0.012					
17.6 0.6929	17.6	22.8	14	10.8	17VS2314AP	11.2	12.1	0.013					
20 0.7874	20	26	13.8	10.8	BE202614BSB1	15.2	18.7	0.017					
	20	26	14	10.8	20VS2614CP-2	13.3	15.7	0.015					
	20	26	14	10.8	BE202614SY1B1	13.3	15.7	0.016					
22 0.8661	22	28	14	10.8	22VS2814FP	13.2	15.9	0.016					
	22	28	15.7	12.8	BE222816ASB1	17.9	23.7	0.02					
	22	28	16	11.8	VS22/16KP-1	13.8	16.9	0.018					
	22	29	16	11.8	22VS2916BP	15.7	18	0.021					
	22	29	16.8	12.8	BE222917ASY1B1-2	18.7	22.7	0.027					
23 0.9055	23	28	12	8.8	23VS2812AP	11.6	15.5	0.013					
25 0.9843	25	32	15.8	12.8	BE253216ASY1B1	20.6	26.6	0.026					
26 1.0236	26	32	19.8	15.8	BE263220ASB1	22.9	34.2	0.03					
27 1.0630	27	36	18	13.8	27VS3618P	23.4	27.1	0.042					
	27	36	20.8	16.8	VE273621AB1	29.8	37.1	0.047					

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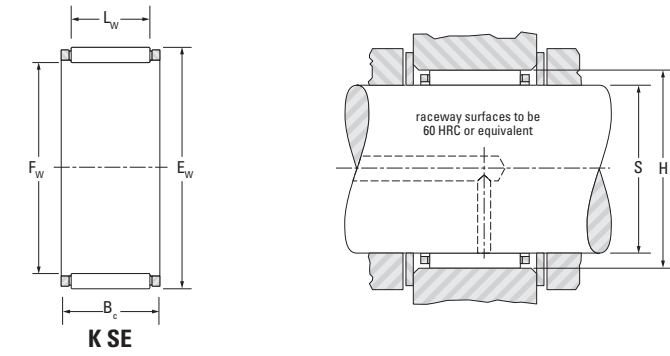
ASSEMBLIES FOR CRANK PIN END APPLICATIONS

METRIC SERIES
BE, GS, VE, VS P SERIES



ASSEMBLIES FOR WRIST PIN END APPLICATIONS

METRIC SERIES
K SE SERIES



Shaft Dia.	F _w	E _w	B _c		L _w	Assembly Designation	Load Ratings		Approx. Wt.	Mounting Dimensions (non-high performance engines)					
			-0.20 -0.008	-0.55 -0.022			Dynamic	Static		S		H			
			C	C ₀						Max.	Min.	Max.	Min.		
30 1.1811	30	37	16	12.8	30VS3716AP-1	20.8	28.3	0.03							
	30	37	20	15.8	30VS3720P	24.6	35.2	0.036							
	30	38	17.8	14.8	VE303818AB1	26.5	35.4	0.038							
32 1.2598	32	40	20	15.8	VE324020SB1	29.9	42.2	0.048							
34 1.3386	34	43	19.8	15.8	BE344320ASB1	34.2	47.2	0.059							
	34	43	22	17.8	GS344322-1	37.7	53.5	0.063							
	34	44	19.8	16.8	BE344420ASY1B1	38.6	51.5	0.064							
35 1.378	35	43	20	15.8	35VS4320BP	32	47.4	0.051							
	35	43	22	17.8	BE354322ASB1	36.6	56.4	0.057							
	35	45	21.8	17.8	BE354522ASYB1	43.5	60.7	0.081							
	35	45	24.8	20.8	BE354525ASYB1	51.8	76.1	0.088							
36 1.4173	36	46	20.8	15.8	VEU364621AB1-6	32.3	41.4	0.067							
	36	46	21	15.8	36VU4621P-2-2	32.3	41.4	0.068							
37 1.4567	37	47	25	20.8	37VS4725P-1	43.9	61.9	0.082							
38 1.4961	38	50	22.8	18.8	BE385023ASY1B3-5	51.4	68.2	0.113							
40.5 1.5945	40.5	50	23.8	17.3	BEU415024ASB1-10	38.9	56.3	0.085							

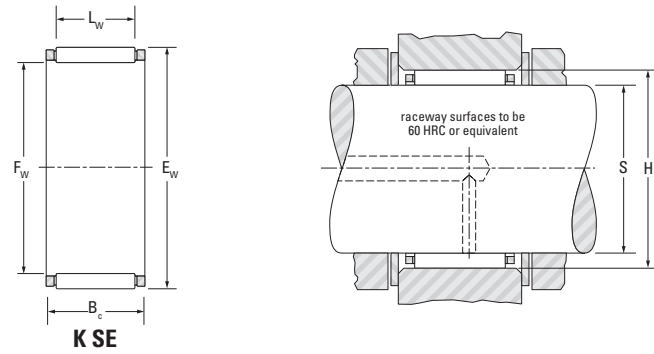
Shaft Dia.	F _w	E _w	B _c		L _w	Assembly Designation	Load Ratings		Approx. Wt.	Mounting Dimensions (non-high performance engines)			
			-0.20 -0.008	-0.55 -0.022			Dynamic	Static		S		H	
			C	C ₀						Max.	Min.	Max.	Min.
9 0.3543	9	12	11.5	8.4	K9X12X11,5SE	4.23	4.53	0.003	9.000	8.994	12.017	12.006	
	9	13	12.5	9.8	K9X13X12,5SE	5.58	5.41	0.005	9.000	8.994	13.017	13.006	
10 0.3937	10	13	14.5	11.8	K10X13X14,5SE	5.93	7.20	0.004	10.000	9.994	13.017	13.006	
	10	14	10	7.0	K10X14X10SE	4.62	4.36	0.004	10.000	9.994	14.017	14.006	
12 0.4724	12	15	13	9.8	K12X15X13SE	6.00	7.72	0.004	12.000	11.992	15.017	15.006	
	12	15	15	11.8	K12X15X15SE	6.97	9.36	0.005	12.000	11.992	15.017	15.006	
	12	15	17.5	12.8	K12X15X17,5SE	7.45	10.2	0.006	12.000	11.992	15.017	15.006	
	12	16	13	9.8	K12X16X13SE	6.03	6.38	0.006	12.000	11.992	16.017	16.006	
	12	17	13	9.8	K12X17X13SE	7.61	7.54	0.007	12.000	11.992	17.017	17.006	
	12	17	15	12.5	K12X17X15SE	9.30	9.75	0.007	12.000	11.992	17.017	17.006	
13 0.5118	13	16	14	9.8	K13X16X14SE	5.62	7.23	0.005	13.000	12.992	16.017	16.006	
	13	17	17.7	13.8	K13X17X17,7SE	9.80	12.3	0.008	13.000	12.992	17.017	17.006	
	13	18	15	12.5	K13X18X15SE	9.28	9.88	0.008	13.000	12.992	18.017	18.006	
14 0.5512	14	18	13	9.8	K14X18X13SE	7.39	8.69	0.007	14.000	13.992	18.017	18.006	
	14	18	17	11.8	K14X18X17SE	8.59	10.5	0.009	14.000	13.992	18.017	18.006	
	14	18	21	14.8	K14X18X21SE	10.3	13.3	0.011	14.000	13.992	18.017	18.006	
15 0.5906	15	19	17	11.8	K15X19X17SE	9.05	11.5	0.009	15.000	14.992	19.020	19.007	

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ASSEMBLIES FOR WRIST PIN END APPLICATIONS

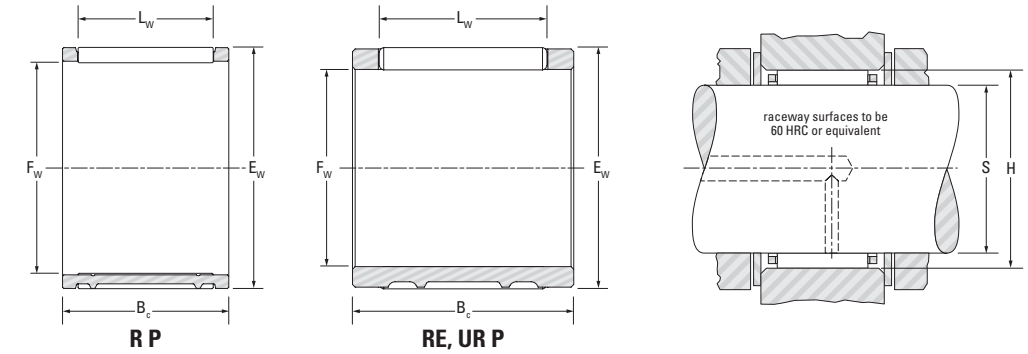
METRIC SERIES
K SE SERIES



Shaft Dia.	F _w	E _w	B _c		L _w	Assembly Designation	Load Ratings		Approx. Wt.	Mounting Dimensions (non-high performance engines)			
			-0.20 -0.008 -0.55 -0.022				Dynamic	Static		S		H	
			C	C ₀			Max.	Min.		Max.	Min.		
mm in	mm in	mm in	mm in	mm in			kN lbf	kg lbs	mm in	mm in	mm in	mm in	
15 0.5906	15 0.5906	19 0.748	19.5 0.768	15.8 0.622	K15X19X19,5SE	10.8 2430	14.3 3210	0.010 0.022	15.000 0.5906	14.992 0.5902	19.020 0.7488	19.007 0.7483	
	15 0.5906	19 0.748	20 0.787	15.8 0.622	K15X19X20SE	10.8 2430	14.3 3210	0.010 0.022	15.000 0.5906	14.992 0.5902	19.020 0.7488	19.007 0.7483	
16 0.6299	16 0.6299	20 0.7874	20 0.787	15.8 0.622	K16X20X20SE	12.0 2700	16.9 3800	0.011 0.024	16.000 0.6299	15.992 0.6296	20.020 0.7882	20.007 0.7877	
	16 0.6299	20 0.7874	22 0.866	15.8 0.622	K16X20X22SE	12.0 2700	16.9 3800	0.013 0.029	16.000 0.6299	15.992 0.6296	20.020 0.7882	20.007 0.7877	
	16 0.6299	20 0.7874	23 0.906	15.8 0.622	K16X20X23SE	10.7 2410	14.5 3260	0.013 0.029	16.000 0.6299	15.992 0.6296	20.020 0.7882	20.007 0.7877	
18 0.7087	18 0.7087	22 0.8661	22 0.866	17.8 0.701	K18X22X22SE	14.4 3240	22.0 4950	0.016 0.035	18.000 0.7087	17.992 0.7083	22.020 0.8669	22.007 0.8664	
	18 0.7087	23 0.9055	20 0.787	15.8 0.622	K18X23X20SE	13.6 3060	17.6 3960	0.015 0.033	18.000 0.7087	17.992 0.7083	23.020 0.9063	23.007 0.9058	
	18 0.7087	23 0.9055	23 0.906	17.8 0.701	K18X23X23SE	15.9 3570	21.6 4860	0.018 0.040	18.000 0.7087	17.992 0.7083	23.020 0.9063	23.007 0.9058	
19 0.7480	19 0.748	24 0.9449	25.5 1.004	17.8 0.701	K19X24X25,5SE	16.7 3750	23.4 5260	0.022 0.049	19.000 0.7480	18.991 0.7477	24.020 0.9457	24.007 0.9452	
20 0.7874	20 0.7874	24 0.9449	23 0.906	17.8 0.701	K20X24X23SE	14.8 3330	23.7 5330	0.017 0.037	20.000 0.7874	19.991 0.7870	24.020 0.9457	24.007 0.9452	
	20 0.7874	25 0.9843	22 0.866	16.8 0.661	K20X25X22SE	15.9 3570	22.2 4990	0.020 0.044	20.000 0.7874	19.991 0.7870	25.020 0.9850	25.007 0.9845	
	20 0.7874	25 0.9843	23 0.906	17.8 0.701	K20X25X23SE	17.5 3930	25.2 5670	0.025 0.055	20.000 0.7874	19.991 0.7870	25.020 0.9850	25.007 0.9845	

ASSEMBLIES FOR WRIST PIN END APPLICATIONS

METRIC SERIES
R P, RE, UR P SERIES



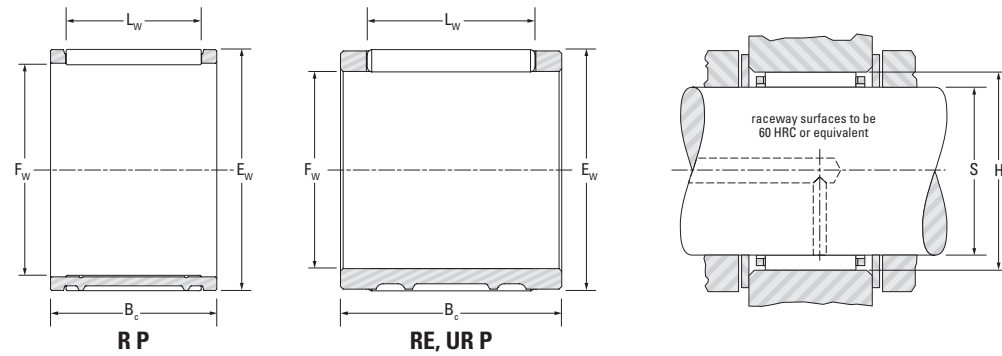
Shaft Dia.	F _w	E _w	B _c		L _w	Assembly Designation	Load Ratings		Approx. Wt.	Mounting Dimensions (non-high performance engines)			
			-0.20 -0.008 -0.55 -0.022				Dynamic	Static		S		H	
			C	C ₀			Max.	Min.		Max.	Min.		
mm in	mm in	mm in	mm in	mm in			kN lbf	kg lbs	mm in	mm in	mm in	mm in	
9 0.3543	9	12	12	8.8	9R1212P	5.25	5.95	0.004					
12 0.4724	12	16	14.8	11.8	12R1615CP	8.35	9.8	0.008					
	12	16	15.4	11.8	RE121615AL1	8.35	9.8	0.008					
	12	16	16	12.8	12UR1616P	7.7	8.75	0.008					
14 0.5512	14	18	15.8	11.8	RE141816AL1	9.4	11.8	0.01					
	14	18	16.5	12.8	RE141817AL2-2	10	12.8	0.01					
	14	18	17.5	11.8	14R1818P	8.85	10.9	0.011					
	14	18	20	13.8	UR14/20P	8.9	11	0.012					
15 0.5906	15	19	17.3	12.8	RE151917BL3	10.5	13.9	0.011					
	15	19	20	15.8	15R1920BP-1	12.1	16.6	0.013					
	15	20	17.8	13.8	RE152018BL2	12.3	14.7	0.014					
	15	20	19.8	15.8	RE152020CL2	14.3	17.9	0.016					
16 0.6299	16	20	18.8	14.8	R16/18.8AP-2	11	15.1	0.013					
	16	20	19.5	13.8	R16/19.5FP	9.95	13.2	0.014					
	16	20	19.5	13.8	RE162020AL2	9.95	13.2	0.013					
	16	20	22.5	14.8	R16/22.5EP	9.85	13	0.016					
	16	21	17.5	13.8	16R2118BP-2	12.2	14.8	0.016					

Continued on next page.



ASSEMBLIES FOR WRIST PIN END APPLICATIONS

METRIC SERIES R P, RE, UR P SERIES



Shaft Dia.	F _w	E _w	B _c		L _w	Assembly Designation	Load Ratings		Approx. Wt.	Mounting Dimensions (non-high performance engines)			
			-0.20 -0.008 -0.55 -0.022				C	C ₀		S		H	
			mm in	mm in						mm in	mm in	mm in	mm in
16 0.6299	16	21	19.5	15.8	16R2120EP-2	13.5	16.9	0.017					
	16	21	22.5	16.8	RE162123AL2	15.4	20	0.02					
18 0.7087	18	22	19.65	13.8	RE182220AL1	10.9	15.4	0.015					
	18	22	22	15.8	18R2222P	12.1	17.6	0.017					
	18	22	23.6	17.8	RE182224AL2	13.3	20	0.017					
	18	23	22	15.8	18R2322P	14.2	18.6	0.021					
18	23	23.8	17.8	RE182324AL2	16.5	22.7	0.024						
	19	24	24.8	18.8	RE192425AL1	18.3	26.2	0.026					
20 0.7874	20	24	13	9.8	R20/13P	10.3	14.9	0.01					
	20	25	13	9.8	20R2513P	11.9	15.3	0.013					
20	25	21.8	16.8	RE202522AL2	17.6	25.3	0.024						
	20	25	23	18.8	RE202523L1	19.1	28.2	0.024					
20	25	24	17.8	RE202524L2-1	16.3	23	0.026						
	20	25	27.8	21.8	RE202528AL1	21.7	33.2	0.03					

RADIAL NEEDLE ROLLER AND CAGE ASSEMBLIES

INCH SERIES

Inch series radial needle roller and cage assemblies are available in a variety of sizes and designs. This catalog includes the most popular, standardized designs.

REFERENCE STANDARDS:

- ANSI/ABMA 18.2 – needle roller bearings – radial, inch design.

Before selecting specific inch series radial needle roller and cage assemblies, the engineering section should be reviewed.



WJ



WJC

Fig. B1-5 . Types of inch series radial needle roller and cage assemblies

There are two primary constructions of inch series needle roller and cage assemblies. WJ assemblies are heavy-duty compared to WJC assemblies due to the nature of the roller diameter.

CONSTRUCTION

Radial needle roller and cage assemblies have a steel cage that provides both inward and outward retention for the needle rollers. The designs provide maximum cage strength consistent with the inherent high load-ratings of needle roller bearings.

Accurate guidance of the needle rollers by the cage bars allows for operation at high speeds. Needle roller and cage assemblies have either one or two rows of needle rollers.

Also available (by request) are needle roller and cage assemblies using molded, one-piece glass-reinforced engineered polymer cages. These operate well at temperatures up to 250° F (120° C) over extended periods. However, care should be exercised when bearings are lubricated with oils containing additives, as service life may be reduced if the operating temperature exceeds 212° F (100° C). At such high temperatures, oil can deteriorate with time and it is suggested that oil change intervals are observed.

Needle rollers with relieved ends – used in these assemblies are made of high carbon chrome steel through-hardened, ground and lapped to close tolerances for diameter and roundness. See the engineering section for further discussion of relieved end rollers.

DIMENSIONAL ACCURACY

The nominal inch assemblies, WJ and WJC, contain needle rollers manufactured to only one diameter grade. Within any one assembly, the needle rollers have a total diameter tolerance of 0.0001 in (0.003 mm).

The limit to precision of the radial clearance of mounted needle roller and cage assemblies is the capability of the user to hold close tolerances on the inner and outer raceways.

The tolerance of the overall width of these assemblies is given in the bearing tables of this section.

MOUNTING DIMENSIONS

The needle roller and cage assembly normally uses the shaft and housing as the inner and outer raceways. To realize full bearing load rating and life, the shaft and housing must have the correct geometric and metallurgical characteristics.

The tables of dimensions for these assemblies list the suggested diameters for the shaft when used as the inner raceway. These are consistent with ISO h5 shaft raceway tolerances. Additional design details for shafts used as inner raceways can be found in the engineering section.

Since the housing normally serves as the outer raceway, it should be of sufficient cross section to maintain adequate roundness and running clearance under load. The tables of dimensions



also list the suggested diameters for the housings when used as outer raceways. These are consistent with ISO G6 housing bore tolerances. Additional design details for housings used as outer raceways can be found in the engineering section.

The suggested mounting diameter tolerances for these needle roller and cage assemblies will provide correct running clearance for most applications.

The needle roller and cage assembly must be axially located by shoulders or other suitable means. End locating surfaces should be hardened to minimize wear. For satisfactory operation, minimum axial clearance should be 0.008 in (0.203 mm). When using type WJ assembly, fillets adjacent to the assembly must not exceed 0.03 in (0.762 mm) radius. When it is necessary to use fillets adjacent to WJC assembly, please consult your representative for suggestions.

LUBRICATION

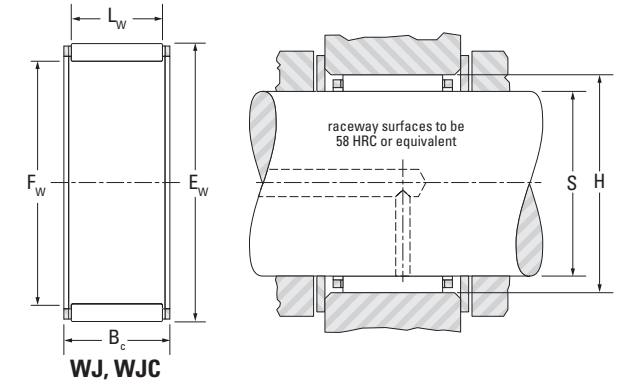
Oil is the preferred lubricant for most applications. In critical applications involving high speeds, ample oil flow must be provided. Where assemblies are subjected to high centrifugal forces, such as in epicyclic gearing, or inertia forces, as in the small end of a connecting rod, the contact pressure between the cage and the raceway guiding surface becomes critical. The allowable contact pressure depends on a combination of the induced force and the relative velocity between the cage and the raceway and the rate of lubricant flow. Consult your representative when cages will be subjected to high induced forces.

SPECIAL DESIGNS

Needle roller and cage assemblies made to special dimensions or configurations, such as those that are split to assemble around a one-piece crankshaft, can be made available on special order where quantities permit. Special plated cages to enhance life under conditions of high induced forces can also be made available.

SINGLE-ROW ASSEMBLIES

INCH SERIES



Shaft Dia.	F _w	E _w	B _c +0 +0 -0.38 -0.015	Assembly Designation	Load Ratings		Speed Rating		S (ISO h5)		H (ISO G6)		Wt.
					C	C ₀	Grease	Oil	Mounting Dimension				
					kN lbf		min ⁻¹		Max.	Min.	Max.	Min.	
in	mm in	mm in	mm in					mm in	mm in	mm in	mm in		
3/8	9.525 0.3750	12.700 0.5000	9.53 0.375	WJC-060806	3.87 870	4.00 900	24000	37000	9.525 0.3750	9.520 0.3748	12.715 0.5006	12.705 0.5002	0.003 0.006
1/2	12.700 0.5000	15.875 0.6250	12.70 0.500	WJC-081008	6.23 1400	8.01 1800	23000	35000	12.700 0.5000	12.692 0.4997	15.890 0.6256	15.880 0.6252	0.005 0.010
9/16	14.288 0.5625	17.463 0.6875	12.70 0.500	WJC-091108	6.81 1530	9.25 2080	22000	34000	14.288 0.5625	14.280 0.5622	17.478 0.6881	17.468 0.6877	0.006 0.013
5/8	15.875 0.6250	19.050 0.7500	12.70 0.500	WJC-101208	7.03 1580	9.96 2240	18000	27000	15.875 0.6250	15.867 0.6247	19.070 0.7508	19.058 0.7503	0.006 0.013
	15.875 0.6250	22.225 0.8750	15.88 0.625	WJ-101410	15.6 3510	17.8 3990	19000	29000	15.875 0.6250	15.867 0.6247	22.245 0.8758	22.233 0.8753	0.012 0.027
	15.875 0.6250	22.225 0.8750	22.23 0.875	WJ-101414	21.3 4780	26.4 5940	19000	29000	15.875 0.6250	15.867 0.6247	22.245 0.8758	22.233 0.8753	0.017 0.038
3/4	19.050 0.7500	25.400 1.0000	25.40 1.000	WJ-121616	26.8 6020	37.2 8370	16000	24000	19.050 0.7500	19.040 0.7496	25.420 1.0008	25.408 1.0003	0.023 0.051
13/16	20.638 0.8125	26.988 1.0625	22.23 0.875	WJ-131714	25.1 5650	35.0 7880	14000	22000	20.638 0.8125	20.627 0.8121	27.008 1.0633	26.995 1.0628	0.021 0.046
7/8	22.225 0.8750	28.575 1.1250	25.40 1.000	WJ-141816	29.2 6570	43.5 9770	13000	20000	22.225 0.8750	22.215 0.8746	28.595 1.1258	28.583 1.1253	0.026 0.058
1	25.400 1.0000	33.338 1.3125	19.05 0.750	WJ-162112	28.1 6320	37.1 8340	12000	18000	25.400 1.0000	25.390 0.9996	33.363 1.3135	33.348 1.3129	0.029 0.063
	25.400 1.0000	33.338 1.3125	25.40 1.000	WJ-162116	36.8 8270	52.5 11800	12000	18000	25.400 1.0000	25.390 0.9996	33.363 1.3135	33.348 1.3129	0.038 0.084
	25.400 1.0000	33.338 1.3125	31.75 1.250	WJ-162120	44.5 10000	67.2 15100	12000	18000	25.400 1.0000	25.390 0.9996	33.363 1.3135	33.348 1.3129	0.048 0.105
1 1/8	28.575 1.1250	38.100 1.5000	25.40 1.000	WJ-182416	42.4 9520	57.8 13000	10000	16000	28.575 1.1250	28.565 1.1246	38.125 1.5010	38.110 1.5004	0.041 0.090
	28.575 1.1250	38.100 1.5000	31.75 1.250	WJ-182420	52 11700	74.7 16800	10000	16000	28.575 1.1250	28.565 1.1246	38.125 1.5010	38.110 1.5004	0.065 0.143
1 1/4	31.750 1.2500	41.275 1.6250	19.05 0.750	WJ-202612	33.4 7520	43.7 9830	9300	14000	31.750 1.2500	31.740 1.2496	41.300 1.6260	41.285 1.6254	0.043 0.094
	31.750 1.2500	41.275 1.6250	25.40 1.000	WJ-202616	44.1 9910	62.3 14000	9300	14000	31.750 1.2500	31.740 1.2496	41.300 1.6260	41.285 1.6254	0.061 0.134
	31.750 1.2500	41.275 1.6250	31.75 1.250	WJ-202620	53.8 12100	81.0 18200	9300	14000	31.750 1.2500	31.740 1.2496	41.300 1.6260	41.285 1.6254	0.071 0.156

· Load ratings are based on a minimum raceway hardness of 58 HRC or equivalent.
 · Minimum axial clearance should be 0.02 mm (0.008 in).

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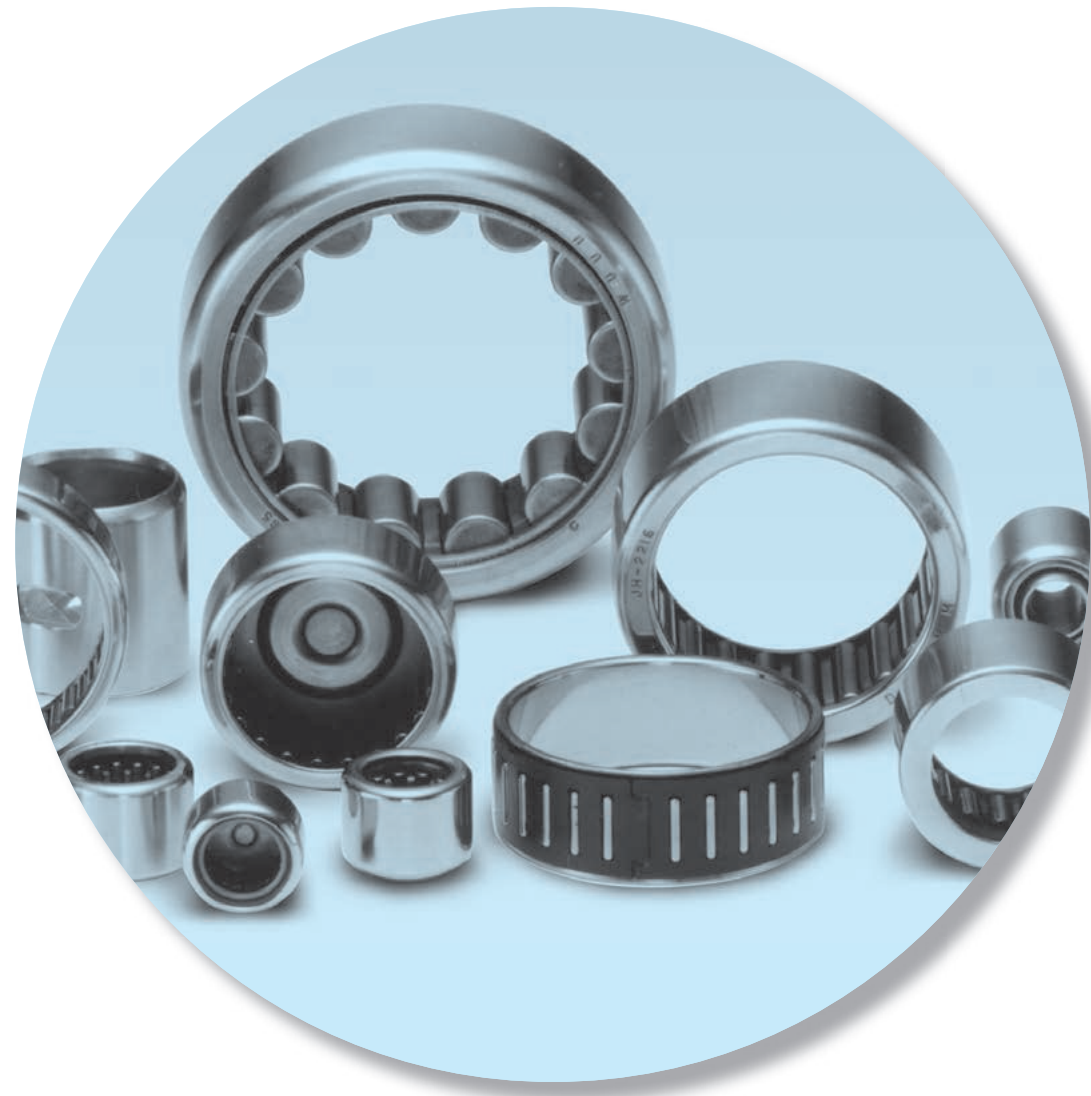


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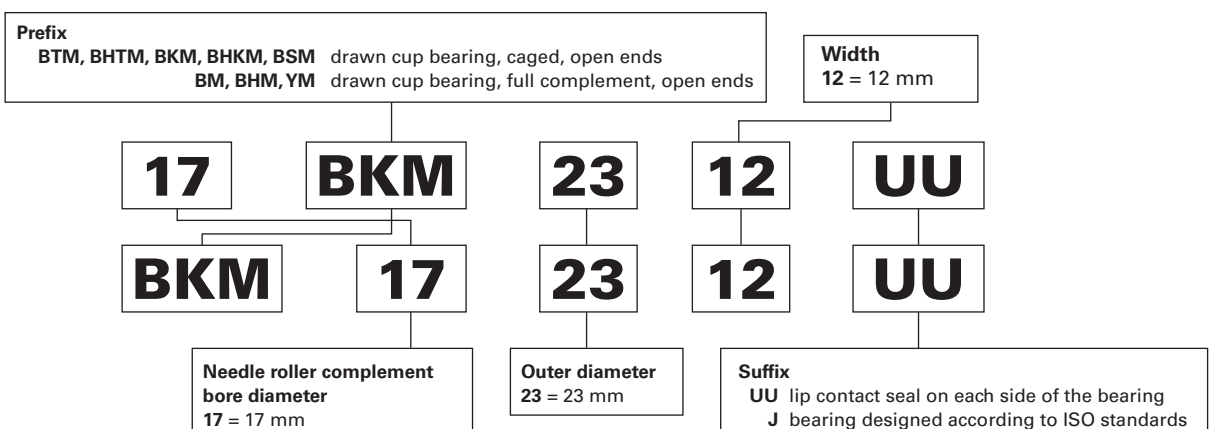
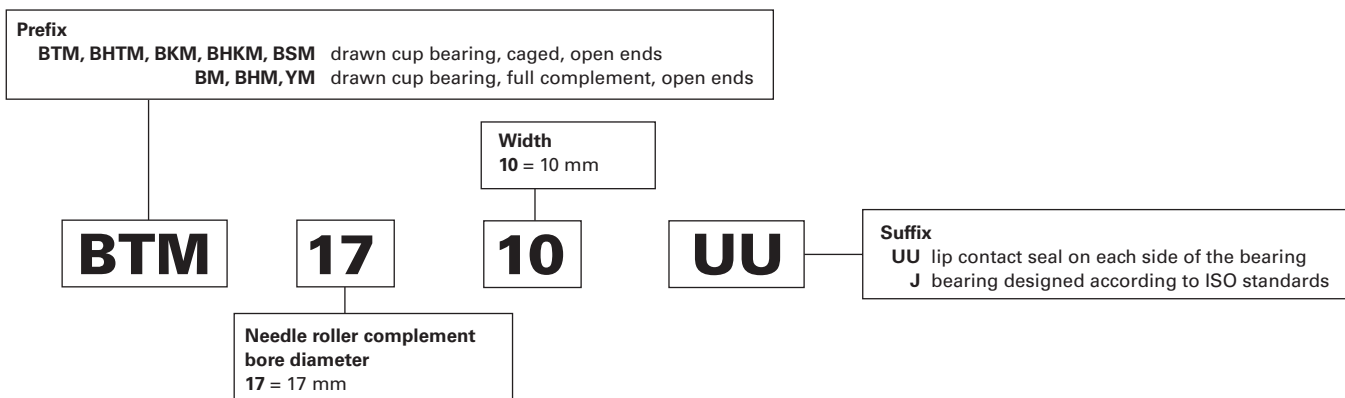
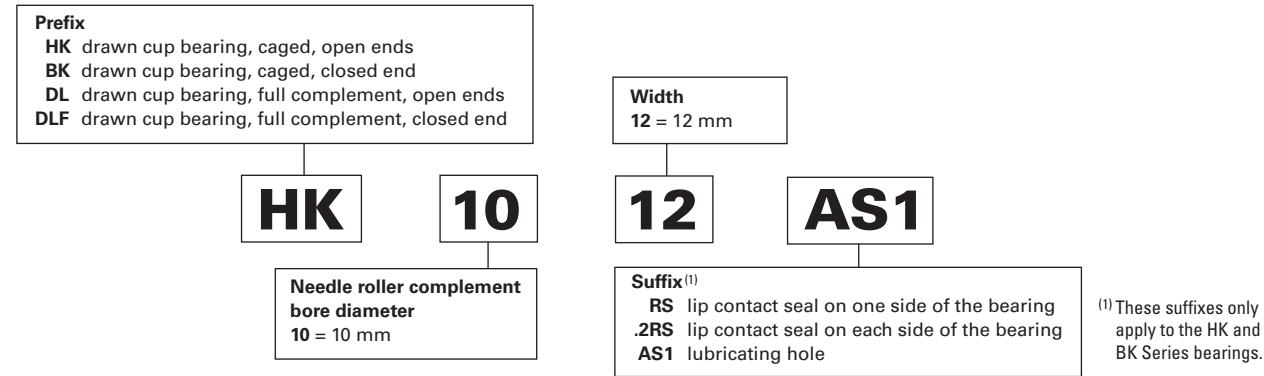
DRAWN CUP NEEDLE ROLLER BEARINGS

Overview: Drawn cup needle roller bearings support radial loads and reduce friction between rotating components, with a drawn outer shell serving as a raceway for the rollers. The small cross section of the drawn cup bearing provides high load-carrying capability with minimum required space. Drawn cup bearings are easily installed with a press fit in the housing.

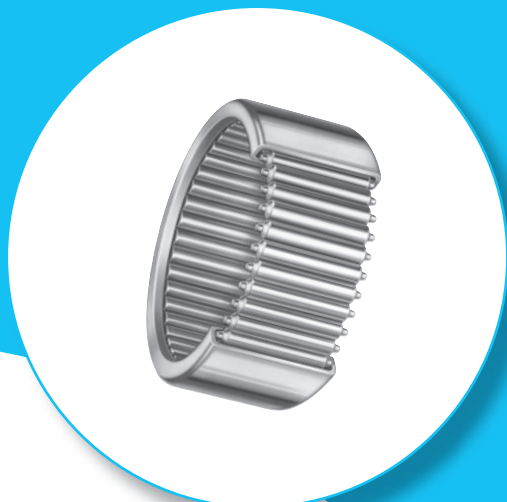
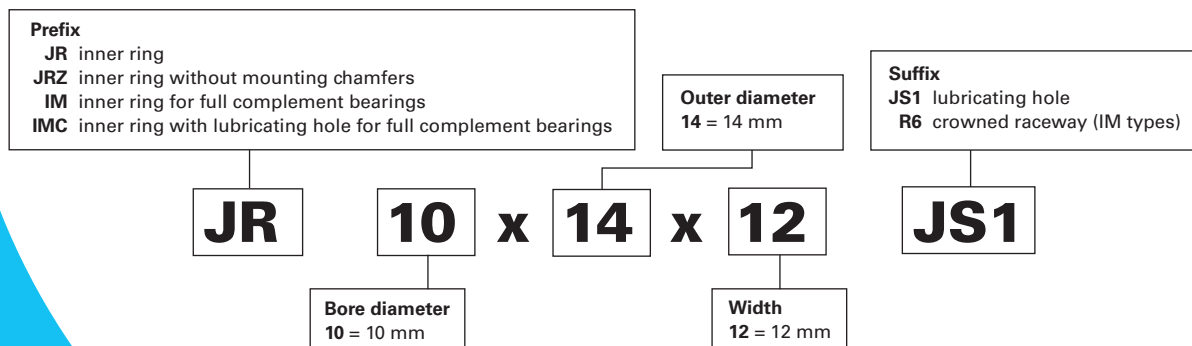
- **Catalogue range:** 3 mm – 139.7 mm (0.1181 in – 5.5000 in) bore.
- **Markets:** Transmissions, transfer cases, engines, valve trains, steering and braking systems, axle supports, outboard engines, power tools, copiers, fax machines, paper-moving equipment and appliances.
- **Features:** Available in two basic designs: full complement and caged.
- **Benefits:** Full complement bearings handle high radial load-carrying capability. Caged bearings provide high speed and maximum lubricant-retention capability.



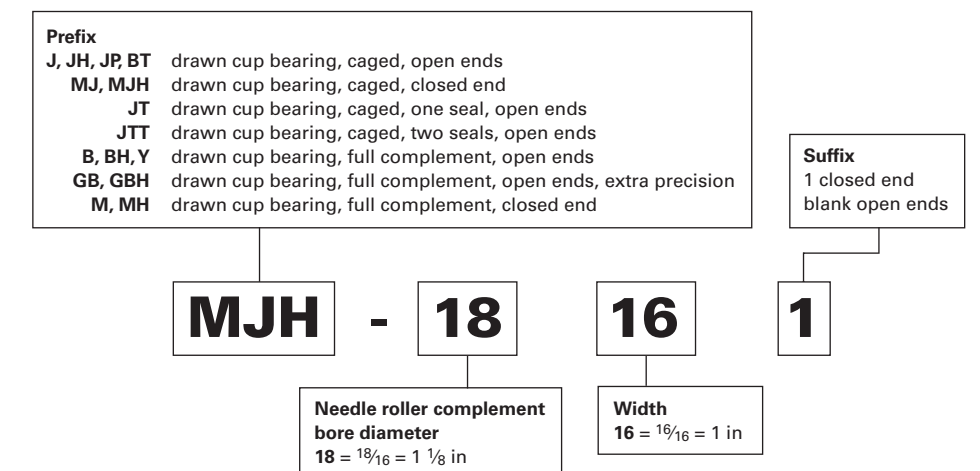
Drawn Cup Needle Roller Bearings – Metric Nominal Dimensions



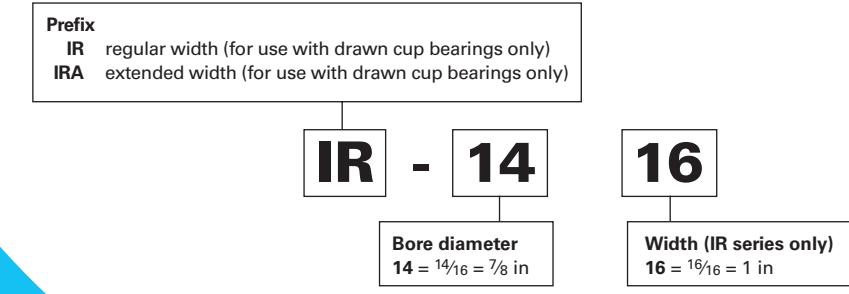
Inner Rings – Metric Nominal Dimensions



Drawn Cup Needle Roller Bearings – Inch Nominal Dimensions



Inner Rings (with four-digit number) Inch Nominal Dimensions





Drawn Cup Needle Roller Bearings

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BM, BHM, YM Series	B-2-41
Inner Rings for Full Complement Drawn Cup Needle Roller Bearings – Metric Series	B-2-43
Drawn Cup Needle Roller Bearings – Inch Series	B-2-46
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Extra-Precision Bearings – Inch Series	B-2-63
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Inner Rings for Inch Series Drawn Cup Bearings	B-2-74



DRAWN CUP NEEDLE ROLLER BEARINGS

METRIC SERIES

When a rolling bearing is needed for a compact and economic design and where it is not practical to harden and grind the housing bore, or where the housing materials are of low rigidity such as cast iron, aluminum or even plastics – drawn cup needle roller bearings should be considered.

REFERENCE STANDARDS ARE:

- **ISO 3245** – rolling bearings – needle roller bearings, drawn cup, without inner ring, boundary dimensions and tolerances.
- **ANSI/ABMA 18.1** – needle roller bearings – radial, metric design.
- **DIN 618** – needle roller bearings with cage – drawn cups with open end, drawn cup with closed end.
- **JIS B 1536** – rolling bearings – needle roller bearings – boundary dimensions and tolerances.

Before selecting specific drawn cup needle roller bearings, please review the engineering section of this catalog.

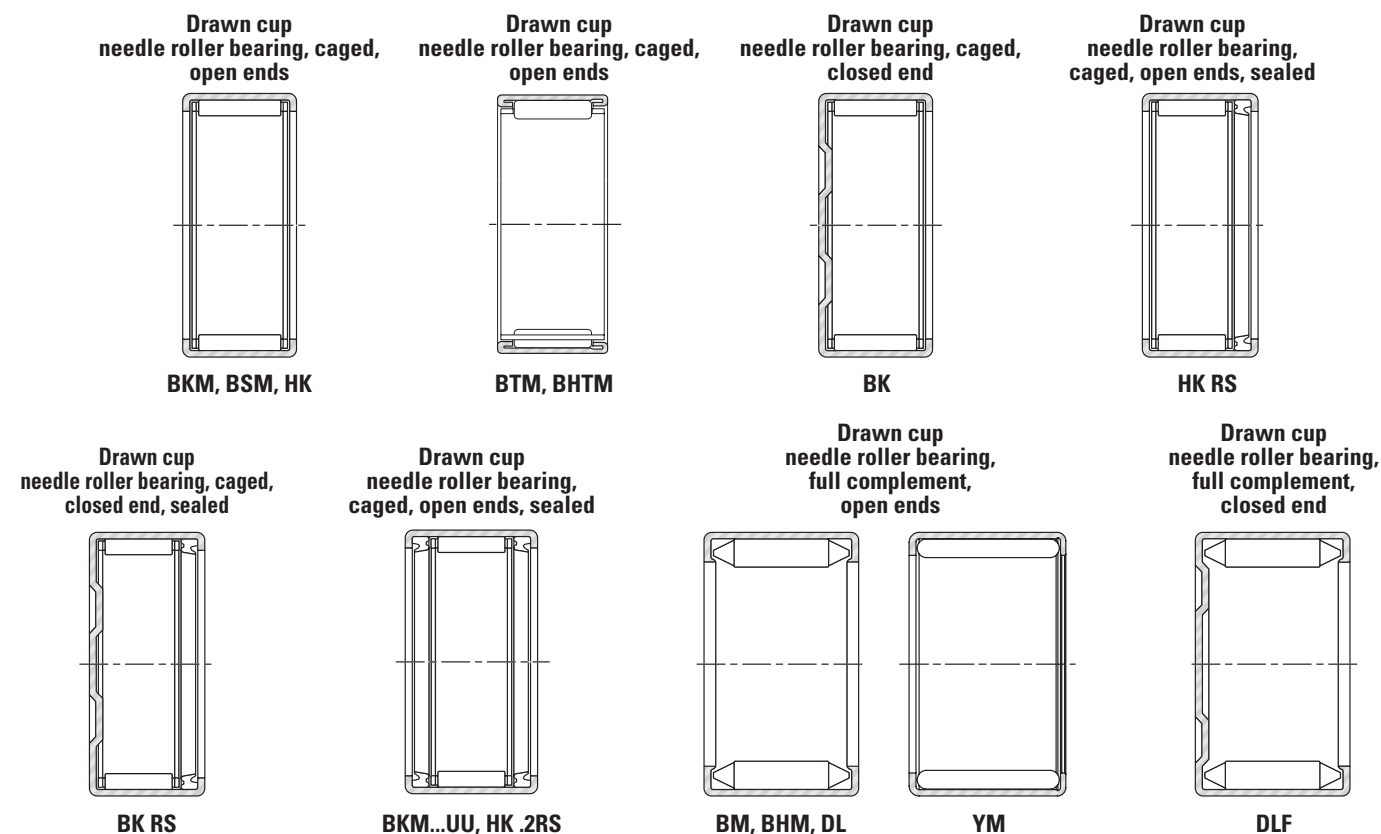


Fig. B2-1. Types of metric series drawn cup needle roller bearings

CONSTRUCTION

The prefix letters in metric series drawn cup bearing designations denote whether the bearings are made with a full complement of needle rollers or caged needle rollers. The use of a full complement of needle rollers is indicated by the prefix code letters **DL, BM, BHM, YM** or **DLF**, and for use of caged needle rollers by the prefix code letters **HK, BKM, BTM, BHTM, BSM** or **BK**.

The outer ring, in the form of a cup, is accurately drawn and no subsequent machining is performed. Drawn cup needle roller bearings of series **HK, BKM, BTM, BHTM, BSM, DL, BM, BHM** and **YM** have open ends. The **HK** and **BKM** series also are available

with one seal, **HK RS**, and with two seals, **HK 2RS** and **BKM UU**. The stamped lip of a drawn cup needle roller bearing of series **HK RS** is at the seal end.

Drawn cup needle roller bearings of series **BK** and **DLF** are closed at one end. They are used for shaft-end mounting. The open end is typically not sealed.

The one-piece steel cage used in **HK, BKM** and **BK** series drawn cup bearings is designed to provide rigidity and minimize wear. This cage design separates the needle roller guiding and retention functions.

Drawn cup needle roller bearings also are available with two needle roller and cage assemblies. They have a lubricating hole in the outer ring. Metric series drawn cup bearings with one needle roller and cage assembly may be made available on request with a lubricating hole, indicated by suffix **AS1** and **JS1**.

SEALED BEARINGS

The **HK** and **BKM** series drawn cup bearings are offered with integral seals. The tables of dimensions on pages B-2-24 to B-2-26, indicate those sizes available with lip contact seals. The seal lip design achieves a light and constant contact with the inner raceway throughout the range of mounted bearing clearances, thereby ensuring positive sealing and low frictional drag.

Sealed drawn cup needle roller bearings are intended to retain grease or non-pressurized oil within a bearing while also preventing contaminants from entering the raceway area.

Details of shaft design for sealed bearings are given in the engineering section of this catalog.

The standard lip contact seals are compatible with common lubricating oils and petroleum based fuels; but, they are adversely affected by certain fire-resistant hydraulic fluids and most common solvents. Sealed drawn cup bearings are normally filled with a high-quality lithium soap-based general purpose grease. The seal material and grease properties limit the bearing operating temperature between -30° C and +100° C (-22° F and +212° F).

If the operating temperature must be outside of the range for the seals mentioned here, or if the seals are exposed to unusual fluids, please consult your representative.

BEARING MOUNTING FITS AND INTERNAL CLEARANCE

Drawn cup needle roller bearings are manufactured to a degree of precision that will satisfy the radial clearance requirements of most applications. The total radial clearance for an installed drawn cup bearing results from the buildup of manufacturing tolerances of the housing bore, the inner raceway diameter and the bearing, as well as the minimum radial clearance required for the application (reference Table B2-1 on page B-2-8).

For metric series **caged** drawn cup needle roller bearings requiring close control of radial internal clearance, the suggested housing bore tolerance is **N6** and **h5** tolerance for the inner raceway diameter. When such exacting close control of radial internal clearance is not required, the user may select **N7** housing bore and **h6** inner raceway diameter tolerances.

For metric series **full complement** drawn cup bearings requiring close control of radial internal clearance, the suggested housing bore tolerance is **H6** and **h5** tolerance for the inner raceway diameter. When such exacting close control of radial internal

clearance is not required, the user may select **H7** housing bore and **h6** inner raceway diameter tolerances.

TOLERANCES FOR HOUSING MATERIALS OF LOW RIGIDITY

The suggested housing bore tolerance for metric series **caged** drawn cup bearings used in housings made from materials of low rigidity or steel housings of small section is **R6**. To maintain normal radial internal clearance, the inner raceway diameter tolerance should be **h5**. When such exacting close control of radial internal clearance is not required, the user may select **R7** housing bore and **h6** inner raceway diameter tolerances.

The suggested housing bore tolerance for metric series **full complement** drawn cup bearings used in housings made from materials of low rigidity or steel housings of small section is **M6**. To maintain normal radial internal clearance, the inner raceway diameter tolerance should be **h5**. When such exacting close control of radial internal clearance is not required, the user may select **M7** housing bore and **h6** inner raceway diameter tolerances.

OUTER RING ROTATION

For metric series **caged** drawn cup bearing applications where the outer ring rotates with respect to the load, it is suggested that both the housing bore and the inner raceway diameter be reduced using **R6** and **f5** tolerance practice respectively. The user may select **R7** housing bore and **f6** inner raceway diameter tolerance when such exacting close control of radial internal clearance is not required.

For metric series **full complement** drawn cup bearings applications where the outer ring rotates with respect to the load, it is suggested that both the housing bore and the inner raceway diameter tolerance be reduced using **M6** and **f5** tolerance practice respectively. The user may select **M7** housing bore and **f6** inner raceway diameter tolerances when such exacting close control of radial internal clearance is not required.

OSCILLATING MOTION

Metric series drawn cup needle roller bearing applications involving oscillating motion may require reduced radial internal clearances. This reduction may be accomplished by increasing the inner raceway diameter using **j5** tolerance. When such exacting close control of radial clearance is not required, the user may select **j6** inner raceway diameter tolerances.



Table B2-1. Metric mounting fits

Bearing type	Operating condition	Shaft fit (recommended internal radial clearances)	Housing fit (recommended internal radial clearances)
HK, BK, HKRS, HK.2RS, BTM, BHTM, BSM, BKM	One piece heavy section steel or cast iron housing	h5 (h6)	N6 (N7)
DL, DLF, BM, BHM, YM	One piece heavy section steel or cast iron housing	h5 (h6)	H6 (H7)
HK, BK, HKRS, HK.2RS, BTM, BHTM, BSM, BKM	Housing material of low rigidity	h5 (h6)	R6 (R7)
DL, DLF, BM, BHM, YM	Housing material of low rigidity	h5 (h6)	M6 (M7)
HK, BK, HKRS, HK.2RS, BTM, BHTM, BSM, BKM	Outer ring rotation (one piece heavy section steel or cast iron housing)	f5 (f6)	R6 (R7)
DL, DLF, BM, BHM, YM	Outer ring rotation (one piece heavy section steel or cast iron housing)	f5 (f6)	M6 (M7)
HK, BK, HKRS, HK.2RS, BTM, BHTM, BSM, BKM	Oscillating motion	j5 (j6)	(1)
DL, DLF, BM, BHM, YM	Oscillating Motion	j5 (j6)	(1)

(1) Tolerance dependent on housing design.

INNER RINGS

When it becomes impractical to meet the shaft raceway design requirements (hardness, case depth, surface finish, etc.) outlined in the engineering section of this catalog, standard inner rings may be used with metric series drawn cup bearings. It is suggested that when metric series inner rings are used with metric series drawn cup bearings, they should be mounted with a loose transition fit on the shaft using g5 shaft diameter tolerance. The inner ring should be end-clamped against a shoulder. If a tight transition fit must be used (shaft diameter tolerance h5) to keep the inner ring from rotating relative to the shaft, the inner ring outer diameter, as mounted, must not exceed the raceway diameter required by the drawn cup bearing for the particular application. In case the outer diameter of the inner ring, when mounted on the shaft, exceeds the required raceway diameter for the matching drawn cup bearing, it should be ground to proper diameter while mounted on the shaft. When such exacting close control of radial internal clearance is not required the user may select g6 or h5 shaft diameter tolerances.

LOAD RATING FACTORS

DYNAMIC LOADS

Drawn cup needle roller bearings can accommodate only radial loads.

$$P = F_r$$

P = The maximum dynamic radial load that may be applied to a drawn cup bearing based on the dynamic load rating, C given in the bearing tables. This load should be $\leq C/3$.

STATIC LOADS

$$f_0 = \frac{C_0}{P_0}$$

f_0 = static load safety factor

C_0 = basic static load rating (kN)

P_0 = maximum applied static load (kN)

To ensure satisfactory operation of drawn cup needle roller bearings, under all types of conditions, the static load safety factor f_0 should be ≥ 3 .

ADJUSTED RATING LIFE

When application data includes details of operating temperature, oil viscosity, operating speed and the applied load meets the $\leq C/3$ condition adjusted rating life may be evaluated using the information given in the engineering section.

INSPECTION OF DRAWN CUP NEEDLE ROLLER BEARINGS

Although the bearing cup is accurately drawn from strip steel, because of its fairly thin section, it may go out-of-round during heat treatment. When the bearing is pressed into a true round housing, or ring gage of correct size and wall thickness, it becomes round and is sized properly. *For this reason, it is incorrect to inspect an unmounted drawn cup bearing by measuring the outer diameter.*

The correct method for inspecting the bearing size is to:

1. Press the bearing into a ring gage of proper size.
2. Plug the bearing bore with the appropriate "go" and "no go" gages, or measure it with a tapered arbor (lathe mandrel).

- HK, BK and DL series

The "go" gage size is the minimum needle roller complement bore diameter.

The "no go" gage size is larger than the maximum needle roller complement bore diameter by 0.002 mm (0.0001 in). (Tables B2-2 and B2-3)

- BTM, BHTM, BSM, BKM, BM and YM series

The inspection gage (ring gage and plug gage) sizes are listed in Table B2-4.

NOTE

SPECIAL BEARINGS. There are bearings available with other cage designs, and materials such as reinforced engineered polymer for use where operating conditions permit.

Table B2-2. Caged bearing gage sizes

Nominal bore diameter	Ring gage ⁽¹⁾	Needle roller complement bore diameter	
		Max.	Min.
mm in	mm in	mm in	mm in
3.000 0.1181	6.484 0.2553	3.024 0.1191	3.006 0.1183
4.000 0.1575	7.984 0.3143	4.028 0.1586	4.010 0.1579
5.000 0.1969	8.984 0.3537	5.028 0.1980	5.010 0.1972
6.000 0.2362	9.984 0.3931	6.028 0.2373	6.010 0.2366
7.000 0.2756	10.980 0.4323	7.031 0.2768	7.013 0.2761
8.000 0.3150	11.980 0.4717	8.031 0.3162	8.013 0.3155
9.000 0.3543	12.980 0.5110	9.031 0.3555	9.013 0.3548
10.000 0.3937	13.980 0.5504	10.031 0.3949	10.013 0.3942
12.000 0.4724	15.980 0.6291	12.034 0.4738	12.016 0.4731
13.000 0.5118	16.976 0.7471	13.034 0.5131	13.016 0.5124
14.000 0.5512	17.976 0.7865	14.034 0.5525	14.016 0.5518
15.000 0.5906	18.976 0.8258	15.034 0.5919	15.016 0.5912
16.000 0.6299	21.976 0.8652	16.034 0.6313	16.016 0.6306
17.000 0.6693	22.976 0.9046	17.034 0.6706	17.016 0.6699
18.000 0.7087	23.976 0.9439	18.034 0.7100	18.016 0.7093
20.000 0.7874	25.976 1.0227	20.041 0.7890	20.020 0.7882
22.000 0.8661	27.976 1.1014	22.041 0.8678	22.020 0.8669
25.000 0.9843	31.972 1.2587	25.041 0.9859	25.020 0.9850
28.000 1.1024	34.972 1.3769	28.041 1.1040	28.020 1.1031
30.000 1.1811	36.972 1.4556	30.041 1.1827	30.020 1.1819
35.000 1.3780	41.972 1.6524	35.050 1.3799	35.025 1.3789
40.000 1.5750	46.972 1.8493	40.050 1.5768	40.025 1.5758
45.000 1.7717	51.967 2.0459	45.050 1.7736	45.025 1.7726
50.000 1.9685	57.967 2.2822	50.050 1.9705	50.025 1.9695
60.000 2.3622	67.967 2.6759	60.060 2.3646	60.030 2.3634

(1) The ring gage sizes are in accordance with ISO N6 lower limit.

Table B2-3. Full complement bearing gage sizes

Nominal bore diameter	Ring gage	Needle roller complement bore diameter	
		Max.	Min.
mm in	mm in	mm in	mm in
6.000 0.2362	12.000 0.4724	6.034 0.2376	6.009 0.2366
8.000 0.3150	14.000 0.5512	8.034 0.3163	8.009 0.3153
9.000 0.3543	14.000 0.5512	9.034 0.3557	9.009 0.3547
10.000 0.3937	16.000 0.6299	10.034 0.3950	10.009 0.3941
12.000 0.4724	18.000 0.7087	10.033 0.3950	10.009 0.3941
13.000 0.5118	19.000 0.7480	13.033 0.5131	13.009 0.5122
14.000 0.5512	20.000 0.7874	14.033 0.5525	14.009 0.5515
15.000 0.5906	21.000 0.8268	15.033 0.5919	15.009 0.5909
16.000 0.6299	22.000 0.8661	16.033 0.6312	16.009 0.6303
17.000 0.6693	23.000 0.9055	17.033 0.6706	17.009 0.6696
18.000 0.7087	24.000 0.9449	18.033 0.7100	18.009 0.7090
20.000 0.7874	26.000 1.0236	20.033 0.7887	20.009 0.7878
22.000 0.8661	28.000 1.1024	22.033 0.8674	22.009 0.8665
25.000 0.9843	33.000 1.2992	25.039 0.9858	25.015 0.9848
28.000 1.1024	36.000 1.4173	28.039 1.1039	28.015 1.1030
30.000 1.1811	38.000 1.4961	30.039 1.1826	30.015 1.1817
35.000 1.3780	43.000 1.6929	35.039 1.3795	35.015 1.3785
40.000 1.5748	48.000 1.8898	40.039 1.5763	40.015 1.5754
44.000 1.7323	52.000 2.0472	44.039 1.7338	44.015 1.7329
47.000 1.8504	55.000 2.1654	47.039 1.8519	47.015 1.8510
50.000 1.9685	58.000 2.2835	50.039 1.9700	50.015 1.9691
55.000 2.1654	63.000 2.4803	55.039 2.1669	55.015 2.1659



Table B2-4. Needle roller bearing gage sizes (metric series)

Needle roller complement bore diameter Fw nominal size	Ring gage	Plug gage		Needle roller complement bore diameter Fw nominal size	Ring gage	Plug gage	
		Go	No go			Go	No go
mm	mm	mm	mm	mm	mm	mm	mm
4	7.996	4.023	4.048	22	27.972 28.972 29.972	22.013	22.038
5	8.996	5.023	5.048	24	29.972 30.967 34.967	24.013	24.038
6	9.996	6.028	6.053	25	31.967 32.967	25.013	25.038
7	10.995	7.031	7.056	26	33.967	26.013	26.038
8	11.995 14.995	8.031	8.056	28	33.967 34.967 36.967	28.013	28.038
9	12.995 15.995	9.031	9.056	30	36.967 37.967 39.967	30.013	30.038
10	13.995 16.995	10.031	10.056	32	37.967 39.967 41.967	32.013	32.038
12	15.995 17.995 18.993	12.031	12.056	35	41.967 44.967	35.013	35.038
13	18.993	13.034	13.059	36	41.967 43.967 47.967	36.013	36.038
14	18.993 19.993 21.993	14.034	14.059	37	42.967 46.967	37.013	37.038
15	19.993 20.993 21.993	15.034	15.059	38	47.967	38.013	38.038
16	21.993 23.993	16.034	16.059	40	46.967 49.967	40.013	40.043
17	21.972 22.972 23.972	17.013	17.038	45	51.961 54.961	45.013	45.043
18	23.972 24.972	18.013	18.038	50	57.961 61.961	50.013	50.043
19	26.972	19.013	19.038	55	62.961	55.013	55.051
20	25.972 26.972	20.013	20.038				

INSTALLATION PROCEDURES

GENERAL INSTALLATION REQUIREMENTS

- A drawn cup needle roller bearing must be pressed into its housing.
- An installation tool, similar to the ones illustrated must be used in conjunction with a standard press.
- The bearing must not be hammered into its housing, even in conjunction with the proper assembly mandrel.
- The bearing must not be pressed tightly against a shoulder in the housing.
- If it is necessary to use a shouldered housing, the depth of the housing bore must be sufficient to ensure that the housing shoulder fillet, as well as the shoulder face, clears the bearing.
- The installation tool must be coaxial with the housing bore.

INSTALLATION OF OPEN ENDS CAGED BEARINGS

It is advisable to utilize a positive stop on the press tool to locate the bearing properly in the housing. The assembly tool should have a leader or a pilot, as shown, to aid in starting the bearing true in the housing. The "O" ring shown on the drawing may be used to assist in holding the bearing on the installation tool. The bearing should be installed with the stamped end (the end with the identification markings) against the angled shoulder of the pressing tool.

- A - 0.40 mm (0.016 in) less than housing bore
- B - 0.08 mm (0.003 in) less than shaft diameter
- C - distance bearing will be inset into housing, minimum of 0.20 mm (0.008 in)
- D - pilot length should be length of bearing less 0.80 mm (0.030 in)
- E - approximately 1/2 D

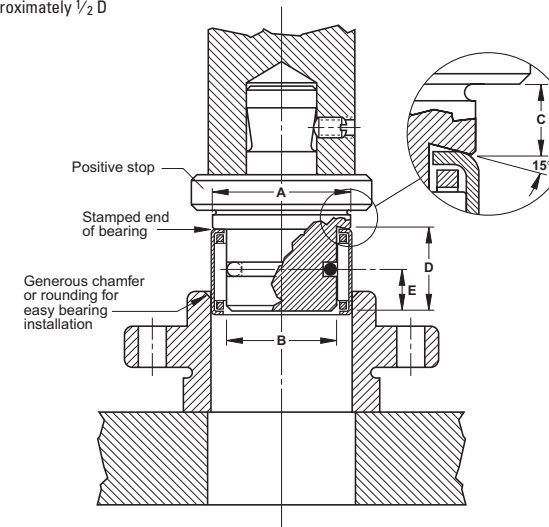


Fig. B2-2. Installation of open ends caged bearings

INSTALLATION OF CLOSED END CAGED BEARINGS

Bearing can be piloted from below for installation.

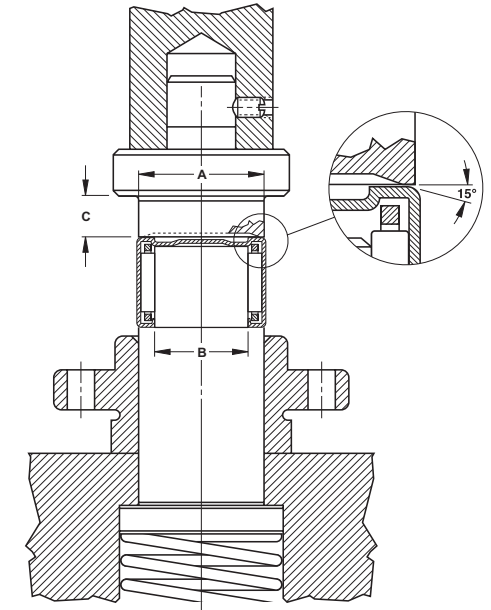


Fig. B2-3. Installation of closed end caged bearings

EXTRACTION FROM A STRAIGHT HOUSING (CAGED AND FULL COMPLEMENT BEARINGS)

Bearing can be extracted by pushing it through the housing. After extraction, the drawn cup needle roller bearing should not be reused.

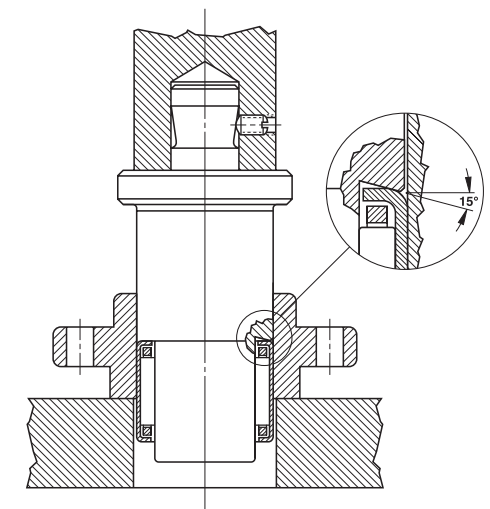


Fig. B2-4. Extraction from a straight housing



INSTALLATION OF OPEN ENDS FULL COMPLEMENT BEARINGS

It is advisable to utilize a positive stop on the press tool to locate the bearing properly in the housing. The assembly tool should have a leader or a pilot, as shown, to aid in starting the bearing true in the housing. The ball detent shown on the drawing is used to assist in aligning the rollers of a full complement bearing during installation and to hold the bearing on the installation tool. The bearing should be installed with the marked end (the end with identification markings) against the angled shoulder of the pressing tool.

- A – 0.40 mm (0.016 in) less than housing bore
- B – 0.08 mm (0.003 in) less than shaft diameter
- C – distance bearing will be inset into housing, minimum of 0.20 mm (0.008 in)
- D – pilot length should be length of bearing less 0.80 mm (0.030 in)
- E – approximately 1/2 D

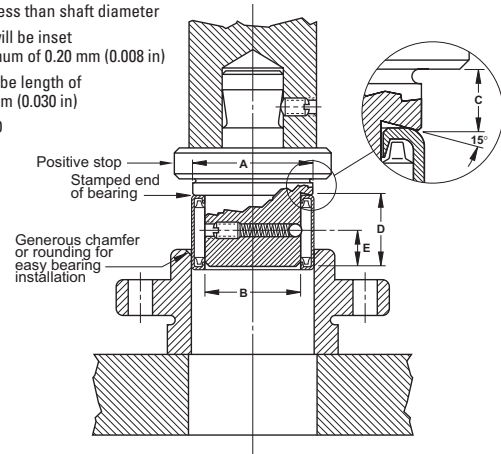


Fig. B2-5. Installation of open ends full complement bearings

INSTALLATION OF CLOSED END FULL COMPLEMENT BEARINGS

The installation tool combines all the features of the tool used to install open end bearings, but the pilot is spring loaded and is part of the press bed.

The angled shoulder of the pressing tool should bear against the closed end with the bearing held on the pilot to aid in starting the bearing true in the housing.

- A – 0.40 mm (0.016 in) less than housing bore
- B – 0.08 mm (0.003 in) less than shaft diameter
- C – distance bearing will be inset into housing, minimum of 0.20 mm (0.008 in)

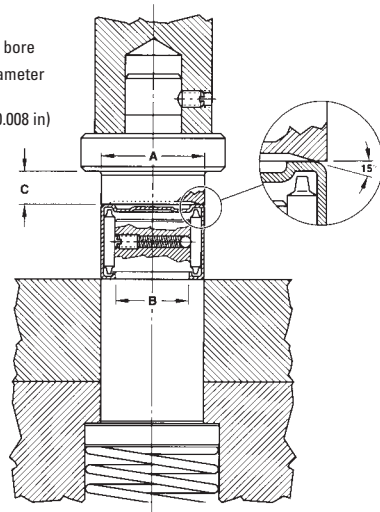


Fig. B2-6. Installation of closed end full complement bearings

EXTRACTION FROM A SHOULDERED OR DEAD END HOUSING (CAGED AND FULL COMPLEMENT BEARINGS) (with space between the bearing and the housing shoulder)

Bearings may be extracted from shouldered or dead end housings with a common bearing puller tool as shown. This type of tool is slotted in two places at right angles to form four prongs. The four puller prongs are pressed together and inserted into the space between the end of the bearing and the shoulder. The prongs are forced outward by inserting the expansion rod, and then the bearing is extracted. Do not reuse the bearing after extraction.

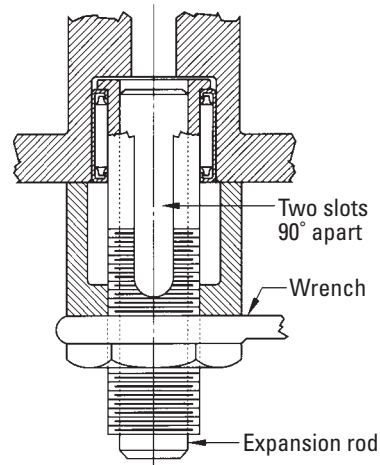


Fig. B2-7. Extraction from a shouldered or dead end housing

EXTRACTION FROM A SHOULDERED HOUSING (CAGED AND FULL COMPLEMENT BEARINGS) (with bearing pressed up close to the shoulder)

The tool to be used, as shown, is of a similar type described for a shouldered or dead end housing, but the rollers must first be removed from the bearing.

The four segment puller jaws are collapsed and slipped into the empty cup. The jaws are then forced outward into the cup bore by means of the tapered expansion rod. The jaws should bear on the lip as near as possible to the cup bore. The cup is then pressed out from the top.

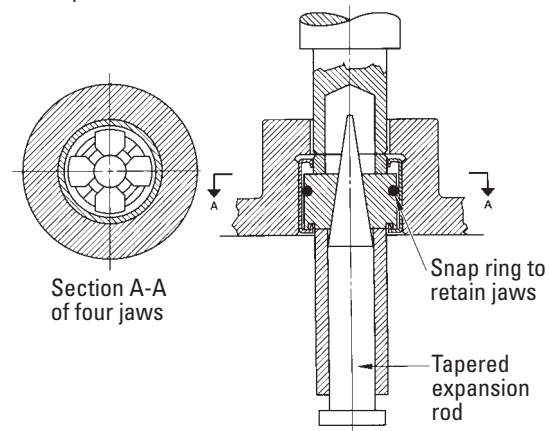


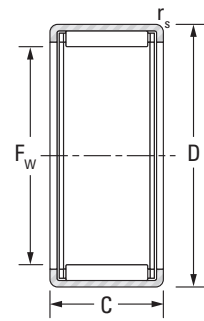
Fig. B2-8. Extraction from a shouldered housing

NOTES

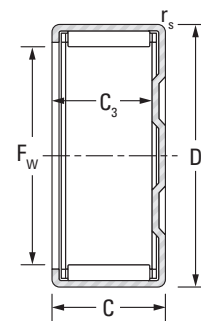


DRAWN CUP NEEDLE ROLLER BEARINGS
CAGED, OPEN ENDS, CLOSED ONE END

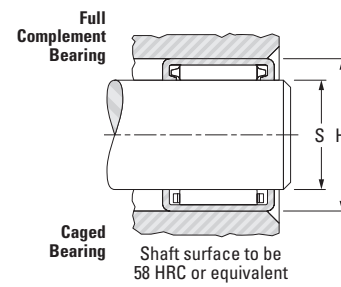
METRIC SERIES
HK, BK SERIES



HK



BK



Shaft surface to be 58 HRC or equivalent

Main technical table for HK and BK series bearings with columns for Shaft Dia., Fw, D, C, C3 min, rs min, Bearing Designation, Load Ratings (Dynamic, Static), Speed Rating (Grease, Oil), Approx. Wt., Inspection gage, and Mounting inner ring.

Note) For the recommended mounting dimensions see Table B2-1. (1) Drawn cup needle roller bearings with two needle roller and cage assemblies and one lubricating hole.

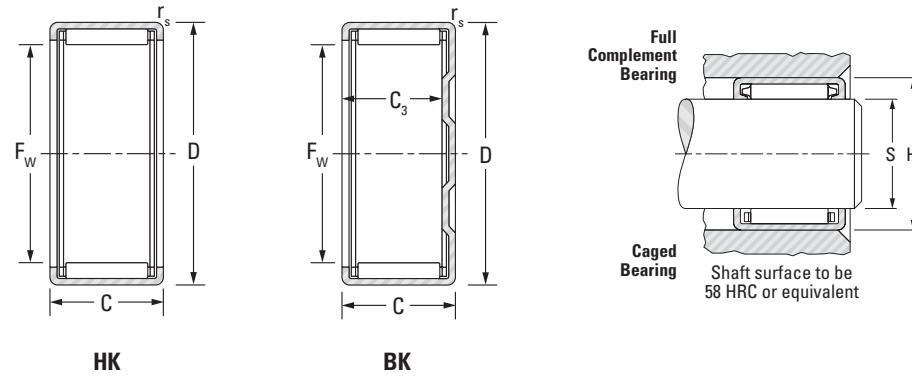
Main technical table for drawn cup needle roller bearings with columns for Shaft Dia., Fw, D, C, C3 min, rs min, Bearing Designation, Load Ratings (Dynamic, Static), Speed Rating (Grease, Oil), Approx. Wt., Inspection gage, and Mounting inner ring.

Continued on next page.



DRAWN CUP NEEDLE ROLLER BEARINGS
CAGED,
OPEN ENDS,
CLOSED ONE END

METRIC SERIES
HK, BK SERIES



Shaft Dia.	F _w	D	C		C _{3 min}	r _{s min}	Bearing Designation		Load Ratings		Speed Rating		Approx. Wt.	Inspection gage	Mounting inner ring (pages B-2-28 to B-2-37)
			+0	+0.000			Open Ends	Closed One End	Dynamic	Static	Grease	Oil			
			-0.3	-0.012											
mm in	mm in	mm in	mm in	mm in	mm in			kN lbf		min ⁻¹		kg lbs			
30 1.1811	30 1.1811	37 1.4567	12 0.472	9.3 0.366	1 0.039	—	BK3012	11.6 2610	16.8 3780	7000	11000	0.031 0.068	Table B2-2		
	30 1.1811	37 1.4567	12 0.472	—	1 0.039	HK3012	—	12.0 2700	17.7 3980	7000	11000	0.024 0.053	Table B2-2		
	30 1.1811	37 1.4567	16 0.630	13.30 0.524	1 0.039	—	BK3016	16.8 3780	27.3 6140	7000	11000	0.041 0.090	Table B2-2	JR25x30x17	
	30 1.1811	37 1.4567	16 0.630	—	1 0.039	HK3016	—	16.8 3780	27.3 6140	7000	11000	0.032 0.071	Table B2-2	JR25x30x17	
	30 1.1811	37 1.4567	20 0.787	17.3 0.681	1 0.039	—	BK3020	22.4 5040	39.6 8900	7000	11000	0.053 0.117	Table B2-2	JR25x30x20,5	
	30 1.1811	37 1.4567	20 0.787	—	1 0.039	HK3020	—	22.4 5040	39.6 8900	7000	11000	0.042 0.093	Table B2-2	JR25x30x20,5	
	30 1.1811	37 1.4567	26 1.024	23.3 0.917	1 0.039	—	BK3026	27.4 6160	51.2 11500	7000	11000	0.067 0.148	Table B2-2	JR25x30x26,5	
	30 1.1811	37 1.4567	26 1.024	—	1 0.039	HK3026	—	27.4 6160	51.2 11500	7000	11000	0.054 0.119	Table B2-2	JR25x30x26,5	
	30 1.1811	37 1.4567	38 1.496	35.3 1.390	1 0.039	—	BK3038 ⁽¹⁾	38.4 8630	79.2 17800	7000	11000	0.093 0.205	Table B2-2	JR25x30x38,5	
	30 1.1811	37 1.4567	38 1.496	—	1 0.039	HK3038 ⁽¹⁾	—	38.4 8630	79.2 17800	7000	11000	0.075 0.165	Table B2-2	JR25x30x38,5	
35 1.3780	35 1.3780	42 1.6535	12 0.472	—	1 0.039	HK3512	—	13.0 2920	20.6 4630	5900	9100	0.028 0.062	Table B2-2		
	35 1.3780	42 1.6535	16 0.630	—	1 0.039	HK3516	—	17.4 3910	29.9 6720	5900	9100	0.037 0.082	Table B2-2	JR30x35x17	
	35 1.3780	42 1.6535	20 0.787	17.3 0.681	1 0.039	—	BK3520	24.5 5510	46.8 10520	5900	9100	0.065 0.143	Table B2-2	JR30x35x20,5	
	35 1.3780	42 1.6535	20 0.787	—	1 0.039	HK3520	—	24.5 5510	46.8 10500	5900	9100	0.049 0.108	Table B2-2	JR30x35x20,5	
40 1.5748	40 1.5748	47 1.8504	12 0.472	—	1 0.039	HK4012	—	14.7 3300	25.3 5690	5200	7900	0.033 0.073	Table B2-2		
	40 1.5748	47 1.8504	16 0.630	—	1 0.039	HK4016	—	18.9 4250	34.8 7820	5200	7900	0.042 0.093	Table B2-2	JR35x40x17	
	40 1.5748	47 1.8504	20 0.787	17.3 0.681	1 0.039	—	BK4020	25.1 5640	50.4 11300	5200	7900	0.070 0.154	Table B2-2	JR35x40x20,5	

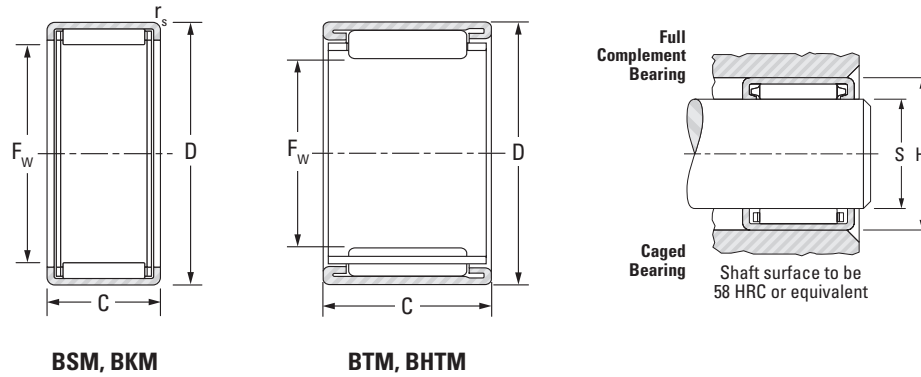
Note) For the recommended mounting dimensions see Table B2-1.
 (1) Drawn cup needle roller bearings with two needle roller and cage assemblies and one lubricating hole.

Shaft Dia.	F _w	D	C		C _{3 min}	r _{s min}	Bearing Designation		Load Ratings		Speed Rating		Approx. Wt.	Inspection gage	Mounting inner ring (pages B-2-28 to B-2-37)
			+0	+0.000			Open Ends	Closed One End	Dynamic	Static	Grease	Oil			
			-0.3	-0.012											
mm in	mm in	mm in	mm in	mm in	mm in			kN lbf		min ⁻¹		kg lbs			
40 1.5748	40 1.5748	47 1.8504	20 0.787	—	1 0.039	HK4020	—	25.1 5640	50.4 11300	5200	7900	0.060 0.132	Table B2-2	JR35x40x20,5	
45 1.7717	45 1.7717	52 2.0472	12 0.472	—	1 0.039	HK4512	—	14.1 3170	24.8 5580	4600	7000	0.036 0.079	Table B2-2		
	45 1.7717	52 2.0472	16 0.630	—	1 0.039	HK4516	—	19.8 4450	38.5 8660	4600	7000	0.048 0.106	Table B2-2	JR40x45x17	
	45 1.7717	52 2.0472	20 0.787	17.3 0.681	1 0.039	—	BK4520	26.3 5910	55.4 12500	4600	7000	0.079 0.174	Table B2-2	JR40x45x20,5	
	45 1.7717	52 2.0472	20 0.787	—	1 0.039	HK4520	—	27.2 6110	58.2 13100	4600	7000	0.059 0.130	Table B2-2	JR40x45x20,5	
50 1.9685	50 1.9685	58 2.2835	12 0.472	—	1 0.039	HK5012	—	17.0 3822	28.7 6452	4100	6300	0.045 0.099	Table B2-2		
	50 1.9685	58 2.2835	20 0.787	—	1 0.039	HK5020	—	30.9 6950	62.2 14000	4100	6300	0.072 0.159	Table B2-2	JR45x50x20	
	50 1.9685	58 2.2835	25 0.984	—	1 0.039	HK5025	—	35.5 7980	74.1 16700	4100	6300	0.092 0.203	Table B2-2	JR45x50x25,5	
55 2.1654	55 2.1654	63 2.4803	20 0.787	—	1 0.039	HK5520	—	31.0 6969	64.4 14478	3700	5700	0.079 0.174	Table B2-2		
60 2.3622	60 2.3622	68 2.6772	12 0.472	—	1 0.039	HK6012	—	18.6 4181	34.4 7733	3400	5200	0.060 0.132	Table B2-2		
	60 2.3622	68 2.6772	20 0.787	—	1 0.039	HK6020	—	32.5 7306	70.2 15782	3400	5200	0.090 0.198	Table B2-2		



DRAWN CUP NEEDLE ROLLER BEARINGS
CAGED,
OPEN ENDS,
CLOSED ONE END

METRIC SERIES
BSM, BKM, BTM, BHTM SERIES



Shaft Dia.	F _w	D	C		C _{3 min}	r _{s min}	Bearing Designation	Load Ratings		Speed Rating		Approx. Wt.	Inspection gage	Mounting inner ring (pages B-2-28 to B-2-37)
			+0 -0.3	+0.000 -0.012				Dynamic	Static	Grease	Oil			
			mm in	mm in				kN lbf	C ₀					
6 0.2362	6	10	9	—	—	6BTM109	2.65	2.4	23000	36000	0.003	Table B2-4	—	
8 0.3150	8	12	10	—	—	8BTM1210	3.55	3.85	21000	33000	0.004	Table B2-4	—	
		15	15	—	—	BHTM815	7.55	6.55	13000	20000	0.009	Table B2-4	—	
9 0.3543	9	13	10	—	—	9BTM1310A	3.8	4.25	21000	32000	0.004	Table B2-4	—	
9.8 0.3858	9.8	13.8	10	—	—	BTM101410A	3.75	4.25	21000	32000	0.004	Table B2-4	—	
10 0.3937	10	14	10	—	—	10BTM1410	3.95	4.6	20000	31000	0.004	Table B2-4	—	
		17	20	—	—	BHTM1020	11.9	12.6	12000	19000	0.015	Table B2-4	—	
12 0.4724	12	16	10	—	—	12BTM1610	4.65	6	20000	30000	0.005	Table B2-4	—	
		18	12	—	—	12BTM1812	6.55	6.7	14000	21000	0.009	Table B2-4	—	
13 0.5118	13	17	15	—	—	BKM131715J	5.65	7.85	20000	30000	0.007	Table B2-4	—	
		19	14	—	—	BKM131914J	8.6	9.95	14000	21000	0.011	Table B2-4	—	
		20	12	—	—	13BTM2012J	8.25	8.4	12000	18000	0.012	Table B2-4	—	
13.5 0.5315	13.5	21	14	—	—	BKM132114BJ	10.8	10.5	10000	16000	0.015	Table B2-4	—	
		19	12	—	—	BTM141912A	6.7	7.6	14000	22000	0.010	Table B2-4	—	
14 0.5512	14	19	16	—	—	14BTM1916B-1	8.8	11.9	16000	24000	0.011	Table B2-4	—	
		20	12	—	—	14BTM2012	6.95	7.5	13000	20000	0.010	Table B2-4	—	
14.5 0.5709	14.5	19.5	13.5	—	—	BTM152014A	8.35	10.9	15000	23000	0.009	Table B2-4	—	

Note) For the recommended mounting dimensions see Table B2-1.

Shaft Dia.	F _w	D	C		C _{3 min}	r _{s min}	Bearing Designation	Load Ratings		Speed Rating		Approx. Wt.	Inspection gage	Mounting inner ring (pages B-2-28 to B-2-37)
			+0 -0.3	+0.000 -0.012				Dynamic	Static	Grease	Oil			
			mm in	mm in				kN lbf	C ₀					
14.975 0.5896	14.975	21	10	—	—	BTM152110JA	5.8	6.25	13000	20000	0.009	Table B2-4	—	
15 0.5906	15	20	16	—	—	15BTM2016C-2	9.05	12.6	15000	23000	0.012	Table B2-4	—	
		21	16	—	—	15BTM2116	10.8	13.6	12000	19000	0.014	Table B2-4	—	
		22	15	—	—	15BTM2122	14.3	19.5	12000	19000	0.020	Table B2-4	—	
15	15	21	22	—	—	15BTM2122	14.3	19.5	12000	19000	0.020	Table B2-4	—	
		22	15	—	—	BHTM1515-1	11.9	13.3	10000	16000	0.010	Table B2-4	—	
		21.5	15	—	—	17BTM2215	6.8	9.6	12000	19000	0.010	Table B2-4	—	
17 0.6693	17	23	12	—	—	BTM172312	8.45	10.2	13000	20000	0.012	Table B2-4	—	
		24	15	—	—	BHTM1715-1	12.4	14.8	13000	20000	0.017	Table B2-4	—	
		24	20	—	—	BHTM1720-1	16.8	21.9	13000	20000	0.023	Table B2-4	—	
17	17	25	15	—	—	BTM172515	13.2	14.9	13000	20000	0.020	Table B2-4	—	
		24	11.6	—	—	18BTM2412	8.75	10.9	12000	18000	0.012	Table B2-4	—	
		24	16	—	—	BTM182416	12.3	16.8	12000	18000	0.017	Table B2-4	—	
18	18	25	20	—	—	BTM1820	16.7	22	12000	19000	0.024	Table B2-4	—	
		25	20	—	—	BTM182520	16.8	22.1	12000	19000	0.024	Table B2-4	—	
		26	16	—	—	BTM202616	13.3	19.6	10000	16000	0.019	Table B2-4	—	
20 0.7874	20	27	20	—	—	BTM202720-2	19.6	27.6	11000	17000	0.027	Table B2-4	—	
		27	25	—	—	BTM2025	24.3	36.4	11000	17000	0.033	Table B2-4	—	
		27	30	—	—	BTM202730	28.1	43.8	11000	17000	0.040	Table B2-4	—	
21.6 0.8504	21.6	26.645	12.4	—	—	BTM222712A	9.15	13.9	9800	15000	0.012	Table B2-4	—	
22 0.8661	22	28	12	—	—	22BTM2812	10	13.5	9800	15000	0.014	Table B2-4	—	
24 0.9449	24	30	13	—	—	BTM243013J	10.5	15.7	9100	14000	0.018	Table B2-4	—	
25 0.9843	25	31	19	—	—	25BTM3119A	17.9	30.1	8500	13000	0.026	Table B2-4	—	
		32	12	—	—	BTM2512	10.2	12.8	8500	13000	0.019	Table B2-4	—	
		33	20	—	—	BHTM2520-1	21.3	29.7	8500	13000	0.037	Table B2-4	—	

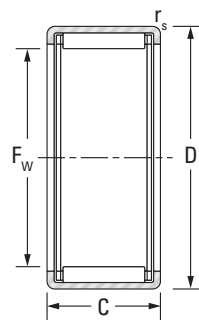
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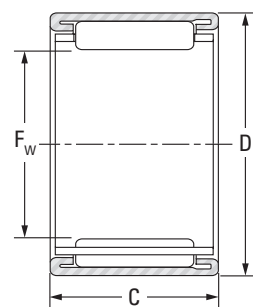
DRAWN CUP NEEDLE ROLLER BEARINGS

**CAGED,
OPEN ENDS,
CLOSED ONE END**

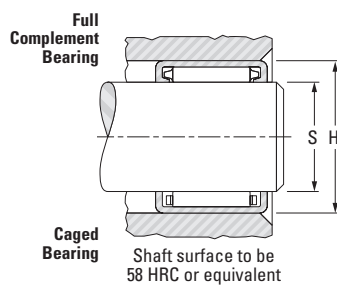
**METRIC SERIES
BSM, BKM, BTM, BHTM SERIES**



BSM, BKM



BTM, BHTM



Shaft Dia.	F _w	D	C		C _{3 min}	r _{s min}	Bearing Designation	Load Ratings		Speed Rating		Approx. Wt.	Inspection gage	Mounting inner ring (pages B-2-28 to B-2-37)
			+0	+0.000				Dynamic	Static	Grease	Oil			
			-0.3	-0.012										
mm in	mm in	mm in	mm in	mm in	mm in		kN lbf	min ⁻¹		kg lbs				
25 0.9843	25	33	30	—	—	BHTM2530-1	31	48	8500	13000	0.054	Table B2-4	—	
25.8 1.0157	25.8	33	16	—	—	BTM263316A	15.7	22.4	8500	13000	0.028	Table B2-4	—	
26 1.0236	26	31.4	12	—	—	BKM263112A	9.45	14.5	7800	12000	0.014	Table B2-4	—	
28 1.1024	28	33	12	—	—	BTM283312J	9.5	15.8	7200	11000	0.015	Table B2-4	—	
						28BTM3520	21.1	33.4	7800	12000	0.035	Table B2-4	—	
		28	36	20.75	—	—	BTM283621JA	25.3	39.3	7800	12000	0.044	Table B2-4	—
		28	37	20	—	—	BTM283720	24.2	33.5	7800	12000	0.046	Table B2-4	—
		28	37	30	—	—	BHTM2830	36.3	56.5	7800	12000	0.069	Table B2-4	—
30 1.1811	30	37	12	—	—	BTM303712	13.3	18.8	7200	11000	0.022	Table B2-4	—	
						30BTM3716BM	18.8	29.3	7200	11000	0.030	Table B2-4	—	
		30	37	20	—	—	30BTM3720	22.7	40.1	7200	11000	0.040	Table B2-4	—
		30	40	25	—	—	BHTM3025-1	32.7	46.8	7200	11000	0.069	Table B2-4	—
		30	40	30	—	—	BHTM3030-1A	39.2	59	7200	11000	0.083	Table B2-4	—
31 1.2205	31	39	17.8	—	—	31BTM3918A	22.9	34.8	7200	11000	0.039	Table B2-4	—	
32 1.2598	32	38	11	—	—	32BTM3811A	5.4	6.75	6500	10000	0.017	Table B2-4	—	
						BHTM3220A	26.1	35.1	6500	10000	0.058	Table B2-4	—	
		32	42	30	—	—	BHTM3230	40.5	61.9	6500	10000	0.086	Table B2-4	—

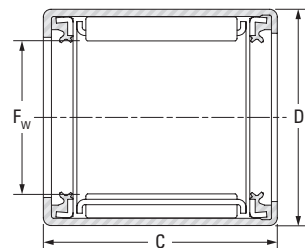
Note) For the recommended mounting dimensions see Table B2-1.

Shaft Dia.	F _w	D	C		C _{3 min}	r _{s min}	Bearing Designation	Load Ratings		Speed Rating		Approx. Wt.	Inspection gage	Mounting inner ring (pages B-2-28 to B-2-37)
			+0	+0.000				Dynamic	Static	Grease	Oil			
			-0.3	-0.012										
mm in	mm in	mm in	mm in	mm in	mm in		kN lbf	min ⁻¹		kg lbs				
33.5 1.3189	33.5	40	17	—	—	BTM344017A	18.5	33.5	6200	9500	0.034	Table B2-4	—	
35 1.3780	35	42	16	—	—	BTM3516	20.3	34.7	6000	9200	0.035	Table B2-4	—	
						BHTM3520	28.8	41.7	6100	9400	0.065	Table B2-4	—	
		35	45	30	—	—	BHTM3530	43.8	71.5	6100	9400	0.096	Table B2-4	—
37 1.4567	37	43	12	—	—	37BTM4312A	8.8	13.6	5600	8600	0.022	Table B2-4	—	
38 1.4961	38	45	12	—	—	BTM384512A	14.2	23.3	5500	8400	0.029	Table B2-4	—	
						BTM3830PL	45.6	76.5	5600	8600	0.102	Table B2-4	—	
40 1.5748	40	51	30	—	—	40BTM5130J	48.6	77.5	5400	8300	0.112	Table B2-4	—	
41.5 1.6339	41.5	46.5	8.5	—	—	BTM424709AJ	8.55	15.7	4900	7500	0.015	Table B2-4	—	
42 1.6535	42	53	30	—	—	BTM425330J	51	85	5100	7800	0.121	Table B2-4	—	
43.52 1.7134	43.52	48.52	14	—	—	44BTM4914A	13.3	29	4700	7200	0.027	Table B2-4	—	
45 1.7717	45	52	12	—	—	45BTM5212A	15.2	27.3	4600	7000	0.034	Table B2-4	—	
48 1.8898	48	56	30	—	—	BTM485630J	45.4	100	4300	6600	0.103	Table B2-4	—	
50 1.9685	50	58	20	—	—	50BTM5820J	31.7	61.9	4200	6400	0.068	Table B2-4	—	
						BTM5025	49.3	79.5	4200	6500	0.125	Table B2-4	—	
55 2.1654	55	63	20	—	—	55BTM6320	32.5	66	3700	5700	0.073	Table B2-4	—	
55.254 2.1754	55.254	60.3	14	—	—	BSM5514BJ-2	16.7	41	3600	5600	0.032	Table B2-4	—	
64 2.5197	64	73.178	21.1	—	—	64BTM7321A	40.3	84.9	3200	4900	0.110	Table B2-4	—	

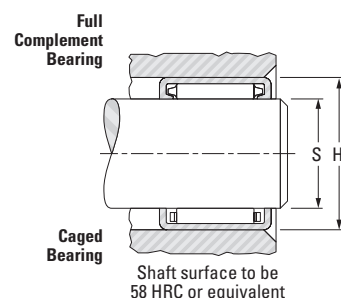


**DRAWN CUP NEEDLE ROLLER BEARINGS
SEALED**

**METRIC SERIES
BKM UU, BHKM UU SERIES**



BKM UU, BHKM UU



Shaft Dia.	F _w	D	C		C _{3 min}	r _{s min}	Bearing Designation	Load Ratings		Speed Rating	Approx. Wt.	Inspection gage	Mounting inner ring (pages B-2-28 to B-2-37)
			+0 -0.3	+0.000 -0.012				Dynamic C	Static C ₀				
mm in	mm in	mm in	mm in	mm in	mm in			kN lbf	min ⁻¹	kg lbs			
17 0.6693	17	24	26	—	—	BHKM1726JUU	17.6	23.3	13000	0.029	Table B2-4	—	
20 0.7874	20	27	26	—	—	BKM2026JUU	20.5	29.2	11000	0.033	Table B2-4	—	
	20	27	30	—	—	BKM2030JUU	24.3	36.4	11000	0.038	Table B2-4	—	
	20	27	35	—	—	BKM2035JUU	28.9	45.4	11000	0.045	Table B2-4	—	

Note) For the recommended mounting dimensions see Table B2-1.

INNER RINGS

METRIC SERIES

When it is impractical to meet the shaft raceway design requirements (hardness, surface finish, case depth, etc.) outlined in the engineering section of this catalog, standard inner rings may be used.

Inner rings are made of rolling bearing steel and after hardening, their bores, raceways and end surfaces are ground. Metric series inner rings may be used to provide inner raceway surfaces for metric series radial needle roller and cage assemblies, metric series needle roller bearings and metric series drawn cup needle roller bearings. The extended inner rings are suitable for use with bearings containing lip contact seals and for applications in which axial movement may be present.

CONSTRUCTION

Metric series inner rings are available in four basic designs and differ only by the chamfers at the ends of the raceway surfaces, the lubricant access holes and the raceway profile. Inner rings of series JR have chamfers to assist in bearing installation but are without lubricating holes. Inner rings of series JR.JS1 and IMC have bearing installation chamfers and lubricating holes (bore diameters 5 to 180 mm [0.1969 in to 7.0866 in]). Inner rings of series JRZ.JS1 are without installation chamfers, allowing for maximum possible raceway contact.

DIMENSIONAL ACCURACY

The tolerances of size, form, and runout for metric series inner rings meet the requirements of ISO normal tolerance class for radial bearings (see the engineering section). Most metric series inner rings are produced with outside diameter raceway tolerance in accordance with h5 which, in most cases, is suitable for combining the metric series needle roller bearings to give the normal clearance class, and for use with drawn cup bearings. Other raceway tolerances may also be found on inner rings for combining with needle roller bearings to give one of the clearance requirements.

MOUNTING OF INNER RINGS

Inner rings may be mounted on the shaft with either a loose transition fit or an interference fit. These fits used in conjunction with the proper fit of the bearing outer ring, will provide the correct operating clearances for most applications.

Regardless of the fit of the inner ring on the shaft, the inner ring should be axially located by shaft shoulders or other positive means. The shaft shoulder diameter adjacent to the inner ring must not exceed the inner ring outside diameter (per suggestions on pages B-4-9 and B-4-10 of the metric series needle roller bearing section).

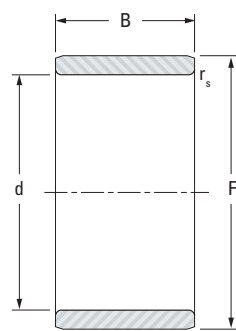
When metric series inner rings are to be used with the metric series needle roller bearings, appropriate shaft tolerances should be selected from Table B4-4 on page B-4-9 in the metric series needle roll bearing section. When Metric series inner rings are to be used with drawn cup bearings the suggested shaft tolerances are given in the "Inner ring" discussion on page B-2-8 of the "metric series drawn cup needle roller bearings" section of this catalog.

INCH SERIES INNER RINGS

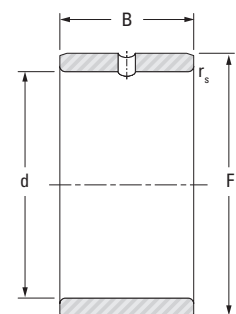
Inch series inner rings for use with inch series drawn cup bearings are tabulated on page B-2-74 of this catalog.



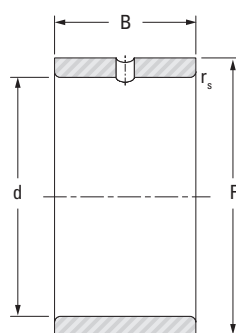
INNER RINGS



JR, IM..P



JR.JS1

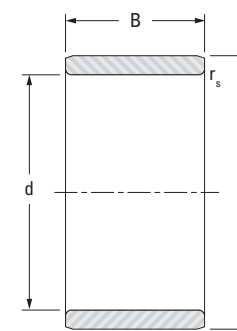


JRZ.JS1

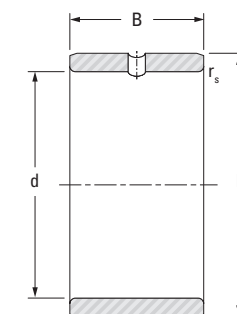
Shaft Dia.	d	F ⁽¹⁾	B	r _s min	Inner Ring Designation	Wt.
mm in	mm in	mm in	mm in	mm in		kg lbs
5 0.1969	5 0.1969	8 0.3150	8 0.3150	0.3 0.01	JR5x8x8JS1	0.002 0.004
	5 0.1969	8 0.3150	12 0.4724	0.3 0.01	JR5x8x12	0.003 0.007
	5 0.1969	8 0.3150	16 0.630	0.3 0.01	JR5x8x16	0.004 0.009
6 0.2362	6 0.2362	9 0.3543	8 0.315	0.3 0.01	JR6x9x8JS1	0.002 0.004
	6 0.2362	9 0.3543	12 0.4724	0.3 0.01	JR6x9x12	0.003 0.007
	6 0.2362	9 0.3543	16 0.630	0.3 0.01	JR6x9x16	0.004 0.009
	6 0.2362	10 0.3937	10 0.394	0.3 0.01	JR6x10x10	0.004 0.009
	6 0.2362	10 0.3937	10 0.394	0.3 0.01	JR6x10x10JS1	0.004 0.009
	6 0.2362	10 0.3937	12 0.4724	0.3 0.01	JRZ6x10x12JS1	0.005 0.011
7 0.2756	7 0.2756	10 0.3937	10.5 0.413	0.3 0.01	JR7x10x10,5	0.003 0.007
	7 0.2756	10 0.3937	12 0.4724	0.3 0.01	JR7x10x12	0.004 0.009
	7 0.2756	10 0.3937	16 0.630	0.3 0.01	JR7x10x16	0.005 0.011
8 0.3150	8 0.3150	12 0.4724	10 0.394	0.3 0.01	JR8x12x10	0.005 0.011
	8 0.3150	12 0.4724	10 0.394	0.3 0.01	JR8x12x10JS1	0.005 0.011
	8 0.3150	12 0.4724	10.5 0.413	0.3 0.01	JR8x12x10,5	0.005 0.011
	8 0.3150	12 0.4724	12 0.472	0.3 0.01	JRZ8x12x12JS1	0.006 0.013
	8 0.3150	12 0.4724	12.5 0.492	0.3 0.01	JR8x12x12,5	0.006 0.013
	8 0.3150	12 0.4724	16 0.630	0.3 0.01	IM 8 12 16 P	0.007 0.016
9 0.3543	9 0.3543	12 0.4724	12 0.4724	0.3 0.01	JR9x12x12	0.005 0.011
	9 0.3543	12 0.4724	16 0.630	0.3 0.01	JR9x12x16	0.006 0.013
10 0.3937	10 0.3937	13 0.5118	12.5 0.492	0.3 0.01	JR10x13x12,5	0.005 0.011
	10 0.3937	14 0.5512	11 0.433	0.3 0.01	JR10x14x11JS1	0.007 0.015
	10 0.3937	14 0.5512	12 0.4724	0.3 0.01	JR10x14x12	0.007 0.015
	10 0.3937	14 0.5512	12 0.4724	0.3 0.01	JR10x14x12JS1	0.007 0.015

(1) Inner rings for metric full complement needle roller bearings are produced with outside diameter tolerance g5.

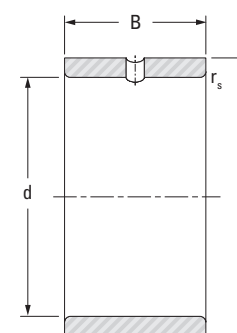
INNER RINGS



JR, IM..P



JR.JS1



JRZ.JS1

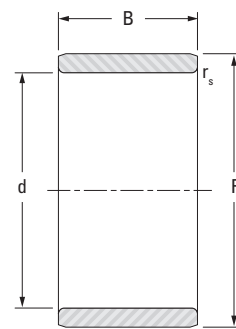
Shaft Dia.	d	F ⁽¹⁾	B	r _s min	Inner Ring Designation	Wt.
mm in	mm in	mm in	mm in	mm in		kg lbs
10 0.3937	10 0.3937	14 0.5512	13 0.512	0.3 0.01	JR10x14x13	0.007 0.015
	10 0.3937	14 0.5512	14 0.551	0.3 0.01	JRZ10x14x14JS1	0.008 0.018
	10 0.3937	14 0.5512	16 0.630	0.3 0.01	JR10x14x16	0.009 0.020
	10 0.3937	14 0.5512	20 0.787	0.3 0.01	JR10x14x20	0.012 0.026
12 0.4724	12 0.4724	15 0.5906	12.5 0.492	0.3 0.01	JR12x15x12,5	0.006 0.013
	12 0.4724	15 0.5906	16 0.630	0.3 0.01	JR12x15x16	0.008 0.018
	12 0.4724	15 0.5906	16.5 0.650	0.3 0.01	JR12x15x16,5	0.008 0.018
	12 0.4724	15 0.5906	18.5 0.728	0.3 0.01	JR12x15x18,5	0.009 0.020
	12 0.4724	15 0.5906	22.4 0.882	0.2 0.01	IM 12 15 22,4 P	0.011 0.024
	12 0.4724	15 0.5906	22.5 0.886	0.3 0.01	JR12x15x22,5	0.011 0.024
	12 0.4724	16 0.6299	12 0.472	0.3 0.01	JR12x16x12	0.008 0.018
	12 0.4724	16 0.6299	12 0.472	0.3 0.01	JR12x16x12JS1	0.008 0.018
	12 0.4724	16 0.6299	13 0.512	0.3 0.01	JR12x16x13	0.008 0.018
	12 0.4724	16 0.6299	14 0.551	0.3 0.01	JRZ12x16x14JS1	0.010 0.022
	12 0.4724	16 0.6299	16 0.630	0.3 0.01	JR12x16x16	0.011 0.024
	12 0.4724	16 0.6299	20 0.787	0.3 0.01	JR12x16x20	0.014 0.031
	12 0.4724	16 0.6299	22 0.866	0.3 0.01	JR12x16x22	0.015 0.033
13 0.5118	13 0.5118	18 0.7087	16 0.630	0.35 0.014	IM 13 18 16 P	0.015 0.033
14 0.5512	14 0.5512	17 0.6693	17 0.669	0.3 0.01	JR14x17x17	0.009 0.020
15 0.5906	15 0.5906	18 0.7087	16.5 0.650	0.3 0.01	JR15x18x16,5	0.010 0.022
	15 0.5906	19 0.7480	16 0.630	0.3 0.01	JR15x19x16	0.013 0.029
	15 0.5906	19 0.7480	20 0.787	0.3 0.01	JR15x19x20	0.017 0.037
	15 0.5906	20 0.7874	12 0.472	0.3 0.01	JR15x20x12	0.012 0.026
	15 0.5906	20 0.7874	12 0.472	0.3 0.01	JR15x20x12JS1	0.012 0.026

(1) Inner rings for metric full complement needle roller bearings are produced with outside diameter tolerance g5.

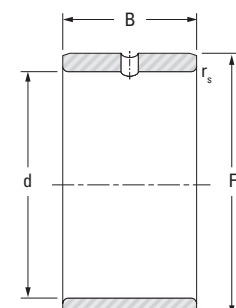
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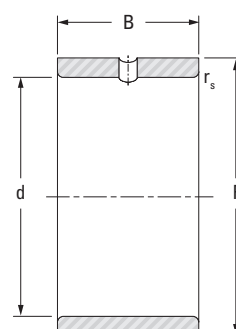
INNER RINGS



JR, IM..P



JR.JS1

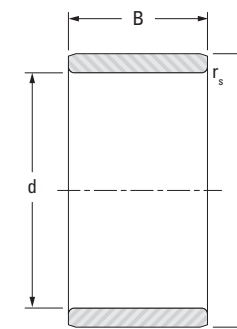


JRZ.JS1

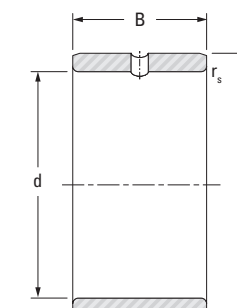
Shaft Dia.	d	F ⁽¹⁾	B	r _s min	Inner Ring Designation	Wt.
mm in	mm in	mm in	mm in	mm in		kg lbs
15 0.5906	15 0.5906	20 0.7874	13 0.512	0.3 0.01	JR15x20x13	0.014 0.031
	15 0.5906	20 0.7874	14 0.551	0.3 0.01	JRZ15x20x14JS1	0.015 0.033
	15 0.5906	20 0.7874	16 0.630	0.3 0.01	JR15x20x16	0.017 0.037
	15 0.5906	20 0.7874	20 0.787	0.35 0.014	IM 15 20 20 P	0.021 0.045
	15 0.5906	20 0.7874	23 0.906	0.3 0.01	JR15x20x23	0.025 0.055
	15 0.5906	20 0.7874	26 1.024	0.3 0.01	JR15x20x26	0.028 0.062
17 0.6693	17 0.6693	20 0.7874	16.5 0.650	0.3 0.01	JR17x20x16,5	0.011 0.024
	17 0.6693	20 0.7874	20 0.787	0.3 0.01	JR17x20x20	0.014 0.031
	17 0.6693	20 0.7874	20.5 0.807	0.3 0.01	JR17x20x20,5	0.014 0.031
	17 0.6693	20 0.7874	30.5 1.201	0.3 0.01	JR17x20x30,5	0.021 0.046
	17 0.6693	21 0.8268	16 0.630	0.3 0.01	JR17x21x16	0.015 0.033
	17 0.6693	21 0.8268	20 0.787	0.3 0.01	JR17x21x20	0.019 0.042
	17 0.6693	22 0.8661	13 0.512	0.3 0.01	JR17x22x13	0.015 0.033
	17 0.6693	22 0.8661	13 0.512	0.35 0.014	IM 4903	0.015 0.033
	17 0.6693	22 0.8661	16 0.630	0.3 0.01	JR17x22x16	0.019 0.042
	17 0.6693	22 0.8661	16 0.630	0.3 0.01	JR17x22x16JS1	0.019 0.042
	17 0.6693	22 0.8661	16 0.630	0.3 0.01	JRZ17x22x16JS1	0.019 0.042
	17 0.6693	22 0.8661	20 0.787	0.35 0.014	IM 17 22 20 P	0.023 0.051
	17 0.6693	22 0.8661	23 0.906	0.3 0.01	JR17x22x23	0.028 0.062
	17 0.6693	22 0.8661	26 1.024	0.3 0.01	JR17x22x26	0.031 0.068
	17 0.6693	22 0.8661	32 1.260	0.3 0.01	JR17x22x32	0.038 0.084
20 0.7874	20 0.7874	24 0.9449	16 0.630	0.3 0.01	JR20x24x16	0.018 0.040
	20 0.7874	24 0.9449	20 0.787	0.3 0.01	JR20x24x20	0.022 0.049
	20 0.7874	25 0.9843	16 0.630	0.3 0.01	JR20x25x16	0.022 0.049

(1) Inner rings for metric full complement needle roller bearings are produced with outside diameter tolerance g5.

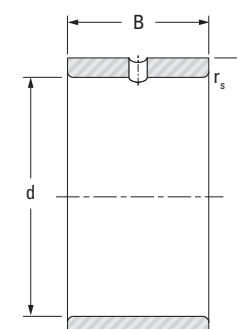
INNER RINGS



JR, IM..P



JR.JS1



JRZ.JS1

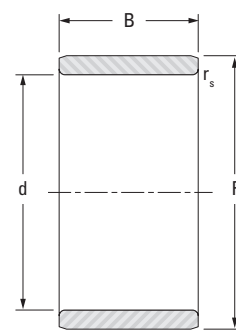
Shaft Dia.	d	F ⁽¹⁾	B	r _s min	Inner Ring Designation	Wt.
mm in	mm in	mm in	mm in	mm in		kg lbs
20 0.7874	20 0.7874	25 0.9843	16 0.630	0.3 0.01	JR20x25x16JS1	0.022 0.049
	20 0.7874	25 0.9843	17 0.669	0.3 0.01	JR20x25x17	0.023 0.051
	20 0.7874	25 0.9843	18 0.709	0.3 0.01	JRZ20x25x18JS1	0.025 0.055
	20 0.7874	25 0.9843	20 0.787	0.3 0.01	JR20x25x20	0.028 0.062
	20 0.7874	25 0.9843	20.5 0.807	0.3 0.01	JR20x25x20,5	0.029 0.064
	20 0.7874	25 0.9843	26 1.024	0.3 0.01	JR20x25x26	0.036 0.079
	20 0.7874	25 0.9843	26.5 1.043	0.3 0.01	JR20x25x26,5	0.037 0.082
	20 0.7874	25 0.9843	30 1.181	0.3 0.01	JR20x25x30	0.042 0.093
	20 0.7874	25 0.9843	32 1.260	0.3 0.01	JR20x25x32	0.044 0.097
	20 0.7874	25 0.9843	38.5 1.516	0.3 0.01	JR20x25x38,5	0.054 0.119
22 0.8661	22 0.8661	26 1.0236	16 0.630	0.3 0.01	JR22x26x16	0.019 0.042
	22 0.8661	26 1.0236	20 0.787	0.3 0.01	JR22x26x20	0.023 0.051
	22 0.8661	28 1.1024	17 0.669	0.3 0.01	JR22x28x17	0.030 0.066
	22 0.8661	28 1.1024	20.5 0.807	0.3 0.01	JR22x28x20,5	0.038 0.084
	22 0.8661	28 1.1024	30 1.181	0.3 0.01	JR22x28x30	0.056 0.123
23 0.9055	23 0.9055	28 1.1024	20 0.787	0.35 0.014	IM 23 28 20 P	0.030 0.066
25 0.9843	25 0.9843	29 1.1417	20 0.787	0.3 0.01	JR25x29x20	0.027 0.060
	25 0.9843	29 1.1417	30 1.181	0.3 0.01	JR25x29x30	0.040 0.088
	25 0.9843	30 1.1811	16 0.630	0.3 0.01	JR25x30x16	0.027 0.060
	25 0.9843	30 1.1811	16 0.630	0.3 0.01	JR25x30x16JS1	0.027 0.060
	25 0.9843	30 1.1811	17 0.669	0.3 0.01	JR25x30x17	0.028 0.062
	25 0.9843	30 1.1811	18 0.709	0.3 0.01	JRZ25x30x18JS1	0.031 0.068
	25 0.9843	30 1.1811	20 0.787	0.3 0.01	JR25x30x20	0.034 0.075
	25 0.9843	30 1.1811	20.5 0.807	0.3 0.01	JR25x30x20,5	0.035 0.077

(1) Inner rings for metric full complement needle roller bearings are produced with outside diameter tolerance g5.

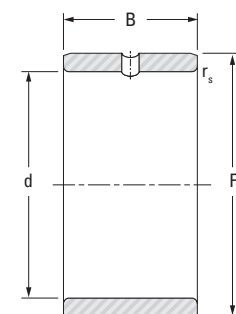
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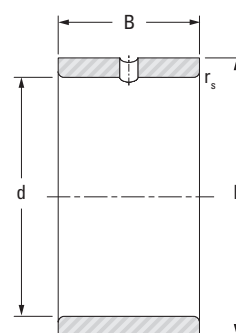
INNER RINGS



JR, IM..P



JR.JS1

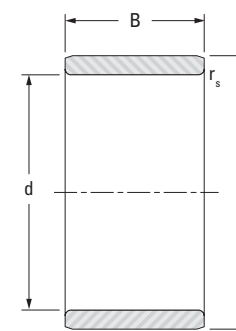


JRZ.JS1

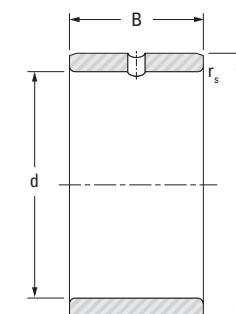
Shaft Dia.	d	F ⁽¹⁾	B	r _s min	Inner Ring Designation	Wt.
mm in	mm in	mm in	mm in	mm in		kg lbs
25 0.9843	25 0.9843	30 1.1811	26 1.024	0.3 0.01	JR25x30x26	0.044 0.097
	25 0.9843	30 1.1811	26.5 1.043	0.3 0.01	JR25x30x26,5	0.045 0.099
	25 0.9843	30 1.1811	30 1.181	0.3 0.01	JR25x30x30	0.051 0.112
	25 0.9843	30 1.1811	32 1.260	0.3 0.01	JR25x30x32	0.054 0.119
	25 0.9843	30 1.1811	38.5 1.516	0.3 0.01	JR25x30x38,5	0.066 0.146
28 1.1024	28 1.1024	32 1.2598	17 0.669	0.3 0.01	JR28x32x17	0.028 0.062
	28 1.1024	32 1.2598	20 0.787	0.3 0.01	JR28x32x20	0.030 0.066
	28 1.1024	32 1.2598	30 1.181	0.3 0.01	JR28x32x30	0.044 0.097
30 1.1811	30 1.1811	35 1.3780	16 0.630	0.3 0.01	JR30x35x16	0.031 0.068
	30 1.1811	35 1.3780	17 0.669	0.3 0.01	JR30x35x17	0.033 0.073
	30 1.1811	35 1.3780	17 0.669	0.35 0.014	IM 4906	0.033 0.073
	30 1.1811	35 1.3780	18 0.709	0.3 0.01	JRZ30x35x18JS1	0.036 0.079
	30 1.1811	35 1.3780	20 0.787	0.3 0.01	JR30x35x20	0.039 0.086
	30 1.1811	35 1.3780	20 0.787	0.3 0.01	JRZ30x35x20JS1	0.039 0.086
	30 1.1811	35 1.3780	20.5 0.807	0.3 0.01	JR30x35x20,5	0.040 0.088
	30 1.1811	35 1.3780	26 1.024	0.3 0.01	JR30x35x26	0.054 0.119
	30 1.1811	35 1.3780	30 1.181	0.3 0.01	JR30x35x30	0.057 0.126
	30 1.1811	35 1.3780	32 1.260	0.3 0.01	JR30x35x32	0.062 0.137
	30 1.1811	38 1.4961	20 0.787	0.6 0.02	JR30x38x20JS1	0.067 0.148
32 1.2598	32 1.2598	37 1.4567	20 0.787	0.3 0.01	JR32x37x20	0.043 0.095
	32 1.2598	37 1.4567	30 1.181	0.3 0.01	JR32x37x30	0.064 0.141
	32 1.2598	40 1.5748	20 0.787	0.6 0.02	JR32x40x20	0.069 0.152
	32 1.2598	40 1.5748	36 1.417	0.6 0.02	JR32x40x36	0.128 0.282
35 1.3780	35 1.3780	40 1.5748	17 0.669	0.3 0.01	JR35x40x17	0.040 0.088

(1) Inner rings for metric full complement needle roller bearings are produced with outside diameter tolerance g5.

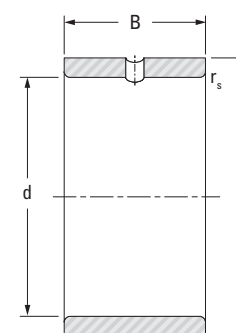
INNER RINGS



JR, IM..P



JR.JS1



JRZ.JS1

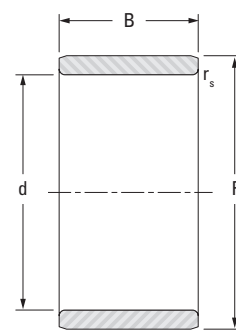
Shaft Dia.	d	F ⁽¹⁾	B	r _s min	Inner Ring Designation	Wt.
mm in	mm in	mm in	mm in	mm in		kg lbs
35 1.3780	35 1.3780	40 1.5748	20 0.787	0.3 0.01	JR35x40x20	0.046 0.101
	35 1.3780	40 1.5748	20.5 0.807	0.3 0.01	JR35x40x20,5	0.049 0.108
	35 1.3780	40 1.5748	22 0.866	0.3 0.01	JR35x40x22	0.052 0.115
	35 1.3780	40 1.5748	30 1.181	0.3 0.01	JR35x40x30	0.071 0.157
	35 1.3780	40 1.5748	34 1.339	0.3 0.01	JR35x40x34	0.080 0.176
	35 1.3780	40 1.5748	40 1.575	0.3 0.01	JR35x40x40	0.094 0.207
	35 1.3780	42 1.6535	20 0.787	0.6 0.02	JR35x42x20	0.065 0.143
	35 1.3780	42 1.6535	20 0.787	0.6 0.02	JR35x42x20JS1	0.065 0.143
	35 1.3780	42 1.6535	23 0.906	0.6 0.02	JRZ35x42x23JS1	0.074 0.163
	35 1.3780	42 1.6535	36 1.417	0.6 0.02	JR35x42x36	0.122 0.269
	35 1.3780	44 1.7323	22 0.866	0.6 0.02	JR35x44x22	0.097 0.214
37 1.4567	37 1.4567	42 1.6535	20 0.787	0.35 0.014	IM 37 42 20 P	0.046 0.101
38 1.4961	38 1.4961	43 1.6929	20 0.787	0.3 0.01	JR38x43x20	0.050 0.110
	38 1.4961	43 1.6929	30 1.181	0.3 0.01	JR38x43x30	0.075 0.165
40 1.5748	40 1.5748	45 1.7717	17 0.669	0.3 0.01	JR40x45x17	0.044 0.097
	40 1.5748	45 1.7717	20 0.787	0.3 0.01	JR40x45x20	0.052 0.115
	40 1.5748	45 1.7717	20.5 0.807	0.3 0.01	JR40x45x20,5	0.054 0.119
	40 1.5748	45 1.7717	25 0.984	0.35 0.014	IM 40 45 25 P	0.062 0.137
	40 1.5748	45 1.7717	30 1.181	0.3 0.01	JR40x45x30	0.078 0.172
	40 1.5748	45 1.7717	34 1.339	0.3 0.01	JR40x45x34	0.089 0.196
	40 1.5748	45 1.7717	40 1.575	0.3 0.01	JR40x45x40	0.115 0.254
	40 1.5748	48 1.8898	22 0.866	0.6 0.02	JR40x48x22	0.094 0.207
	40 1.5748	48 1.8898	23 0.906	0.6 0.02	JRZ40x48x23JS1	0.100 0.220
	40 1.5748	48 1.8898	40 1.575	0.6 0.02	JR40x48x40	0.173 0.381

(1) Inner rings for metric full complement needle roller bearings are produced with outside diameter tolerance g5.

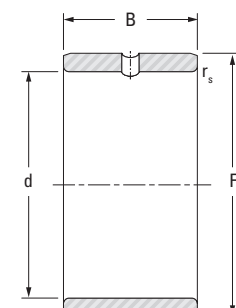
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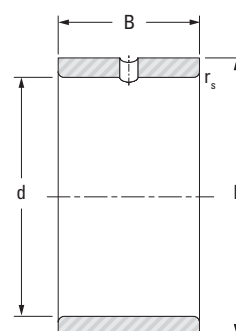
INNER RINGS



JR, IM..P



JR.JS1

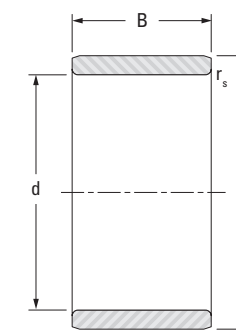


JRZ.JS1

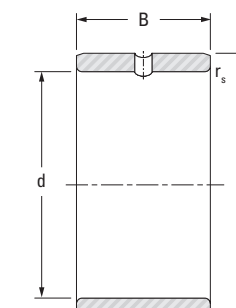
Shaft Dia.	d	F (1)	B	r _s min	Inner Ring Designation	Wt.
mm in	mm in	mm in	mm in	mm in		kg lbs
40 1.5748	40 1.5748	50 1.9685	20 0.787	1 0.04	JR40x50x20	0.110 0.243
42 1.6535	42 1.6535	47 1.8504	20 0.787	0.3 0.01	JR42x47x20	0.055 0.121
	42 1.6535	47 1.8504	30 1.181	0.3 0.01	JR42x47x30	0.083 0.183
45 1.7717	45 1.7717	50 1.9685	20 0.787	0.3 0.01	JR45x50x20	0.058 0.128
	45 1.7717	50 1.9685	25 0.984	0.6 0.02	JR45x50x25	0.073 0.161
	45 1.7717	50 1.9685	25.5 1.004	0.3 0.01	JR45x50x25,5	0.075 0.165
	45 1.7717	50 1.9685	35 1.378	0.6 0.02	JR45x50x35	0.103 0.227
	45 1.7717	50 1.9685	40 1.575	0.3 0.01	JR45x50x40	0.117 0.258
	45 1.7717	52 2.0472	22 0.866	0.6 0.02	JR45x52x22	0.090 0.198
	45 1.7717	52 2.0472	22 0.866	0.85 0.033	IM 4909	0.087 0.192
	45 1.7717	52 2.0472	23 0.906	0.6 0.02	JR45x52x23	0.096 0.212
	45 1.7717	52 2.0472	23 0.906	0.6 0.02	JRZ45x52x23JS1	0.096 0.212
	45 1.7717	52 2.0472	40 1.575	0.6 0.02	JR45x52x40	0.167 0.368
	45 1.7717	55 2.1654	20 0.787	1 0.04	JR45x55x20	0.133 0.293
	45 1.7717	55 2.1654	20 0.787	1 0.04	JR45x55x20JS1	0.133 0.293
	45 1.7717	55 2.1654	22 0.866	1 0.04	JR45x55x22	0.135 0.298
	45 1.7717	55 2.1654	40 1.575	1 0.04	JR45x55x40	0.247 0.545
50 1.9685	50 1.9685	55 2.1654	20 0.787	0.3 0.01	JR50x55x20	0.065 0.143
	50 1.9685	55 2.1654	25 0.984	0.6 0.02	JR50x55x25	0.081 0.179
	50 1.9685	55 2.1654	35 1.378	0.65 0.026	IM 50 55 35 P	0.107 0.236
	50 1.9685	55 2.1654	35 1.378	0.6 0.02	JR50x55x35	0.113 0.249
	50 1.9685	55 2.1654	40 1.575	0.3 0.01	JR50x55x40	0.130 0.287
	50 1.9685	58 2.2835	22 0.866	0.6 0.02	JR50x58x22	0.117 0.258
	50 1.9685	58 2.2835	23 0.906	0.6 0.02	JRZ50x58x23JS1	0.122 0.269

(1) Inner rings for metric full complement needle roller bearings are produced with outside diameter tolerance g5.

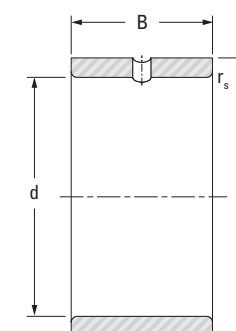
INNER RINGS



JR, IM..P



JR.JS1



JRZ.JS1

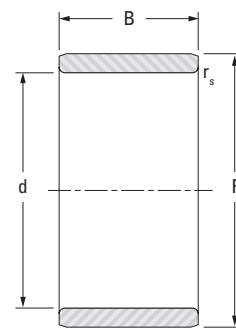
Shaft Dia.	d	F (1)	B	r _s min	Inner Ring Designation	Wt.
mm in	mm in	mm in	mm in	mm in		kg lbs
50 1.9685	50 1.9685	58 2.2835	40 1.575	0.6 0.02	JR50x58x40	0.213 0.470
	50 1.9685	60 2.3622	20 0.787	1 0.04	JR50x60x20	0.155 0.342
	50 1.9685	60 2.3622	20 0.787	1 0.04	JR50x60x20JS1	0.155 0.342
	50 1.9685	60 2.3622	25 0.984	1 0.04	JR50x60x25	0.170 0.375
	50 1.9685	60 2.3622	40 1.575	1 0.04	JR50x60x40	0.310 0.683
55 2.1654	55 2.1654	60 2.3622	25 0.984	0.6 0.02	JR55x60x25	0.088 0.194
	55 2.1654	60 2.3622	35 1.378	0.65 0.026	IM 55 60 35 P	0.118 0.260
	55 2.1654	60 2.3622	35 1.378	0.6 0.02	JR55x60x35	0.124 0.273
	55 2.1654	63 2.4803	25 0.984	1 0.04	JR55x63x25	0.141 0.311
	55 2.1654	63 2.4803	45 1.772	1 0.04	JR55x63x45	0.286 0.631
	55 2.1654	65 2.5591	30 1.181	1 0.04	JR55x65x30	0.222 0.489
	55 2.1654	65 2.5591	60 2.362	1 0.04	JR55x65x60	0.444 0.979
58 2.2835	58 2.2835	65 2.5591	25 0.984	0.85 0.033	IM 58 65 25 P	0.125 0.276
60 2.3622	60 2.3622	68 2.6772	25 0.984	0.6 0.02	JR60x68x25	0.153 0.337
	60 2.3622	68 2.6772	35 1.378	0.6 0.02	JR60x68x35	0.220 0.485
	60 2.3622	68 2.6772	45 1.772	1 0.04	JR60x68x45	0.284 0.626
	60 2.3622	70 2.7559	25 0.984	1 0.04	JR60x70x25	0.200 0.441
	60 2.3622	70 2.7559	30 1.181	1 0.04	JR60x70x30	0.240 0.529
	60 2.3622	70 2.7559	35 1.378	0.85 0.033	IM 60 70 35 P	0.280 0.616
	60 2.3622	70 2.7559	60 2.362	1 0.04	JR60x70x60	0.480 1.058
65 2.5591	65 2.5591	72 2.8346	25 0.984	1 0.04	JR65x72x25	0.143 0.315
	65 2.5591	72 2.8346	45 1.772	1 0.04	JR65x72x45	0.266 0.586
	65 2.5591	73 2.8740	25 0.984	0.6 0.02	JR65x73x25	0.170 0.375
	65 2.5591	73 2.8740	35 1.378	0.6 0.02	JR65x73x35	0.240 0.529

(1) Inner rings for metric full complement needle roller bearings are produced with outside diameter tolerance g5.

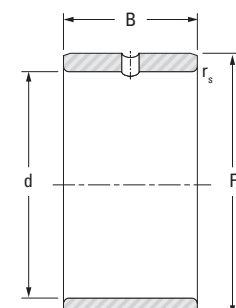
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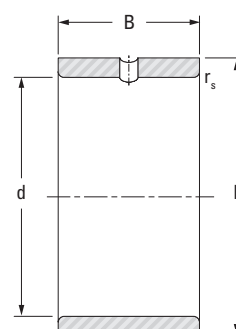
INNER RINGS



JR, IM..P



JR.JS1

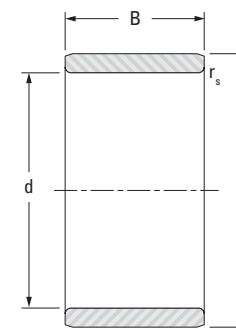


JRZ.JS1

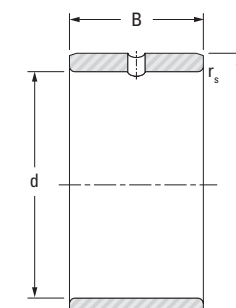
Shaft Dia.	d	F ⁽¹⁾	B	r _s min	Inner Ring Designation	Wt.
mm in	mm in	mm in	mm in	mm in		kg lbs
65 2.5591	65 2.5591	75 2.9528	28 1.102	1 0.04	JR65x75x28	0.240 0.529
	65 2.5591	75 2.9528	30 1.181	1 0.04	JR65x75x30	0.260 0.573
	65 2.5591	75 2.9528	60 2.362	1 0.04	JR65x75x60	0.520 1.146
70 2.7559	70 2.7559	80 3.1496	25 0.984	1 0.04	JR70x80x25	0.230 0.507
	70 2.7559	80 3.1496	30 1.181	1 0.04	JR70x80x30	0.270 0.595
	70 2.7559	80 3.1496	35 1.378	1 0.04	JR70x80x35	0.320 0.705
	70 2.7559	80 3.1496	54 2.126	1 0.04	JR70x80x54	0.500 1.102
	70 2.7559	80 3.1496	60 2.362	1 0.04	JR70x80x60	0.556 1.226
75 2.9528	75 2.9528	85 3.3465	25 0.984	1 0.04	JR75x85x25	0.240 0.529
	75 2.9528	85 3.3465	30 1.181	1 0.04	JR75x85x30	0.289 0.637
	75 2.9528	85 3.3465	35 1.378	1 0.04	JR75x85x35	0.338 0.745
	75 2.9528	85 3.3465	54 2.126	1 0.04	JR75x85x54	0.530 1.168
80 3.1496	80 3.1496	90 3.5433	25 0.984	1 0.04	JR80x90x25	0.260 0.573
	80 3.1496	90 3.5433	30 1.181	1 0.04	JR80x90x30	0.306 0.675
	80 3.1496	90 3.5433	35 1.378	1 0.04	JR80x90x35	0.355 0.783
	80 3.1496	90 3.5433	54 2.126	1 0.04	JR80x90x54	0.565 1.246
85 3.3465	85 3.3465	95 3.7402	26 1.024	1 0.04	JR85x95x26	0.290 0.639
	85 3.3465	95 3.7402	30 1.181	1 0.04	JR85x95x30	0.334 0.736
	85 3.3465	95 3.7402	36 1.417	1 0.04	JR85x95x36	0.397 0.875
	85 3.3465	100 3.9370	35 1.378	1.1 0.04	JR85x100x35	0.595 1.312
	85 3.3465	100 3.9370	63 2.480	1.1 0.04	JR85x100x63	1.080 2.381
90 3.5433	90 3.5433	100 3.9370	26 1.024	1 0.04	JR90x100x26	0.300 0.661
	90 3.5433	100 3.9370	30 1.181	1 0.04	JR90x100x30	0.350 0.772
	90 3.5433	100 3.9370	36 1.417	1 0.04	JR90x100x36	0.422 0.930

(1) Inner rings for metric full complement needle roller bearings are produced with outside diameter tolerance g5.

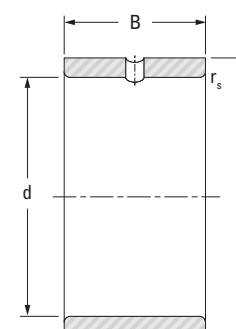
INNER RINGS



JR, IM..P



JR.JS1



JRZ.JS1

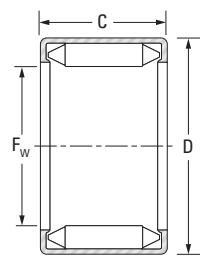
Shaft Dia.	d	F ⁽¹⁾	B	r _s min	Inner Ring Designation	Wt.
mm in	mm in	mm in	mm in	mm in		kg lbs
90 3.5433	90 3.5433	105 4.1339	32 1.260	1.1 0.04	JR90x105x32	0.580 1.279
	90 3.5433	105 4.1339	35 1.378	1.1 0.04	JR90x105x35	0.624 1.376
	90 3.5433	105 4.1339	63 2.480	1.1 0.04	JR90x105x63	1.140 2.513
95 3.7402	95 3.7402	105 4.1339	26 1.024	1 0.04	JR95x105x26	0.310 0.683
	95 3.7402	105 4.1339	36 1.417	1 0.04	JR95x105x36	0.430 0.948
	95 3.7402	110 4.3307	35 1.378	1.1 0.04	JR95x110x35	0.653 1.440
	95 3.7402	110 4.3307	63 2.480	1.1 0.04	JR95x110x63	1.200 2.646
100 3.9370	100 3.9370	110 4.3307	30 1.181	1.1 0.04	JR100x110x30	0.384 0.847
	100 3.9370	110 4.3307	40 1.575	1.1 0.04	JR100x110x40	0.510 1.124
	100 3.9370	115 4.5276	40 1.575	1.1 0.04	JR100x115x40	0.790 1.742
110 4.3307	110 4.3307	120 4.7244	30 1.181	1 0.04	JR110x120x30	0.425 0.937
	110 4.3307	125 4.9213	40 1.575	1.1 0.04	JR110x125x40	0.870 1.918
120 4.7244	120 4.7244	130 5.1181	30 1.181	1 0.04	JR120x130x30	0.460 1.014
	120 4.7244	135 5.3150	45 1.772	1.1 0.04	JR120x135x45	1.060 2.337
130 5.1181	130 5.1181	145 5.7087	35 1.378	1.1 0.04	JR130x145x35	0.890 1.962
	130 5.1181	150 5.9055	50 1.969	1.5 0.06	JR130x150x50	1.730 3.814
140 5.5118	140 5.5118	155 6.1024	35 1.378	1.1 0.04	JR140x155x35	0.955 2.105
	140 5.5118	160 6.2992	50 1.969	1.5 0.06	JR140x160x50	1.860 4.101
150 5.9055	150 5.9055	165 6.4961	40 1.575	1.1 0.04	JR150x165x40	1.170 2.579
160 6.2992	160 6.2992	175 6.8898	40 1.575	1.1 0.04	JR160x175x40	1.240 2.734
170 6.6929	170 6.6929	185 7.2835	45 1.772	1.1 0.04	JR170x185x45	1.480 3.263
180 7.0866	180 7.0866	195 7.6772	45 1.772	1.1 0.04	JR180x195x45	1.560 3.439

(1) Inner rings for metric full complement needle roller bearings are produced with outside diameter tolerance g5.

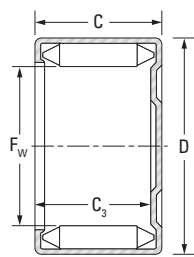


**DRAWN CUP NEEDLE ROLLER BEARINGS
FULL COMPLEMENT
OPEN ENDS,
CLOSED ONE END**

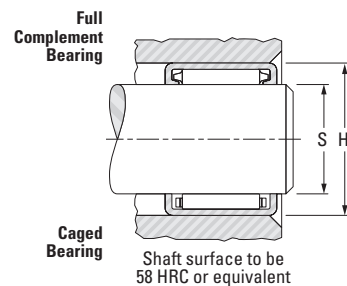
**METRIC SERIES
DL, DLF SERIES**



DL



DLF

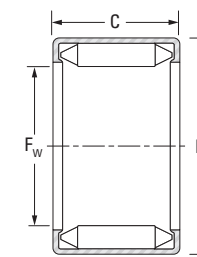


Shaft Dia.	F _w	D	C		C _{3 min}	Bearing Designation		Load Ratings		Approx. Wt.	Inspection gage	Mounting inner ring (pages B-2-43 to B-2-45)
			+0 -0.3	+0.000 -0.012		Open Ends	Closed One End	Dynamic C	Static C ₀			
mm in	mm in	mm in	mm in	mm in	mm in			kN lbf	kg lbs			
35 1.3780	35 1.3780	43 1.6929	16 0.630	13.70 0.539	—	DLF 35 16	—	24.0 5400	54.0 12100	0.053 0.117	Table B2-3	IM 30 35 16,4
	35 1.3780	43 1.6929	20 0.787	—	—	DL 35 20	—	29.0 6520	65.0 14600	0.057 0.126	Table B2-3	IM 30 35 20,4
	35 1.3780	43 1.6929	20 0.787	17.70 0.697	—	DLF 35 20	—	29.0 6520	65.0 14600	0.064 0.141	Table B2-3	IM 30 35 20,4
40 1.5748	40 1.5748	48 1.8898	16 0.630	—	—	DL 40 16	—	26.5 5960	62.0 13900	0.051 0.112	Table B2-3	IM 35 40 16,4
	40 1.5748	48 1.8898	16 0.630	13.70 0.539	—	DLF 40 16	—	26.50 5960	62.0 13900	0.061 0.134	Table B2-3	IM 35 40 16,4
	40 1.5748	48 1.8898	20 0.787	—	—	DL 40 20	—	36.0 8090	84.0 18900	0.064 0.141	Table B2-3	IM 35 40 20,4
	40 1.5748	48 1.8898	20 0.787	17.7 0.697	—	DLF 40 20	—	36.0 8090	84.0 18900	0.074 0.163	Table B2-3	IM 35 40 20,4
44 1.7323	44 1.7323	52 2.0472	16 0.630	—	—	DL 44 16	—	23.80 5350	57.00 12800	0.056 0.123	Table B2-3	IM 40 44 16,4
	44 1.7323	52 2.0472	16 0.630	13.70 0.539	—	DLF 44 16	—	23.80 5350	57.00 12800	0.066 0.146	Table B2-3	IM 40 44 16,4
47 1.8504	47 1.8504	55 2.1654	16 0.630	—	—	DL 47 16	—	25.00 5620	61.00 13700	0.060 0.132	Table B2-3	
	47 1.8504	55 2.1654	16 0.630	13.70 0.539	—	DLF 47 16	—	25.00 5620	61.00 13700	0.071 0.157	Table B2-3	
50 1.9685	50 1.9685	58 2.2835	12 0.472	—	—	DL 50 12	—	20.00 4500	50.00 11200	0.047 0.104	Table B2-3	
	50 1.9685	58 2.2835	12 0.472	9.70 0.382	—	DLF 50 12	—	20.00 4500	50.00 11200	0.061 0.134	Table B2-3	
	50 1.9685	58 2.2835	18 0.709	—	—	DL 50 18	—	36.50 8210	92.00 20700	0.071 0.157	Table B2-3	
	50 1.9685	58 2.2835	18 0.709	15.70 0.618	—	DLF 50 18	—	36.50 8210	92.00 20700	0.085 0.187	Table B2-3	
	50 1.9685	58 2.2835	20 0.787	—	—	DL 50 20	—	37.00 8320	93.00 20900	0.077 0.170	Table B2-3	IM 45 50 20,4
	50 1.9685	58 2.2835	20 0.787	17.70 0.697	—	DLF 50 20	—	37.00 8320	93.00 20900	0.091 0.201	Table B2-3	IM 45 50 20,4
55 2.1654	55 2.1654	63 2.4803	20 0.787	—	—	DL 55 20	—	39.5 8880	102.0 22900	0.086 0.190	Table B2-3	IM 50 55 20,4
	55 2.1654	63 2.4803	20 0.787	17.70 0.697	—	DLF 55 20	—	39.5 8880	102.0 22900	0.102 0.225	Table B2-3	IM 50 55 20,4

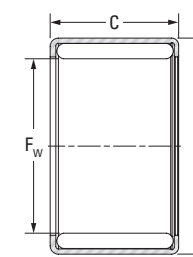
Note) · For information on the speed ratings, contact JTEKT.
· For the recommended mounting dimensions see Table B2-1.

**DRAWN CUP NEEDLE ROLLER BEARINGS
FULL COMPLEMENT
OPEN ENDS,
CLOSED ONE END**

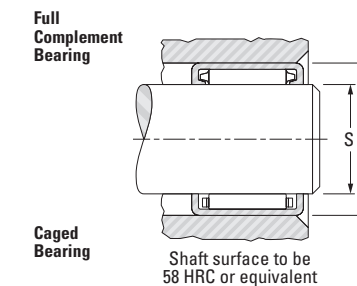
**METRIC SERIES
BM, BHM, YM SERIES**



BM, BHM



YM



Shaft Dia.	F _w	D	C		C _{3 min}	Bearing Designation	Load Ratings		Approx. Wt.	Inspection gage	Mounting inner ring (pages B-2-43 to B-2-45)
			+0 -0.3	+0.000 -0.012			Dynamic C	Static C ₀			
mm in	mm in	mm in	mm in	mm in			kN lbf	kg lbs			
3.5 0.1378	3.5	8	11	—	—	YM040811A	4.5	4.2	0.003	Table B2-4	—
6.13 0.2413	6.13	11	9.7	—	—	6YM1110BM	5.55	6.3	0.004	Table B2-4	—
8 0.3150	8	12	10	—	—	YM081210	6.7	8.8	0.004	Table B2-4	—
	8	13	10	—	—	YM081310AM	6.6	8.35	0.006	Table B2-4	—
10 0.3937	10	14	10	—	—	10BM1410	8.55	11.8	0.004	Table B2-4	—
12 0.4724	12	18	12	—	—	12BM1812	13	16.6	0.010	Table B2-4	—
14 0.5512	14	20	12	—	—	14BM2012	14.2	19.3	0.011	Table B2-4	—
15 0.5906	15	21	10	—	—	15BM2110	12.6	16.7	0.009	Table B2-4	—
	15	21	12	—	—	15BM2112	15	20.9	0.012	Table B2-4	—
	15	21	16	—	—	15BM2116	19.4	29.1	0.016	Table B2-4	—
16 0.6299	16	22	12	—	—	16BM2212	15.8	22.4	0.012	Table B2-4	—
17 0.6693	17	23	12	—	—	17BM2312	16	23.5	0.013	Table B2-4	—
	17	24	12	—	—	YM172412-1	16.3	21.5	0.016	Table B2-4	—
	17	24	17	—	—	BM172417-1	23.8	35	0.023	Table B2-4	—
	17	24	20	—	—	BHM1720A	27.4	41.9	0.026	Table B2-4	—
	17	24	25	—	—	BHM1725	33.3	53.7	0.034	Table B2-4	—
18 0.7087	18	24	16	—	—	18BM2416	21.7	35.1	0.018	Table B2-4	—
20 0.7874	20	26	14	—	—	YM202614	19	31.4	0.019	Table B2-4	—
	20	26	16	—	—	20BM2616	21.6	38	0.021	Table B2-4	—

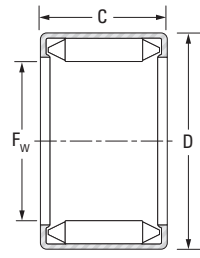
Note) · For information on the speed ratings, contact JTEKT.
· For the recommended mounting dimensions see Table B2-1.

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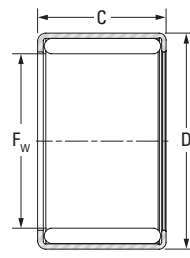


DRAWN CUP NEEDLE ROLLER BEARINGS
FULL COMPLEMENT
OPEN ENDS,
CLOSED ONE END

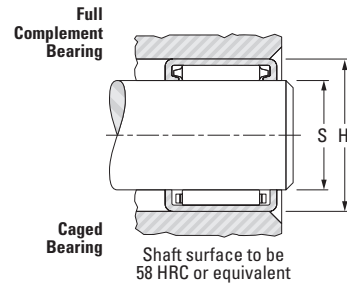
METRIC SERIES
BM, BHM, YM SERIES



BM, BHM



YM

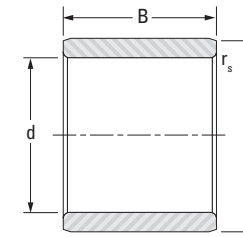


Shaft Dia.	F _w	D	C		C _{3 min}	Bearing Designation	Load Ratings		Approx. Wt.	Inspection gage	Mounting inner ring (pages B-2-43 to B-2-45)
			+0 -0.3	+0.000 -0.012			Dynamic C	Static C ₀			
mm in	mm in	mm in	mm in	mm in			kN lbf	kg lbs			
20 0.7874	20	26	20	—	20BM2620	26.3	49.1	0.026	Table B2-4	—	
		27	15	—	BM2015	23.8	35.9	0.022	Table B2-4	—	
		27	26	—	BM2026	38.3	66.2	0.040	Table B2-4	—	
21 0.8268	21	27	20	—	21YM2720J	27.6	52.4	0.029	Table B2-4	—	
		30	13	—	BM222925	37.3	68.9	0.018	Table B2-4	—	
24 0.9449	24	32	16	—	BM2516	28.3	48.2	0.028	Table B2-4	—	
		32	20	—	BM2520	34.4	62	0.036	Table B2-4	—	
		32	26	—	BM2526	43	82.7	0.048	Table B2-4	—	
25 0.9843	25	33	25	—	BHM2525	44.8	78.7	0.053	Table B2-4	—	
		34	17	—	BM2817	29.5	58.9	0.029	Table B2-4	—	
		34	24	—	BM2824	39.5	86	0.042	Table B2-4	—	
28 1.1024	28	37	30	—	28BHM3730	60.1	107	0.080	Table B2-4	—	
		39	30	—	BM283930A	64.7	104	0.101	Table B2-4	—	
		37	20	—	30BM3720	38.5	74.9	0.042	Table B2-4	—	
30 1.1811	30	37	26	—	30BM3726	48.2	99.7	0.056	Table B2-4	—	
		42	25	—	34YM4225L	50.9	106	0.075	Table B2-4	—	
34 1.3386	34	48	20	—	YM3820PL	52.2	92.7	0.082	Table B2-4	—	
		53	20	—	YM405320JM	63	96.5	0.116	Table B2-4	—	

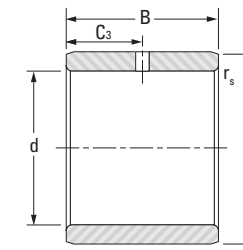
Note) · For information on the speed ratings, contact JTEKT.
 · For the recommended mounting dimensions see Table B2-1.

INNER RINGS FOR FULL COMPLEMENT DRAWN CUP NEEDLE ROLLER BEARINGS

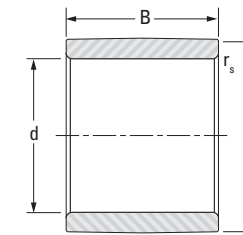
METRIC SERIES



IM



IMC



IM...R6

Shaft Dia.	d	F ⁽¹⁾	B	Hole Location C ₃	r _{s min}	Inner Ring Designation	Wt.
mm in	mm in	mm in	mm in	mm in	mm in		kg lbs
8 0.3150	8 0.3150	12 0.4724	12.4 0.488		0.3 0.01	IM 8 12 12,4	0.006 0.013
		13 0.5118	12.4 0.488		0.3 0.01	IM 9 13 12,4	0.006 0.013
9 0.3543	9 0.3543	13 0.5118	12.4 0.488		0.3 0.01	IM 9 13 12,4 R6	0.006 0.013
		14 0.5512	12.4 0.488		0.3 0.01	IM 10 14 12,4	0.007 0.015
		14 0.5512	16.4 0.646		0.3 0.01	IM 10 14 16,4	0.009 0.020
11 0.4331	11 0.4331	15 0.5906	12.4 0.488		0.3 0.01	IM 11 15 12,4	0.008 0.018
		15 0.5906	12.4 0.488		0.2 0.01	IM 12 15 12,4	0.006 0.013
12 0.4724	12 0.4724	16 0.6299	12.4 0.488		0.2 0.01	IM 12 16 12,4	0.008 0.018
		16 0.6299	12.4 0.488		0.3 0.01	IM 12 16 12,4 R6	0.008 0.018
		16 0.6299	12.4 0.488	6.2 0.24	0.3 0.01	IMC 12 16 12,4	0.008 0.018
13 0.5118	13 0.5118	17 0.6693	12.4 0.488		0.3 0.01	IM 13 17 12,4	0.009 0.020
		18 0.7087	12.4 0.488		0.35 0.014	IM 13 18 12,4	0.011 0.025
13 0.5118	13 0.5118	18 0.7087	12.4 0.488		0.35 0.014	IM 13 18 12,4 R6	0.011 0.025
		18 0.7087	16.4 0.646		0.35 0.014	IM 13 18 16,4	0.015 0.033
		20 0.7874	12.4 0.488		0.35 0.014	IM 15 20 12,4	0.013 0.028
15 0.5906	15 0.5906	20 0.7874	16.4 0.646		0.35 0.014	IM 15 20 16,4	0.017 0.037
		22 0.8661	16.4 0.646		0.35 0.014	IM 17 22 16,4	0.019 0.041
17 0.6693	17 0.6693	22 0.8661	16.4 0.646		0.35 0.014	IM 17 22 16,4 R6	0.019 0.041
		22 0.8661	16.4 0.646	8.2 0.32	0.35 0.014	IMC 17 22 16,4	0.019 0.041
20 0.7874	20 0.7874	25 0.9843	16.4 0.646		0.35 0.014	IM 20 25 16,4	0.022 0.047
		25 0.9843	16.4 0.646		0.35 0.014	IM 20 25 16,4 R6	0.022 0.047
20 0.7874	20 0.7874	25 0.9843	16.4 0.646	8.2 0.32	0.35 0.014	IMC 20 25 16,4	0.022 0.047
		25 0.9843	20.4 0.803		0.35 0.014	IM 20 25 20,4	0.027 0.060

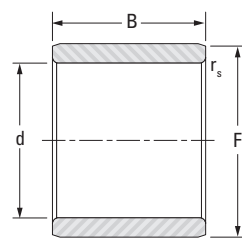
(1) Call for O.D. tolerance

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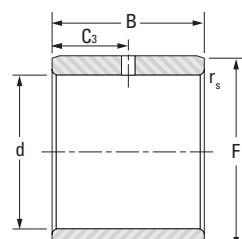


INNER RINGS FOR FULL COMPLEMENT DRAWN CUP NEEDLE ROLLER BEARINGS

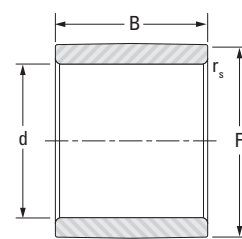
METRIC SERIES



IM



IMC



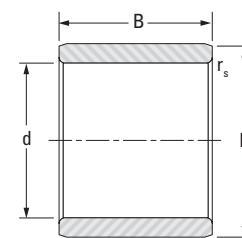
IM...R6

Shaft Dia.	d	F (1)	B	Hole Location C ₃	r _s min	Inner Ring Designation	Wt.
mm in	mm in	mm in	mm in	mm in	mm in		kg lbs
20 0.7874	20 0.7874	25 0.9843	20.4 0.803	10.2 0.40	0.35 0.014	IMC 20 25 20,4	0.027 0.060
	20 0.7874	25 0.9843	25.0 0.984		0.35 0.014	IM 20 25 25	0.033 0.073
23 0.9055	23 0.9055	28 1.1024	20.4 0.803		0.35 0.014	IM 23 28 20,4	0.031 0.067
25 0.9843	25 0.9843	30 1.1811	16.4 0.646		0.35 0.014	IM 25 30 16,4	0.027 0.060
	25 0.9843	30 1.1811	16.4 0.646		0.35 0.014	IM 25 30 16,4 R6	0.027 0.060
	25 0.9843	30 1.1811	16.4 0.646	8.2 0.32	0.35 0.014	IMC 25 30 16,4	0.027 0.058
	25 0.9843	30 1.1811	20.4 0.803		0.35 0.014	IM 25 30 20,4	0.033 0.073
	25 0.9843	30 1.1811	20.4 0.803	10.2 0.40	0.35 0.014	IMC 25 30 20,4	0.033 0.073
	25 0.9843	30 1.1811	25 0.984		0.35 0.014	IM 25 30 25	0.040 0.088
30 1.1811	30 1.1811	35 1.3780	16.4 0.646		0.35 0.014	IM 30 35 16,4	0.031 0.068
	30 1.1811	35 1.3780	16.4 0.646		0.35 0.014	IM 30 35 16,4 R6	0.031 0.068
	30 1.1811	35 1.3780	16.4 0.646	8.2 0.32	0.35 0.014	IMC 30 35 16,4	0.031 0.068
	30 1.1811	35 1.3780	20.4 0.803		0.35 0.014	IM 30 35 20,4	0.039 0.086
	30 1.1811	35 1.3780	20.4 0.803		0.35 0.014	IM 30 35 20,4 R6	0.039 0.086
	30 1.1811	35 1.3780	20.4 0.803	10.2 0.40	0.35 0.014	IMC 30 35 20,4	0.039 0.086
	30 1.1811	35 1.3780	25.0 0.984		0.35 0.014	IM 30 35 25	0.048 0.106
35 1.3780	35 1.3780	40 1.5748	16.4 0.646		0.35 0.014	IM 35 40 16,4	0.036 0.079
	35 1.3780	40 1.5748	16.4 0.646		0.35 0.014	IM 35 40 16,4 R6	0.036 0.079
	35 1.3780	40 1.5748	20.4 0.803		0.35 0.014	IM 35 40 20,4	0.045 0.099
	35 1.3780	40 1.5748	20.4 0.803		0.35 0.014	IM 35 40 20,4 R6	0.045 0.099
	35 1.3780	40 1.5748	20.4 0.803	10.2 0.40	0.35 0.014	IMC 35 40 20,4	0.045 0.099
	35 1.3780	40 1.5748	25 0.984		0.35 0.014	IM 35 40 25	0.055 0.121
40 1.5748	40 1.5748	44 1.7323	16.4 0.646		0.3 0.01	IM 40 44 16,4	0.032 0.071

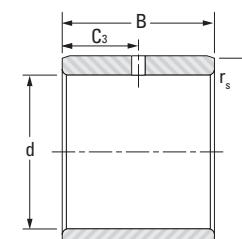
(1) Call for O.D. tolerance

INNER RINGS FOR FULL COMPLEMENT DRAWN CUP NEEDLE ROLLER BEARINGS

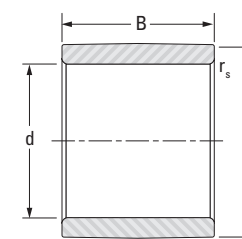
METRIC SERIES



IM



IMC



IM...R6

Shaft Dia.	d	F (1)	B	Hole Location C ₃	r _s min	Inner Ring Designation	Wt.
mm in	mm in	mm in	mm in	mm in	mm in		kg lbs
40 1.5748	40 1.5748	44 1.7323	16.4 0.646		0.3 0.01	IM 40 44 16,4 R6	0.032 0.071
	40 1.5748	44 1.7323	16.4 0.646	8.2 0.32	0.3 0.01	IMC 40 44 16,4	0.032 0.071
	40 1.5748	45 1.7717	20.4 0.803		0.35 0.014	IM 40 45 20,4	0.051 0.112
	40 1.5748	44 1.7323	20.4 0.803	10.2 0.40	0.35 0.014	IMC 40 45 20,4	0.051 0.112
45 1.7717	45 1.7717	50 1.9685	20.4 0.803		0.65 0.026	IM 45 50 20,4	0.056 0.123
	45 1.7717	50 1.9685	20.4 0.803		0.65 0.026	IM 45 50 20,4 R6	0.056 0.123
	45 1.7717	50 1.9685	25 0.984		0.65 0.026	IM 45 50 25	0.069 0.152
	45 1.7717	50 1.9685	25 0.984		0.65 0.026	IM 45 50 25 R6	0.069 0.152
50 1.9685	50 1.9685	55 2.1654	20.4 0.803		0.65 0.026	IM 50 55 20,4 R6	0.062 0.137
	50 1.9685	55 2.1654	20.4 0.803		0.65 0.026	IM 50 55 20,4	0.062 0.137

(1) Call for O.D. tolerance



DRAWN CUP NEEDLE ROLLER BEARINGS

INCH SERIES

When a rolling bearing is needed for a compact and economical design, where it is not practical to harden and grind the housing bore, or where the housing materials are of low rigidity such as cast iron, aluminum or even plastics – drawn cup needle roller bearings should be considered.

REFERENCE STANDARDS

- **ANSI/ABMA 18.2** – needle roller bearings - radial, inch design.
- **JIS B 1536** – rolling bearings – needle roller bearings – boundary dimensions and tolerances.

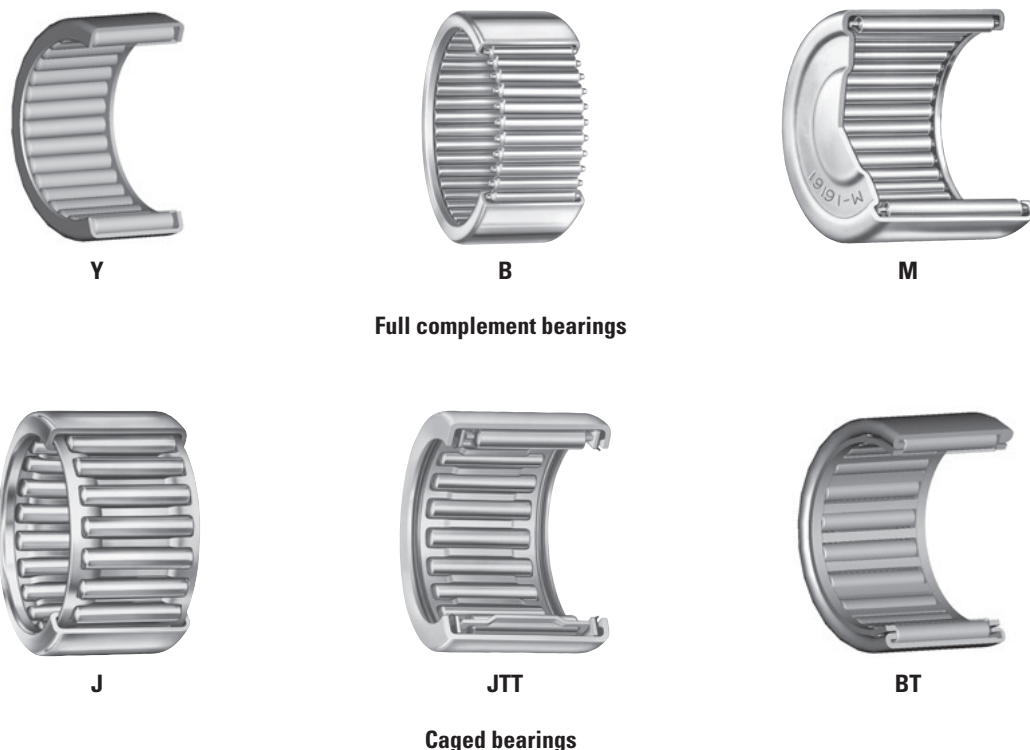


Fig. B2-9. Types of inch series drawn cup needle roller bearings

CONSTRUCTION

FULL COMPLEMENT BEARINGS

The original drawn cup needle roller bearing employs a full complement of needle rollers. The full complement drawn cup bearing combines maximum load-carrying capability with the advantages of the drawn outer ring.

The inward turned lips of the cup are used to mechanically retain the full complement of needle rollers, providing their positive radial retention – even though it may be necessary to remove the shaft repeatedly during servicing of the mechanism employing the bearing.

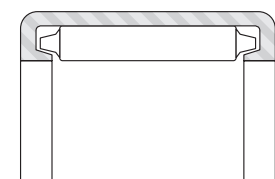


Fig. B2-10. Full complement bearing

CAGED BEARINGS

The one-piece steel cage, used in most caged drawn cup bearings, is designed to provide rigidity and minimize wear. This cage design separates the roller guiding and roller retention functions. The portions of the cage that retain the rollers cannot contact the rollers while the bearing is operating. Thus, there is no wear which might affect roller retention.

The cage contacts the rollers only near their ends at the roller pitch line, so accurate guidance is achieved with least effort. Pitch line guidance at the ends of the rollers prevents skewing and assures roller stability, with little stress on the cage itself. The design minimizes the contact area and force required for roller guidance, and thus minimizes drag between cage and rollers.

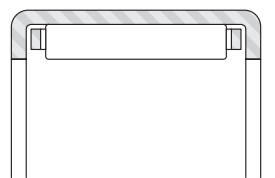


Fig. B2-11. Caged bearing

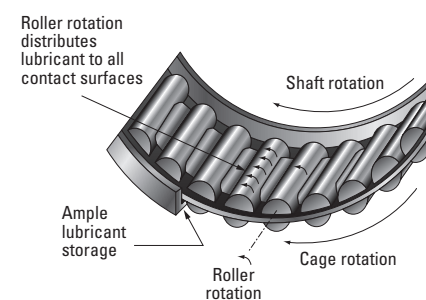


Fig. B2-12. Cage design

The same design feature that assures no contact between roller retention bars and rollers while the bearing is operating, also provides ample clearance along the length of the roller to enhance the circulation of lubricant.

There are bearings with other cage designs. Bearings with engineered polymer cages are for use where operating conditions permit. Before applying bearings with engineered polymer cages, please consult your representative.

SEALED BEARINGS

Drawn cup caged needle roller bearings are offered with integral seals. The tables of dimensions on pages B-2-72 and B-2-73 indicate those sizes available with lip contact seals. The seal lip design achieves a light and constant contact with the shaft throughout the range of mounting bearing clearances thereby ensuring positive sealing and low frictional drag.

Sealed drawn cup bearings are intended to retain grease or non-pressurized oil within a bearing while also preventing contaminants from entering the raceway area.

Details of shaft design for sealed bearings are given in the engineering section.

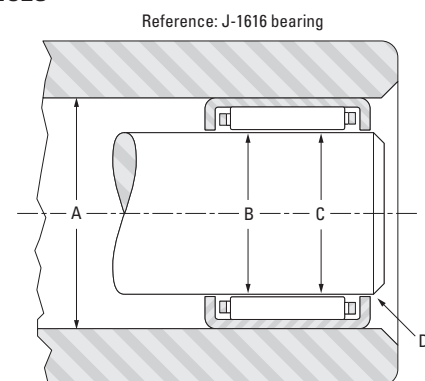
The standard lip contact seals are compatible with common lubricating oils and petroleum based fuels. But they are adversely affected by certain fire-resistant hydraulic fluids and most common solvents.

If the operating temperature must be outside of the specified range, or if the seals are exposed to unusual fluids, please consult your representative.



DIMENSIONAL ACCURACY AND MOUNTING DIMENSIONS

MANUFACTURING TOLERANCES AND RESULTING CLEARANCES



Reference: J-1616 bearing
 A. Housing bore tolerance 0.025 mm (0.0010 in)
 B. Manufacturing tolerance for bearing 0.023 mm (0.0009 in)
 C. Shaft diameter tolerance 0.013 mm (0.0005 in)
 D. Min. Initial radial clearance 0.013 mm (0.0005 in)

Fig. B2-13. Manufacturing tolerances and resulting clearances

BEARING MOUNTING FITS AND RADIAL INTERNAL CLEARANCE

Drawn cup bearings are manufactured to a degree of precision that will satisfy the radial clearance requirements of most applications. The total radial clearance of an installed drawn cup bearing results from the buildup of manufacturing tolerances of the housing bore, inner raceway O.D., and the bearing – as well as the minimum radial clearance required for the application.

For bearings of nominal inch dimensions, the suggested mounting dimensions will provide correct running clearance for most applications. Closer control of radial clearance would be governed by the user's capability of holding housing and shaft raceway dimensional tolerances tighter than the limits shown in the bearing tables.

The drawing illustrates the manufacturing tolerances and resulting clearances applying to medium size drawn cup bearings, in rotating applications, when using the suggested tabulated mounting dimensions.

Radial clearance in a mounted bearing may be more closely controlled by reducing the manufacturing tolerances of the housing bore and inner raceway diameter. Where extremely close control of radial clearance is required for bearings of nominal inch dimensions, extra-precision full complement bearings are available (see page B-2-63).

Table B2-7. Recommended inch series fits (inner ring rotation)

Bearing design	Shaft			Housing		
	Classification	Maximum	Minimum	Classification	Maximum	Minimum
B, M, J, JTT 1)	Fw ≤ 5.556mm (7/32")	0	-0.008mm (-0.0003")	D ≤ 7.144mm (9/32")	+0.013mm (+0.0005")	0
	5.556mm (7/32") < Fw ≤ 50.006mm (1 31/32")	0	-0.013mm (-0.0005")		+0.013mm (+0.0005")	-0.013mm (-0.0005")
	50.006mm (1 31/32") < Fw ≤ 119.856mm (4 23/32")	0	-0.015mm (-0.0006")	7.144mm (9/32") < D	+0.013mm (+0.0005")	-0.013mm (-0.0005")
	119.856mm (4 23/32") < Fw ≤ 180.181mm (7 3/32")	0	-0.018mm (-0.0007")	7.144mm (9/32") < D ≤ 8.731mm (11/32")	0	-0.013mm (-0.0005")
Y, BT	h6			8.731mm(11/32") < D		J7

NOTE 1: Special fits
 When D = 8.733 mm (0.3438"): housing fit: -0.003 mm (-0.0001") maximum, -0.015 mm (-0.0006") minimum
 When D = 22.212 mm (0.8745"): housing fit: +0.025 mm (+0.0010") maximum, 0 mm (0") minimum
 When D = 152.400 mm (6.0000"): housing fit: +0.025 mm (+0.0010") maximum, -0.025 mm (-0.0010") minimum

TOLERANCES FOR HOUSING MATERIALS OF LOW RIGIDITY

For housing materials of low rigidity, or steel housings of small section, it is suggested that for initial trial the housing bore diameters given in the bearing tables be reduced by the amounts shown in Table B2-5. To maintain normal radial internal clearance, the inner raceway diameter tolerance given in the bearing tables should be used.

Table B2-5. Low Rigidity Housing Bore

Nom. housing bore				Subtract	
Over	Incl.	Over	Incl.	mm	in
0.0	9.5	0.00	0.38	0.010	0.0004
9.5	25.4	0.38	1.00	0.015	0.0006
25.4	50.8	1.00	2.00	0.025	0.0010
50.8	76.2	2.00	3.00	0.030	0.0012
76.2	152.4	3.00	6.00	0.036	0.0014

OUTER RING ROTATION

For applications where the outer ring rotates with respect to the load, it is suggested that both the housing bore and inner raceway diameter be reduced. Bearings of nominal inch dimensions should have the housing bore and inner raceway diameters reduced by 0.013 mm (0.0005 in)

OSCILLATING MOTION

Applications involving oscillating motion often require reduced radial clearances. This reduction is accomplished by increasing the shaft raceway diameters as shown in Table B2-6.

Table B2-6. Nominal inch bearing oscillating shaft size

Shaft size		Add	
mm	in	mm	in
2.38 to 4.76	0.094 to 0.188	0.008	0.0003
6.35 to 47.62	0.250 to 1.875	0.013	0.0005
50.8 to 139.70	2.000 to 5.500	0.015	0.0006

For information on fits to housing materials of low rigidity and on fits during outer ring rotation and during oscillation rotation, contact JTEKT.

INNER RINGS

Where it becomes impractical to meet the shaft raceway design requirements (hardness, case depth, surface finish, etc.) outlined in the engineering section, standard inner rings for drawn cup bearings are available. These are tabulated on pages B-2-74 to B-2-76 of the drawn cup section.

Inner rings for drawn cup bearings are designed to be a loose transition fit on the shaft and should be clamped against a shoulder. If a tight transition fit must be used to keep the inner ring from rotating relative to the shaft, the inner ring O.D., as mounted, must not exceed the raceway diameters required by the drawn cup bearing for the particular application.

LOAD RATING FACTORS

Dynamic Loads

Drawn cup needle roller bearings can accommodate only radial loads.

$P = F_r$

P = The maximum dynamic radial load that may be applied to a drawn cup bearing based on the dynamic load rating, C given in the bearing tables. This load should be ≤ C/3.

Static Loads

$f_0 = \frac{C_0}{P_0}$

f₀ = static load safety factor

C₀ = basic static load rating

P₀ = maximum applied static load

To ensure satisfactory operation of drawn cup needle roller bearings under all types of conditions the static load safety factor f₀ should be ≥ 3.

INSPECTION PROCEDURES

Although the bearing cup (outer ring) is accurately drawn from strip steel it may go out of round during heat treatment. When the bearing is pressed into a true, round housing or ring gage of correct size and wall thickness, it becomes round and is sized properly. For this reason, it is incorrect to inspect an unmounted drawn cup bearing by measuring the O.D. The correct method for inspecting the bearing size is to:

1. Press the bearing into a ring gage of proper size.
2. Plug the bearing bore with the appropriate "go" and "no go" gages.

Tables B2-8 and B2-9 starting on page B-2-50 provide the correct ring and plug gage diameters for inspecting drawn cup needle roller bearings.

When the letter **H** appears in the columns headed "Bearing Bore Designation" and "Nominal Shaft Diameter" in Table B2-8, the gage sizes listed are for the larger cross section bearings, which include **H** in their bearing designation prefix.

Example

Find the ring gage and plug gage dimensions for a BH-68 bearing.

The nominal bore diameter (F_w) for this bearing, as shown in the table of dimensions on page B-2-55, is 9.525 mm (0.3750 in). Since the letter H appears in the bearing designation, the following information will be found opposite H6 9.525 mm (0.3750 in) in Table B2-8 on page B-2-50.

	in
ring gage diameter under needle rollers, min.	0.6255
ring gage diameter under needle rollers, max.	0.3765
plug gage, "go"	0.3775
plug gage, "no go"	0.3774

The "go" plug gage is the same size as the minimum needle roller complement bore diameter and the "no go" plug gage size is 0.002 mm (0.0001 in) larger than the maximum bore diameter. Therefore the correct ring and plug gage dimensions are:

	in
ring gage diameter under needle rollers, min.	0.6255
ring gage diameter under needle rollers, max.	0.3765
plug gage, "go"	0.3775
plug gage, "no go"	0.3775

These same gage dimensions also apply to JH-68.

Table B2-8 applies to the B, M, J and JTT series. Table B2-9 applies to the BT and Y series and to the B228 and B3216.



Table B2-8. Ring and plug gage dimensions

Bearing bore designation	Nominal shaft diameter	Nominal bore diameter	Ring gage	Needle roller complement bore diameter	
				Max.	Min
				mm in	mm in
2	3.175 1/8	3.175 0.1250	6.363 0.2505	3.218 0.1267	3.195 0.1258
2 1/2	3.970 5/32	3.967 0.1562	7.155 0.2817	4.013 0.1580	3.99 0.1571
3	4.763 3/16	4.763 0.1875	8.730 0.3437	4.806 0.1892	4.783 0.1883
4	6.350 1/4	6.350 0.2500	11.125 0.4380	6.411 0.2524	6.388 0.2515
5	7.938 5/16	7.938 0.3125	12.713 0.5005	7.998 0.3149	7.976 0.3140
H 5	H 7.938 H 5/16	7.938 0.3125	14.300 0.5630	7.998 0.3149	7.976 0.3140
6	9.525 3/8	9.525 0.3750	14.300 0.5630	9.586 0.3774	9.563 0.3765
H 6	H 9.525 H 3/8	9.525 0.3750	15.888 0.6255	9.586 0.3774	9.563 0.3765
7	11.113 7/16	11.113 0.4375	15.888 0.6255	11.174 0.4399	11.151 0.4390
H 7	H 11.113 H 7/16	11.113 0.4375	17.475 0.6880	11.174 0.4399	11.151 0.4390
8	12.700 1/2	12.700 0.5000	17.475 0.6880	12.761 0.5024	12.738 0.5015
H 8	H 12.700 H 1/2	12.700 0.5000	19.063 0.7505	12.761 0.5024	12.738 0.5015
9	14.288 9/16	14.288 0.5625	19.063 0.7505	14.349 0.5649	14.326 0.5640
H 9	H 14.288 H 9/16	14.288 0.5625	20.650 0.8130	14.349 0.5649	14.326 0.5640
10	15.875 5/8	15.875 0.6250	20.650 0.8130	14.349 0.6274	15.913 0.6265
H 10	H 15.875 H 5/8	15.875 0.6250	22.238 0.8755	14.349 0.6274	15.913 0.6265
11	17.463 1 1/16	17.463 0.6875	22.238 0.8755	17.524 0.6899	17.501 0.6890
H 11	H 17.463 H 1 1/16	17.463 0.6875	23.825 0.9380	17.524 0.6899	17.501 0.6890
12	19.050 3/4	19.050 0.7500	25.387 0.9995	19.086 0.7514	19.063 0.7505
H 12	H 19.050 H 3/4	19.050 0.7500	26.975 1.0620	19.086 0.7514	19.063 0.7505
13	20.638 1 3/16	20.638 0.8125	26.975 1.0620	20.673 0.8139	20.650 0.8130
H 13	H 20.638 H 1 3/16	20.638 0.8125	28.562 1.1245	20.673 0.8139	20.650 0.8130
14	22.225 7/8	22.225 0.8750	28.562 1.1245	22.261 0.8764	22.238 0.8755
H 14	H 22.225 H 7/8	22.225 0.8750	30.150 1.1870	22.261 0.8764	22.238 0.8755
15	23.813 1 9/16	23.813 0.9375	30.150 1.1870	23.848 0.9389	23.825 0.9380
16	25.400 1	25.400 1.0000	31.737 1.2495	25.436 1.0014	25.413 1.0005
H 16	H 25.400 H 1	25.400 1.0000	33.325 1.3120	25.436 1.0014	25.413 1.0005
17	26.988 1 1/16	26.988 1.0625	33.325 1.3120	27.023 1.0639	27.000 1.0630
18	28.575 1 1/8	28.575 1.1250	34.912 1.3745	28.611 1.1264	28.588 1.1255
H 18	H 28.575 H 1 1/8	28.575 1.1250	38.087 1.4995	28.611 1.1264	28.588 1.1255
19	30.163 1 3/16	30.163 1.1875	38.087 1.4995	30.198 1.1889	30.175 1.1880
20	31.750 1 1/4	31.750 1.2500	38.087 1.4995	31.786 1.2514	31.763 1.2505
H 20	H 31.750 H 1 1/4	31.750 1.2500	41.262 1.6245	31.786 1.2514	31.763 1.2505
21	33.338 1 5/16	33.338 1.3125	41.262 1.6245	33.376 1.3140	33.350 1.3130
22	34.925 1 3/8	34.925 1.3750	41.262 1.6245	34.963 1.3765	34.938 1.3755
H 22	H 34.925 H 1 3/8	34.925 1.3750	44.437 1.7495	34.963 1.3765	34.938 1.3755
24	38.100 1 1/2	38.100 1.5000	47.612 1.8745	38.141 1.5016	38.113 1.5005
26	41.275 1 5/8	41.275 1.6250	50.787 1.9995	41.316 1.6266	41.288 1.6255
28	44.450 1 3/4	44.450 1.7500	53.962 2.1245	44.493 1.7517	44.463 1.7505
30	47.625 1 7/8	47.625 1.8750	57.137 2.2495	47.668 1.8767	47.638 1.8755
32	50.800 2	50.800 2.0000	60.312 2.3745	50.846 2.0018	50.815 2.0006
H 33	H 52.388 H 2 1/16	52.388 2.0625	64.280 2.5307	52.436 2.0644	52.400 2.0630
34	53.975 2 1/8	53.975 2.1250	63.487 2.4995	54.026 2.1270	53.990 2.1256
36	57.150 2 1/4	57.150 2.2500	66.662 2.6245	57.201 2.2520	57.165 2.2506
42	66.675 2 5/8	66.675 2.6250	76.187 2.9995	66.736 2.6274	66.700 2.6260
44	69.850 2 3/4	69.850 2.7500	79.362 3.1245	69.911 2.7524	69.875 2.7510
56	88.900 3 1/2	88.900 3.5000	101.587 3.9995	88.961 3.5024	88.925 3.5010
88	139.700 5 1/2	139.700 5.5000	152.375 5.9990	139.774 5.5029	139.725 5.5010

Bearing bore should be checked with "go" and "no go" plug gages. The "go" gage size is the minimum needle roller complement bore diameter. The "no go" gage size is larger than the maximum needle roller complement bore diameter by 0.0001 in

Table B2-9. Ring and plug gage dimensions¹⁾

Needle roller complement bore diameter F _w nominal size	Ring gage	Plug gage	
		Go	No go
		mm	mm
4.762(3/16)	8.730	4.783	4.808
6.350(1/4)	11.125	6.388	6.413
7.938(5/16)	14.300	7.976	8.001
9.525(3/8)	14.300 15.888	9.563	9.588
11.112(7/16)	15.888 17.475	11.151	11.176
12.700(1/2)	17.475 19.063	12.738	12.763
14.288(9/16)	19.063 20.650	14.326	14.351
15.875(5/8)	20.650 22.237	15.913	15.938
17.462(11/16)	22.237 23.825	17.501	17.526
19.050(3/4)	23.825 25.387	19.063	19.088
20.638(13/16)	25.387 26.975 28.562	20.650	20.675
22.225(7/8)	26.975 28.562 30.150	22.238	22.263
23.812(15/16)	28.562 30.150	23.825	23.850
25.400(1)	30.150 31.737 33.325	25.413	25.438

¹⁾ These values apply to the needle roller bearings of the BT series and Y series with inch nominal dimensions as well as to the B228 and B3216.



INSTALLATION OF DRAWN CUP NEEDLE ROLLER BEARINGS

GENERAL INSTALLATION REQUIREMENTS

- A drawn cup needle roller bearing must be pressed into its housing.
- An installation tool, similar to the ones shown, must be used in conjunction with a standard press.
- The bearing must not be hammered into its housing – even in conjunction with the proper assembly mandrel.
- The bearing must not be pressed tightly against a shoulder in the housing.
- If it is necessary to use a shouldered housing, the depth of the housing bore must be sufficient to ensure the housing shoulder fillet, and the shoulder face, clear the bearing.
- The installation tool must be coaxial with the housing bore.

INSTALLATION OF OPEN END BEARINGS

It is advisable to utilize a positive stop on the press tool to locate the bearing properly in the housing. The assembly tool should have a leader or a pilot, as shown, to aid in starting the bearing true in the housing. The ball detent shown on the drawing is used to assist in aligning the rollers of a full complement bearing during installation and to hold the bearing on the installation tool. A caged-type drawn cup bearing does not require a ball detent to align its rollers. The ball detent may still be used to hold the bearing on the installation tool or an “O” ring may be used as shown in the drawing on this page. The bearing should be installed with the marked end (the end with identification markings) against the angled shoulder of the pressing tool.

- A – 0.40 mm (0.016 in) less than housing bore
- B – 0.08 mm (0.003 in) less than shaft diameter
- C – distance bearing will be inset into housing, minimum of 0.20 mm (0.008 in)
- D – pilot length should be length of bearing less 0.80 mm (0.030 in)
- E – approximately 1/2 D

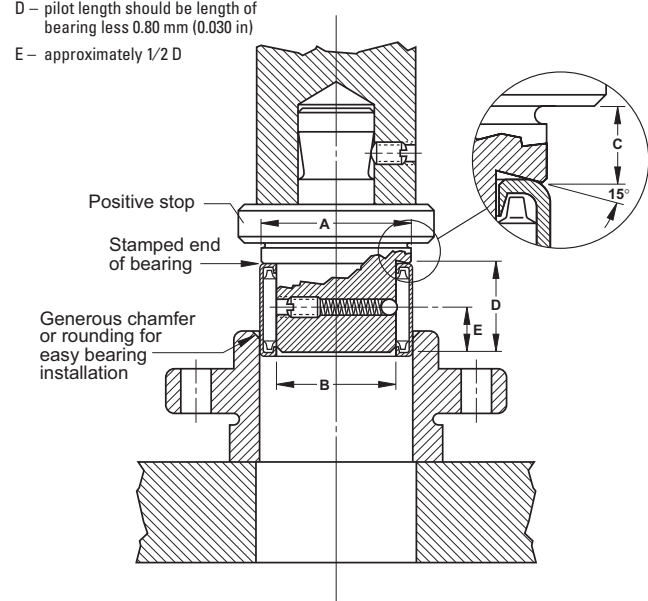


Fig. B2-14. Installation of open ends caged bearings

- A – 0.40 mm (0.016 in) less than housing bore
- B – 0.08 mm (0.003 in) less than shaft diameter
- C – distance bearing will be inset into housing, minimum of 0.20 mm (0.008 in)
- D – pilot length should be length of bearing less 0.80 mm (0.030 in)
- E – approximately 1/2 D

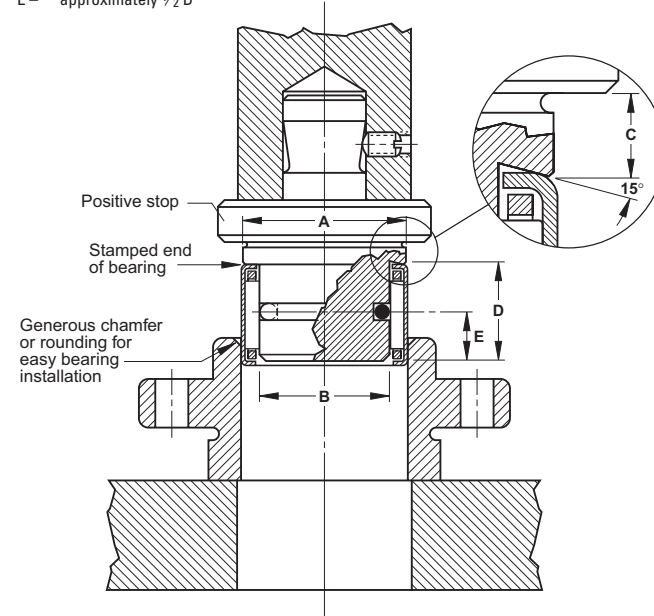


Fig. B2-15. Installation of open ends full complement bearings

INSTALLATION OF CLOSED END BEARINGS

The installation tool combines all the features of the tool used to install open end bearings. But the pilot is spring loaded and is part of the press bed.

The angled shoulder of the pressing tool should bear against the closed end, with the bearing held on the pilot, to aid in starting the bearing true in the housing.

- A – 0.40 mm (0.016 in) less than housing bore
- B – 0.08 mm (0.003 in) less than shaft diameter
- C – distance bearing will be inset into housing, minimum of 0.20 mm (0.008 in)

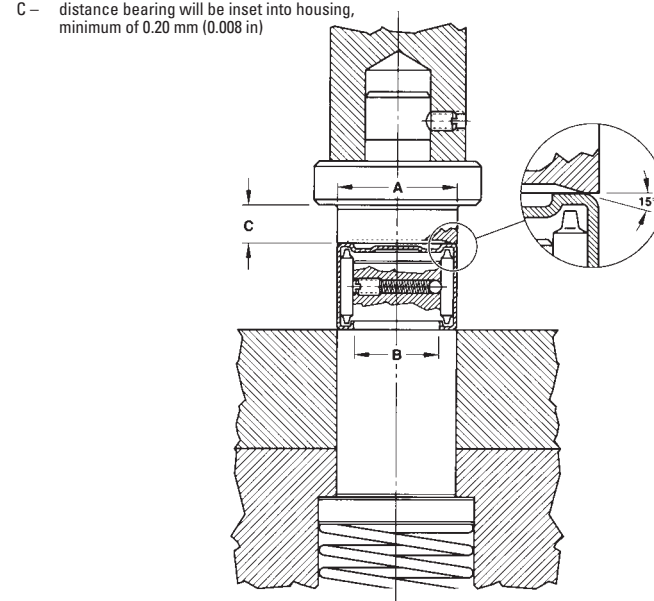


Fig. B2-16. Installation of closed end bearings

EXTRACTION OF DRAWN CUP NEEDLE ROLLER BEARINGS

The need to extract a drawn cup needle roller bearing does not arise often. Standard extractor tools may be purchased from a reputable manufacturer. Customers may produce the special extraction tools at their own facilities. After extraction, the drawn cup needle roller bearing should not be reused.

EXTRACTION FROM A STRAIGHT HOUSING

When it is necessary to extract a drawn cup needle roller bearing from a straight housing, a similar tool to the installation tool – but without the stop – may be used. To avoid damage to the bearing, pressure should be applied against the marked end of the bearing, just as it is done at installation.

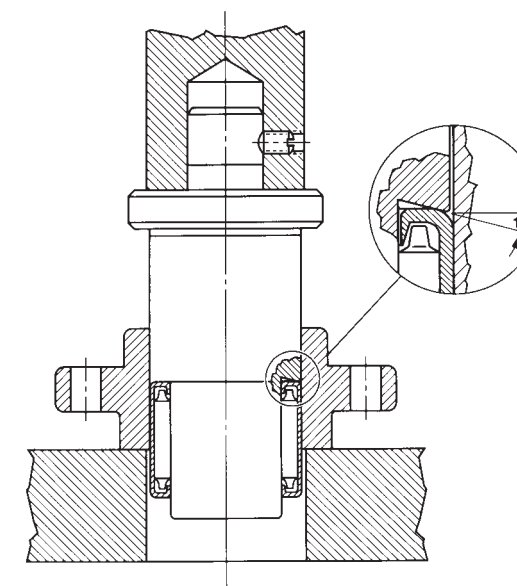


Fig. B2-17. Extraction from a straight housing

EXTRACTION FROM A SHOULDERED HOUSING

(with bearing pressed up close to the shoulder)

The tool to be used, as shown, is of a similar type described for a shouldered or dead end housing. But the rollers must first be removed from the bearing.

The four segment puller jaws are collapsed and slipped into the empty cup. The jaws are then forced outward into the cup bore, by means of the tapered expansion rod. The jaws should bear on the lip as near as possible to the cup bore. The cup is then pressed out from the top.

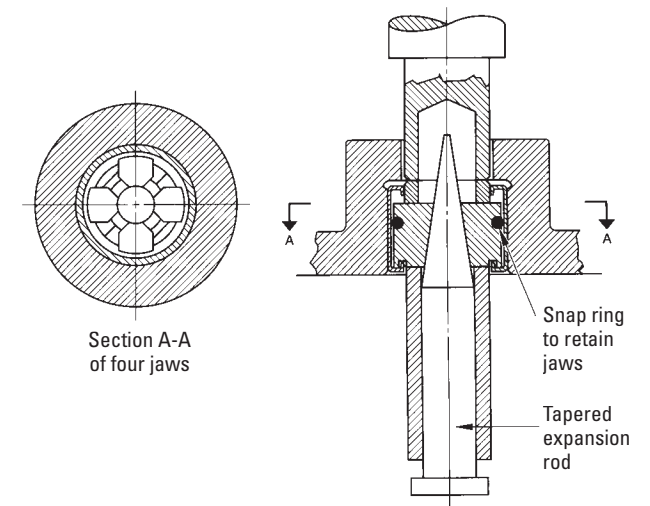


Fig. B2-18. Extraction from a shouldered housing

EXTRACTION FROM A SHOULDERED OR DEAD END HOUSING

(with space between the bearing and the housing shoulder)

Bearings may be extracted from shouldered or dead end housings with a common bearing puller tool as shown. This type of tool is slotted in two places, at right angles, to form four prongs. The four puller prongs are pressed together and inserted into the space between the end of the bearing and the shoulder. The prongs are forced outward by inserting the expansion rod, and then the bearing is extracted. Do not reuse the bearing after extraction.

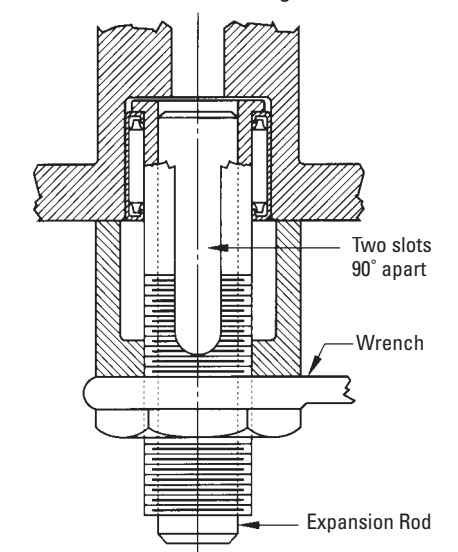
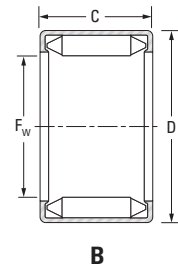


Fig. B2-19. Extraction from a shouldered or dead end housing

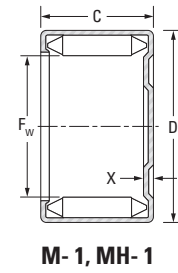


FULL COMPLEMENT BEARINGS
OPEN ENDS, CLOSED ONE END

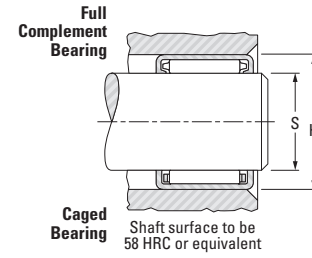
INCH SERIES
B, BH, M- 1, MH- 1 SERIES



B



M- 1, MH- 1



Caged Bearing
Shaft surface to be 58 HRC or equivalent

Table with columns: Shaft Dia., Fw, D, C, Xmax, Bearing Designation, Load Ratings (Dynamic, Static), Approx. Wt., Inspection gage, Mounting inner ring. Rows include series B, BH, M-1, MH-1 for shaft diameters from 1/8 to 3/8 inch.

Note) - For information on the speed ratings, contact JTEKT.
- For the recommended mounting dimensions see Table B2-7.

(1) IRA inner ring provides additional length if required.

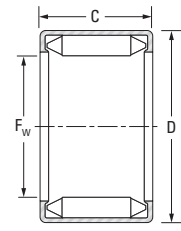
Table with columns: Shaft Dia., Fw, D, C, Xmax, Bearing Designation, Load Ratings (Dynamic, Static), Approx. Wt., Inspection gage, Mounting inner ring. Rows include series B, BH, M-1, MH-1 for shaft diameters from 3/8 to 9/16 inch.

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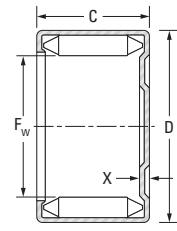


FULL COMPLEMENT BEARINGS
OPEN ENDS, CLOSED ONE END

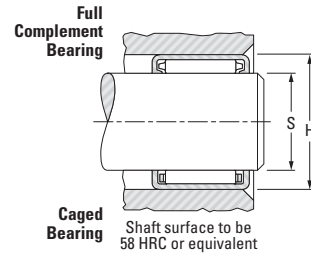
INCH SERIES
B, BH, M- 1, MH- 1 SERIES



B



M- 1, MH- 1



Caged Bearing
Shaft surface to be 58 HRC or equivalent

Table with columns: Shaft Dia., Fw, D, C, Xmax, Bearing Designation, Load Ratings (Dynamic, Static), Approx. Wt., Inspection gage, Mounting inner ring. Rows include bearings B-912, B-105, B-107, B-108, B-1010, B-1012, BH-108, BH-1010, BH-1012, BH-1016, B-116, B-118, B-1110, B-1112, BH-117, BH-1110, BH-1112, B-126, B-128.

Note) - For information on the speed ratings, contact JTEKT.
- For the recommended mounting dimensions see Table B2-7.

(1) IRA inner ring provides additional length if required.

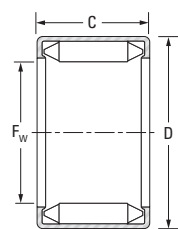
Table with columns: Shaft Dia., Fw, D, C, Xmax, Bearing Designation, Load Ratings (Dynamic, Static), Approx. Wt., Inspection gage, Mounting inner ring. Rows include bearings B-1210, B-1212, B-136, B-138, B-1314, B-1316, B-1320, BH-138, BH-1310, BH-1312, B-146, B-148, B-1412, B-1416, B-1418, BH-1410, BH-1412, BH-1416, B-158, B-1516, B-166, B-167, B-168, B-1610, B-1612, B-1616.

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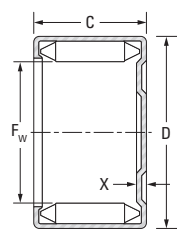


FULL COMPLEMENT BEARINGS
OPEN ENDS, CLOSED ONE END

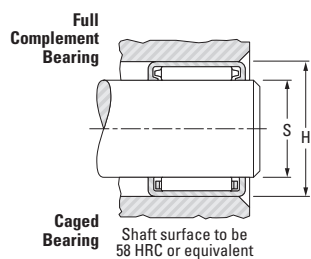
INCH SERIES
B, BH, M- 1, MH- 1 SERIES



B



M- 1, MH- 1



Caged Bearing

Shaft surface to be 58 HRC or equivalent

Table with columns: Shaft Dia., Fw, D, C, Xmax, Bearing Designation, Load Ratings (Dynamic, Static), Approx. Wt., Inspection gage, Mounting inner ring. Rows include various bearing sizes from 1 inch to 1 3/16 inch.

Note) - For information on the speed ratings, contact JTEKT. For the recommended mounting dimensions see Table B2-7.

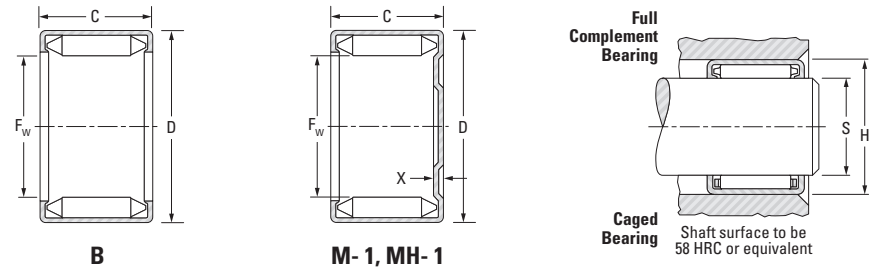
(1) IRA inner ring provides additional length if required.

Table with columns: Shaft Dia., Fw, D, C, Xmax, Bearing Designation, Load Ratings (Dynamic, Static), Approx. Wt., Inspection gage, Mounting inner ring. Rows include various bearing sizes from 1 1/4 inch to 1 1/2 inch.

Continued on next page.

FULL COMPLEMENT BEARINGS OPEN ENDS, CLOSED ONE END

INCH SERIES B, BH, M- 1, MH- 1 SERIES



Shaft Dia.	F _w	D	C		X _{max}	Bearing Designation		Load Ratings		Approx. Wt.		Inspection gage	Mounting inner ring (pages B-2-74 to B-2-76)
			+0 -0.3	+0.000 -0.012		Open Ends	Closed One End	Dynamic C	Static C ₀	Open Ends	Closed One End		
in	mm in	mm in	mm in	mm in					kN lbf	kg lbs			
1 1/2	38.100 1.5000	47.625 1.8750	31.75 1.250	3.05 0.120	B-2420	M-24201	61.8 13900	138.0 31000	0.119 0.263	0.135 0.298	Table B2-8	IR-1920	
1 5/8	41.275 1.6250	50.800 2.0000	12.70 0.500	—	B-268	—	22.8 5120	39.2 8820	0.051 0.113	—	Table B2-8	IR-2020 ⁽¹⁾	
	41.275 1.6250	50.800 2.0000	15.88 0.625	3.05 0.120	B-2610	M-26101	30.6 6890	57.4 12900	0.064 0.141	0.073 0.160	Table B2-8	IR-2020 ⁽¹⁾	
	41.275 1.6250	50.800 2.0000	25.40 1.000	—	B-2616	—	51.6 11600	112.0 25200	0.103 0.226	—	Table B2-8	IR-2020 ⁽¹⁾	
	41.275 1.6250	50.800 2.0000	31.75 1.250	3.05 0.120	B-2620	M-26201	64.0 14400	149.0 33400	0.128 0.282	0.145 0.320	Table B2-8	IR-2220 ⁽¹⁾	
1 3/4	44.450 1.7500	53.975 2.1250	19.05 0.750	3.05 0.120	B-2812	M-28121	39.3 8830	81.4 18300	0.082 0.181	0.093 0.205	Table B2-8	IR-2316	
	44.450 1.7500	53.975 2.1250	25.40 1.000	3.05 0.120	B-2816	M-28161	53.4 12000	121.0 27100	0.110 0.242	0.124 0.274	Table B2-8	IR-2316	
	44.450 1.7500	53.975 2.1250	31.75 1.250	—	B-2820	—	66.3 14900	160.0 36000	0.137 0.302	—	Table B2-8	IR-2324	
	44.450 1.7500	53.975 2.1250	38.10 1.500	3.05 0.120	B-2824	M-26241	78.7 17700	199.0 44800	0.165 0.363	0.186 0.411	Table B2-8	IR-2324	
1 7/8	47.625 1.8750	57.150 2.2500	12.70 0.500	3.05 0.120	B-308	M-3081	25.1 5650	46.3 10400	0.059 0.129	0.066 0.146	Table B2-8		
	47.625 1.8750	57.150 2.2500	15.888 0.625	—	B-3010	—	33.6 7550	67.6 15200	0.073 0.161	—	Table B2-8		
	47.625 1.8750	57.150 2.2500	19.05 0.750	—	B-3012	—	41.5 9330	88.5 19900	0.088 0.193	—	Table B2-8		
	47.625 1.8750	57.150 2.2500	25.40 1.000	3.05 0.120	B-3016	M-30161	56.0 12600	130.0 29200	0.117 0.258	0.132 0.292	Table B2-8		
2	50.800 2.0000	60.325 2.3750	12.70 0.500	3.05 0.120	B-328	M-3281	25.4 5710	48.0 10800	0.062 0.136	0.070 0.154	Table B2-8		
	50.800 2.0000	60.325 2.3750	15.88 0.625	—	B-3210	—	34.2 7680	70.7 15900	0.078 0.171	—	Table B2-8		
	50.800 2.0000	60.325 2.3750	22.23 0.875	—	B-3214	—	54.3 11300	115.0 26000	0.108 0.239	—	Table B2-8		
	50.800 2.0000	60.325 2.3750	25.40 1.000	3.05 0.120	B-3216	M-32161	57.4 12900	138.0 31000	0.124 0.273	0.140 0.309	Table B2-8		
	50.800 2.0000	60.325 2.3750	31.75 1.250	3.05 0.120	B-3220	M-32201	71.6 16100	183.0 41100	0.155 0.341	0.175 0.386	Table B2-8		
	50.800 2.0000	60.325 2.3750	38.10 1.500	3.05 0.120	B-3224	M-32241	85.0 19100	228.0 51200	0.186 0.410	0.211 0.465	Table B2-8		

Note) · For information on the speed ratings, contact JTEKT.
· For the recommended mounting dimensions see Table B2-7.

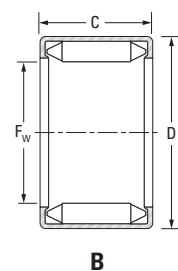
(1) IRA inner ring provides additional length if required.

Shaft Dia.	F _w	D	C		X _{max}	Bearing Designation		Load Ratings		Approx. Wt.		Inspection gage	Mounting inner ring (pages B-2-74 to B-2-76)
			+0 -0.3	+0.000 -0.012		Open Ends	Closed One End	Dynamic C	Static C ₀	Open Ends	Closed One End		
in	mm in	mm in	mm in	mm in					kN lbf	kg lbs			
2	50.800 2.0000	60.325 2.3750	44.45 1.750	3.05 0.120	B-3228	M-32281	97.4 21900	273.0 61300	0.217 0.478	0.245 0.541	Table B2-8		
2 1/16	52.388 2.0625	64.292 2.5312	19.05 0.750	—	BH-3312	—	46.3 10400	86.7 19500	0.122 0.269	—	Table B2-8	IR-2916	
	52.388 2.0625	64.292 2.5312	25.40 1.000	3.56 0.140	BH-3316	MH-33161	64.0 14400	133.0 29900	0.162 0.358	0.184 0.406	Table B2-8	IR-2916	
	52.388 2.0625	64.292 2.5312	38.10 1.500	3.56 0.140	BH-3324	MH-33241	97.0 21800	226.0 50700	0.244 0.537	0.276 0.609	Table B2-8	IR-2924	
2 1/8	53.975 2.1250	63.500 2.5000	12.70 0.500	—	B-348	—	26.1 5870	51.2 11500	0.065 0.144	—	Table B2-8	IR-3024	
	53.975 2.1250	63.500 2.5000	19.05 0.750	—	B-3412	—	43.6 9790	99.2 22300	0.098 0.216	—	Table B2-8	IR-3024	
	53.975 2.1250	63.500 2.5000	25.40 1.000	3.05 0.120	B-3416	M-34161	59.2 13300	147.0 33000	0.131 0.289	0.148 0.327	Table B2-8	IR-3024	
	53.975 2.1250	63.500 2.5000	31.75 1.250	—	B-3420	—	73.4 16500	194.0 43700	0.164 0.361	—	Table B2-8	IR-3024	
	53.975 2.1250	63.500 2.5000	38.10 1.500	3.05 0.120	B-3424	M-34241	87.2 19600	242.0 54400	0.196 0.433	0.223 0.491	Table B2-8	IR-3024	
2 1/4	57.150 2.2500	66.675 2.6250	19.05 0.750	3.30 0.130	B-3612	M-36121	45.8 10300	105.0 23700	0.103 0.228	0.117 0.258	Table B2-8		
	57.150 2.2500	66.675 2.6250	25.40 1.000	—	B-3616	—	62.2 14000	155.6 35000	0.138 0.304	—	Table B2-8		
	57.150 2.2500	66.675 2.6250	31.75 1.250	—	B-3620	—	77.4 17400	206.0 46400	0.172 0.380	—	Table B2-8		
	57.150 2.2500	66.675 2.6250	38.10 1.500	3.30 0.130	B-3624	M-36241	92.1 20700	257.0 57700	0.207 0.456	0.235 0.517	Table B2-8		
2 5/8	66.675 2.6250	76.200 3.0000	25.40 1.000	3.30 0.130	B-4216	M-42161	66.7 15000	182.0 40900	0.159 0.351	0.181 0.398	Table B2-8		
2 3/4	69.850 2.7500	79.375 3.1250	15.88 0.625	—	B-4410	—	41.0 9210	98.0 22000	0.104 0.229	—	Table B2-8	IR-4016	
	69.850 2.7500	79.375 3.1250	19.05 0.7500	—	B-4412	—	50.7 11400	129.0 29000	0.124 0.274	—	Table B2-8	IR-4016	
	69.850 2.7500	79.375 3.1250	25.40 1.000	—	B-4416	—	69.0 15500	190.0 42800	0.166 0.366	—	Table B2-8	IR-4016	
	69.850 2.7500	79.375 3.1250	31.75 1.250	3.30 0.130	B-4420	M-44201	85.4 19200	252.0 56700	0.208 0.458	0.235 0.519	Table B2-8		
3 1/2	88.900 3.5000	101.600 4.0000	19.05 0.750	—	B-5612	—	64.9 14600	150.0 33700	0.212 0.468	—	Table B2-8		
5 1/2	139.700 5.5000	152.400 6.0000	19.05 0.750	—	B-8812	—	77.0 17300	231.0 52000	0.325 0.717	—	Table B2-8		

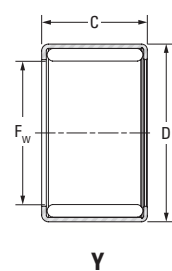


**FULL COMPLEMENT BEARINGS
OPEN ENDS, CLOSED ONE END**

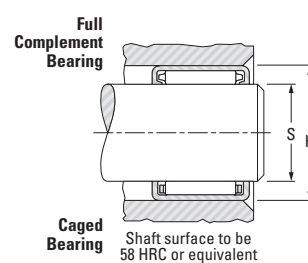
**INCH SERIES
B, Y SERIES**



B



Y



Shaft Dia.	F _w	D	C		X _{max}	Bearing Designation		Load Ratings		Approx. Wt.		Inspection gage	Mounting inner ring (pages B-2-74 to B-2-76)
			+0 -0.3	+0.000 -0.012		Open Ends	Closed One End	Dynamic	Static	Open Ends	Closed One End		
			mm in	mm in		mm in	mm in	C	C ₀	Open Ends	Closed One End		
7/8	22.225	28.575	19.05	—	—	B1412	—	28.4	51.9	0.029	—	Table B2-9	—
1 1/8	28.575	34.925	19.05	—	—	Y1812MU	—	32.8	67.1	0.038	—	Table B2-9	—
1 3/16	30.163	38.1	19.05	—	—	Y1912AM	—	39.5	70.7	0.050	—	Table B2-9	—
1 3/8	34.925	41.275	12.7	—	—	B228	—	24.6	50.6	0.027	—	Table B2-9	—
2	50.800	60.325	25.4	—	—	B3216	—	71.3	160	0.121	—	Table B2-9	—

Note) · For information on the speed ratings, contact JTEKT.
· For the recommended mounting dimensions see Table B2-7.

EXTRA-PRECISION BEARINGS

INCH SERIES

Open-end full-complement mechanically retained drawn cup needle roller bearings, manufactured to inch standards, are offered with extra-precision specifications. The manufacturing tolerance of these bearings is one-third that of the standard precision bearings. In production operations, using closer tolerances on shaft and housing, they will assemble with consistently lower radial internal clearances than can be expected with the standard precision series bearings.

Extra-precision bearings are suitable for those applications requiring close control of radial play and eccentricity. They are also preferred when two bearings are mounted adjacent to each other because greater accuracy in manufacture will provide better load distribution between the bearings.

Nominal dimensions, load ratings, speed ratings and other general specifications for extra-precision bearings are the same as for the corresponding “B” or “BH” sizes of drawn cup needle roller bearings. Consequently, the data on pages B-2-54 to B-2-61 can be used in bearing size selection.

When ordering an extra-precision bearing, add the prefix letter “G” to the bearing designation. For example, after following the size selection procedure outlined in the engineering section, bearing B-1212 is selected – but extra-precision tolerances are required. These are designated by ordering a GB-1212 bearing.

To realize the advantages of the expected closer radial internal clearance of the extra-precision bearing, the user must have the capability of producing housing bore and shaft raceway diameters to the close tolerances indicated by the bearing tables on page B-2-65.

The resulting total radial internal clearance, within the installed GB-1212 extra-precision drawn cup needle roller bearing, will lie in the range from 0.005 mm to 0.030 mm (0.0002 in to 0.0012 in)

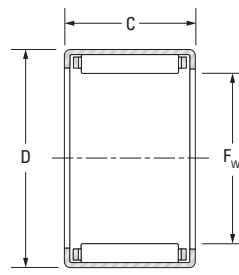
Inspection dimensions for the extra-precision bearings are given in Table B2-10 on page B-2-64. Note that these bearings must be inspected while mounted in the specified ring gage. Bearing bores are checked with “go” and “no go” plug gages. The “go” gage size is the minimum diameter inside the needle rollers. The “no go” gage size is 0.002 mm (0.0001 in) larger than the maximum diameter inside the needle rollers.

Procedures for selecting ring and plug gage dimensions are the same as for those involving standard precision needle roller bearings – except that the ring gage diameters and diameters inside the needle rollers must be drawn from the table on page B-2-64.

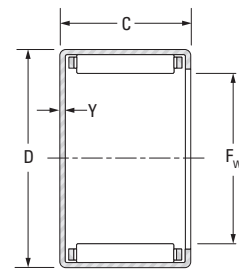


CAGED BEARINGS – OPEN ENDS, CLOSED ONE END

INCH SERIES J, JH, MJ- 1, MJH- 1 SERIES



J, JH



MJ- 1, MJH- 1

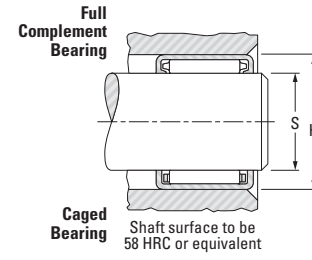


Table with columns: Shaft Dia., Fw, D, C, Ymax, Bearing Designation, Load Ratings (Dynamic, Static), Speed Rating (Grease, Oil), Approx. Wt., Inspection gage, Mounting inner ring. Rows include bearings like JP-23-F, JP-24-F, JP-2 1/2 3F, JP-33-F, JP-34-F, J-36, MJ-361, J-45, MJ-451, J-47, MJ-471, J-55, J-57, MJ-571, JH-57, MJH-571, J-65, MJ-651, J-66, MJ-661, J-68, MJ-681, JH-68, J-78, MJ-781, JH-78.

Note) For the recommended mounting dimensions see Table B2-7. (1) IRA inner ring provides additional length if required.

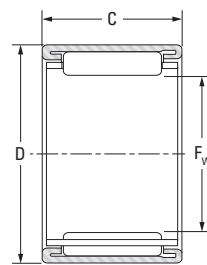
Table with columns: Shaft Dia., Fw, D, C, Ymax, Bearing Designation, Load Ratings (Dynamic, Static), Speed Rating (Grease, Oil), Approx. Wt., Inspection gage, Mounting inner ring. Rows include bearings like J-85, MJ-851, J-86, MJ-861, J-88, MJ-881, J-812, JH-87, MJH-871, JH-88, MJH-881, JH-812, J-97, MJ-971, J-98, MJ-981, J-910, JH-98, MJH-981, J-108, MJ-1081, J-1010, MJ-10101, J-1012, MJ-10121, JH-1010, MJH-10101, JH-1016, MJH-10161, J-1112, MJ-11121, JH-1110, MJH-11101, JH-1112, J-126, J-128, J-1210, MJ-12101, J-1212, MJ-12121, JH-1212, MJH-12121.

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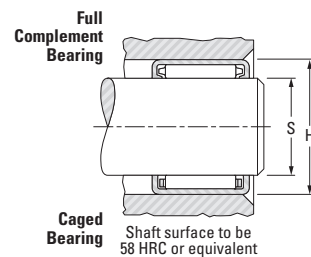


**CAGED BEARINGS –
OPEN ENDS,
CLOSED ONE END**

**INCH SERIES
BT SERIES**



BT



NOTES

Shaft Dia.	F _w	D	C		Y _{max}	Bearing Designation		Load Ratings		Speed Rating		Approx. Wt.		Inspection gage	Mounting inner ring (pages B-2-74 to B-2-76)
			+0 -0.3	+0.000 -0.012		Open Ends	Closed One End	Dynamic	Static	Grease	Oil	Open Ends	Closed One End		
in	mm in	mm in	mm in	mm in				kN lbf		min ⁻¹		kg lbs			
1 ³ / ₁₆	20.638	26.988	19.05	—	—	BT1112-1	—	12.7	21.2	12000	19000	0.024		Table B2-9	—
7 ⁷ / ₈	22.225	28.575	9.525	—	—	BT146P	—	7.05	8.55	9800	15000	0.012		Table B2-9	—
1	25.40	31.75	9.525	—	—	BT166	—	7.45	9.5	8500	13000	0.014		Table B2-9	—
1 1 ¹ / ₈	28.575	34.925	12.7	—	—	BT188	—	13.1	20.3	7200	11000	0.021		Table B2-9	—
1 3 ³ / ₁₆	30.162	38.1	25.4	—	—	BT1916M	—	31.5	51.9	7200	11000	0.054		Table B2-9	—
1 1 ¹ / ₄	31.75	38.1	19.05	—	—	BT2012	—	21.2	38.7	6500	10000	0.035		Table B2-9	—
1 5 ⁵ / ₈	41.275	50.8	22.225	—	—	BT2614	—	34.1	56.9	5100	7900	0.082		Table B2-9	—
1 7 ⁷ / ₈	47.625	57.15	15.875	—	—	BT3010-1	—	25.2	40.1	4400	6800	0.064		Table B2-9	—

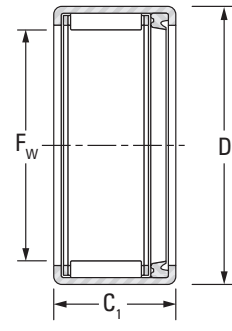
Note) For the recommended mounting dimensions see Table B2-7.



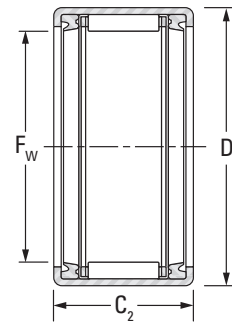
SEALED DRAWN CUP BEARINGS

INCH SERIES

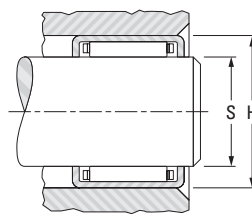
- Check for availability. Not all bearings are in production.
Pre-packed with general purpose ball and roller bearing grease unless otherwise specified.
Bearing operating temperature limited between -30° C and +110° C (-25° F and +225° F).
Consult your representative for operating temperatures outside the above range or if seals have been exposed to unusual fluids.
Speed rating based on shaft contact speed of 610 m/min. (2000 fpm).
Reduce the listed speed rating by one-half for outer ring rotation.



JT - One Seal



JTT - Two Seals



Shaft surface to be 58 HRC or equivalent

Drawn cup bearings of nominal inch dimensions, with one closed end, that are not tabulated, may be made available upon request.

Mounting dimensions are based on the inner ring rotating and the outer ring being stationary, relative to the load. The housing should be of high strength material.

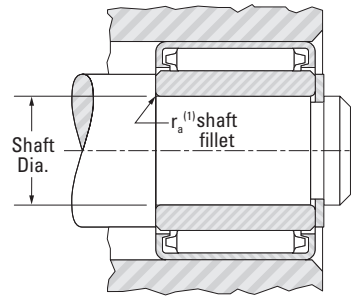
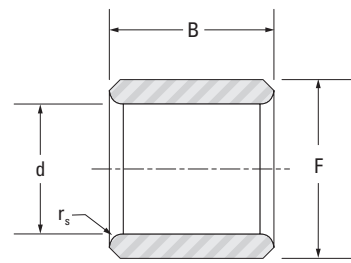
Table with columns: Shaft Dia., Fw, D, Bearings With One Seal (C1, Bearing Designation, Approx. Wt.), Bearings With Two Seals (C2, Bearing Designation, Approx. Wt.). Rows include sizes from 5/16 to 1 1/2 inches.

Table with columns: Load Ratings (Dynamic, Static), Approx. Speed Rating (Grease), C0, Mounting Dimension (S, H), Inspection (Ring Gage, Plug Gage), Shaft Dia. Rows include load ratings in kN and lbf, speed ratings in min-1, and shaft diameters in inches.



**INNER RINGS FOR INCH SERIES
DRAWN CUP BEARINGS**

- Check for availability.
- Ideal choice when shaft is not practical to use as inner raceway.
- Provided in inch (IR, IRA) nominal dimensions for use with inch series drawn cup bearings.
- Designed to meet established inch tolerances.
- Designed to be wider than matching drawn cup bearing.
- Maximum shaft fillet radius ($r_{a \max}$) cannot exceed inner ring bore chamfer ($r_{s \min}$) as shown.
- Optional centralized lubrication groove (bore) and thru-hole available – specify when ordering.
- Designed to provide a loose transition fit on the shaft and should be axially clamped against a shoulder.
- If a tight transition fit must be used to keep the inner ring from rotating relative to the shaft, the inner ring O.D. must not exceed the raceway diameter for the matching drawn cup bearing after being mounted on the shaft.
- See tables for bearing raceway diameter dimensions.
- After mounting, if O.D. of inner ring exceeds required raceway diameter for matching bearing, ring should be ground to proper diameter while mounted on shaft.



Shaft Dia.	d		F		B		$r_{s \min}$	Inner Ring Designation	Mounting Dimensions Transition Fit				Approx. Wt.
	Max.	Min.	Max.	Min.	Max.	Min.			Loose		Tight		
									Max.	Min.	Max.	Min.	
in	mm in	mm in	mm in	mm in	mm in	mm in	mm in	mm in	mm in	mm in	mm in	mm in	kg lbs
1 1/4	31.750 1.2500	31.737 1.2495	38.100 1.5000	38.087 1.4995	32.66 1.286	32.41 1.276	1.52 0.060	IRA-20	31.742 1.2497	31.730 1.2492	31.753 1.2501	31.740 1.2496	0.086 0.190
1 3/8	34.925 1.3750	34.912 1.3745	41.275 1.6250	41.262 1.6245	32.13 1.265	31.88 1.255	1.52 0.060	IR-2220	34.917 1.3747	34.905 1.3742	34.928 1.3751	34.915 1.3746	0.094 0.208
1 7/16	36.513 1.4375	36.500 1.4370	44.450 1.7500	44.437 1.7495	25.78 1.015	25.53 1.005	1.52 0.060	IR-2316	36.505 1.4372	36.492 1.4367	36.515 1.4376	36.502 1.4371	0.100 0.220
	36.513 1.4375	36.500 1.4370	44.450 1.7500	44.437 1.7495	38.48 1.515	38.23 1.505	1.52 0.060	IR-2324	36.505 1.4372	36.492 1.4367	36.515 1.4376	36.502 1.4371	0.150 0.331
1 1/2	38.100 1.5000	38.087 1.4995	44.450 1.7500	44.437 1.7495	25.78 1.015	25.53 1.005	1.52 0.060	IR-2416	38.092 1.4997	38.080 1.4992	38.103 1.5001	38.090 1.4996	0.078 0.173
	38.100 1.5000	38.087 1.4995	44.450 1.7500	44.437 1.7495	38.48 1.515	38.23 1.505	1.52 0.060	IR-2424	38.092 1.4997	38.080 1.4992	38.103 1.5001	38.090 1.4996	0.122 0.270
1 11/16	42.863 1.6875	42.850 1.6870	52.388 2.0625	52.375 2.0620	38.48 1.515	38.23 1.505	1.52 0.060	IR-2724	42.855 1.6872	42.842 1.6867	42.865 1.6876	42.852 1.6871	0.212 0.468
1 3/4	44.450 1.7500	44.437 1.7495	52.388 2.0625	52.375 2.0620	38.48 1.515	38.23 1.505	1.52 0.060	IR-2824	44.442 1.7497	44.430 1.7492	44.453 1.7501	44.440 1.7496	0.180 0.396
1 13/16	46.038 1.8125	46.025 1.8120	52.388 2.0625	52.375 2.0620	25.78 1.015	25.53 1.005	1.52 0.060	IR-2916	46.030 1.8122	46.017 1.8117	46.040 1.8126	46.027 1.8121	0.097 0.214
	46.038 1.8125	46.025 1.8120	52.388 2.0625	52.375 2.0620	38.48 1.515	38.23 1.505	1.52 0.060	IR-2924	46.030 1.8122	46.017 1.8117	46.040 1.8126	46.027 1.8121	0.146 0.322
1 7/8	47.625 1.8750	47.612 1.8745	53.975 2.1250	53.962 2.1245	38.48 1.515	38.23 1.505	1.52 0.060	IR-3024	47.617 1.8747	47.605 1.8742	47.628 1.8751	47.615 1.8746	0.145 0.319
2 1/2	63.500 2.5000	63.487 2.4995	69.850 2.7500	69.837 2.7495	25.78 1.015	25.53 1.005	1.52 0.060	IR-4016	63.495 2.4998	63.477 2.4991	63.505 2.5002	63.487 2.4995	0.132 0.290

Bore and O.D. tolerance limits correspond to the single mean diameter (the arithmetical mean of the largest and smallest diameters in a single radial plane).

⁽¹⁾ $r_{a \max}$ is equal to minimum inner ring bore chamfer ($r_{s \min}$).

DRAWN CUP ROLLER CLUTCHES

Overview: Drawn cup needle roller clutches are similar to drawn cup needle roller bearings in design; however, they allow free rotation in only one direction while transmitting torque in the opposite direction. These designs use the same small radial section as drawn cup needle roller bearings and are offered as clutch-only units or as clutch and bearing assemblies.

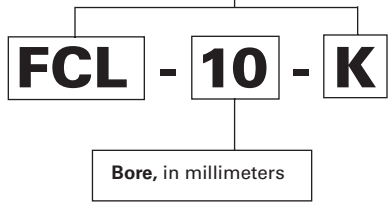
- **Catalogue range:** 3.2 mm – 35 mm (0.1250 in – 1.3780 in) bore.
- **Markets:** Office equipment, paper-towel dispensers, exercise equipment, appliances and two-speed gearboxes.
- **Features:** Compact, lightweight and operate directly on a hardened shaft.
- **Benefits:** Installation is easily accomplished with a simple press fit.





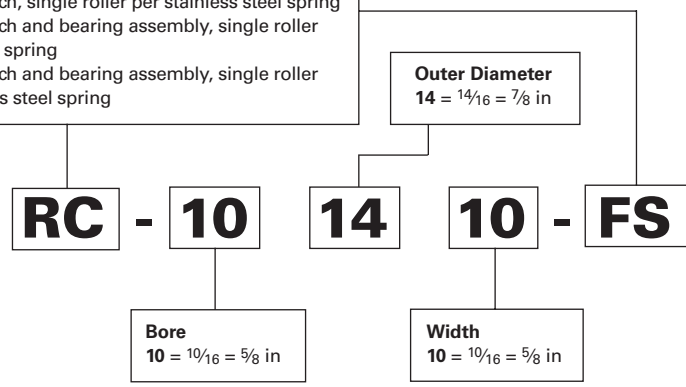
**Drawn Cup Roller Clutches
Metric Series**

- FCS, FC-K** regular clutch, single roller per stainless steel spring
- FC** regular clutch, multi-roller per stainless steel spring
- FCL-K** light series clutch, single roller per stainless steel spring
- FCB** regular clutch and bearing assembly, multi-roller per stainless steel spring
- FCBL-K, FCBN-K** light series clutch and bearing assembly, single roller per stainless steel spring



Inch Series

- RC** regular clutch, single roller per integral spring
- RC-FS** regular clutch, single roller per stainless steel spring
- RCB** regular clutch and bearing assembly, single roller per integral spring
- RCB-FS** regular clutch and bearing assembly, single roller per stainless steel spring



**Drawn Cup
Roller Clutches**

	<i>Page</i>
Introduction	B-3-4
Drawn Cup Roller Clutches – Metric Series.....	B-3-10
Drawn Cup Roller Clutches and Bearing Assemblies – Metric Series	B-3-12
Drawn Cup Roller Clutches – Inch Series	B-3-14
Drawn Cup Roller Clutch and Bearing Assemblies – Inch Series	B-3-16
Drawn Cup Roller Clutches for Use in Plastic Housings.....	B-3-18



DRAWN CUP ROLLER CLUTCHES

METRIC AND INCH SERIES

Drawn cup roller clutch transmits torque between shaft and housing in one direction and allows free overrun in the opposite direction. When transmitting torque, either the shaft or the housing can be the input member. Applications are generally described as indexing, backstopping or overrunning.

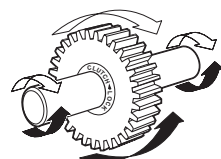


Fig. B3-1. Lock function: shaft drives gear clockwise (white arrows) or gear can drive shaft counterclockwise (black arrows)

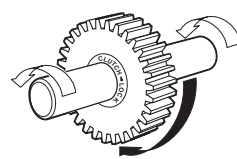


Fig. B3-2. Overrun function: shaft overruns in gear counterclockwise (white arrows) or gear overruns on shaft clockwise (black arrow)

IDENTIFICATION

The prefix letters in the designation of the drawn cup roller clutches and drawn cup roller clutch and bearing assemblies denote whether these are manufactured to metric or inch nominal dimensions. Designation codes for clutches and clutch and bearing assemblies with metric nominal dimensions begin with the letter "F." Designation codes for clutches and clutch and bearing assemblies with inch nominal dimensions begin with the letter "R."

The basic types of clutches and clutch and bearing assemblies are listed below:

METRIC SERIES TYPES

- FCS, FC-K** Regular clutch, single roller per stainless steel spring.
- FC** Regular clutch, multi-roller per stainless steel spring.
- FCB** Regular clutch and bearing assembly, multi-roller per stainless steel spring.
- FCL-K** Light series clutch, single roller per stainless steel spring.
- FCBL-K, FCBN-K** Light series clutch and bearing assembly. Single roller per stainless steel spring.

INCH SERIES TYPES

- RC** Regular clutch, single roller per integral spring.
- RC-FS** Regular clutch, single roller per stainless steel spring.
- RCB** Regular clutch and bearing assembly, single roller per integral spring.
- RCB-FS** Regular clutch and bearing assembly, single roller per stainless steel spring.

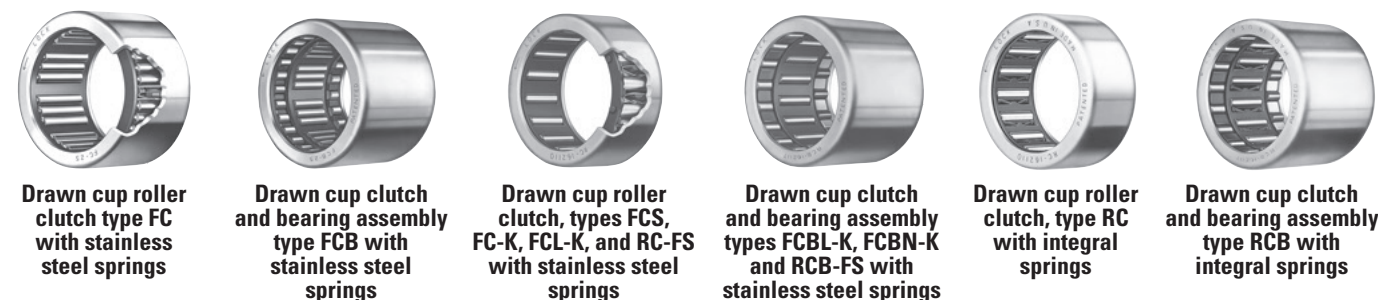


Fig. B3-3. Types of clutches and clutch and bearing assemblies

CONSTRUCTION

In many respects, construction is similar to that of drawn cup bearings. Design and manufacture of drawn cup clutches – just as with drawn cup bearings – was pioneered and developed by The Torrington Company. The well-established design utilizes the same low-profile radial section as drawn cup bearings. The precisely formed interior ramps provide surfaces against which the needle rollers wedge. These positively lock the clutch with the shaft when rotated in the proper direction. These ramps, formed during the operation of drawing the cup, are case hardened for wear resistance. The incorporation of ramp forming into the cup drawing operation is a manufacturing innovation that contributes to the low cost of the unit.

Two designs of precision molded clutch cages are employed. Clutch and clutch and bearing assembly types – FC, FC-K, FCS, FCL-K, RC-FS, FCB, FCBN-K, FCBL-K and RCB-FS – use a glass fiber, reinforced nylon cage, equipped with inserted stainless steel leaf springs. The stainless steel springs permit higher rates of clutch engagement and achieve greater spring life. The nylon cage permits operation at higher temperatures. Clutch types RC and RCB utilize a one-piece cage of acetyl resin polymer with integral leaf style springs. They are used for lower temperatures than permitted for the units with nylon cages.

Types FCB, FCBL-K, FCBN-K, RCB and RCB-FS clutch and bearing assemblies have cages, for retention and guidance of the needle rollers in the bearings, located on both sides of the clutch unit.



Fig. B3-4. Clutch and bearing assembly

Types FC, FC-K, FCS, FCL-K, RC and RC-FS are of clutch-only configurations for use with external radial support (usually two drawn cup needle roller bearings). Separate bearings position the shaft and housing concentrically and carry the radial load during overrun.



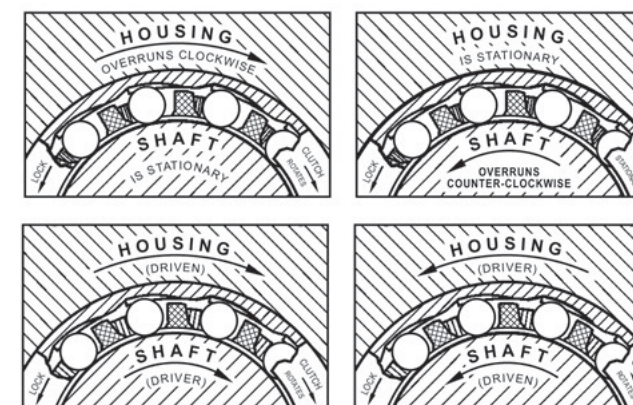
Fig. B3-5. Clutch only

OPERATION

Operation is in two modes: the overrun mode and the lock mode. Operational mode is controlled by the direction of the clutch or shaft rotation with respect to the locking ramps.

In the overrun mode, shown in the drawings below, the relative rotation between the housed clutch and the shaft causes the rollers to move away from their locking position against the locking ramps in the drawn cup. The housing and the clutch are then free to overrun in one direction, or the shaft is free to overrun in the other direction.

In the lock mode, shown in the drawings below, the relative rotation between the housed clutch and the shaft is opposite to that in the overrun mode. The rollers, assisted by the leaf-type springs, become wedged between the locking ramps and the shaft to transmit torque between the two members. Either the member housing the clutch drives the shaft in one direction, or the shaft can drive the clutch and its housing member in the other direction.



Clearance between the rollers and cup ramps is exaggerated in these drawings.

Fig. B3-6. Overrun mode and lock mode



APPLICATION

Clutches and clutch and bearing assemblies are successfully applied in a wide range of commercial products where indexing, backstopping and overrunning operations must be performed reliably. The sketches on these pages illustrate some of the many possible uses.

When applying the clutch-only unit, separate bearings on each side of the clutch are required to position the shaft concentrically with the housing, and to carry the radial loads during overrun. Drawn cup needle roller bearings, with the same radial section as the clutch, should be used in the through-bored housings for simplicity and economy. Two clutches can be used side by side for greater torque capacity.

Where the radial loads are light, the clutch and bearing assembly can be used without additional support bearings. This reduces the overall assembly width, the number of stocked and ordered parts and assembly costs, as well.

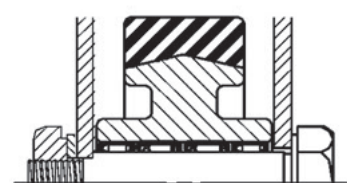


Fig. B3-7. Clutch and bearing arrangement for heavy loads

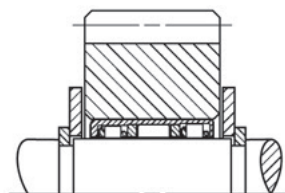


Fig. B3-8. Clutch and bearing assembly for light loads

Drawn cup roller clutches are manufactured to commercial hardware standards and are used extensively in appliances, business machines, industrial and recreation equipment and a wide range of other applications.

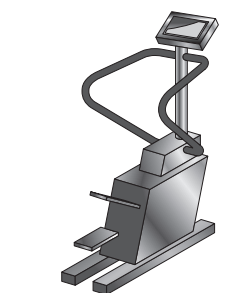
In any application where our clutch may be considered, it will be part of a system in which the operating conditions and the clutch mounting will affect its function. Before any clutch selection is made, it is important that the following catalog section be carefully studied to understand the effects of these factors. Consideration should be given to operating conditions such as:

- Magnitude of externally applied torque, as well as inertial torque.
- Magnitude of applied radial loads during overrunning.
- Potential for vibration or axial shaft movement within the clutch during engagement.
- Engagement rate, as it pertains to the selection of stainless steel or plastic leaf springs.
- Oil lubricant supply during high overrunning speeds.
- External and internal environmental temperatures that can affect clutch performance.
- Lubricant selection effect on clutch engagement.
- Indexing inaccuracies resulting from backlash (lost motion).

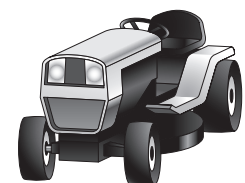
Consideration should be given to the shaft and housing design requirements such as:

- Shaft hardness and strength particularly when approaching torque rating limits.
- Shaft roundness, taper and surface finish necessary to ensure sufficient fatigue life and torque-carrying ability.
- Housing strength (hardness and cross section) to support the applied torque loads.
- Housing roundness, taper and surface finish necessary to ensure uniform torque and load distribution.

A test program under all expected operating conditions should be carried out before putting a new application into production. Customer engineers are constantly working with and testing new applications, and their experience can be of great help to the designer considering the use of a drawn cup roller clutch.



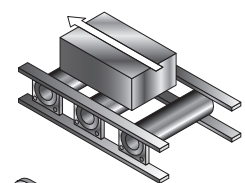
Stair steppers and other athletic equipment



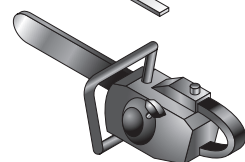
Lawnmower differential



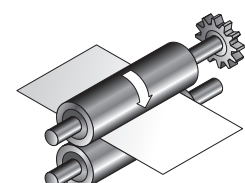
Towel dispensers and similar web roll feed mechanisms



Conveyor rollers

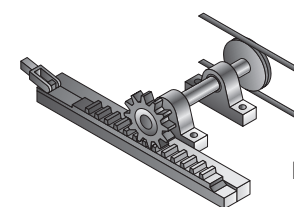


Chainsaw starters

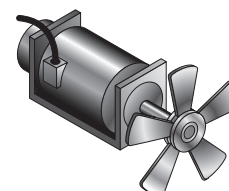


Paper feed rolls in business machines

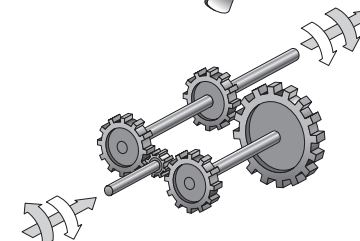
Fig. B3-9(1). Drawn cup clutches and clutch and bearing assembly applications



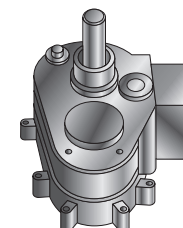
Rack indexing drive



Motor backstops



Two-speed gearbox with reversing input



Washing machine transmission

Fig. B3-9(2). Drawn cup clutches and clutch and bearing assembly applications

HOUSING DESIGN

Drawn cup clutches and clutch and bearing assemblies are mounted with a simple press fit in their housings. Through-bored and chamfered housings are preferred. A 30 degree angle is suggested and care should be taken to round the edge where the chamfer meets the housing bore. A sharp edge at this location can greatly increase installation forces. Provisions for axial location, such as shoulders or snap rings, are not required. The case hardened cups must be properly supported. Steel housings are preferred and must be used for applications involving high-torque loads to prevent radial expansion of the clutch cups. The suggested minimum housing outer diameters in the tables of dimensions are for steel.

The housing bore should be round within one-half of the diameter tolerance.

The taper within the length of the outer ring should not exceed 0.013 mm (0.0005 in).

The surface finish of the housing bore should not exceed 1.6 μm Ra (63 μin Ra).

The torque ratings, given in the clutch tables, are based on a steel housing of a large section. When other housing material must be used (such as aluminum, powdered metal and plastics), the torque rating of the clutch will be reduced. Such housings may be satisfactory for lightly torqued applications. But, your representative should be consulted for appropriate housing and shaft suggestions. Otherwise, an insufficient press fit and use of a lower strength housing material can result in more internal clearance and reduced performance of the clutch.

When using non-steel housings, thorough testing of the design is suggested.

Adhesive compounds can be used to prevent creeping rotation of the clutch in plastic housings with low friction properties. Adhesives will not provide proper support in oversized metal housings. When using adhesives, care must be taken to keep the adhesive out of the clutches and bearings.

SHAFT DESIGN

The clutch or clutch and bearing assembly operates directly on the shaft whose specifications of dimension, hardness and surface finish are well within standard manufacturing limits.

Either case-hardening or through-hardening grades of good bearing-quality steel are satisfactory for raceways. Steels modified for free machining, such as those high in sulfur content and particularly those containing lead, are seldom satisfactory for raceways.

For long fatigue life, the shaft raceway must have a hardness equivalent to 58 HRC minimum and must be ground to the suggested diameter shown in the tables of dimensions. It may be through-hardened, or it may be case hardened with an effective case depth of 0.40 mm (0.015 in). Effective case depth is defined as the distance from the surface inward to the equivalent of 50 HRC hardness level after grinding.

Taper within the length of the raceway should not exceed 0.008 mm (0.0003 in), or one-half the diameter tolerance – whichever is smaller. The radial deviation from true circular form of the raceway should not exceed 0.0025 mm (0.0001 in) for diameters up to and including 25 mm (1.0 in). For raceways greater than 25 mm (1.0 in), the allowable radial deviation should not exceed 0.0025 mm (0.0001 in) multiplied by a factor of the raceway diameter divided by 25 (1.0 in). Surface finish on the raceway should not exceed 0.4 μm (16 μin) Ra. Deviations will reduce the load capacity and fatigue life of the shaft.



INSTALLATION

Simplicity of installation promotes additional cost savings. The drawn cup roller clutch or the clutch and bearing assembly must be pressed into its housing. Procedures are virtually identical with those for installing drawn cup bearings, as detailed on pages B-2-11 and B-2-52. The unit is pressed into the bore of a gear or pulley hub or housing of the proper size. No shoulders, splines, keys, screws or snap rings are required.

Installation procedures are summarized in the following sketches:

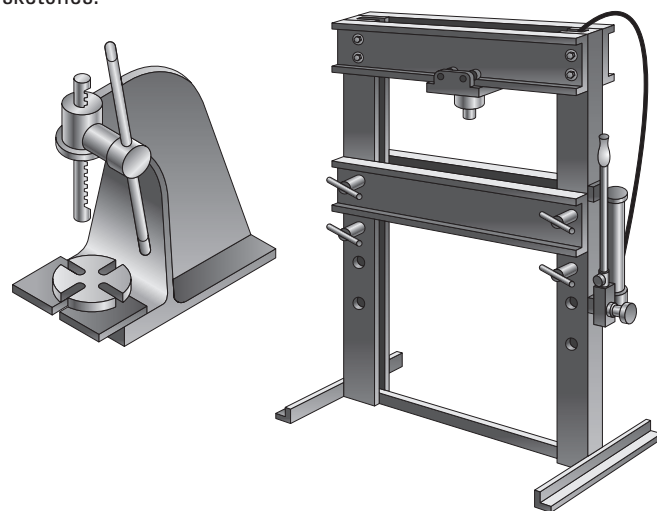


Fig. B3-10. Arbor press and hydraulic ram press

Use an arbor press or hydraulic ram press to exert steady pressure. Never use a hammer, or other tool requiring pounding to drive the clutch into its housing.

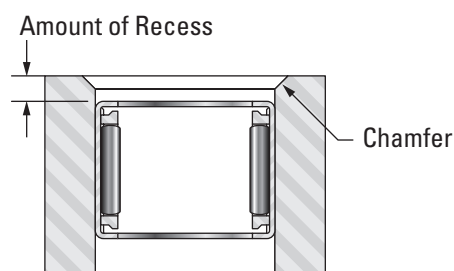


Fig. B3-11. Chamfered housing bore

Make sure that the housing bore is chamfered to permit easy introduction of the clutch and bearing or the clutch unit. Press unit slightly beyond the chamfer in the housing bore to assure full seating. Through-bored housings are always preferred. If the housing has a shoulder, never seat the clutch against the shoulder. For further details, see pages B-2-11 and B-2-52.



Fig. B3-12. Lock marking

IMPORTANT: The mounted clutch or clutch and bearing assembly engages when the housing is rotated relative to the shaft in the direction of the arrow and lock marking (← LOCK) stamped on the cup. Make sure that the unit is oriented properly before pressing it into its housing.

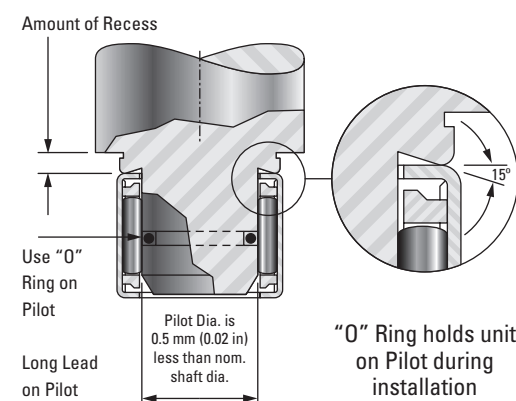


Fig. B3-13. Installation tool

Use an installation tool as shown in Fig. B3-13. If the clutch is straddled by needle roller bearings, press units into position – in proper sequence – and preferably leave a small clearance between units.

When assembling the shaft, it should be rotated in the overrun direction during insertion. The end of the shaft should have a large chamfer or rounding.

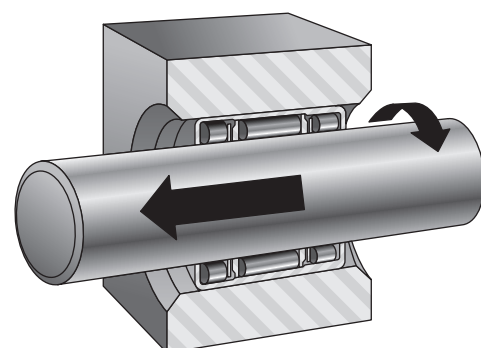


Fig. B3-14. Rotate shaft in the overrun direction during insertion

APPLIED LOADS

The clutch-only unit is designed to transmit purely torque loads. Applied torque should not exceed the catalog ratings, which are based on the compressive strength of well-aligned clutch components. Bearings on either side of the clutch are to assure concentricity between the shaft and the housing to support radial loads during clutch overrun. Integral clutch and bearing assemblies are available for this purpose, especially where the radial loads are light. The total maximum dynamic radial load that may be shared by the two needle roller and cage radial bearing assemblies should not be greater than Cr/3.

In determining the total torque load on a clutch, it is essential to consider the torque, due to inertial forces developed in the mechanism, in addition to the externally applied torque. The larger the clutch, and the greater the mass of the mechanism controlled by it, the more important this consideration becomes.

Clutch lockup depends on friction. For this reason, applications involving severe vibrations or axial motion of the shaft within the clutch are to be avoided. Applications where overhanging or overturning loads occur should incorporate bearings that will maintain alignment between the shaft and the clutch housing. Consult your representative for suggestions.

LUBRICATION

Oil is the preferred lubricant; it minimizes wear and heat generation. For those applications where oil is not practical, clutches are packed with a soft grease containing mineral oil. Thick grease will retard roller engagement and can cause individual rollers to slip, possibly overloading any engaged rollers.

TEMPERATURE

Temperature extremes can cause clutch malfunctions and failure. The molded plastic cage with integral springs holds its necessary resiliency and strength when the operating temperature within the clutch is kept below 90° C (200° F). The clutch with reinforced nylon cage and separate steel springs operates well at temperatures up to 120° C (250° F) continuously and to 150° C (300° F) intermittently. Excessive thickening of the lubricant at low temperatures may prevent some, or all, of the rollers from engaging. New applications should be tested under expected operating conditions to determine whether or not temperature problems exist.

BACKLASH

Backlash, or lost motion, prior to engagement is minimal. The variation in backlash from one cycle to another is extremely low. Grease lubrication, or improper fit (housing bore and shaft diameter), may increase backlash. Angular displacement between the shaft and housing increases as an applied torque load is increased.

RATE OF ENGAGEMENT

Clutch lockup depends upon static friction. Axial motion between shaft and clutch rollers prevents lockup.

Clutches with integral springs engage satisfactorily at cyclic rates up to 200 engagements per minute. Intermittent operation at higher rates has been successful. The steel spring type clutches have proven dependability at rates up to 6000 or 7000 engagements per minute. Even higher cyclic rates may be practical. Because grease may impair engagement at high cyclic rates, a light oil should be used.

OVERRUN LIMIT SPEED RATING

Exact limiting speed ratings are not easily predictable. The value for each clutch given in the bearing tables is not absolute but serves as a guide for the designer. Oil lubrication is absolutely necessary for high speed operations. Consult your representative when overrunning speeds are high.

INSPECTION

Although the outer cup of the clutch is accurately drawn from strip steel, it can go slightly out of round during heat treat. When the assembly is pressed into a ring gage, or properly prepared housing of correct size and wall thickness, it becomes round and properly sized. Direct measurement of the outer diameter of a drawn cup assembly is an incorrect procedure. The proper inspection procedure is as follows:

1. Press the assembly into a ring gage of the proper size, as given in the tables.
2. Gage the bore with the specified plug gages of the proper size, as given in the tables of dimensions.
 - a. The locking plug is rotated to ensure lockup when the clutch is operated on a low-limit shaft and is mounted in a high-limit housing, strong enough to properly size the clutch.
 - b. The overrun plug is rotated to ensure free overrunning when the clutch is operated on a high-limit shaft and is mounted in a low-limit housing.
 - c. The "go" plug and "no go" plug ensure proper size of the bearings in the clutch and bearing assemblies.

Gage sizes are listed in the tables of dimensions. Plug gage sizes reflect adjustment for the loose and tight conditions resulting from high or low housings or shafts.



DRAWN CUP ROLLER CLUTCHES

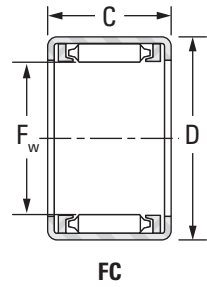
METRIC SERIES

- For proper application, separate bearings are suggested (adjacent to clutch) to carry radial loads and assure concentricity between shaft and housing.
- The clutch engages when housing is rotated relative to the shaft in direction of arrow marking (← LOCK), as labeled on cup.
- Proper inspection requires use of ring gage and bore plug gage(s). See the inspection section on page B-3-9.
- Full details on installation are given on page B-3-8.

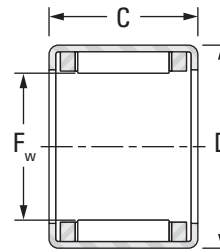
- Shaft raceway and housing bore diameters that are necessary for proper mounting and operation are listed on the opposite page.
- Types FC, FCS, FC-K and FCL-K clutches have stainless steel springs inserted in molded cage to position rollers for lockup.



The mounted clutch engages when the housing is rotated relative to the shaft in the direction of the arrow marking (← LOCK) stamped on the cup.



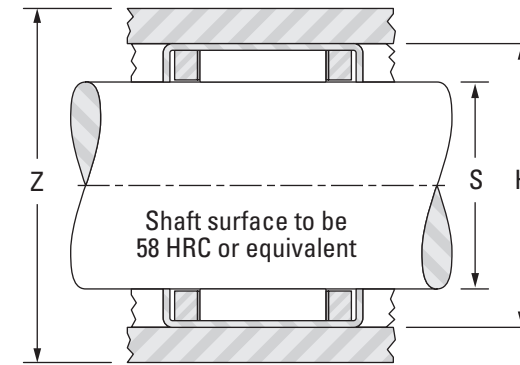
FC



FCS, FCL-K and FC-K

Shaft Diameter	F _w	D	C	Clutch Designation	Torque Rating	Z	Overrun Limiting Speed Rating for Rotating Shaft	Suitable Drawn Cup Bearing ⁽¹⁾
						Minimum O.D. of Steel Housing for Rated Torque		
mm in	mm in	mm in	mm in		N-m lbf-in	mm in	min ⁻¹	
4 0.1575	4 0.1575	8 0.3150	6 0.236	FC-4-K	0.349 3.09	11 0.433	26000	HK0408
6 0.2362	6 0.2362	10 0.3937	12 0.472	FCS-6	2.15 19.0	14 0.551	22000	HK0608
	6 0.2362	10 0.3937	12 0.472	FC-6	2.63 23.3	14 0.551	22000	HK0608
8 0.3150	8 0.3150	12 0.4724	12 0.472	FCL-8-K	3.39 30.0	17 0.669	21000	HK0808
	8 0.3150	14 0.5512	12 0.472	FC-8	4.42 39.1	20 0.787	21000	—
10 0.3937	10 0.3937	14 0.5512	12 0.472	FCL-10-K	4.60 40.7	20 0.787	19000	HK1010
	10 0.3937	16 0.6299	12 0.472	FC-10	5.82 51.5	25 0.984	19000	—
12 0.4724	12 0.4724	18 0.7087	16 0.630	FC-12	14.0 124	27 1.063	19000	HK1212
16 0.6299	16 0.6299	22 0.8661	16 0.630	FC-16	21.7 192	31 1.22	14000	HK1612
20 0.7874	20 0.7874	26 1.0236	16 0.630	FC-20	32.6 289	38 1.496	11000	HK2012
25 0.9843	25 0.9843	32 1.2598	20 0.787	FC-25	71.0 628	46 1.811	8700	HK2512
30 1.1811	30 1.1811	37 1.4567	20 0.787	FC-30	99.1 877	51 2.008	7300	HK3012
35 1.3780	35 1.3780	42 1.6535	20 0.787	FCS-35	107.0 947	56 2.205	6100	HK3512

⁽¹⁾ See pages B-2-14 to B-2-25 for suitable bearing types and sizes.



Gaging			S		H		Approx. Wt.
Ring Gage	Clutch Locking Plug	Clutch Overrun Plug	Shaft Raceway Diameter		Housing Bore		
			Mounting				
mm in	mm in	mm in	Max. mm in	Min. mm in	Max. mm in	Min. mm in	kg lbs
7.984 0.3143	3.980 0.1567	4.004 0.1576	4.000 0.1575	3.995 0.1573	7.993 0.3147	7.984 0.3143	0.001 0.002
9.984 0.3931	5.980 0.2354	6.004 0.2364	6.000 0.2362	5.995 0.2360	9.993 0.3934	9.984 0.3931	0.003 0.007
9.984 0.3931	5.980 0.2354	6.004 0.2364	6.000 0.2362	5.995 0.2360	9.993 0.3934	9.984 0.3931	0.004 0.009
11.980 0.4717	7.976 0.3140	8.005 0.3152	8.000 0.3150	7.994 0.3147	11.991 0.4721	11.980 0.4717	0.003 0.007
13.980 0.5504	7.976 0.3140	8.005 0.3152	8.000 0.3150	7.994 0.3147	13.991 0.5508	13.980 0.5504	0.007 0.015
13.980 0.5504	9.976 0.3928	10.005 0.3939	10.000 0.3937	9.994 0.3935	13.991 0.5508	13.980 0.5504	0.004 0.009
15.980 0.6291	9.976 0.3928	10.005 0.3939	10.000 0.3937	9.994 0.3935	15.991 0.6296	15.980 0.6291	0.009 0.020
17.980 0.7079	11.974 0.4714	12.006 0.4727	12.000 0.4724	11.992 0.4721	17.991 0.7083	17.980 0.7079	0.012 0.026
21.976 0.8652	15.972 0.6288	16.006 0.6302	16.000 0.6299	15.992 0.6296	21.989 0.8657	21.976 0.8652	0.018 0.040
25.976 1.0227	19.970 0.7862	20.007 0.7877	20.000 0.7874	19.991 0.7870	25.989 1.0232	25.976 1.0227	0.021 0.046
31.972 1.2587	24.967 0.9830	25.007 0.9845	25.000 0.9843	24.991 0.9839	31.988 1.2594	31.972 1.2587	0.034 0.075
36.972 1.4556	29.967 1.1798	30.007 1.1814	30.000 1.1811	29.991 1.1807	36.988 1.4562	36.972 1.4556	0.042 0.093
41.972 1.6524	34.964 1.3765	35.009 1.3783	35.000 1.3780	34.989 1.3775	41.988 1.6531	41.972 1.6524	0.048 0.106



DRAWN CUP ROLLER CLUTCHES AND BEARING ASSEMBLIES

METRIC SERIES

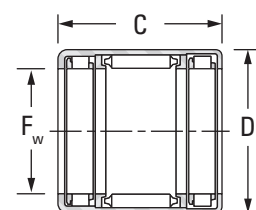
- The clutch and bearing assembly engages when the housing is rotated relative to shaft in direction of arrow marking (← LOCK), as labeled on cup.
- Shaft raceway and housing bore diameters that are necessary for proper mounting and operation are listed on the opposite page.
- Proper inspection requires use of ring gage and bore plug gage(s). See the inspection section on page B-3-9.

- Full details on installation are given on page B-3-8.
- Types FCB, FCBL-K and FCBN-K clutch and bearing assemblies have stainless steel springs inserted in molded cage to position rollers for lockup.

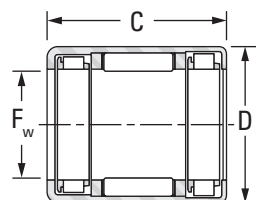


The mounted clutch and bearing assembly engages when the housing is rotated relative to the shaft in the direction of the arrow marking (← LOCK) stamped on the cup.

Clutch and bearing assemblies



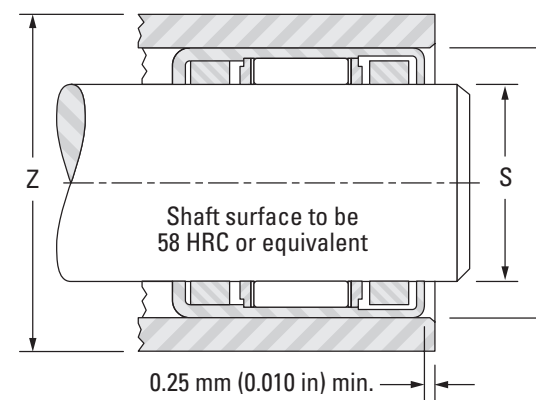
FCB



FCBL-K and FCBN-K

Shaft Diameter	F _w	D	C	Clutch and Bearing Assembly Designation	Torque Rating	Z	Load Ratings ⁽¹⁾		Overrun Limiting Speed Rating for Rotating Shaft	
							Minimum O.D. of Steel Housing for Rated Torque	C		
								Dynamic		Static
mm in	mm in	mm in	mm in		N-m lbf-in		kN lbf	kN lbf	min ⁻¹	
4 0.1575	4 0.1575	10 0.3937	9 0.354	FCBN-4-K	0.19 1.68	16 0.630	1.86 418	0.99 223	26000	
6 0.2362	6 0.2362	12 0.4724	10 0.394	FCBN-6-K	0.56 4.96	18 0.709	2.48 558	1.48 333	22000	
8 0.3150	8 0.3150	12 0.4724	22 0.866	FCBL-8-K	3.39 30.0	17 0.669	3.62 814	3.28 737	21000	
	8 0.3150	14 0.5512	20 0.787	FCB-8	4.42 39.1	20 0.787	4.22 949	3.04 683	21000	
10 0.3937	10 0.3937	16 0.6299	20 0.787	FCB-10	5.82 51.5	25 0.984	4.84 1090	3.80 854	19000	
12 0.4724	12 0.4724	18 0.7087	26 1.024	FCB-12	14.0 124	27 1.063	6.30 1420	5.84 1310	19000	
16 0.6299	16 0.6299	22 0.8661	26 1.024	FCB-16	21.7 192	31 1.220	6.64 1490	7.12 1600	14000	
20 0.7874	20 0.7874	26 1.0236	26 1.024	FCB-20	32.6 289	38 1.496	8.16 1830	9.46 2130	11000	
25 0.9843	25 0.9843	32 1.2598	30 1.181	FCB-25	71.0 628	46 1.811	11.3 2540	13.1 2940	8700	
30 1.1811	30 1.1811	37 1.4567	30 1.181	FCB-30	99.1 877	51 2.008	11.5 2590	14.9 3350	7300	

⁽¹⁾ Load ratings are based on a minimum raceway hardness of 58 HRC or equivalent.



Gaging				S		H		Approx. Wt.
Ring Gage	Clutch Locking Plug	Clutch Overrun and Bearing Go Plug	Bearing No Go Plug	Mounting				
				Max.	Min.	Max.	Min.	
mm in	mm in	mm in	mm in	mm in	mm in	mm in	mm in	kg lbs
9.984 0.3931	3.980 0.1567	4.004 0.1576	4.030 0.1587	4.000 0.1575	3.995 0.1573	9.993 0.3934	9.984 0.3931	0.003 0.007
11.980 0.4717	5.980 0.2354	6.004 0.2364	6.030 0.2374	6.000 0.2362	5.995 0.2360	11.991 0.4721	11.980 0.4717	0.004 0.009
11.980 0.4717	7.976 0.3140	8.005 0.3152	8.033 0.3163	8.000 0.3150	7.994 0.3147	11.991 0.4721	11.980 0.4717	0.005 0.011
13.980 0.5504	7.976 0.3140	8.005 0.3152	8.033 0.3163	8.000 0.3150	7.994 0.3147	13.991 0.5508	13.980 0.5504	0.011 0.024
15.980 0.6291	9.976 0.3928	10.005 0.3939	10.033 0.3950	10.000 0.3937	9.994 0.3935	15.991 0.6296	15.980 0.6291	0.013 0.029
17.980 0.7079	11.974 0.4714	12.006 0.4727	12.036 0.4739	12.000 0.4724	11.992 0.4721	17.991 0.7083	17.980 0.7079	0.018 0.040
21.976 0.8652	15.972 0.6288	16.006 0.6302	16.036 0.6313	16.000 0.6299	15.992 0.6296	21.989 0.8657	21.976 0.8652	0.024 0.053
25.976 1.0227	19.970 0.7862	20.007 0.7877	20.043 0.7891	20.000 0.7874	19.991 0.7870	25.989 1.0232	25.976 1.0227	0.028 0.062
31.972 1.2587	24.967 0.9830	25.007 0.9845	25.043 0.9859	25.000 0.9843	24.991 0.9839	31.988 1.2594	31.972 1.2587	0.048 0.106
36.972 1.4556	29.967 1.1798	30.007 1.1814	30.043 1.1828	30.000 1.1811	29.991 1.1807	36.988 1.4562	36.972 1.4556	0.054 0.119



DRAWN CUP ROLLER CLUTCHES

INCH SERIES

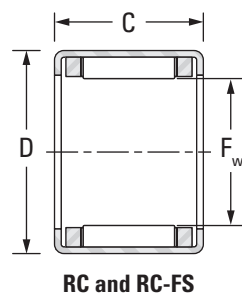
- For proper application, separate bearings are suggested (adjacent to clutch) to carry radial loads and assure concentricity between shaft and housing.
- The clutch engages when housing is rotated relative to the shaft in direction of arrow marking (← LOCK), as labeled on cup.
- Proper inspection requires use of ring gage and bore plug gage(s). See the inspection section on page B-3-9.
- Full details on installation are given on page B-3-8.

- Shaft raceway and housing bore diameters that are necessary for proper mounting and operation are listed on the opposite page.
- Type RC clutches have springs integrally molded with the cage to position the rollers for lockup.

Type RC-FS clutches have stainless steel springs inserted into the molded cage to position the rollers for lockup.



The mounted clutch engages when the housing is rotated relative to the shaft in the direction of the arrow marking (← LOCK) stamped on the cup.

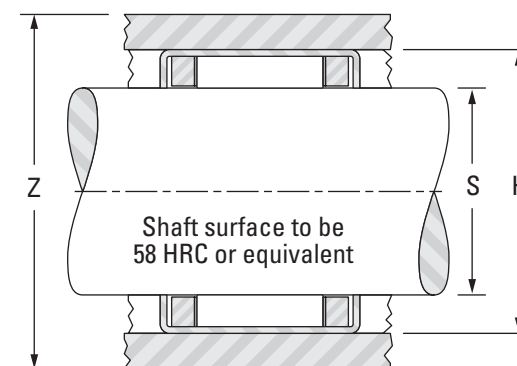


RC and RC-FS

Shaft Diameter	F _w	D	C	Clutch Designations		Torque Rating	Z	Overrun Limiting Speed Rating for Rotating Shaft
				With Stainless Steel Springs	With Integral Springs			
3.175 0.1250	3.18 0.125	7.14 0.281	6.35 0.250	—	RC-02	0.323 2.86	11.2 0.44	34000
6.350 0.2500	6.35 0.250	11.13 0.438	12.70 0.500	RC-040708-FS ⁽¹⁾	RC-040708	1.94 17.2	15.7 0.62	20000
9.525 0.3750	9.53 0.375	15.88 0.625	12.70 0.500	RC-061008-FS ⁽¹⁾	RC-061008	5.45 48.2	22.4 0.88	18000
12.700 0.5000	12.70 0.500	19.05 0.750	12.70 0.500	RC-081208-FS ⁽¹⁾	RC-081208	8.85 78.3	27.9 1.10	17000
15.875 0.6250	15.88 0.625	22.23 0.875	15.88 0.625	RC-101410-FS ⁽¹⁾	RC-101410	16.8 149	30.5 1.20	14000
19.050 0.7500	19.05 0.750	25.40 1.000	15.88 0.625	RC-121610-FS ⁽¹⁾	RC-121610	23.3 206	35.6 1.40	12000
25.400 1.0000	25.40 1.000	33.35 1.313	15.88 0.625	RC-162110-FS ⁽¹⁾	RC-162110	49.6 439	48.3 1.90	8700

⁽¹⁾ Suffix "-FS" is not always stamped on the clutch cup. Type RC-FS with stainless steel springs are always readily identified by RED clutch cage.

⁽²⁾ See pages B-2-66 to B-2-69 for other suitable bearing types and sizes.



Suitable Drawn Cup Bearing ⁽²⁾	Gaging			S		H		Approx. Wt.
	Ring Gage	Clutch Locking Plug	Clutch Overrun Plug	Shaft Raceway Diameter		Housing Bore		
				Max.	Min.	Max.	Min.	
—	7.155 0.2817	3.160 0.1244	3.195 0.1258	3.175 0.1250	3.167 0.1247	7.155 0.2817	7.142 0.2812	0.001 0.002
J-45	11.125 0.4380	6.337 0.2495	6.383 0.2513	6.350 0.2500	6.337 0.2495	11.125 0.4380	11.100 0.4370	0.004 0.008
JH-68	15.888 0.6255	9.512 0.3745	9.558 0.3763	9.525 0.3750	9.512 0.3745	15.888 0.6255	15.862 0.6245	0.008 0.017
JH-87	19.063 0.7505	12.687 0.4995	12.733 0.5013	12.700 0.5000	12.687 0.4995	19.063 0.7505	19.037 0.7495	0.009 0.020
JH-1010	22.238 0.8755	15.862 0.6245	15.908 0.6263	15.875 0.6250	15.862 0.6245	22.238 0.8755	22.212 0.8745	0.014 0.030
J-126	25.387 0.9995	19.012 0.7485	19.058 0.7503	19.050 0.7500	19.037 0.7495	25.413 1.0005	25.387 0.9995	0.015 0.034
JH-1612	33.325 1.3120	25.362 0.9985	25.408 1.0003	25.400 1.0000	25.387 0.9995	33.350 1.3130	33.325 1.3120	0.026 0.058



DRAWN CUP ROLLER CLUTCH AND BEARING ASSEMBLIES

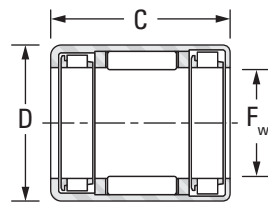
INCH SERIES

- Clutch and bearing assembly engages when the housing is rotated relative to shaft in direction of arrow marking (← LOCK), as labeled on cup.
- Shaft raceway and housing bore diameters that are necessary for proper mounting and operation are listed on the opposite page.
- Proper inspection requires use of ring gage and bore plug gage(s). See the inspection section on page B-3-9.
- Full details on installation are given on page B-3-8.

- Type RCB clutch and bearing assemblies have springs integrally molded with the cage to position the rollers for lockup.
- Type RCB-FS clutch and bearing assemblies have stainless steel springs inserted into the molded cage to position the rollers for lockup.



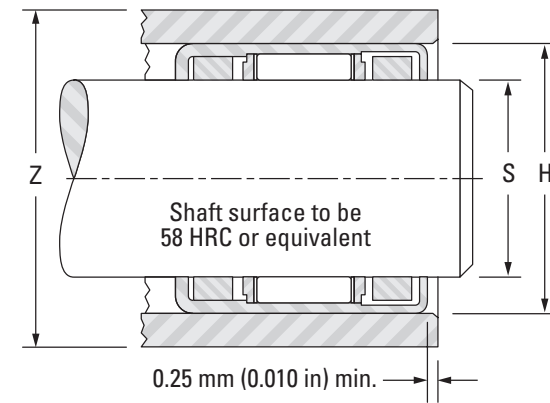
The mounted clutch and bearing assembly engages when the housing is rotated relative to the shaft in the direction of the arrow marking (← LOCK) stamped on the cup.



RCB and RCB-FS

Shaft Diameter	F _w	D	C -0.25 mm -0.010 in	Clutch and Bearing Designations		Torque Rating	Z Minimum O.D. of Steel Housing for Rated Torque	Load Ratings ⁽²⁾		Overrun Limiting Speed Rating for Rotating Shaft
				With Stainless Steel Springs	With Integral Springs			C	C ₀	
mm in	mm in	mm in	mm in			N-m lbf-in		kN lbf	kN lbf	min ⁻¹
9.525 0.3750	9.53 0.375	15.88 0.625	22.23 0.875	RCB-061014-FS ⁽¹⁾	RCB-061014	5.45 48.2	22.4 0.88	6.01 1350	4.89 1100	18000
12.700 0.5000	12.70 0.500	19.05 0.750	22.23 0.875	RCB-081214-FS ⁽¹⁾	RCB-081214	8.85 78.3	27.9 1.1	7.12 1600	6.49 1460	17000
15.875 0.6250	15.88 0.625	22.23 0.875	25.40 1.000	RCB-101416-FS ⁽¹⁾	RCB-101416	16.8 149	30.5 1.2	8.05 1810	8.14 1830	14000
19.050 0.7500	19.05 0.750	25.40 1.000	25.40 1.000	RCB-121616-FS ⁽¹⁾	RCB-121616	23.3 206	35.6 1.4	8.90 2000	9.79 2200	12000
25.400 1.0000	25.40 1.000	33.35 1.313	27.00 1.063	RCB-162117-FS ⁽¹⁾	RCB-162117	49.6 439	48.3 1.9	15.4 3460	17.6 3960	8700

⁽¹⁾ Suffix "-FS" is not always stamped on the clutch cup. Type RC-FS with stainless steel springs are always readily identified by RED clutch cage.
⁽²⁾ Load ratings are based on a minimum raceway hardness of 58 HRC or equivalent.



Gaging				S		H		Approx. Wt.
Ring Gage	Clutch Locking Plug	Clutch Overrun and Bearing Go Plug	Bearing No Go Plug	Shaft Raceway Diameter		Housing Bore		
				Mounting				
				Max.	Min.	Max.	Min.	
mm in	mm in	mm in	mm in	mm in	mm in	mm in	mm in	kg lbs
15.888 0.6255	9.512 0.3745	9.553 0.3761	9.589 0.3775	9.525 0.3750	9.512 0.3745	15.888 0.6255	15.862 0.6245	0.014 0.030
19.063 0.7505	12.687 0.4995	12.728 0.5011	12.764 0.5025	12.700 0.5000	12.687 0.4995	19.063 0.7505	19.037 0.7495	0.016 0.036
22.238 0.8755	15.862 0.6245	15.903 0.6261	15.939 0.6275	15.875 0.6250	15.862 0.6245	22.238 0.8755	22.212 0.8745	0.023 0.050
25.387 0.9995	19.012 0.7485	19.053 0.7501	19.088 0.7515	19.050 0.7500	19.037 0.7495	25.413 1.0005	25.387 0.9995	0.026 0.057
33.325 1.3120	25.362 0.9985	25.403 1.0001	25.438 1.0015	25.400 1.0000	25.387 0.9995	33.350 1.3130	33.325 1.3120	0.045 0.100



INTRODUCTION

OTHER AVAILABLE CLUTCHES

In addition to the metric and inch sizes of drawn cup clutches and clutch and bearing assemblies already discussed, JTEKT offers other types of drawn cup clutches to address special customer needs:

DRAWN CUP ROLLER CLUTCHES FOR USE IN PLASTIC HOUSINGS

FCP AND DF TYPES

Types **FCP** and **DF** clutches feature axial grooves in the outside surface of the clutch cup. It is important that these grooves align with similar protrusions in the housing bore to prevent the clutch from slipping relative to the housing.

Types **FCP** and **DF** clutches are available with bore diameters of 4, 6, 8 and 10 mm.

These clutches may be made available already mounted in a plastic housing such as a gear or a pulley to meet the customer's design specifications.

Please contact your representative for details and availability.

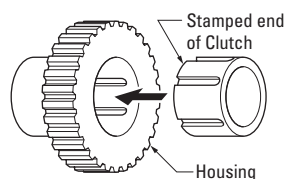


Fig. B3-15. Clutch installation into housing

CHARACTERISTICS

- Easily unitized – they can be unitized with plastic parts such as gears, pulleys, rollers, etc. as needed.
- Creep preventing structure – creep is prevented by mating a thin cross section roller clutch, which has special grooves on O.D. formed by a precision press, with a plastic part that has an equal number of bosses on the bore of the housing.
- High precision and good durability – high precision and good durability is obtained because cam surfaces are formed by precision deep drawing.
- Small and compact – this series satisfies the need for a lighter compact product.

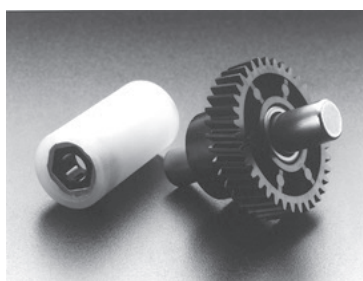


Fig. B3-16. Sample DF and FCP clutches

STRUCTURE

Drawn cup roller clutches for plastic housings are composed of a drawn cup with internal cam surfaces and creep preventing grooves on O.D., rollers, and a retainer with either integral plastic or stainless steel springs.

The plastic housings can be a plastic gear, a pulley, a roller, etc., so it is possible to design the housing to meet any customers' needs.

ROLLER CLUTCH UNITS WITH PLASTIC HOUSINGS

FCU TYPES

Type **FCU** clutches were developed for office equipment and similar applications.

The **FCU** clutches are available with bore diameters of 6 and 8 mm.

They can be supplied with housings of various shapes to meet customer needs.

Please contact your representative for details and availability.

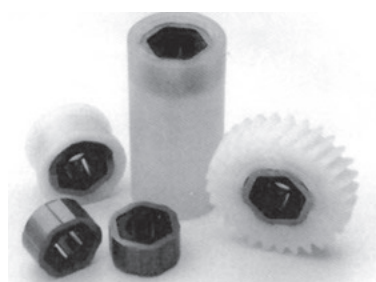


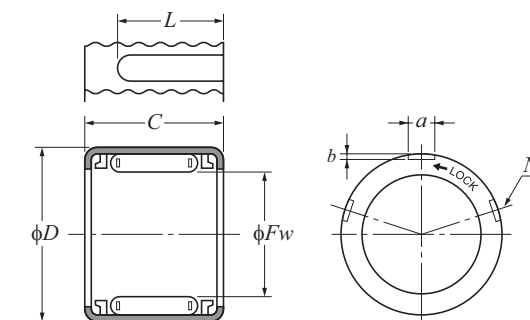
Fig. B3-17. Sample of FCU clutch

RECOMMENDED FIT FOR SHAFT AND HOUSING

Drawn cup roller clutches for plastic housings are at their designed dimensions and tolerances only when they are installed in plastic housings.

- Shaft Material:
 - Carbon steel for machine structural use
 - Rolled steel for general use
 - Stainless steel
- Shaft Tolerance: h9 class
- Shaft surface finish: 0.4 micrometers
- Housing: Please consult your representative for housing bore sizes if purchasing roller clutches without housings. These roller clutches can be used with cylindrical steel or aluminum housings. In this case, please consult your representative for proper fit.

Specially designed clutches for use with plastic housings. Available in bores from 4 to 10 mm and 1/4" and 3/8" bores. Grooves drawn into cup O.D. mate with protrusions molded into plastic housing bore to prevent clutch from moving relative to plastic housing. JTEKT can supply molded plastic housing and clutch assemblies.



* Number of equally spaced grooves

Fig. B3-18. Nominal clutch dimensions

JTEKT also has low cost FCU clutches available in 6 mm (0.2362 in) to 8 mm (0.3150 in) bores.

Can be designed and supplied with housings of various shapes to meet customer needs.

Table B3-1. Drawn cup roller clutches for plastic housings

Fw	D	C	a	b	L	N	Clutch Designation	Locking ⁽¹⁾ Direction	Torque Rating (N-m)	Overrunning Drag (mN-m)	Type of Spring
mm in	mm in	mm in	mm in	mm in	mm in				N-m	mN-m	
4 0.1575	8 0.3150	6 0.2362	1.0 0.0394	0.25 0.0098	4 0.1575	5	DF-500401	CCW	0.13	1.96	Stainless Steel
	8 0.3150	6 0.2362	1.0 0.0394	0.25 0.0098	4 0.1575	5	DF-500408	CW	0.13	1.96	Stainless Steel
6 0.2362	10 0.3937	8 0.3150	1.2 0.0472	0.25 0.0098	5.5 0.2165	3	DF-500609	CCW	0.44	2.94	Integral Plastic
	10 0.3937	8 0.3150	1.2 0.0472	0.25 0.0098	5.5 0.2165	3	DF-500610	CW	0.44	2.94	Integral Plastic
	12 0.4724	11 0.4331	1.5 0.0591	0.25 0.0098	8.5 0.3346	5	FCP-6	CCW	0.10	2.94	Integral Plastic
	12 0.4724	11 0.4331	1.5 0.0591	0.25 0.0098	8.5 0.3346	5	FCPC-6	CW	0.10	2.94	Integral Plastic
	12 0.4724	11 0.4331	1.5 0.0591	0.25 0.0098	8.5 0.3346	5	FCP-6H	CCW	0.90	2.94	Integral Plastic
	12 0.4724	11 0.4331	1.5 0.0591	0.25 0.0098	8.5 0.3346	5	FCPC-6H	CW	0.90	2.94	Integral Plastic
8 0.3150	12 0.4724	8 0.3150	1.2 0.0472	0.25 0.0098	5.5 0.2165	9	DF-500808	CCW	0.50	2.94	Integral Plastic
	12 0.4724	8 0.3150	1.2 0.0472	0.25 0.0098	5.5 0.2165	9	DF-500809	CW	0.50	2.94	Integral Plastic
	12 0.4724	12 0.4724	1.2 0.0472	0.25 0.0098	9.5 0.3740	9	FCP-8	CCW	0.21	2.94	Integral Plastic
	12 0.4724	12 0.4724	1.2 0.0472	0.25 0.0098	9.5 0.3740	9	FCPC-8	CW	0.21	2.94	Integral Plastic
	12 0.4724	12 0.4724	1.2 0.0472	0.25 0.0098	9.5 0.3740	9	FCP-8H	CCW	1.67	2.94	Integral Plastic
	12 0.4724	12 0.4724	1.2 0.0472	0.25 0.0098	9.5 0.3740	9	FCPC-8H	CW	1.67	2.94	Integral Plastic
	12 0.4724	12 0.4724	1.2 0.0472	0.25 0.0098	9.5 0.3740	9	DF-500804	CCW	1.67	2.94	Integral Plastic
10 0.3937	14 0.5512	12 0.4724	1.2 0.0472	0.25 0.0098	9.5 0.3740	5	FCP-10	CCW	0.28	3.92	Integral Plastic
	14 0.5512	12 0.4724	1.2 0.0472	0.25 0.0098	9.5 0.3740	5	FCPC-10	CW	0.28	3.92	Integral Plastic
	14 0.5512	12 0.4724	1.2 0.0472	0.25 0.0098	9.5 0.3740	5	FCP-10H	CCW	2.26	3.92	Integral Plastic
	14 0.5512	12 0.4724	1.2 0.0472	0.25 0.0098	9.5 0.3740	5	FCPC-10H	CW	2.26	3.92	Integral Plastic

⁽¹⁾ Locking direction = Direction clutch must be rotated relative to shaft for clutch to lock as seen from stamped end.

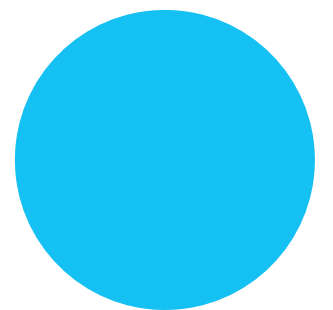
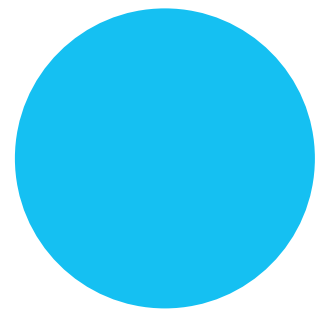


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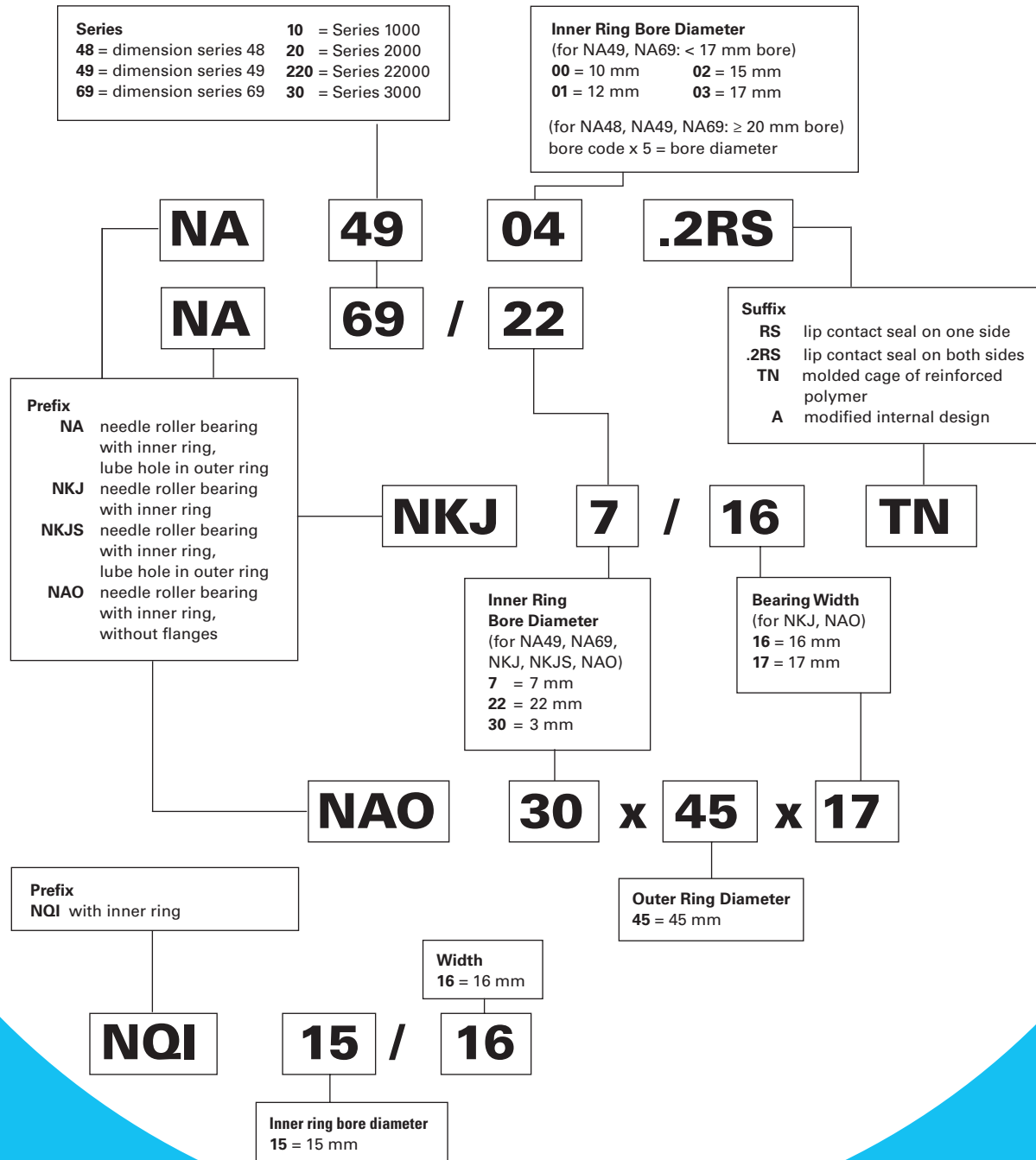
HEAVY-DUTY NEEDLE ROLLER BEARINGS

Overview: Heavy-duty needle roller bearings consist of a machined and ground channel-shaped outer ring with a complement of needle rollers, and a cage. The high-strength cage retains and guides the rollers. An optional lubrication groove and hole in the outer ring facilitates re-lubrication. These bearings can be used with or without a machined and ground inner ring, depending on the suitability of the shaft as a raceway surface.

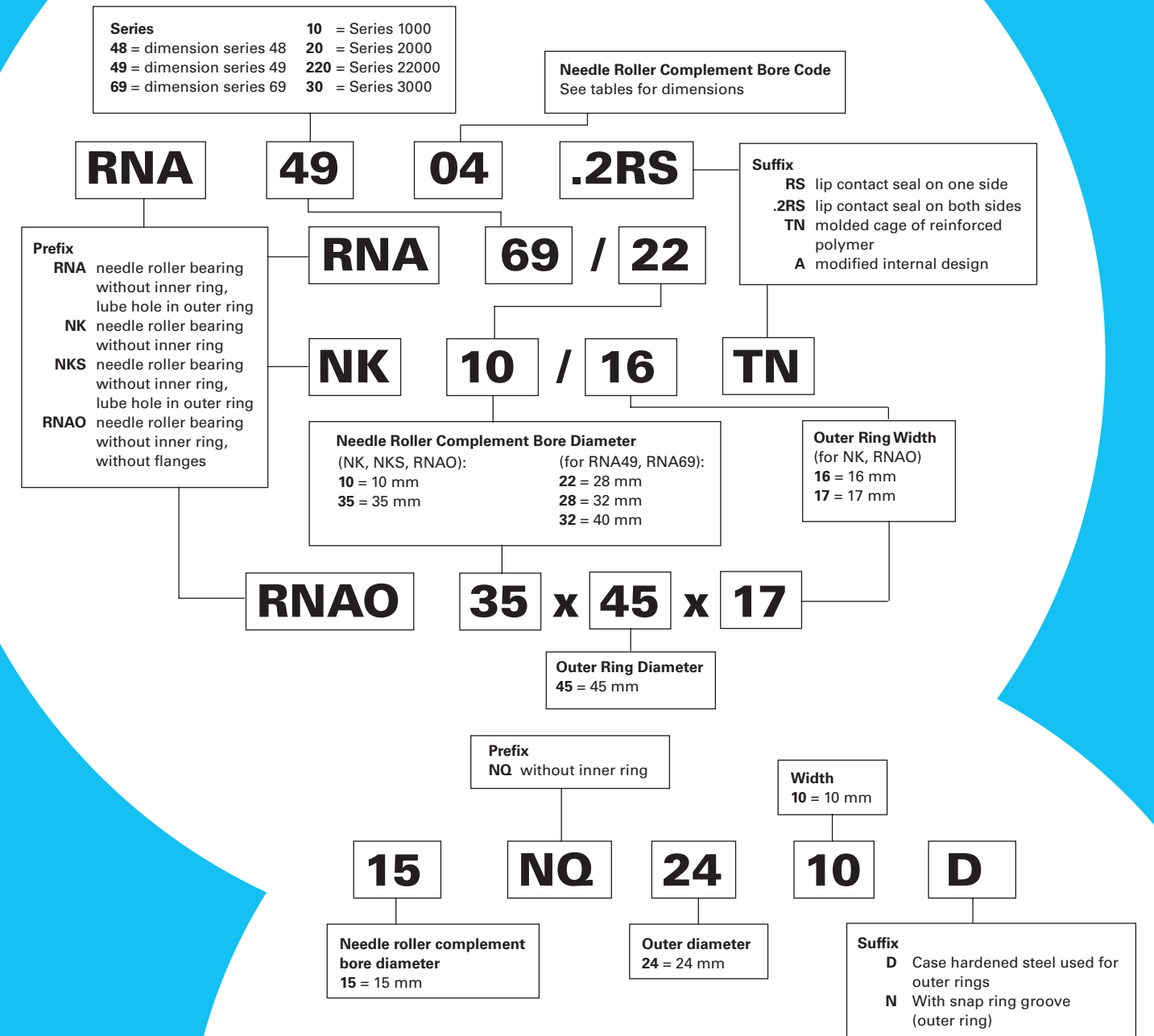
- **Catalogue range:** 5 mm – 335 mm (0.1969 in – 13.1890 in) bore.
- **Markets:** Gear pumps, sheaves, automotive transmissions and two-cycle engines.
- **Features:** Thick outer ring provides maximum load capacity and shock resistance with a relatively small radial cross section.
- **Benefits:** Optimum speed and lubrication-retention capability.



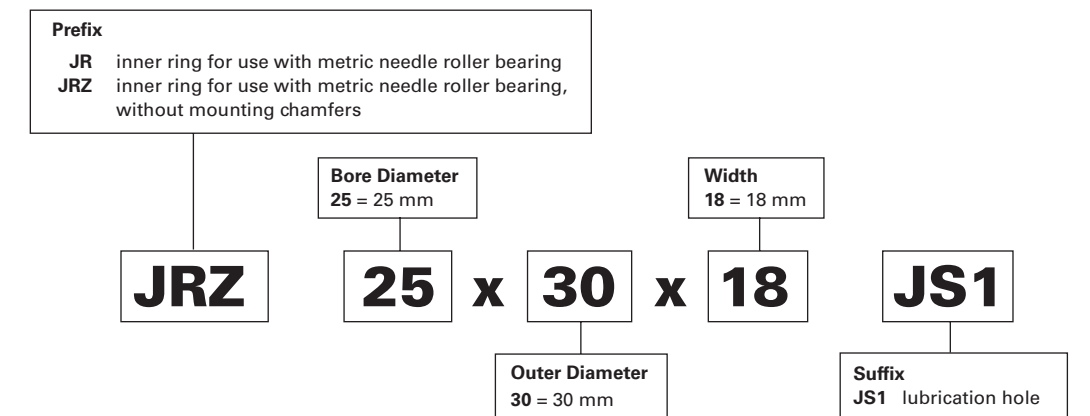
Needle Roller Bearings with Inner Rings – Metric Nominal Dimensions



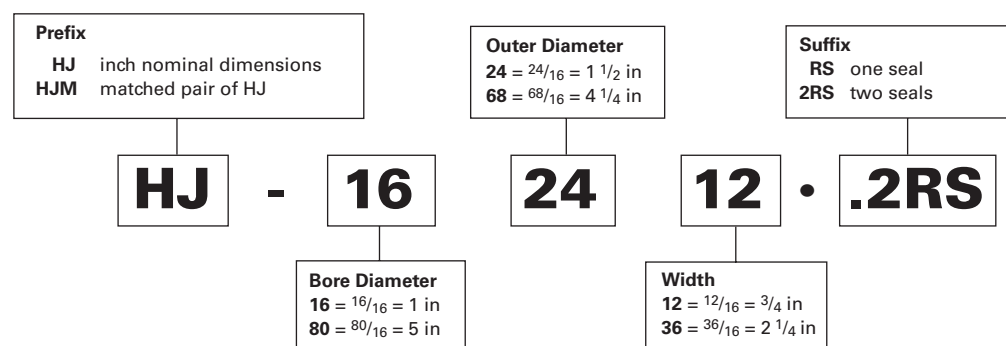
Needle Roller Bearings without Inner Rings – Metric Nominal Dimensions



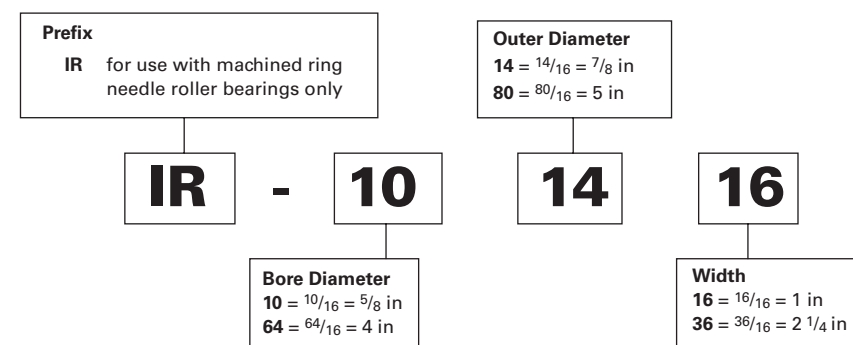
Inner Rings for Needle Roller Bearings – Metric Nominal Dimensions



Needle Roller Bearings – Inch Nominal Dimensions



Inner Rings (six-digit number) – Inch Nominal Dimensions



Heavy-Duty Needle Roller Bearings

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NEEDLE ROLLER BEARINGS

METRIC SERIES

When applications involve very heavy dynamic, static or even shock load conditions, the needle roller bearing may be found to give best results.

REFERENCE STANDARDS ARE:

- **ISO 1206** – needle roller bearings – light and medium series – dimensions and tolerances.
- **DIN 617** – rolling bearings – needle roller bearings with cage – dimension Series 48 and 49.
- **JIS B 1536** – rolling bearings – needle roller bearings – boundary dimensions and precision.

TYPES OF METRIC SERIES NEEDLE ROLLER BEARINGS

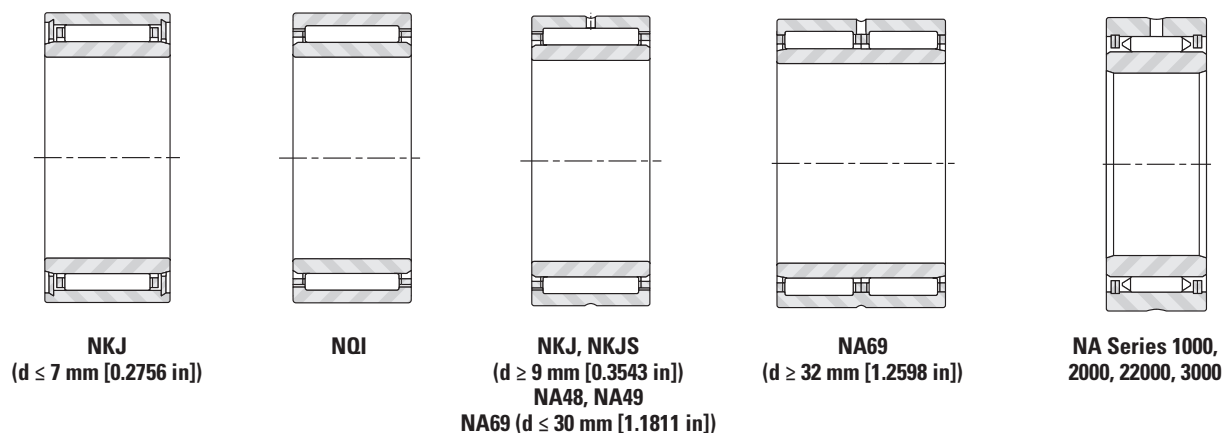


Fig. B4-1. Needle roller bearings with inner rings

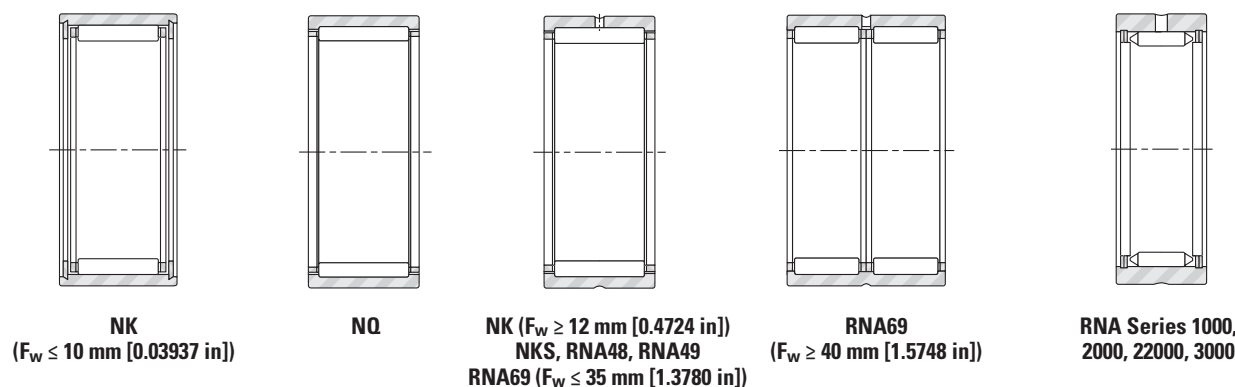


Fig. B4-2. Needle roller bearings without inner rings



Fig. B4-3. Sealed needle roller bearings with inner rings

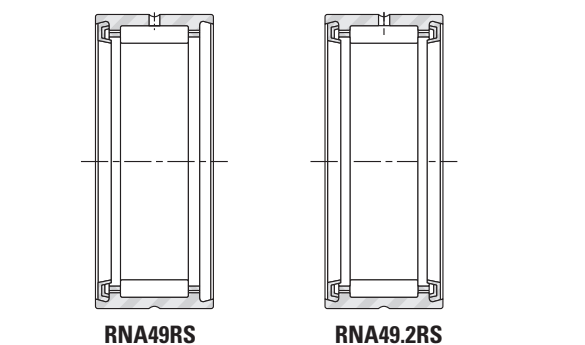


Fig. B4-4. Sealed needle roller bearings without inner rings

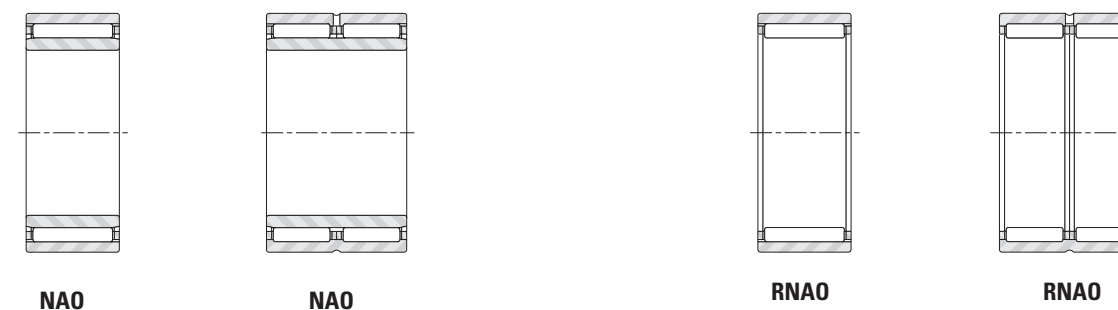


Fig. B4-5. Needle roller bearings without flanges, with inner rings

Fig. B4-6. Needle roller bearings without flanges, without inner rings

CONSTRUCTION

The basic constructions of metric series needle roller bearings are:

- With integral end flanges on the one-piece, channel-shaped outer rings ($F_w \geq 12.000$ mm [0.4724 in]).
- With inserted-end washers to provide axial retention of the needle roller and cage assemblies ($F_w \leq 10.000$ mm 0.3937 in).
- Without flanges where separate end washers or housing shoulders are required to provide axial retention of the needle roller and cage assemblies.
- Full, outer ring piloted complement of needle rollers (with or without inner ring).

METRIC SERIES NEEDLE ROLLER BEARINGS WITH INNER RINGS

This applies to the NKJ, NA, and NAO series.

When it is impractical to finish the shaft to meet the desired raceway design requirements, an inner ring may be used. Standard needle roller bearings are available with inner rings (such as the NA Series) to form complete bearings. Bearings furnished with inner rings meet the quality requirements in accordance with ISO standards.

- For inner- and outer-ring tolerances, the metric series bearings follow the normal tolerance class in ISO Standard 492 covering radial bearings. Bearings to more precise tolerance classes, P6 and P5, may be obtained upon request.
- The metric series bearings may be obtained with radial internal clearance in accordance with ISO Standard 5753, also specified for cylindrical roller bearings. Mostly, they follow the normal (C0) radial clearance group, although bearings to clearance groups C2, C3 and C4 may be made available on request.
- Inner ring and outer ring chamfer dimensions meet the requirements of ISO Standard 582.

METRIC SERIES NEEDLE ROLLER BEARINGS WITHOUT INNER RINGS

Whenever the shaft can be used as the inner raceway, needle roller bearings without inner rings provide advantages of economy and close control of radial internal clearance in operation. Tolerance class F6 is the normal specification for the metric series needle roller complement bore diameter of an unmounted bearing, as shown in Table B4-1 on page B-4-7 and Table B4-2 on page B-4-8. In the case of needle roller bearings of series RNAO, without flanges and without inner rings, the outer rings and needle roller and cage assemblies are not interchangeable.

Table B4-1. Metric series caged needle roller complement bore diameter for bearings without inner rings

F_w		ΔF_w min	
>	≤	Max.	Min.
mm in	mm in	mm in	mm in
3.000 0.1181	6.000 0.2362	+0.018 +0.0007	+0.010 +0.0004
6.000 0.2362	10.000 0.3937	+0.022 +0.0009	+0.013 +0.0005
10.000 0.3937	18.000 0.7087	+0.027 +0.0011	+0.016 +0.0006
18.000 0.7087	30.000 1.1811	+0.033 +0.0013	+0.020 +0.0008
30.000 1.1811	50.000 1.9685	+0.041 +0.0016	+0.025 +0.0010
50.000 1.9685	80.000 3.1496	+0.049 +0.0019	+0.030 +0.0012
80.000 3.1496	120.000 4.7244	+0.058 +0.0023	+0.036 +0.0014
120.000 4.7244	180.000 7.0866	+0.068 +0.0027	+0.043 +0.0017
180.000 7.0866	250.000 9.8425	+0.079 +0.0031	+0.050 +0.0020
250.000 9.8425	315.000 12.4016	+0.088 +0.0035	+0.056 +0.0022
315.000 12.4016	400.000 15.7480	+0.098 +0.0039	+0.062 +0.0024



Table B4-2. Full complement metric needle roller complement bore diameter for bearings without inner rings

F _w		ΔF _w min	
>	≤	Max.	Min.
mm in	mm in	mm in	mm in
5.000 0.1969	15.000 0.5906	+0.040 +0.0016	+0.020 +0.0008
15.000 0.5906	25.000 0.9843	+0.043 +0.0017	+0.020 +0.0008
25.000 0.9843	30.000 1.1811	+0.048 +0.0019	+0.025 +0.0010
30.000 1.1811	35.000 1.3780	+0.053 +0.0021	+0.030 +0.0012
35.000 1.3780	60.000 2.3622	+0.058 +0.0023	+0.035 +0.0014
60.000 2.3622	80.000 3.1496	+0.073 +0.0029	+0.045 +0.0018
80.000 3.1496	115.000 4.5276	+0.078 +0.0031	+0.050 +0.0020
115.000 4.5276	180.000 7.0866	+0.088 +0.0035	+0.060 +0.0024
180.000 7.0866	220.000 8.6614	+0.103 +0.0041	+0.070 +0.0028
220.000 8.6614	270.000 10.6299	+0.113 +0.0044	+0.080 +0.0031
270.000 10.6299	350.000 13.7795	+0.128 +0.0050	+0.090 +0.0035

METRIC SERIES NEEDLE ROLLER BEARINGS WITH INTEGRAL FLANGES

The needle roller bearing has a one-piece, channel-shaped outer ring of bearing-quality steel heat treated to yield maximum load rating. The integral end flanges provide axial location for the needle rollers. The bores of the end flanges serve as piloting surfaces for the cage.

A steel cage provides inward retention for the needle rollers, and the design assures roller stability and minimizes friction between the cage and the needle rollers. The cage has maximum strength consistent with the inherent high-load ratings of needle roller bearings.

Needle roller bearings of series NKJ, NQI, NKJS, NA48 and NA49 contain one needle roller and cage assembly. Bearings of series NA69, with bearing bores of 32.000 mm (1.2598 in) and above, have two needle roller and cage assemblies.

The outer ring has a lubricating groove and a lubricating hole for more convenient lubrication of the bearing. However, the smaller bearings of series NKJ and NK (F_w < 10 mm [0.3937 in]) do not have a lubricating groove or a lubricating hole.

METRIC SERIES NEEDLE ROLLER BEARINGS WITH INSERTED END WASHERS

Some metric series needle roller bearings have inserted end washers to provide axial retention of the needle roller and cage assembly. The radial needle roller and cage assemblies, consistent with other designs, provide inward and outward retention for the needle rollers.

METRIC SERIES NEEDLE ROLLER BEARINGS WITHOUT FLANGES

The radial needle roller and cage assembly, used in the metric series needle roller bearings without flanges, is slightly narrower than the inner and outer rings to ensure unobstructed operation. Separate end washers are required to provide axial retention of the radial needle roller and cage assembly. Wide needle roller bearings, using two needle roller and cage assemblies, have a lubricating groove and one lubricating hole in the outer ring to facilitate re-lubrication of the bearing. Narrow needle roller bearings do not have a lubricating groove or a lubricating hole in the outer ring.

SEALED METRIC SERIES NEEDLE ROLLER BEARINGS OF DIMENSION SERIES 49

Needle roller bearings of Series 49 are available with one or two integral lip-contact seals, as listed on page B-4-30. One seal is designated by suffix letters RS. Two seals are designated by .2RS. When combining sealed metric series needle roller bearings with inner rings, it is suggested to use inner rings, shown on pages B-2-28 and B-8-22, with designation JRZ because they are wider than the outer rings to ensure positive seal contact.

Sealed bearings are normally packed with a high quality lithium soap-based grease suitable up to 120° C (248° F) for short periods of operation.

The speed rating specified for sealed bearings listed in the bearing tables is based on operating conditions determined by testing. Optimum performance may be expected providing the bearing is properly installed with appropriate internal clearances and subjected to a load of low magnitude. Care should be taken that overheating will not occur, thus preventing breakdown of the grease and eventual bearing failure.

METRIC SERIES FULL COMPLEMENT NEEDLE ROLLER BEARINGS

Series NA and RNA 1000, 2000, 22000 and 3000 are available with possible options of extra wide and/or crowned inner ring raceways. Consult your representative for application details.

BEARING MOUNTING

MOUNTING DIMENSIONS

It is suggested that needle roller bearings are mounted in their housings with a clearance fit, if the load is stationary relative to the housing, or with a tight transition fit, if the load rotates relative to the housing. Table B4-3 lists the suggested tolerances for the housing bore and the shaft raceway for metric series bearings without inner rings. Table B4-4 lists the suggested shaft tolerances for the above two mounting conditions when the metric series bearings are used with inner rings. The suggested housing bore tolerances for metric series bearings with inner rings is the same as the housing bore tolerance listed in Table B4-3 for metric series bearings without inner rings. Other quality requirements for shafts and housings are given in the engineering section.

Other mounting dimensions may be required for special operating conditions such as:

1. Extremely heavy radial loads.
2. Shock loads.
3. Temperature gradient across bearing.
4. Housing material with heat expansion coefficient different than that of the bearing.
5. Oscillating motion applications.

Table B4-3. Mounting tolerances for metric series bearings without inner ring

Rotation conditions	Nominal housing bore diameter D	ISO tolerance zone for housing		Nominal shaft diameter F	ISO tolerance zone for shaft	
		caged	full		caged	full
Load stationary relative to housing	all diameters	H7 (J7)	J6	all diameters	h6 (h5)	h5
General work with larger clearance	all diameters	K7	—	all diameters	g6	—
Load rotates relative to housing	all diameters	N7	M6	all diameters	f6	g5

Care should be taken that the selected bearing internal clearance is appropriate for the operating conditions.

Table B4-4. Shaft tolerances for metric series bearings with inner rings (use housing tolerance shown in Table B4-3)

Rotation conditions	Nominal shaft diameter, d		ISO tolerance zone for shaft	
	mm in	mm in	caged	full
Load rotates relative to housing	all diameters		g6	h5 (h6)
Load stationary relative to housing	>	≤		
	40.000 1.5748		k6	k5
	40.000 1.5748	100.000 3.9370	m6	m5
	100.000 3.9370	140.000 5.5118	m6	m5
	140.000 5.5118		n6	n6

Care should be taken that the selected bearing internal clearance is appropriate for the operating conditions.

Regardless of the fit of the bearing outer ring in the housing, the outer ring should be axially located by housing shoulders or other positive means. The bearing rings should closely fit against the shaft and housing shoulders and must not contact the fillet radius. The maximum shaft or housing fillet r_{a max} should be no greater than the minimum bearing chamfer r_{s min}, as shown in Table B4-5 on page B-4-10.

In order to permit mounting and dismounting of the shaft, the maximum diameter D₁ in Table B4-6 on page B-4-10 must not be exceeded. F_w is shown in the bearing tables.

Needle roller bearings without flanges of series RNA0 and NAO must have the radial needle roller and cage assembly properly end-guided by shoulders, as shown in Table B4-7(1) on page B-4-11 and Table B4-7(2) on page B-4-12, or other suitable means, such as spring steel washers (SNSH) shown on page B-8-39. These end-guiding surfaces should be hardened and precision turned, or ground to minimize wear, and should properly fit against the outer rings and the inner rings to provide the desired end clearance for the needle roller and cage assembly.

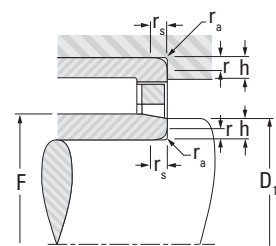


Fig. B4-7. Fillet

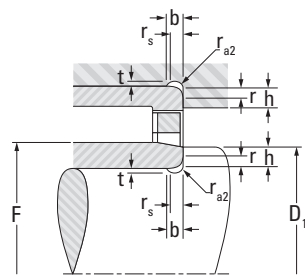


Fig. B4-8. Undercut

Table B4-5. Fillets, undercuts, and shoulder heights for metric series bearings

$r_s^{(1)}$		r_a		t	r_{a2}		b		h	
Min.	Max.	Min.	Max.		Min.	Max.	Min.	Max.	Min.	Max.
mm	in	mm	in	mm	mm	mm	mm	mm	mm	mm
0.15	0.0059	0.15	0.0059						0.6	0.0236
0.3	0.0118	0.3	0.0118						1	0.0394
0.6	0.0236	0.6	0.0236						2	0.0787
1	0.0394	1	0.0394	0.2	1.3	0.0079	0.0512	2	0.0787	2.5
1.1	0.0433	1	0.0394	0.3	2	0.0118	0.0787	3	0.1181	3.25
1.5	0.0591	1.5	0.0591	0.4	2	0.0158	0.0787	3.2	0.1260	4
2	0.0787	2	0.0787	0.5	2.5	0.0197	0.0984	4	0.1575	5
2.1	0.0827	2.1	0.0827	0.5	3	0.0197	0.1181	4.7	0.1850	5.5
3	0.1181	2.5	0.0984	0.5	3.5	0.0197	0.1378	5.3	0.2087	6

⁽¹⁾ r_s : Bearing component corner rounding.

Table B4-6. Shoulder diameter D_{1max} for metric series bearings

		mm in	mm in	mm in	mm in	mm in
Needle roller complement bore diameter F_w	>		20.000 0.7874	55.000 2.1653	100.000 3.9370	250.000 9.8425
	≤	20.000 0.7874	55.000 2.1653	100.000 3.9370	250.000 9.8425	
Diameter	D_{1max}	$F_w - 0.3$	$F_w - 0.5$	$F_w - 0.7$	$F_w - 1.0$	$F_w - 1.5$

LOAD RATING FACTORS

DYNAMIC LOADS

Needle roller bearings can accommodate only radial loads.

$$P = F_r \quad (\text{kN})$$

P = The maximum dynamic radial load that may be applied to a needle roller bearing based on the dynamic load rating, C, given in the bearing tables. This load should be $\leq C/3$.

STATIC LOADS

Needle roller bearings can accommodate only radial loads.

$$P_0 = F_r \quad (\text{kN})$$

MOUNTING IN SETS

Radial needle roller and cage assemblies that are mounted side by side must have needle rollers of the same group limits to ensure uniform load distribution.

RNAO Series

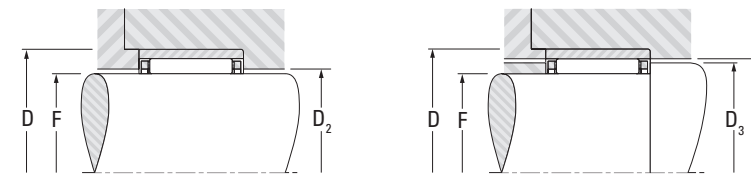


Fig. B4-9. Guidance in the housing (left) and on the shaft (right)

Table B4-7(1). Mounting dimensions for metric series needle roller bearings without flanges

Fx D	D ₃	D ₂	D ₅	Bearing series RNAO			
				Max.			Min.
				mm in	mm in	mm in	mm in
10x17 0.3937x0.6693	12.7 0.5000	10.3 0.4055	13.3 0.5236				
12x19 0.4724x0.7480	14.7 0.5787	12.3 0.4843	15.3 0.6024				
14x22 0.5512x0.8661	17.6 0.6929	14.4 0.5669	18.3 0.7205				
15x23 0.5906x0.9055	18.6 0.7323	15.4 0.6063	19.3 0.7598				
16x24 0.6299x0.9499	19.6 0.7717	16.4 0.6457	20.3 0.7992				
17x25 0.6693x0.9843	20.6 0.8110	17.4 0.6850	21.3 0.8386				
18x26 0.7087x1.0236	21.6 0.8504	18.4 0.7244	22.3 0.8780				
18x30 0.7087x1.1811	23.6 0.9291	18.6 0.7323	24.5 0.9646				
20x28 0.7874x1.1024	23.6 0.9291	20.4 0.8032	24.3 0.9567				
20x32 0.7874x1.2598	25.6 1.0079	20.6 0.8110	26.5 1.0433				
22x30 0.8661x1.1811	25.6 1.0079	22.4 0.8819	26.3 0.9291				
22x35 0.8661x1.3780	28.4 1.1181	22.8 0.8976	29.5 1.1614				
25x35 0.9843x1.3780	29.4 1.1575	25.6 1.0079	30.5 1.2008				
25x37 0.9843x1.4567	31.4 1.2362	25.8 1.0158	32.5 1.2795				
28x40 1.1024x1.5748	34.4 1.3543	28.8 1.1339	35.5 1.3976				
30x40 1.1811x1.5748	34.4 1.3543	30.6 1.2047	35.5 1.3976				
30x42 1.1811x1.6535	36.4 1.4331	30.8 1.2126	37.5 1.4764				
35x45 1.3780x1.7717	39.4 1.5512	35.6 1.4016	40.5 1.5945				
35x47 1.3780x1.8504	41.4 1.6299	35.8 1.4096	42.5 1.6732				
40x50 1.5748x1.9685	44.4 1.7480	40.6 1.5984	45.5 1.7913				
40x55 1.5748x2.1654	47.2 1.8582	41 1.6142	48.5 1.9095				
45x55 1.7717x2.1654	49.4 1.9449	45.6 1.7953	50.5 1.9882				
45x62 1.7717x2.4409	52.2 2.0551	46 1.8110	53.5 2.1063				
50x62 1.9685x2.4409	54.4 2.1417	50.6 1.9921	55.8 2.1969				
50x65 1.9685x2.5591	57.2 2.2520	51 2.0079	58.8 2.3032				
55x68 2.1654x2.6772	59.4 2.3386	55.6 2.1890	60.8 2.3937				
55x72 2.1654x2.8347	62.2 2.4488	56 2.2047	63.8 2.5118				
60x78 2.3622x3.0709	67.2 2.6457	61 2.4016	68.8 2.7087				
65x85 2.5591x3.3465	72.2 2.8425	66 2.5984	73.8 2.9055				
70x90 2.7559x3.5433	77.2 3.0394	71 2.7953	78.8 3.1024				
75x95 2.9528x3.7402	82.2 3.2362	76 2.9921	84 3.3071				
80x100 3.1496x3.9370	87.2 3.4331	81 3.1890	89 3.5039				
85x105 3.3465x4.1339	92.2 3.6299	86 3.3858	94 3.7008				
90x110 3.5433x4.3307	97.2 3.8268	91 3.5827	99 3.8976				
95x115 3.7402x4.5276	102.2 4.0236	96 3.7795	104 4.0945				
100x120 3.9370x4.7244	107.2 4.2205	101 3.9764	109 4.2913				



NEEDLE ROLLER BEARINGS WITH INNER RINGS

METRIC SERIES NKJ, NKJS, NA48 NA49, NA69 SERIES

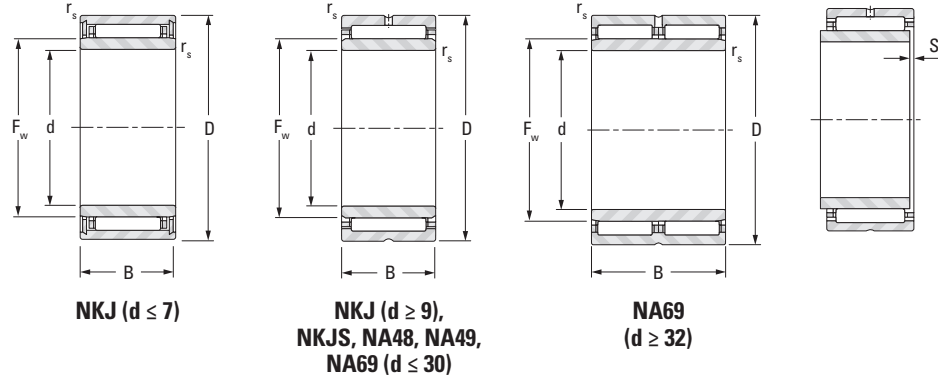


Table with columns for Shaft Dia., d, D, B, Fw, rs min, s, Bearing Designation, Load Ratings (Dynamic, Static), Speed Rating (Grease, Oil), and Approx. Wt. (kg lbs). Rows list various bearing models like NKJ45/35, NA4909, etc.

(1) Max. axial displacement

Table with columns for Shaft Dia., d, D, B, Fw, rs min, s, Bearing Designation, Load Ratings (Dynamic, Static), Speed Rating (Grease, Oil), and Approx. Wt. (kg lbs). Rows list heavy-duty bearing models like NKJ65/25, NKJ65/35, etc.

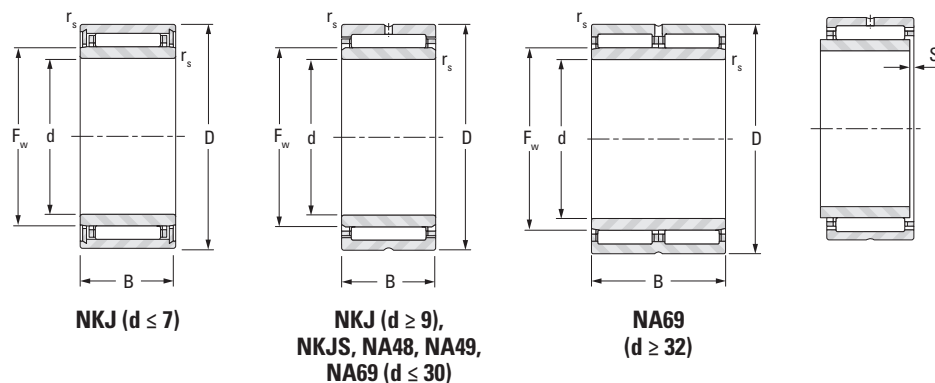
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NEEDLE ROLLER BEARINGS

NEEDLE ROLLER BEARINGS WITH INNER RINGS

METRIC SERIES
NKJ, NKJS, NA48
NA49, NA69 SERIES



NKJ (d ≤ 7)

NKJ (d ≥ 9),
NKJS, NA48, NA49,
NA69 (d ≤ 30)

NA69
(d ≥ 32)

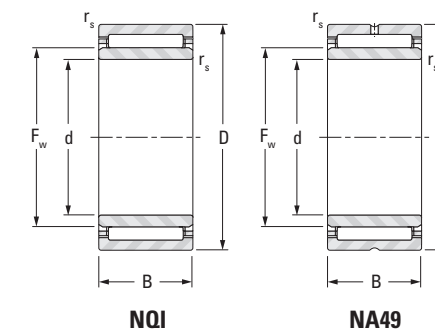
Shaft Dia.	d	D	B	F _w	r _{s min}	s ⁽¹⁾	Bearing Designation	Load Ratings		Speed Rating		Approx. Wt.
								Dynamic	Static	Speed Rating		
								C	C ₀	Grease	Oil	
mm in	mm in	mm in	mm in	mm in	mm in	mm in		kN lbf		min ⁻¹		kg lbs
90 3.5433	90 3.5433	125 4.9213	63 2.48	105 4.1339	1.1 0.043	2 0.079	NA6918	175 39300	427 96000	2600	4000	2.64 5.82
95 3.7402	95 3.7402	125 4.9213	26 1.024	105 4.1339	1 0.039	2.5 0.098	NKJ95/26	52.2 11700	127 28600	2600	3900	0.935 2.061
	95 3.7402	125 4.9213	36 1.417	105 4.1339	1 0.039	3.5 0.138	NKJ95/36	72.8 16400	195 43800	2600	3900	1.3 2.866
	95 3.7402	130 5.1181	35 1.378	110 4.3307	1.1 0.043	2.5 0.098	NA4919	115 25900	253 56900	2500	3800	1.43 3.153
	95 3.7402	130 5.1181	63 2.48	110 4.3307	1.1 0.043	2 0.079	NA6919	158 35500	458 103000	2500	3800	2.67 5.88
100 3.937	100 3.937	130 5.1181	30 1.181	110 4.3307	1.1 0.043	2 0.079	NKJ100/30	103 23200	220 49500	2500	3800	0.984 2.169
	100 3.937	130 5.1181	40 1.575	110 4.3307	1.1 0.043	2 0.079	NKJ100/40	132 29700	301 67700	2500	3800	1.41 3.109
	100 3.937	135 5.315	32 1.26	115 4.5276	1.1 0.043	2 0.079	NKJS100	104 23400	226 50800	2400	3700	2.01 4.431
	100 3.937	140 5.5118	40 1.575	115 4.5276	1.1 0.043	3.5 0.138	NA4920	139 31200	296 66500	2400	3700	2.01 4.431
110 4.3307	110 4.3307	140 5.5118	30 1.181	120 4.7244	1 0.039	0.5 0.02	NA4822	90.3 20300	230 51700	2300	3500	1.21 2.668
	110 4.3307	150 5.9055	40 1.575	125 4.9213	1.1 0.043	3.5 0.138	NA4922	147 33000	325 73100	2200	3400	2.19 4.828
120 4.7244	120 4.7244	150 5.9055	30 1.181	130 5.1181	1 0.039	0.5 0.02	NA4824	94.2 21200	249 56000	2100	3200	1.31 2.888
	120 4.7244	165 6.4961	45 1.772	135 5.315	1.1 0.043	3.5 0.138	NA4924	177 39800	407 91500	2000	3100	3.04 6.702
130 5.1181	130 5.1181	165 6.4961	35 1.378	145 5.7087	1.1 0.043	1 0.039	NA4826	112 25200	323 72600	1900	2900	1.99 4.387
	130 5.1181	180 7.0866	50 1.969	150 5.9055	1.5 0.059	3 0.118	NA4926	201 45200	495 111000	1800	2800	4.14 9.127
140 5.5118	140 5.5118	175 6.8898	35 1.378	155 6.1024	1.1 0.043	1 0.039	NA4828	116 26100	346 77800	1700	2700	2.12 4.674
	140 5.5118	190 7.4803	50 1.969	160 6.2992	1.5 0.059	3 0.118	NA4928	214 48100	549 123000	1700	2600	4.41 9.72
150 5.9055	150 5.9055	190 7.4803	40 1.575	165 6.4961	1.1 0.043	2 0.079	NA4830	142 31900	402 90400	1600	2500	2.7 5.952
160 6.2992	160 6.2992	200 7.874	40 1.575	175 6.8898	1.1 0.043	2 0.079	NA4832	146 32800	425 95500	1500	2400	3.15 6.944

⁽¹⁾ Max. axial displacement

Heavy-Duty Needle Roller Bearings

NEEDLE ROLLER BEARINGS WITH INNER RINGS

METRIC SERIES
NQI, NA49 SERIES



NQI

NA49

Shaft Dia.	d	D	B	F _w	r _{s min}	s ⁽¹⁾	Bearing Designation	Load Ratings		Speed Rating		Approx. Wt.
								Dynamic	Static	Speed Rating		
								C	C ₀	Grease	Oil	
mm in	mm in	mm in	mm in	mm in	mm in	mm in		kN lbf		min ⁻¹		kg lbs
12 0.4724	12	24	13	16	0.3	—	NA4901C3	8.65	11.1	—	28000	0.027
20 0.7874	20	32	20	24	0.3	—	NQI203220AD	17.4	26.5	—	18000	0.062
	20	37	17	25	0.3	—	NA4904NA	16.2	21.5	—	18000	0.083
25 0.9843	25	44	25	30	0.3	—	25NQI4425A	36.6	49.6	—	15000	0.161
30 1.1811	30	47	17	35	0.3	—	NA4906D	20.2	31.9	—	12000	0.110
38 1.4961	38	53	30	43	0.6	—	NQI38/30	41.3	85.9	—	9900	0.212

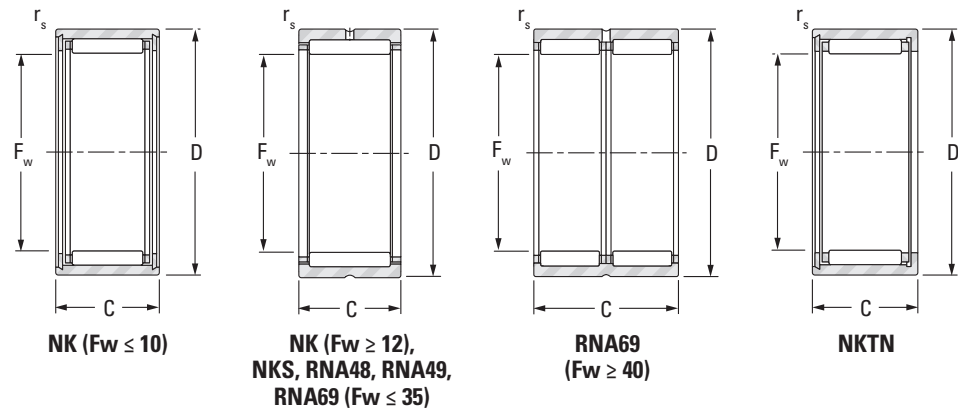
⁽¹⁾ Max. axial displacement



NEEDLE ROLLER BEARINGS

NEEDLE ROLLER BEARINGS WITHOUT INNER RINGS

METRIC SERIES
NK, NKS, RNA48, RNA49
RNA69, NKTN SERIES

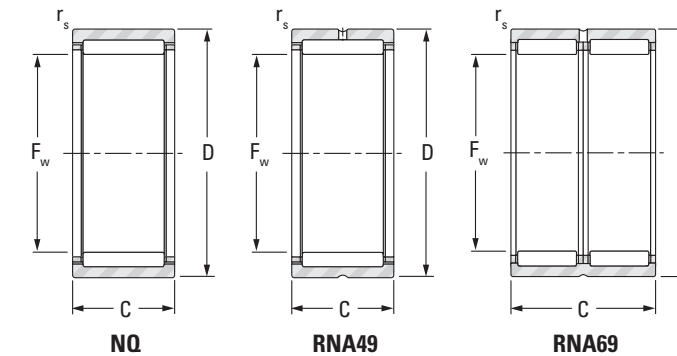


Shaft Dia.	F _w	D	C	r _{s min}	Bearing Designation	Load Ratings		Speed Rating		Approx. Wt.	
						Dynamic	Static	Grease			Oil
						C	C ₀	min ⁻¹			
mm in	mm in	mm in	mm in	mm in		kN lbf		min ⁻¹		kg lbs	
105 4.1339	105 4.1339	125 4.9213	35 1.378	1.1 0.043	RNA4918	114 25600	245 55100	2600	4000	0.746 1.645	
	105 4.1339	125 4.9213	63 2.48	1.1 0.043	RNA6918	154 34600	437 98200	2600	4000	1.500 3.300	
110 4.3307	110 4.3307	130 5.1181	30 1.181	1.1 0.043	NK110/30	103 23200	220 49500	2500	3800	0.660 1.455	
	110 4.3307	130 5.1181	35 1.378	1.1 0.043	RNA4919	115 25900	253 56900	2500	3800	0.777 1.713	
	110 4.3307	130 5.1181	40 1.575	1.1 0.043	NK110/40	132 29700	132 29700	2500	3800	0.900 1.984	
	110 4.3307	130 5.1181	63 2.48	1.1 0.043	RNA6919	158 35500	458 103000	2500	3800	1.470 3.241	
115 4.5276	115 4.5276	140 5.5118	40 1.575	1.1 0.043	RNA4920	139 31200	296 66500	2400	3700	1.220 2.690	
120 4.7244	120 4.7244	140 5.5118	30 1.181	1 0.039	RNA4822	90.3 20300	230 51700	2300	3500	0.785 1.731	
	125 4.9213	150 5.9055	40 1.575	1.1 0.043	RNA4922	147 33000	325 73100	2200	3400	1.320 2.910	
130 5.1181	130 5.1181	150 5.9055	30 1.181	1 0.039	RNA4824	94.1 21200	249 56000	2100	3200	0.850 1.874	
135 5.315	135 5.315	165 6.4961	45 1.772	1.1 0.043	RNA4924	177 39800	407 91500	2000	3100	1.980 4.365	
145 5.7087	145 5.7087	165 6.4961	35 1.378	1 0.039	RNA4826	112 25200	323 72600	1900	2900	1.100 2.425	
150 5.9055	150 5.9055	180 7.0866	50 1.969	1.5 0.059	RNA4926	201 45200	495 111000	1800	2800	2.420 5.335	
155 6.1024	155 6.1024	175 6.8898	35 1.378	1.1 0.043	RNA4828	116 26100	346 77800	1700	2700	1.170 2.579	
160 6.2992	160 6.2992	190 7.4803	50 1.969	1.5 0.059	RNA4928	214 48100	549 123000	1700	2600	2.560 5.644	
165 6.4961	165 6.4961	190 7.4803	40 1.575	1.1 0.043	RNA4830	142 31900	402 90400	1600	2500	1.540 3.395	
175 6.8898	175 6.8898	200 7.874	40 1.575	1.1 0.043	RNA4832	146 32800	425 95500	1500	2400	1.910 4.211	

Heavy-Duty Needle Roller Bearings

NEEDLE ROLLER BEARINGS WITHOUT INNER RINGS

METRIC SERIES
NQ, RNA49, RNA69 SERIES



Shaft Dia.	F _w	D	C	r _{s min}	Bearing Designation	Load Ratings		Speed Rating		Approx. Wt.	
						Dynamic	Static	Grease			Oil
						C	C ₀	min ⁻¹			
mm in	mm in	mm in	mm in	mm in		kN lbf		min ⁻¹		kg lbs	
12 0.4724	12	19	12	0.3	NQ12/12AD	5.4	5.5	—	30000	0.012	
	12	24	9.8	0.3	12NQ2410A	5.9	6.3	—	30000	0.023	
13 0.5118	13	21	12	0.3	NQ132112	8.25	8.4	—	24000	0.015	
14 0.5512	14	22	16	0.5	NQ14/16D	11.8	13.8	—	24000	0.021	
15 0.5906	15	23	16	0.3	NQ15/16B	15.2	17.4	—	21000	0.021	
	15	24	10	0.3	15NQ2410D	8.65	8.45	—	21000	0.016	
	15	24	12	0.3	15NQ2412A	9.7	9.75	—	21000	0.019	
	15	25	16	0.6	NQ152516	11.8	14	—	24000	0.032	
	15	28	12	0.6	15NQ2812	10.7	11.1	—	21000	0.034	
	15	28	12	0.6	NQ152512	10.7	11.1	—	21000	0.022	
	15	28	12	0.6	NQ152812-1	10.7	11.1	—	21000	0.034	
	15	28	15	1.0	15NQ2815	12.7	13.7	—	21000	0.042	
16 0.6299	16	23	16	0.3	16NQ2316	13	16.2	—	23000	0.019	
	16	23	22	0.3	16NQ2322A	17	22.9	—	23000	0.026	
17 0.6693	17	25	16	0.5	NQ17/16D	11.4	16.2	—	26000	0.026	
	17	30	13	0.3	17NQ3013D	10.2	10.8	—	27000	0.041	
	17	32	16	0.6	17NQ3216D	18.5	17.1	—	29000	0.053	
18 0.7087	18	29	25	0.3	NQ182925-1	24.2	27.5	—	26000	0.056	
	18	34	20	0.3	18NQ3420AD	17.1	21.2	—	25000	0.090	
20 0.7874	20	28	16	0.3	NQ20/16D	12.1	18.2	—	22000	0.030	
	20	28	23	0.3	NQ202823	18.5	27.1	—	22000	0.040	
	20	30	15	0.6	20NQ3015ED	11.4	15.4	—	22000	0.037	

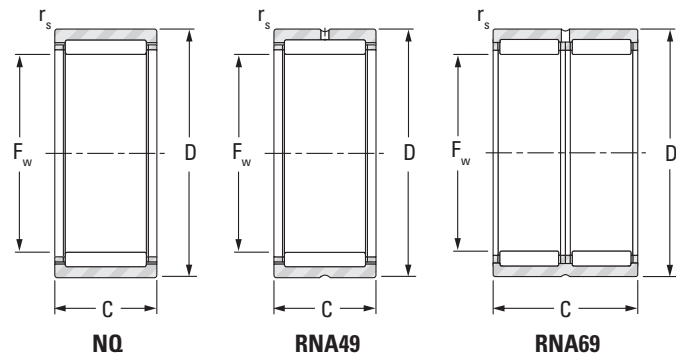
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NEEDLE ROLLER BEARINGS

NEEDLE ROLLER BEARINGS WITHOUT INNER RINGS

METRIC SERIES NQ, RNA49, RNA69 SERIES



Heavy-Duty Needle Roller Bearings

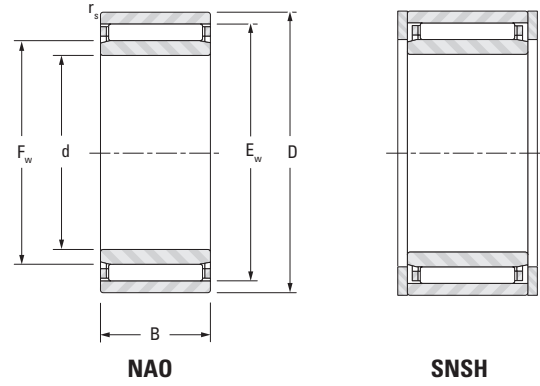
Shaft Dia.	F _w	D	C	r _{s min}	Bearing Designation	Load Ratings		Speed Rating		Approx. Wt.
						Dynamic	Static	Grease	Oil	
						C	C ₀			
mm in	mm in	mm in	mm in	mm in		kN lbf		min ⁻¹	kg lbs	
40 1.5748	40	60	25	0.9	NQ406025	54.2	66.8	—	11000	0.213
45 1.7717	45	58	20	0.6	RNA49/38R-1	36.7	56.2	—	9700	0.116
48 1.8898	48	62	22	0.6	RNA4908R-2	44.3	67.8	—	9100	0.152

Shaft Dia.	F _w	D	C	r _{s min}	Bearing Designation	Load Ratings		Speed Rating		Approx. Wt.
						Dynamic	Static	Grease	Oil	
						C	C ₀			
mm in	mm in	mm in	mm in	mm in		kN lbf		min ⁻¹	kg lbs	
20 0.7874	20	30	20	0.3	20NQ3020	19.9	26.4	—	23000	0.048
	20	32	12	0.3	20NQ3212	11.9	11.3	—	23000	0.033
	20	32	18	0.3	NQ203218	21.2	26.1	—	23000	0.053
	20	32	20	0.3	NQ203220	23	26.6	—	23000	0.057
	20	33	15	0.6	20NQ3315NE	13.8	16.5	—	23000	0.093
	20	34	18	0.6	20NQ3418D	21.6	21.5	—	24000	0.060
22 0.8661	22	30	20	0.3	NQ22/20	15.3	25.6	—	20000	0.041
	22	35	20	0.3	NQS22/20D	21.8	25.4	—	21000	0.071
24 0.9449	24	32	20	0.3	NQ24/20AD	17.4	26.5	—	18000	0.041
25 0.9843	25	37	17	1.0	25NQ3717AD-1	21.1	25.1	—	18000	0.056
	25	37	17	0.9	RNA4904ARD	21.5	25.7	—	18000	0.057
28 1.1024	28	37	20	0.3	NQ283720D	20.7	34.9	—	15000	0.056
	28	39	17	0.3	RNA49/22R	22.2	30.3	—	16000	0.055
30 1.1811	30	42	30	0.6	NQ304230	40.6	61.2	—	15000	0.118
35 1.378	35	45	14	0.6	NQ354514	16.9	29	—	12000	0.055
	35	47	17	0.3	RNA4906D	20.2	31.9	—	12000	0.110
	35	47	30	0.3	RNA6906	43.1	69.3	—	13000	0.186
	35	48	23.7	0.3	35NQ4824D	34.1	51.3	—	13000	0.123
37 1.4567	37	47	20	0.3	NQ37/20D	26.3	45.7	—	12000	0.079
40 1.5748	40	48	20	0.3	NQ404820	21.2	40.4	—	11000	0.064
	40	50	15	0.3	NQ40/15AD	21.3	35.8	—	11000	0.063
	40	52	20	0.6	RNA49/32R-1	32.4	50	—	11000	0.100



NEEDLE ROLLER BEARINGS WITHOUT FLANGES WITH INNER RINGS

METRIC SERIES



Main table for NAO and SNSH needle roller bearings with columns for Shaft Dia, d, D, B, Fw, Ew, rs min, s(1), Bearing Designation, End Washer Designation, Load Ratings (Dynamic C, Static Co), Speed Rating (Grease, Oil), and Approx. Wt. (kg, lbs).

(1) Max. axial displacement.

Main table for Heavy-Duty Needle Roller Bearings with columns for Shaft Dia, d, D, B, Fw, Ew, rs min, s(1), Bearing Designation, End Washer Designation, Load Ratings (Dynamic C, Static Co), Speed Rating (Grease, Oil), and Approx. Wt. (kg, lbs).

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NEEDLE ROLLER BEARINGS WITHOUT FLANGES WITH INNER RINGS

METRIC SERIES

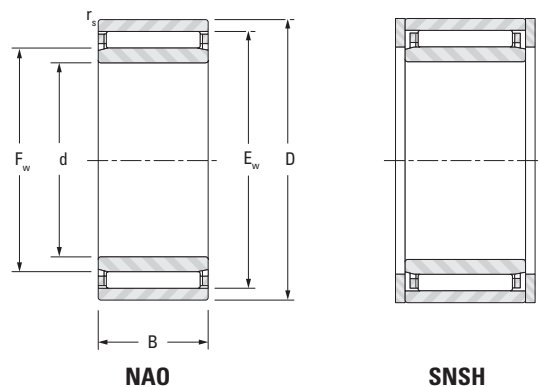


Table with columns: Shaft Dia., d, D, B, Fw, Ew, rs min, s(1), Bearing Designation, End Washer Designation, Load Ratings (Dynamic, Static), Speed Rating (Grease, Oil), Approx. Wt. Rows include various bearing models like NAO50X78X40, NAO55X85X30, etc.

(1) Max. axial displacement.

NEEDLE ROLLER BEARINGS WITHOUT FLANGES WITHOUT INNER RINGS

METRIC SERIES

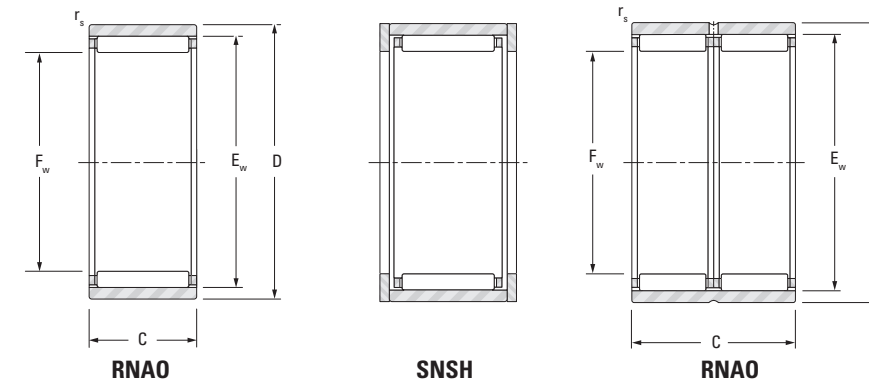


Table with columns: Shaft Dia., Fw, D, C, Ew, rs min, Bearing Designation, End Washer Designation, Load Ratings (Dynamic, Static), Speed Rating (Grease, Oil), Approx. Wt. Rows include various RNAO and SNSH bearing models like RNA06X13X8TN, RNA07X14X8TN, etc.

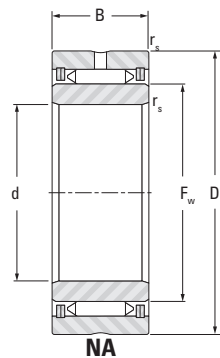
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NEEDLE ROLLER BEARINGS
FULL COMPLEMENT
WITH INNER RINGS

METRIC SERIES

- Check for availability.



Shaft Dia.	d	D	B	F _w	r _s min	Bearing Designation	Load Ratings		Speed Rating		Approx. Wt.
							Dynamic	Static	Grease	Oil	
							C	C ₀			
mm in	mm in	mm in	mm in	mm in	mm in		kN lbf		min⁻¹		kg lbs
100 3.9370	100 3.9370	145 5.7087	43 1.693	119.2 4.6929	1.35 0.053	NA 3100	195.0 43800	520 117000	2100	3200	2.74 6.03
105 4.1339	105 4.1339	140 5.5118	32 1.260	119.2 4.6929	1.35 0.053	NA 2105	129.0 29000	340 76400	2100	3200	1.56 3.43
	105 4.1339	150 5.9055	45 1.772	124.7 4.9094	1.35 0.053	NA 3105	203.0 45600	550 124000	2000	3000	2.99 6.59
110 4.3307	110 4.3307	145 5.7087	34 1.339	124.7 4.9094	1.35 0.053	NA 2110	133.0 29900	360 80900	2000	3000	1.72 3.79
	110 4.3307	160 6.2992	45 1.772	132.5 5.2165	1.35 0.053	NA 3110	210.0 47200	580 130000	1900	2900	3.53 7.79
115 4.5276	115 4.5276	155 6.1024	34 1.339	132.5 5.2165	1.35 0.053	NA 2115	139.0 31200	380 85400	1900	2900	2.10 4.63
	115 4.5276	165 6.4961	45 1.772	137.0 5.3937	1.35 0.053	NA 3115	215.0 48300	600 135000	1800	2800	3.66 8.07
120 4.7244	120 4.7244	160 6.2992	34 1.339	137.0 5.3937	1.35 0.053	NA 2120	142.0 31900	395 88800	1800	2800	2.17 4.78
	120 4.7244	170 6.6929	45 1.772	143.5 5.6496	1.35 0.053	NA 3120	224.0 50400	630 142000	1800	2700	3.79 8.36
125 4.9213	125 4.9213	165 6.4961	34 1.339	143.5 5.6496	1.35 0.053	NA 2125	145.0 32600	410 92200	1800	2700	2.24 4.94
130 5.1181	130 5.1181	170 6.6929	34 1.339	148.0 5.8268	1.35 0.053	NA 2130	150.0 33700	425 95500	1700	2600	2.33 5.13
140 5.5118	140 5.5118	180 7.0866	36 1.417	158.0 6.2205	1.35 0.053	NA 2140	157.0 35300	455 102000	1600	2400	2.64 5.83
	140 5.5118	205 8.0709	52 2.047	170.5 6.7126	1.35 0.053	NA 3140	290.0 65200	860 193000	1400	2200	6.84 15.1
150 5.9055	150 5.9055	195 7.6772	36 1.417	170.5 6.7126	1.35 0.053	NA 2150	165.0 37100	490 110000	1400	2200	3.23 7.12
160 6.2992	160 6.2992	205 8.0709	36 1.417	179.3 7.0591	1.35 0.053	NA 2160	170.0 38200	515 116000	1400	2100	3.40 7.50
170 6.6929	170 6.6929	220 8.6614	42 1.654	193.8 7.6299	1.35 0.053	NA 2170	233.0 52400	720 162000	1300	2000	4.77 10.5
180 7.0866	180 7.0866	230 9.0551	42 1.654	202.6 7.9764	1.35 0.053	NA 2180	240.0 54000	750 169000	1200	1900	5.01 11.0
190 7.4803	190 7.4803	245 9.6457	42 1.654	216.0 8.5039	1.35 0.053	NA 2190	250.0 56200	800 180000	1200	1800	5.89 13.0
200 7.8740	200 7.8740	255 10.0394	42 1.654	224.1 8.8228	1.35 0.053	NA 2200	257.0 57800	830 187000	1100	1700	6.15 13.6

NEEDLE ROLLER BEARINGS

INCH SERIES

When there is a requirement for a rolling bearing to support very high dynamic, static or even shock loads with a restricted mounting space – the needle roller bearing may give best results.

REFERENCE STANDARDS ARE:

- **ANSI/ABMA Standard 18.2** – needle roller bearings – radial, inch design.
- **ASTM Standard F 2246** – standard specification for bearing, roller, needle: thick outer ring with rollers and cage.
- **Military Standard MS 51961** – bearing, roller, needle: thick outer ring with rollers and cage.
- **ASTM Standard F2431** – standard specification for ring, bearing, inner: needle roller bearing with thick outer ring.

IDENTIFICATION

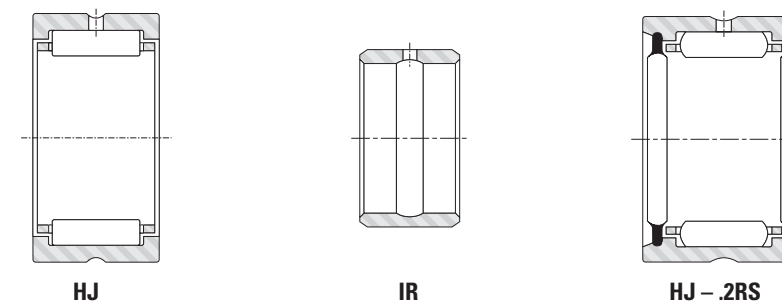


Fig. B4-11. Construction of inch series heavy-duty needle roller bearings

The prefix letters HJ in the needle roller bearing designation denote that the bearing is manufactured to inch nominal dimensions.

Bearings are available with one or two lip-contact seals, as listed on pages B-4-52 and B-4-53. One seal is designated by suffix letters RS. Two seals are designated by .2RS.

Inner rings can be used with HJ Series needle roller bearings for applications where it is impractical to use the shaft as the inner

raceway. These inch series inner rings are identified by the prefix letters IR.

Because the entire identification code may not appear on the bearing itself, the manufacturer's parts list or another reliable source should always be consulted when ordering bearings for service or field replacement to make certain that the correct bearing with the correct lubricant is used.

CONSTRUCTION

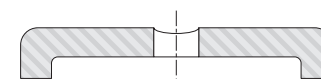


Fig. B4-12. One-piece, channel-shaped outer ring



Fig. B4-13. Steel cage

The HJ Series needle roller bearing has a one-piece channel-shaped outer ring of bearing-quality steel heat treated to provide maximum load rating. The integral end flanges provide axial location for the needle rollers. The bores of the end flanges serve as piloting surfaces for the cage, locating it to prevent removal of the lubricant film on the raceway.

These bearings have a steel cage, which provides inward retention for the needle rollers. The design assures roller stability and minimizes friction between the cage and the needle rollers. The cage has a maximum strength consistent with the inherent high load ratings of needle roller bearings.

The needle rollers are made from high-carbon chrome steel, through-hardened, ground and lapped to close tolerance with controlled contour for optimum load distribution.

SEALS

Shaft contact seals, which fit into the same housing bore as the heavy-duty needle roller bearings, may be obtained from recognized seal manufacturers. Bearings can also be made available with one or two integral seals. For information and listing of sealed bearings, see pages B-4-52 and B-4-53.



LUBRICATION

The outer rings of the HJ bearings are supplied with a lubrication groove on the O.D. and a lubrication hole in this groove to facilitate re-lubrication through the outer ring. The IR inner rings have lubrication grooves in the bore and a re-lubrication hole to facilitate re-lubrication through the inner ring.

HJ Series bearings (with or without seals) are typically shipped protected with a corrosion-preventive compound that is not a lubricant. When specified by the customer, HJ Series bearings may be ordered prelubricated with suitable greases and oils.

MOUNTING DIMENSIONS

HJ needle roller bearings are normally mounted in their housings with a clearance fit if the load is stationary relative to the housing, and with a tight transition fit if the load rotates relative to the housing. Because the tight transition fit of the bearing in its housing may result in a reduction of the needle roller complement bore diameter, the shaft raceway diameter should be reduced to a like amount.

The mounting dimensions in the bearing tables (pages B-4-48 to B-4-53) list the suggested ISO H7 tolerances for the housing bore and the suggested ISO h6 tolerances for the shaft raceway when the outer ring is to be mounted with a clearance fit. The tables also list the suggested ISO N7 tolerances for the housing bore and the suggested ISO f6 tolerances for the shaft raceway when the outer ring is to be mounted with a tight transition fit.

Other mounting dimensions may be required for special conditions such as:

- 1. Extremely heavy radial loads.
2. Shock loads.
3. Load rotating relative to both inner and outer rings.
4. Temperature gradient across bearing.
5. Housing with heat expansion coefficient differing from that of the bearing.

If these conditions are expected, please consult your representative.

DIMENSIONAL ACCURACY, BEARINGS

HJ SERIES

Tolerances for the HJ bearings are given in Tables B4-8 and B4-9. Pages B-4-48 to B-4-53 list the nominal outer diameter, width and needle roller complement bore diameter for the HJ bearings.

Table B4-8. Outer diameter and width tolerances, HJ bearings

Table with 12 columns: D (Nominal outer diameter), Deviaton from nominal (of single mean outer diameter, Dmp, of width, C), and sub-columns for Max./Min. in mm and in.

(1) "Single mean diameter" is defined as the mean diameter in a single radial plane.

Table B4-9. Roller complement bore tolerance, HJ bearings

Table with 8 columns: Fw (Nominal roller complement bore diameter), Deviaton from nominal of the smallest single diameter of the roller complement bore, Fm, and sub-columns for Max./Min. in mm and in.

(1) "The smallest single diameter of the roller complement bore" is defined as the diameter of the cylinder which, when used as a bearing inner ring, results in zero radial internal clearance in the bearing on at least one diameter.

DIMENSIONAL ACCURACY, INNER RINGS

IR SERIES

Tolerances for the IR inner rings are given in Tables B4-10 and B4-11. Pages B-4-54 to B-4-57 list the nominal outer diameter, width and bore diameter for the IR series inner rings.

Table B4-10. Bore and width tolerances, IR inner rings

Table with 12 columns: d (Nominal bore diameter), Deviaton from nominal (of single mean bore diameter, dmp, of width, B), and sub-columns for Max./Min. in mm and in.

(1) "Single mean diameter" is defined as the mean diameter in a single radial plane.

Table B4-11. Outer diameter tolerance, IR inner rings

Table with 8 columns: F (Nominal outer diameter), Deviaton from nominal (of single mean outer diameter, Fmp), and sub-columns for Max./Min. in mm and in.

(1) "Single mean diameter" is defined as the mean diameter in a single radial plane.

LOAD RATING FACTORS

DYNAMIC LOADS

Needle roller bearings can accommodate only radial loads.

P = Fr

P = The maximum dynamic radial load that may be applied to a needle roller bearing based on the dynamic load rating, C, given in the bearing tables. This load should be <= C/3.

STATIC LOADS

Needle roller bearings can accommodate only radial loads.

P0 = Fr

SPECIAL BEARINGS

For needle roller bearings with special dimensions or special features, such as split outer ring, consult your representative.



HJ TYPE

INCH SERIES

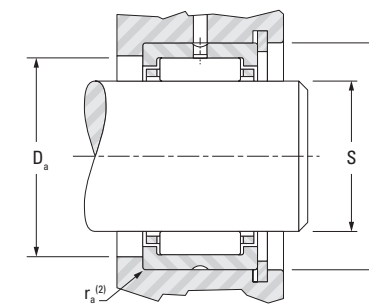
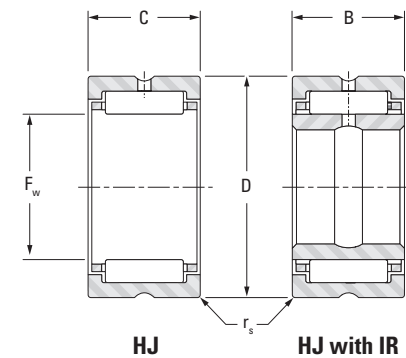
- Check for availability.
- Nominal bearing diameters and widths shown.
- Tolerance tables found on page B-4-46.
- Clearance fit suggested for outer ring when housing is stationary relative to load.
- Tight transition fit suggested if housing rotates relative to load.

- Consult your representative for oscillating applications (e.g., low radial clearance concerns).
- Unmarked end of outer ring should be assembled against housing shoulder to clear maximum allowed housing fillet ($r_{a\max}^{(2)}$).
- Meets Military Standard MS 51961 and ASTM F2246.

Shaft Dia.	F_w	D	C (B)	$r_s \text{ min}$	Bearing Designation	Used With Inner Ring Designation ⁽¹⁾	Load Ratings		Speed Rating		Approx. Wt.
							Dynamic	Static	Grease	Oil	
							C	C_0			
1 3/4	44.450 1.7500	58.738 2.3125	31.750 1.250	1.52 0.06	HJ-283720	IR-222820 IR-232820 IR-253820	61.8 13900	106 23900	6400	9900	0.222 0.49
1 7/8	47.625 1.8750	61.913 2.4375	31.750 1.250	1.52 0.06	HJ-303920	IR-253020	65.4 14700	117 26300	6000	9200	0.236 0.52
2	50.800 2.0000	65.088 2.5625	25.400 1.000	1.52 0.06	HJ-324116	IR-273216	53.8 12100	93.0 20900	5600	8600	0.200 0.44
	50.800 2.0000	65.088 2.5625	31.750 1.250	1.52 0.06	HJ-324120	IR-243220 IR-253220 IR-263220 IR-273220	66.7 15000	122 27500	5600	8600	0.249 0.55
2 1/4	57.150 2.2500	76.200 3.0000	38.100 1.500	1.52 0.06	HJ-364824	IR-283624	89.9 20200	164 36900	5000	7600	0.458 1.01
	57.150 2.2500	76.200 3.0000	44.450 1.750	1.52 0.06	HJ-364828	IR-283628	104 23400	198 44500	5000	7600	0.531 1.17
2 1/2	63.500 2.5000	82.550 3.2500	38.100 1.500	2.03 0.08	HJ-405224	IR-314024 IR-324024	97.0 21800	187 42100	4400	6800	0.499 1.10
	63.500 2.5000	82.550 3.2500	44.450 1.750	2.03 0.08	HJ-405228	IR-314028 IR-324028	97.0 25200	187 50800	4400	6800	0.499 1.29
2 3/4	69.850 2.7500	88.900 3.5000	25.400 1.000	2.03 0.08	HJ-445616	—	67.2 15100	120 27000	4000	6200	0.363 0.80
	69.850 2.7500	88.900 3.5000	38.100 1.500	2.03 0.08	HJ-445624	IR-364424	101 22700	203 45700	4000	6200	0.544 1.20
3	69.850 2.7500	88.900 3.5000	44.450 1.750	2.03 0.08	HJ-445628	IR-354428 IR-364428	117 26300	245 55100	4000	6200	0.635 1.40
	76.200 3.0000	95.250 3.7500	38.100 1.500	2.03 0.08	HJ-486024	IR-404824	107 24100	226 50900	3700	5600	0.585 1.29
3 1/4	76.200 3.0000	95.250 3.7500	44.450 1.750	2.03 0.08	HJ-486028	IR-384828 IR-404828	124 27900	273 61400	3700	5600	0.685 1.51
	82.550 3.2500	107.950 4.2500	44.450 1.750	2.03 0.08	HJ-526828	IR-445228	162 36400	305 68600	3400	5300	1.016 2.24
3 1/2	82.550 3.2500	107.950 4.2500	50.800 2.000	2.03 0.08	HJ-526832	IR-445232	184 41300	358 80500	3400	5300	1.161 2.56
	88.900 3.5000	114.300 4.5000	50.800 2.000	2.03 0.08	HJ-567232	IR-475632 IR-485632	187 42000	375 84300	3200	4900	1.238 2.73

⁽¹⁾ See pages B-4-54 to B-4-57 for inch series inner rings. Order inner rings separately.

⁽²⁾ $r_{a\max}$ is equal to the minimum bearing chamfer ($r_s \text{ min}$) at unmarked end.



Shaft surface to be 58 HRC or equivalent

S (ISO h6)	H (ISO H7)		Bearing Designation	S (ISO f6)	H (ISO N7)		D_a	Shoulder Dia. $\pm.38 \pm.015$	Shaft Dia.
	Mounting Dimension Clearance Fit				Mounting Dimension Tight Transition Fit				
	Max.	Min.			Max.	Min.			
44.450 1.7500	44.435 1.7494	58.768 2.3137	58.738 2.3125	HJ-283720	44.425 1.7490	44.409 1.7484	58.730 2.3122	58.699 2.3110	53.98 2.125
47.625 1.8750	47.610 1.8744	61.943 2.4387	61.913 2.4375	HJ-303920	47.600 1.8740	47.584 1.8734	61.905 2.4372	61.874 2.4360	57.15 2.250
50.800 2.0000	50.782 1.9993	65.118 2.5637	65.088 2.5625	HJ-324116	50.770 1.9988	50.752 1.9981	65.080 2.5622	65.049 2.5610	60.33 2.375
50.800 2.0000	50.782 1.9993	65.118 2.5637	65.088 2.5625	HJ-324120	50.770 1.9988	50.752 1.9981	65.080 2.5622	65.049 2.5610	60.33 2.375
57.150 2.2500	57.132 2.2493	76.230 3.0012	76.200 3.0000	HJ-364824	57.120 2.2488	57.102 2.2481	76.192 2.9997	76.162 2.9985	68.28 2.688
57.150 2.2500	57.132 2.2493	76.230 3.0012	76.200 3.0000	HJ-364828	57.120 2.2488	57.102 2.2481	76.192 2.9997	76.162 2.9985	68.28 2.688
63.500 2.5000	63.482 2.4993	82.586 3.2514	82.550 3.2500	HJ-405224	63.470 2.4988	63.452 2.4981	82.537 3.2495	82.502 3.2481	74.63 2.938
63.500 2.5000	63.482 2.4993	82.586 3.2514	82.550 3.2500	HJ-405228	63.470 2.4988	63.452 2.4981	82.537 3.2495	82.502 3.2481	74.63 2.938
69.850 2.7500	69.832 2.7493	88.936 3.5014	88.900 3.5000	HJ-445616	69.820 2.7488	69.802 2.7481	88.887 3.4995	88.852 3.4981	80.98 3.188
69.850 2.7500	69.832 2.7493	88.936 3.5014	88.900 3.5000	HJ-445624	69.820 2.7488	69.802 2.7481	88.887 3.4995	88.852 3.4981	80.98 3.188
69.850 2.7500	69.832 2.7493	88.936 3.5014	88.900 3.5000	HJ-445628	69.820 2.7488	69.802 2.7481	88.887 3.4995	88.852 3.4981	80.98 3.188
76.200 3.0000	76.182 2.9993	95.286 3.7514	95.250 3.7500	HJ-486024	76.170 2.9988	76.152 2.9981	95.237 3.7495	95.202 3.7481	87.33 3.438
76.200 3.0000	76.182 2.9993	95.286 3.7514	95.250 3.7500	HJ-486028	76.170 2.9988	76.152 2.9981	95.237 3.7495	95.202 3.7481	87.33 3.438
82.550 3.2500	82.527 3.2491	107.986 4.2514	107.950 4.2500	HJ-526828	82.514 3.2486	82.492 3.2477	107.937 4.2495	107.902 4.2481	98.43 3.875
82.550 3.2500	82.527 3.2491	107.986 4.2514	107.950 4.2500	HJ-526832	82.514 3.2486	82.492 3.2477	107.937 4.2495	107.902 4.2481	98.43 3.875
88.900 3.5000	88.877 3.4991	114.336 4.5014	114.300 4.5000	HJ-567232	88.864 3.4986	88.842 3.4977	114.287 4.4995	114.252 4.4981	104.78 4.125



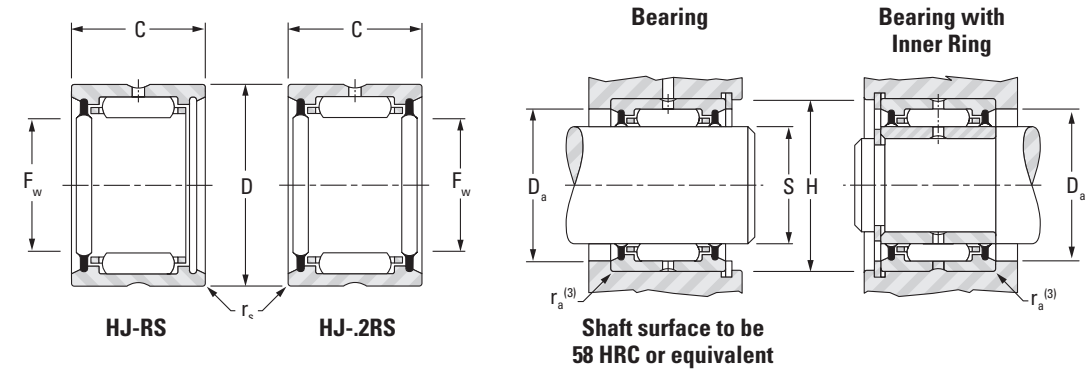
**SEALED HEAVY-DUTY
NEEDLE ROLLER BEARINGS**

INCH SERIES

- Bearing diameters and widths listed are nominal.
- For inspection purposes, see tolerance tables on page B-4-46.
- Available with one or two lip-contact seals designed to retain lubricant and exclude foreign material.
- Single seals are normally installed in the stamped end of bearing.
- Seals limit the bearing operating temperature between -30° C and +110° C (-25° F and +225° F).
- For operating temperature outside of the above range or if seals are exposed to unusual fluids, please consult your representative.

Shaft Dia.	F _w	D	C (B)	r _{s min}	Bearing Designation		Used With Inner Ring ⁽¹⁾	Load Ratings		Speed Rating ⁽²⁾
								Dynamic	Static	
								C	C ₀	
in	mm in	mm in	mm in	mm in	One Seal	Two Seals		kN lbf	min ⁻¹	
5/8	15.875 0.6250	28.575 1.1250	25.40 1.000	0.64 0.03	HJ-101816RS	HJ-101816.2RS	—	19.3 4350	20.7 4650	12000
3/4	19.050 0.7500	31.750 1.2500	25.40 1.000	1.02 0.04	HJ-122016RS	HJ-122016.2RS	IR-081216	20.7 4650	23.3 5240	10000
7/8	22.225 0.8750	34.925 1.3750	25.40 1.000	1.02 0.04	HJ-142216RS	HJ-142216.2RS	IR-101416	23.0 5180	27.9 6270	8700
1	25.400 1.0000	38.100 1.5000	25.40 1.000	1.02 0.04	HJ-162416RS	HJ-162416.2RS	IR-121616 IR-131616	25.3 5680	32.5 7300	7600
1 1/8	28.575 1.1250	41.275 1.6250	31.75 1.250	1.02 0.04	HJ-182620RS	HJ-182620.2RS	IR-141820	36.3 8170	53.8 12100	6800
1 1/4	31.750 1.2500	44.450 1.7500	31.75 1.250	1.02 0.04	HJ-202820RS	HJ-202820.2RS	IR-162020	37.4 8410	57.4 12900	6100
1 3/8	34.925 1.3750	47.625 1.8750	31.75 1.250	1.02 0.04	HJ-223020RS	HJ-223020.2RS	IR-182220	39.8 8950	64.1 14400	5600
1 1/2	38.100 1.5000	52.388 2.0625	31.75 1.250	1.52 0.06	HJ-243320RS	HJ-243320.2RS	IR-192420	47.6 10700	72.5 16300	5100
1 5/8	41.275 1.6250	55.563 2.1875	31.75 1.250	1.52 0.06	HJ-263520RS	HJ-263520.2RS	IR-212620	48.5 10900	76.5 17200	2400
1 3/4	44.450 1.7500	58.738 2.3125	31.75 1.250	1.52 0.06	HJ-283720RS	HJ-283720.2RS	IR-222820 IR-232820 IR-242820	49.8 11200	81.0 18200	4400
2	50.800 2.0000	65.088 2.5625	31.75 1.250	1.52 0.06	HJ-324120RS	HJ-324120.2RS	IR-243220 IR-253220 IR-263220 IR-273220	53.8 12100	93.0 20900	3800
2 1/4	57.150 2.2500	76.200 3.0000	44.45 1.750	1.52 0.06	HJ-364828RS	HJ-364828.2RS	IR-283628	89.9 20200	164.1 36900	1700
2 1/2	63.500 2.5000	82.550 3.2500	44.45 1.750	2.03 0.08	HJ-405228RS	HJ-405228.2RS	IR-314028 IR-324028	97.0 21800	187.3 42100	3100
2 3/4	69.850 2.7500	88.900 3.5000	44.45 1.750	2.03 0.08	HJ-445628RS	HJ-445628.2RS	IR-354428 IR-364428	101.0 22700	203.3 45700	1400
3	76.200 3.0000	95.250 3.7500	44.45 1.750	2.03 0.08	HJ-486028RS	HJ-486028.2RS	IR-384828 IR-404828	107.2 24100	226.4 50900	2500

⁽¹⁾ See pages B-4-54 to B-4-57 for inch series inner rings. Order inner rings separately.
⁽²⁾ Based on standard seal shaft contact speed of 5 m/sec., 1000 ft./min.
⁽³⁾ r_{a max} is equal to the minimum bearing chamfer (r_{s min}) at unmarked end.



Approx. Wt.	S (ISO h6)		H (ISO H7)		Bearing Designation	S (ISO f6)		H (ISO N7)		D _a	Shaft Dia.
	Mounting Dimension Clearance Fit					Mounting Dimension Tight Transition Fit					
	Max.	Min.	Max.	Min.		Max.	Min.	Max.	Min.		
	mm in	mm in	mm in	mm in		mm in	mm in	mm in	mm in	mm in	mm in
0.07 0.15	15.875 0.6250	15.865 0.6246	28.595 1.1258	28.575 1.1250	HJ-101816-	15.860 0.6244	15.850 0.6240	28.567 1.1247	28.547 1.1239	23.83 0.938	5/8
0.08 0.17	19.050 0.7500	19.037 0.7495	31.775 1.2510	31.750 1.2500	HJ-122016-	19.030 0.7492	19.017 0.7487	31.742 1.2497	31.717 1.2487	26.97 1.062	3/4
0.09 0.19	22.225 0.8750	22.212 0.8745	34.950 1.3760	34.925 1.3750	HJ-142216-	22.205 0.8742	22.192 0.8737	34.917 1.3747	34.892 1.3737	30.18 1.188	7/8
0.10 0.21	25.400 1.0000	25.387 0.9995	38.125 1.5010	38.100 1.5000	HJ-162416-	25.380 0.9992	25.367 0.9987	38.092 1.4997	38.067 1.4987	33.32 1.312	1
0.13 0.29	28.575 1.1250	28.562 1.1245	41.300 1.6260	41.275 1.6250	HJ-182620-	28.555 1.1242	28.542 1.1237	41.267 1.6247	41.242 1.6237	36.53 1.438	1 1/8
0.15 0.32	31.750 1.2500	31.735 1.2494	44.475 1.7510	44.450 1.7500	HJ-202820-	31.725 1.2490	31.709 1.2484	44.442 1.7497	44.417 1.7487	39.67 1.562	1 1/4
0.16 0.35	34.925 1.3750	34.910 1.3744	47.650 1.8760	47.625 1.8750	HJ-223020-	34.900 1.3740	34.884 1.3734	47.617 1.8747	47.592 1.8737	42.88 1.688	1 3/8
0.20 0.43	38.100 1.5000	38.085 1.4994	52.418 2.0637	52.388 2.0625	HJ-243320-	38.075 1.4990	38.059 1.4984	52.380 2.0622	52.349 2.0610	47.63 1.875	1 1/2
0.21 0.46	41.275 1.6250	41.260 1.6244	55.593 2.1887	55.563 2.1875	HJ-263520-	41.250 1.6240	41.234 1.6234	55.555 2.1872	55.524 2.1860	50.80 2.000	1 5/8
0.22 0.49	44.450 1.7500	44.435 1.7494	58.768 2.3137	58.738 2.3125	HJ-283720-	44.425 1.7490	44.409 1.7484	58.730 2.3122	58.699 2.3110	53.98 2.125	1 3/4
0.25 0.55	50.800 2.0000	50.782 1.9993	65.118 2.5637	65.088 2.5625	HJ-324120-	50.770 1.9988	50.752 1.9981	65.080 2.5622	65.049 2.5610	60.33 2.375	2
0.53 1.17	57.150 2.2500	57.132 2.2493	76.230 3.0012	76.200 3.0000	HJ-364828-	57.120 2.2488	57.102 2.2481	76.192 2.9997	76.162 2.9985	68.28 2.688	2 1/4
0.59 1.29	63.500 2.5000	63.482 2.4993	82.586 3.2514	82.550 3.2500	HJ-405228-	63.470 2.4988	63.452 2.4981	82.537 3.2495	82.502 3.2481	74.63 2.938	2 1/2
0.64 1.40	69.850 2.7500	69.832 2.7493	88.936 3.5014	88.900 3.5000	HJ-445628-	69.820 2.7488	69.802 2.7481	88.887 3.4995	88.852 3.4981	80.98 3.188	2 3/4
0.68 1.51	76.200 3.0000	76.182 2.9993	95.286 3.7514	95.250 3.7500	HJ-486028-	76.170 2.9988	76.152 2.9981	95.237 3.7495	95.202 3.7481	87.33 3.438	3



INNER RINGS

INCH SERIES

- Check for availability.
Ideal choice when shaft is not practical to use as inner raceway.
Provided in inch nominal dimensions for use with inch series heavy-duty needle roller bearings.
Designed to meet established inch tolerances.
Selected size should be wider than matching needle roller bearing.

- Maximum shaft fillet radius (r_s max) cannot exceed inner ring bore chamfer (r_s min) as shown.
Optional centralized lubrication groove (bore) or through-hole available. Specify when ordering.
Designed to be axially clamped against shoulder for loose transition fit on shaft.
After mounting, for tight transition fit (keeping inner ring from rotating relative to shaft), inner ring O.D. must not exceed raceway diameter on matching bearing. (See mounting

Table with columns: Shaft Dia., d, F, B, r_s min, Bearing Designation, Approx. Wt., S (Loose Transition Fit, Interference Fit), and Used With Bearing Designation. Rows include various inch sizes from 3/8 to 1 1/4.

(1) r_a max is equal to the minimum bearing chamfer (r_s min).

dimensions in the bearing table for the required raceway diameter.)

- After mounting, if O.D. of inner ring exceeds the required raceway diameter for matching bearing, ring should be ground to proper diameter while mounted on shaft.
Meets ASTM F-2431.

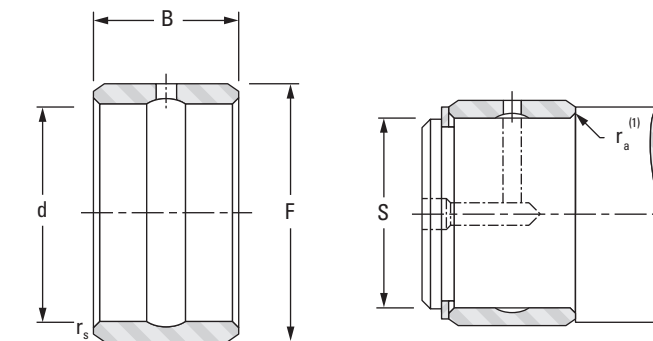


Table with columns: Shaft Dia., d, F, B, r_s min, Bearing Designation, Approx. Wt., S (Loose Transition Fit, Interference Fit), and Used With Bearing Designation. Rows include various inch sizes from 1 1/4 to 1 15/16.

Continued on next page.



INNER RINGS

INCH SERIES

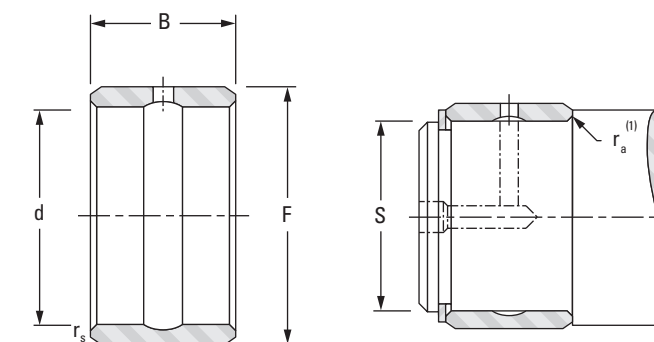
- Check for availability.
- Ideal choice when shaft is not practical to use as inner raceway.
- Provided in inch nominal dimensions for use with inch series heavy-duty needle roller bearings.
- Designed to meet established inch tolerances.
- Selected size should be wider than matching needle roller bearing.

- Maximum shaft fillet radius ($r_{a \max}$) cannot exceed inner ring bore chamfer ($r_{s \min}$) as shown.
- Optional centralized lubrication groove (bore) or through-hole available. Specify when ordering.
- Designed to be axially clamped against shoulder for loose transition fit on shaft.
- After mounting, for tight transition fit (keeping inner ring from rotating relative to shaft), inner ring O.D. must not exceed raceway diameter on matching bearing. (See mounting

Shaft Dia.	d	F	B	$r_{s \min}$	Bearing Designation	Approx. Wt.	S		S		Used With Bearing Designation
							Loose Transition Fit		Interference Fit		
							Max.	Min.	Max.	Min.	
in	mm in	mm in	mm in	mm in		kg lbs	mm in	mm in	mm in	mm in	
2	50.800 2.0000	63.500 2.5000	38.10 1.500	2.03 0.08	IR-324024	0.322 0.710	50.790 1.9996	50.772 1.9989	50.823 2.0009	50.810 2.0004	HJ-405224
	50.800 2.0000	63.500 2.5000	44.45 1.750	2.03 0.08	IR-324028	0.376 0.830	50.790 1.9996	50.772 1.9989	50.823 2.0009	50.810 2.0004	HJ-405228
2 3/16	55.563 2.1875	69.850 2.7500	44.45 1.750	2.03 0.08	IR-354428	0.467 1.030	55.552 2.1871	55.535 2.1864	55.585 2.1884	55.573 2.1879	HJ-445628
2 1/4	57.150 2.2500	69.850 2.7500	38.10 1.500	2.03 0.08	IR-364424	0.358 0.790	57.140 2.2496	57.122 2.2489	57.173 2.2509	57.160 2.2504	HJ-445624
	57.150 2.2500	69.850 2.7500	44.45 1.750	2.03 0.08	IR-364428	0.417 0.920	57.140 2.2496	57.122 2.2489	57.173 2.2509	57.160 2.2504	HJ-445628
2 3/8	60.325 2.3750	76.200 3.0000	44.45 1.750	2.03 0.08	IR-384828	0.562 1.240	60.315 2.3746	60.297 2.3739	60.348 2.3759	60.335 2.3754	HJ-486028
2 1/2	63.500 2.5000	76.200 3.0000	38.10 1.500	2.03 0.08	IR-404824	0.395 0.870	63.490 2.4996	63.472 2.4989	63.523 2.5009	63.510 2.5004	HJ-486024
	63.500 2.5000	76.200 3.0000	44.45 1.750	2.03 0.08	IR-404828	0.463 1.020	63.490 2.4996	63.472 2.4989	63.523 2.5009	63.510 2.5004	HJ-486028
2 3/4	69.850 2.7500	82.550 3.2500	44.45 1.750	2.03 0.08	IR-445228	0.503 1.110	69.840 2.7496	69.822 2.7489	69.873 2.7509	69.860 2.7504	HJ-526828
	69.850 2.7500	82.550 3.2500	50.80 2.000	2.03 0.08	IR-445232	0.576 1.270	69.840 2.7496	69.822 2.7489	69.873 2.7509	69.860 2.7504	HJ-526832
2 15/16	74.613 2.9375	88.900 3.5000	50.80 2.000	2.03 0.08	IR-475632	0.694 1.530	74.602 2.9371	74.585 2.9364	74.635 2.9384	74.623 2.9379	HJ-567232
3	76.200 3.0000	88.900 3.5000	50.80 2.000	2.03 0.08	IR-485632	0.621 1.370	76.190 2.9996	76.172 2.9989	76.223 3.0009	76.210 3.0004	HJ-567232

⁽¹⁾ $r_a \max$ is equal to the minimum bearing chamfer ($r_s \min$).

- dimensions in the bearing table for the required raceway diameter).
- After mounting, if O.D. of inner ring exceeds the required raceway diameter for matching bearing, ring should be ground to proper diameter while mounted on shaft.
- Meets ASTM F-2431.





NOTES

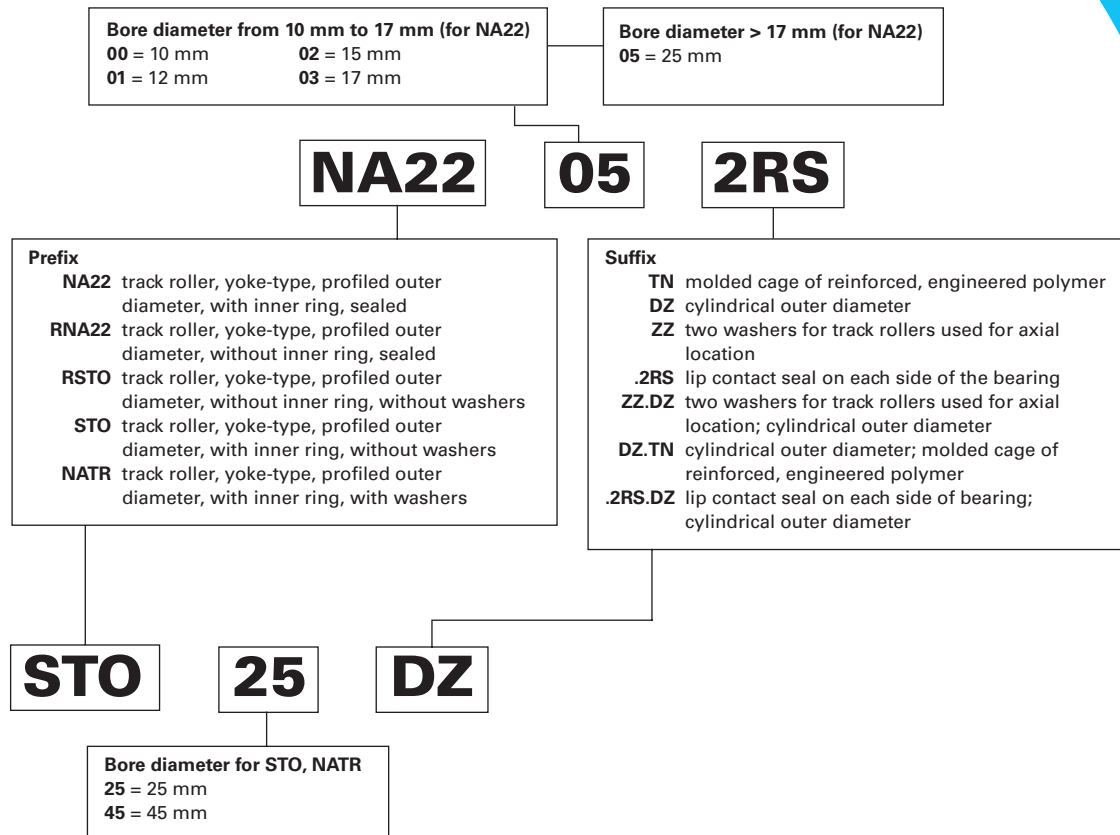
TRACK ROLLERS

Overview: Track rollers (also known as cam followers) are characterized by their thick-walled outer rings that run directly on a track. The thick outer rings permit high load-carrying capability while minimizing both distortion and bending stresses. Sealed designs with internal thrust washers help extend service life under conditions of infrequent lubrication.

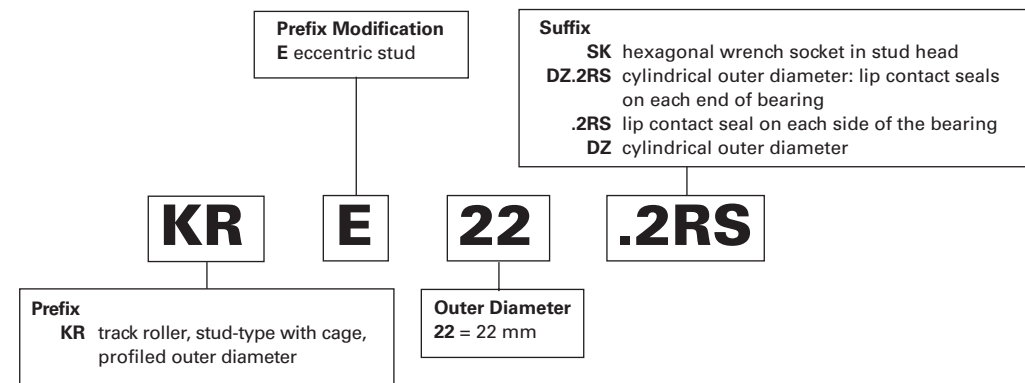
- **Catalogue range:** Stud-Type: 10 mm – 130 mm (0.3937 in – 5.1180 in) O.D.
Yoke-Type: 10 mm – 300 mm (0.3937 in – 11.816 in) O.D.
- **Markets:** Ram support rollers, material handling and indexing equipment.
- **Features:** Available in two basic designs: with an inner ring for straddle mounting in a yoke or with an integral stud for cantilever mounting.
- **Benefits:** High load-carrying capability with minimized distortion and bending stresses. Extended service life under conditions of infrequent re-lubrication.



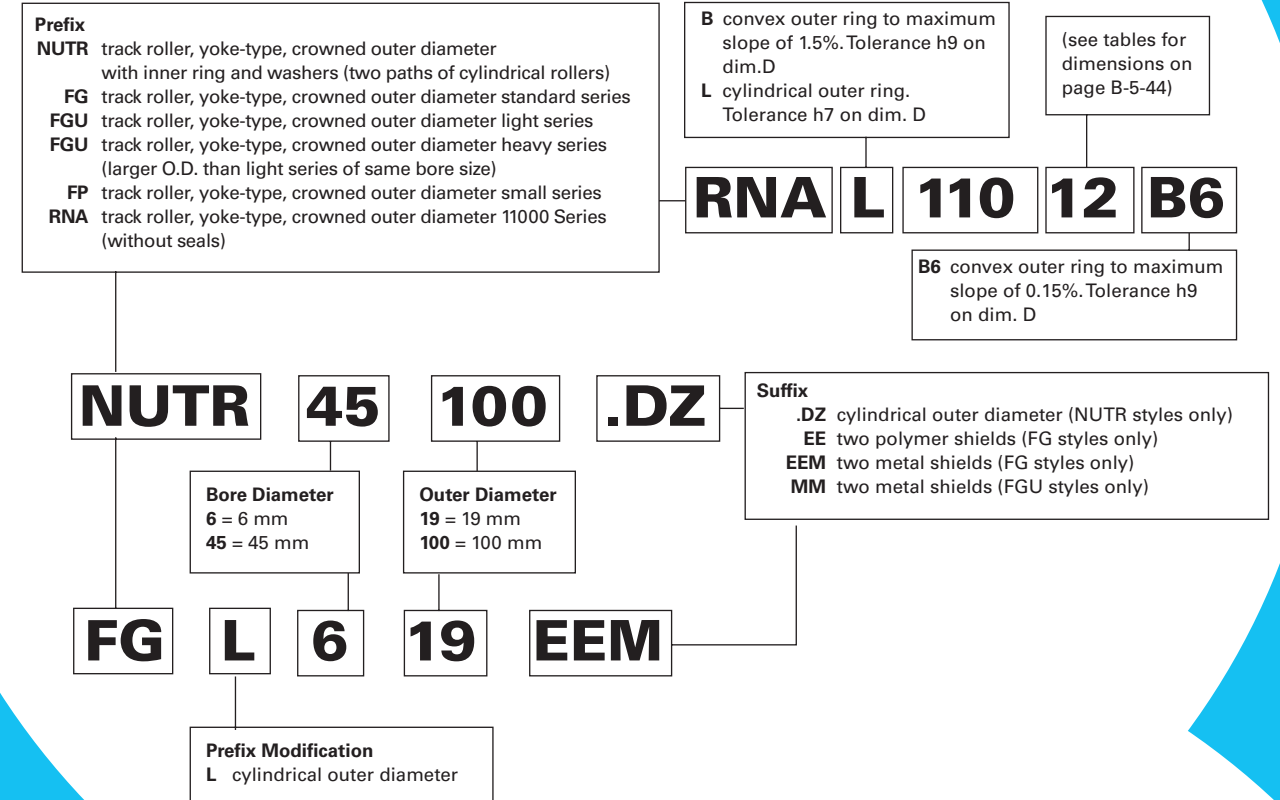
Caged Yoke-Type Track Rollers – Metric Nominal Dimensions



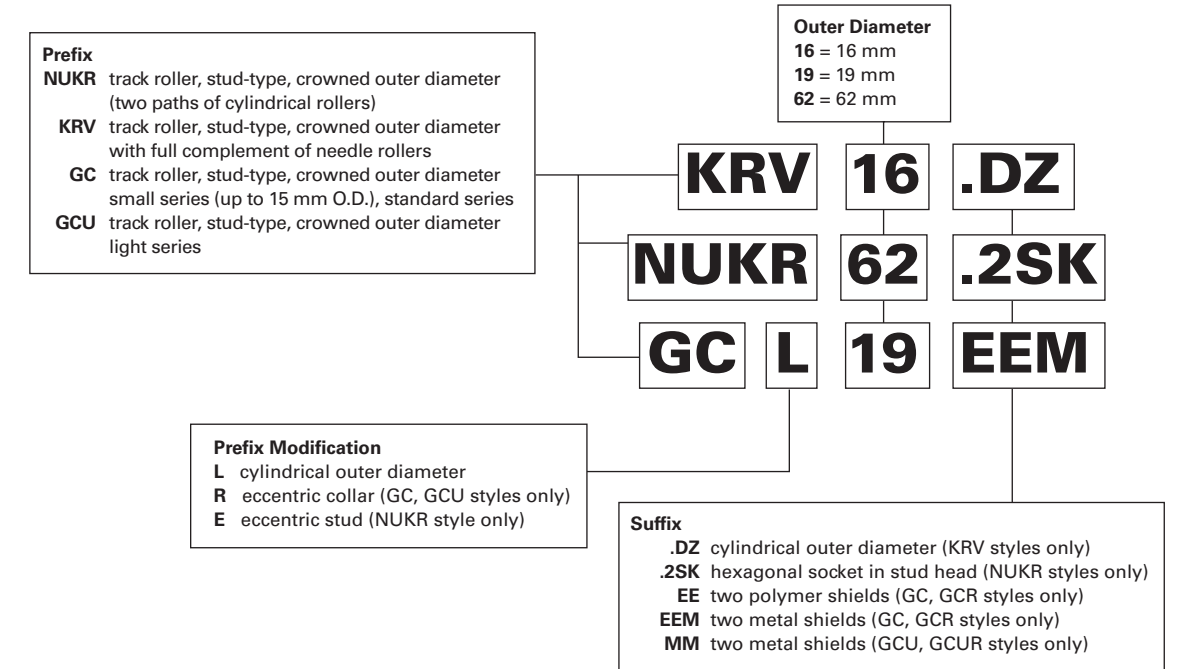
Caged Stud-Type Track Rollers – Metric Nominal Dimensions



Full Complement Yoke-Type Track Rollers – Metric Nominal Dimensions



Full Complement Stud-Type Track Rollers – Metric Nominal Dimensions



Track Roller

STUD-TYPE AND YOKE-TYPE TRACK ROLLERS METRIC SERIES

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STUD-TYPE AND YOKE-TYPE TRACK ROLLERS

METRIC SERIES

JTEKT track rollers listed in this catalog have been designed with outer rings of a large radial cross section to withstand heavy rolling and shock loads on track-type or cam-controlled equipment. The outer diameters of the outer rings are either crowned or cylindrical. Crowned track rollers are designed to alleviate uneven bearing loading resulting from deflection, bending or misalignment in mounting.

Stud-type track rollers are available in various open designs, as well as with lip contact seals or metal shields.

Yoke-type track rollers are designed for straddle mounting. The various metric series designs are grouped and organized on page B-5-7 and page B-5-8.

REFERENCE STANDARDS ARE:

- ISO 6278 – needle roller bearings – track rollers – boundary dimensions.
- ISO 492 – radial bearings – tolerances.
- DIN 620 – tolerances of ball and roller bearings.
- ISO 281 – rolling bearings – dynamic load ratings and rating life.

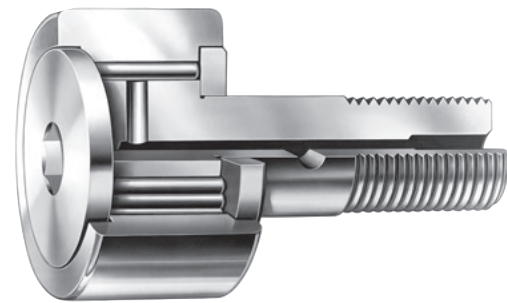


Fig. B5-1. Stud-type track rollers



Fig. B5-2. Yoke-type track rollers

Suffixes – Stud-Type, Metric Series (except GC types)

.2RS	two seals
DZ	cylindrical outer diameter
DZ.2RS	cylindrical outer diameter • two seals
SK	hexagonal socket in flange end
2SK	hexagonal socket in both flange and stud ends

Suffixes – Yoke-Type, Metric Series (except FP or FG types)

DZ.TN	cylindrical outer diameter • molded cage of reinforced engineered polymer
TN	molded cage of reinforced engineered polymer
DZ	cylindrical outer diameter
ZZ	two end washers for the outer ring
ZZ.DZ	two end washers for the outer ring • cylindrical outer diameter
.2RS	two seals
.2RS.DZ	two seals • cylindrical outer diameter

Suffixes – Yoke-Type (FP, FG) and Stud-Type (GC)

EE	polymer shields
EEM	metal shields
MM	metal shields

STUD-TYPE METRIC SERIES TRACK ROLLER TYPES

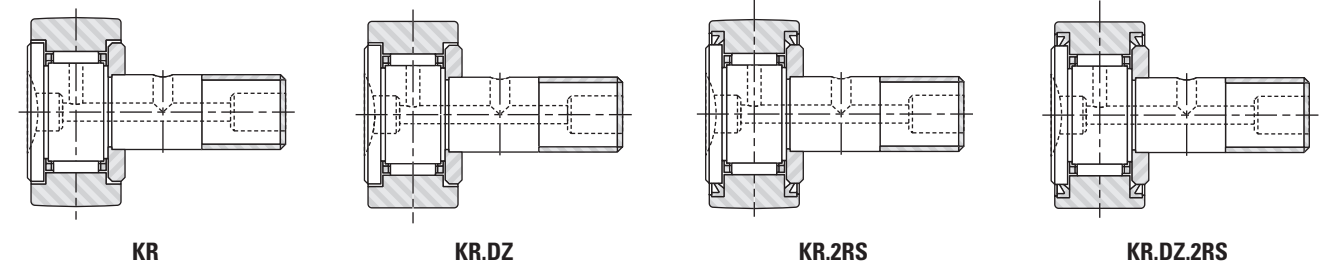


Fig. B5-3. Stud-type track rollers, caged needle rollers

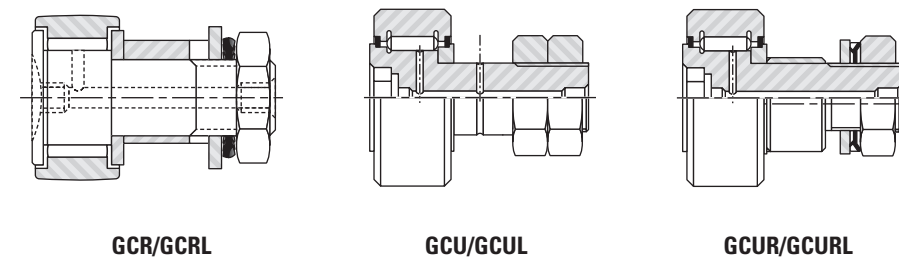
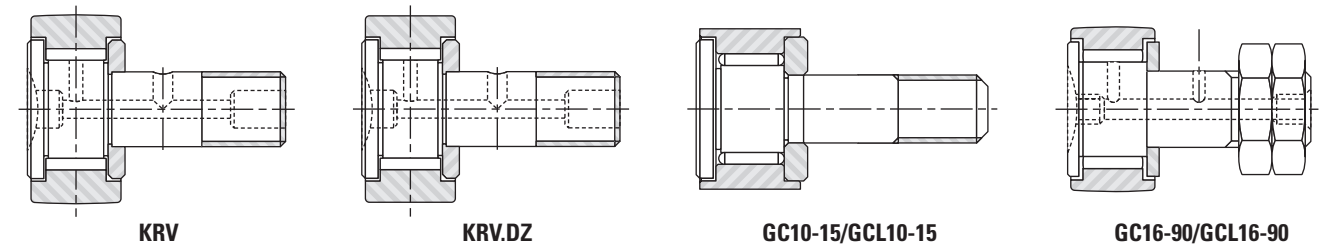


Fig. B5-4. Stud-type track rollers, full complement needle rollers

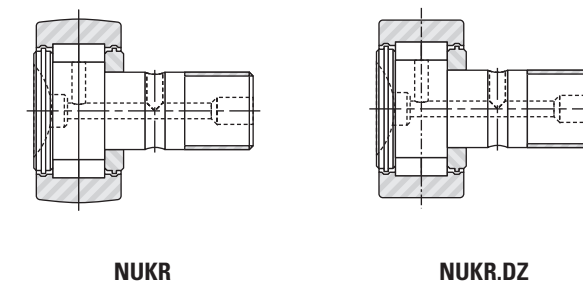


Fig. B5-5. Stud-type track rollers, full complement cylindrical rollers

TYPES OF METRIC SERIES YOKE-TYPE TRACK ROLLERS

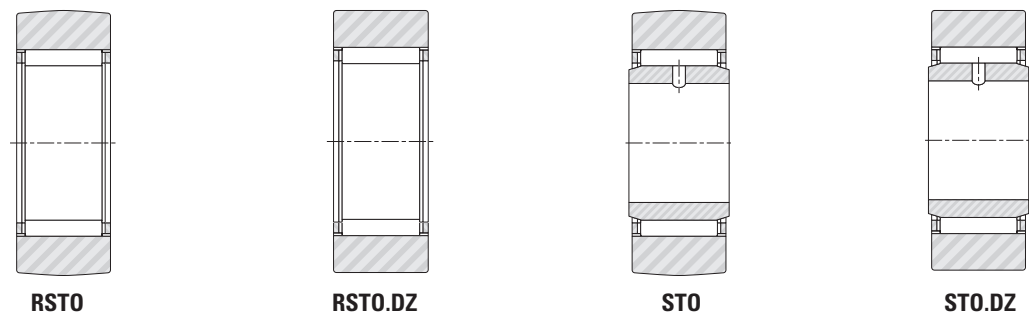


Fig. B5-6. Yoke-type track rollers without end washers

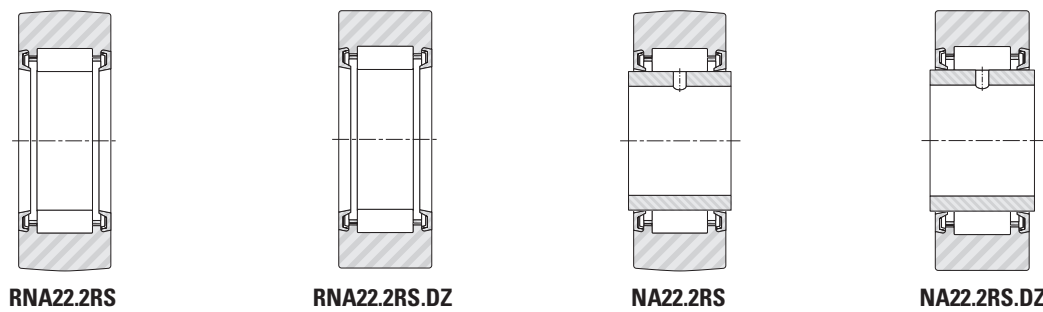


Fig. B5-7. Sealed yoke-type track rollers without end washers

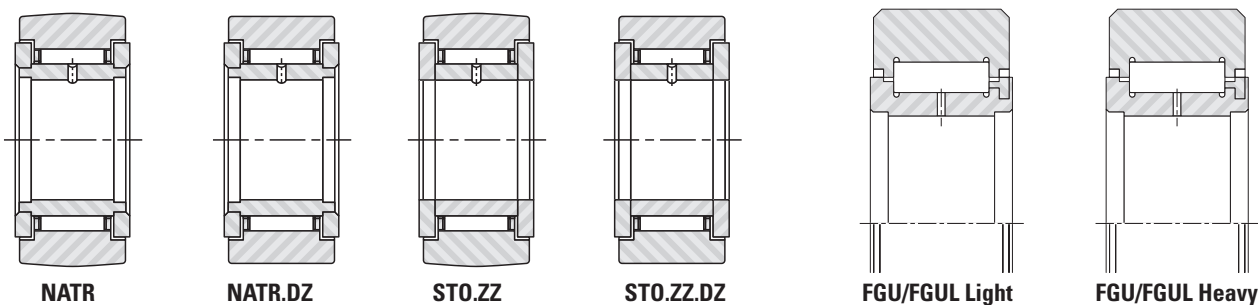


Fig. B5-8. Yoke-type track rollers with end washers

Fig. B5-9. Yoke-type track rollers with metal seals, full complement of cylindrical rollers

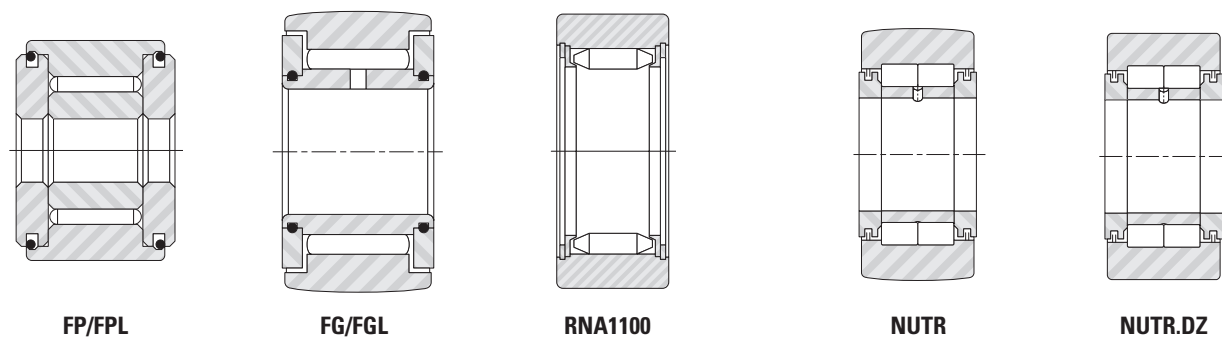


Fig. B5-10. Yoke-type track rollers with end washers, full complement of needle rollers

Fig. B5-11. Yoke-type track rollers with end washers, full complement of cylindrical rollers

CONSTRUCTION

STUD-TYPE TRACK ROLLERS

The metric series stud-type track roller is a non-separable unit – consisting of a large radial cross section outer ring, radial needle roller and cage assembly, or a full complement of needle or cylindrical rollers, a stud and a retaining washer securely fastened to the stud.

The seals on the sealed stud-type track rollers are located in the counterbores of the outer ring and seal against the stud flange and the retaining washer, providing good retention of lubricant and exclusion of foreign material. The seals are thermally stable in a temperature range between -30° C and 110° C (-25° F and 225° F).

A screwdriver slot (standard) or a hexagonal wrench socket (customer requested) in the head of the stud facilitates mounting. Wrench sizes are listed on the dimensional tables where found among certain GC Series sizes, beginning on page B-5-24. Other metric series hexagonal socket sizes are listed in Table B5-1.

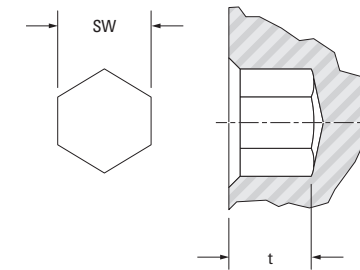


Fig. B5-12. Hexagonal socket – metric series.

Table B5-1. Hexagonal socket wrench sizes

Stud-type track roller O.D.		SW	t
>	≤	mm in	mm in
-	16.000 0.6299	3.000 0.1181	2.500 0.0984
19.000 0.7480	26.000 1.0236	4.000 0.1575	2.500 0.0984
30.000 1.1811	35.000 1.3779	6.000 0.2362	4.000 0.1575
40.000 1.5748	52.000 2.0472	8.000 0.3150	5.000 0.1968
62.000 2.4409	72.000 2.8346	12.000 0.4724	7.000 0.2756
80.000 3.1496	90.000 3.5433	17.000 0.6693	10.000 0.3937

ECCENTRIC STUDS FOR STUD-TYPE TRACK ROLLERS

To provide radial adjustment of the outer ring toward the track or cam surface at the time of installation, some metric series stud-type track rollers are available with eccentric studs – specified by adding the letter “E” to the designation letters: KRE and NUKRE. The GCR and GCUR Series include an eccentric bushing added to the track roller stud. Appropriate dimensions of the eccentric stud bushing are listed in Table B5-2 on page B-5-9 and Table B5-3 on page B-5-10.

Since a track roller with an eccentric stud is usually adjusted upon installation by turning the stud in the mounting hole, a close clearance fit between the outer diameter of the bushing and the mounting hole is necessary. For turning the stud, a hexagonal wrench is generally more convenient than a screwdriver. Thus, the option of a hexagonal wrench socket in the head of the stud should be exercised.

Some applications may require more secure positioning than provided by the tightened stud nut. If so, it is recommended that the mounting hole and the eccentric bushing be drilled at the time of installation to accept a locating dowel pin.

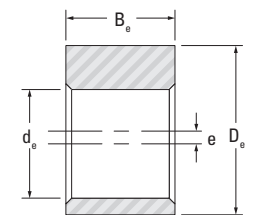


Fig. B5-13. Eccentric bushing dimensions – metric series (except GCR, GCUR series)

Table B5-2. Eccentric bushing dimensions – metric series (except GCR, GCUR series)

Stud-type track roller O.D.		d _e	D _e	B _e	e
>	≤	mm in	mm in	mm in	mm in
19.000 0.7480	19.000 0.7480	8.000 0.3150	11.000 0.4331	9.000 0.3543	0.500 0.0197
22.000 0.8661	26.000 1.10236	10.000 0.3937	13.000 0.5118	10.000 0.3937	0.500 0.0197
30.000 1.1811	32.000 1.2598	12.000 0.4724	15.000 0.5905	11.000 0.4331	0.500 0.0197
35.000 1.3779	35.000 1.3779	16.000 0.6299	20.000 0.7874	14.000 0.5512	1.000 0.0394
40.000 1.5748	40.000 1.5748	18.000 0.7087	22.000 0.8661	16.000 0.6299	1.000 0.0394
47.000 1.8504	52.000 2.0472	20.000 0.7874	24.000 0.9449	18.000 0.7087	1.000 0.0394
62.000 2.4409	72.000 2.8346	24.000 0.9449	28.000 1.1024	22.000 0.8661	1.000 0.0394
80.000 3.1496	90.000 3.5433	30.000 1.1811	35.000 1.3779	29.000 1.1417	1.500 0.0591



Table B5-3. Eccentric bushing dimensions metric series GCR and GCUR

Stud-type track roller O.D.		d _e	D _e	B _e	e
Over	Incl.	Eccentric bushing dimensions			
mm in	mm in	mm in	mm in	mm in	mm in
16.000 0.6299	16.000 0.6299	6.000 0.2362	9.000 0.3543	7.500 0.2953	0.500 0.0197
16.000 0.6299	19.000 0.7480	8.000 0.3149	11.000 0.4330	7.500 0.2953	0.500 0.0197
19.000 0.7480	28.000 1.1024	10.000 0.3937	14.000 0.5512	10.500 0.4134	1.000 0.0394
28.000 1.1024	32.000 1.2598	12.000 0.4724	16.000 0.6299	11.500 0.4528	1.000 0.0394
32.000 1.2598	35.000 1.3779	16.000 0.6299	21.000 0.8268	15.100 0.5945	1.500 0.0591
35.000 1.3779	40.000 1.5748	18.000 0.7087	24.000 0.9449	17.100 0.6732	1.500 0.0591
40.000 1.5748	52.000 2.0472	20.000 0.7874	27.000 1.0630	19.100 0.7520	2.000 0.0787
52.000 2.0472	72.000 2.8346	24.000 0.9449	36.000 1.4173	24.100 0.9488	3.000 0.1181
72.000 2.8346	90.000 3.5433	30.000 1.1811	42.000 1.6535	30.700 1.2087	3.000 0.1181
90.000 3.5433	110.000 4.3307	36.000 1.4173	48.000 1.8898	36.500 1.4370	3.000 0.1181
110.000 4.3307	- -	42.000 1.6535	54.000 2.1260	43.500 1.7126	3.000 0.1181

METRIC SERIES YOKE-TYPE TRACK ROLLERS WITHOUT END WASHERS

These yoke-type track rollers are available with a profiled or a cylindrical outer diameter of the outer ring, and with or without a separable inner ring. Since they are supplied without end washers, their outer rings must be guided by the adjacent end locating surfaces. Tolerance class F6 is the normal specification for the bore of the metric series radial needle roller and cage assemblies used with these yoke-type track rollers.

YOKE-TYPE TRACK ROLLERS – SERIES RSTO AND STO

Series STO have a separable inner ring and when the inner ring is removed they become series RSTO. They run directly on a hardened and ground inner raceway. Quality requirements for inner raceways are given in the engineering section of this catalog.

SEALED YOKE-TYPE TRACK ROLLERS WITHOUT END WASHERS – SERIES RNA 22.2RS AND NA22.2RS

These yoke-type track rollers have the same bore diameter and outer diameter as most of the other metric series yoke-type track rollers listed in this catalog. The thick section outer ring is made of one-piece channel-shaped bearing-quality steel – heat-treated to yield maximum load-carrying capability. The integral end flanges provide axial guidance for the large diameter needle rollers, and a cage supplies their inward retention. These track rollers have two integral lip contact seals designated by .2RS. The seals are

thermally stable in a temperature range between -30° C and 110° C (-25° F and 225° F). Care should be exercised when mounting track rollers without inner rings onto inner raceways, to avoid damage to the seals.

METRIC SERIES YOKE-TYPE TRACK ROLLERS WITH END WASHERS

These yoke-type track rollers are available with a crowned or a cylindrical outer diameter to the outer ring. Metric series yoke-type track rollers with end washers – depending on the internal construction – may be end guided, either through the end washers or between the end faces of the rollers and the inside faces of the outer ring flanges.

YOKE-TYPE TRACK ROLLERS – SERIES NATR AND STO.ZZ

The series NATR yoke-type track rollers are of non-separable design, consisting of a crowned or a cylindrical outer ring, caged needle rollers, an inner ring and two retaining end washers securely fastened to the inner ring. The series STO.ZZ yoke-type track rollers are of separable design with two loose end washers. These end washers, placed in the counter bores of the outer ring, form very effective labyrinth-type shields, providing good retention of lubricant and exclusion of foreign material. A lubrication hole in the inner ring enables re-lubrication when a cross-drilled bolt or shaft – which can be serviced from the end – is used.

YOKE-TYPE TRACK ROLLERS – SERIES NUTR

The series NUTR yoke-type track rollers are of non-separable design consisting of a crowned or cylindrical outer ring, two rows of full complements of cylindrical rollers, an inner ring, two retaining end washers and two shields. The outer ring is located axially through the cylindrical rollers.

A lubricating hole in the inner ring enables re-lubrication when a cross-drilled bolt or shaft, which can be serviced from the end, is used.

The smallest track roller of this series has an outer diameter of 35.000 mm (1.3780 in). NUTR yoke-type track rollers are well-suited to carry high loads and designs with a thicker outer ring and particularly suitable for high shock loads. Designs with thicker outer rings have a larger outer diameter which can be identified by the bearing designation (e.g., NUTR 1542).

YOKE-TYPE TRACK ROLLERS – SERIES FP AND FG

The FP and FG non-separable inner ring designs are available in crowned or cylindrical outer rings. Both employ a full complement of needle rollers and require re-lubrication via a pathway through the shaft. The FP Series is the smallest series available and is not offered with seals.

YOKE-TYPE TRACK ROLLERS – SERIES FGU (LIGHT AND HEAVY TYPES)

The FGU non-separable inner ring designs are available in crowned or cylindrical outer rings. All FGU series use a full complement of cylindrical rollers between the inner and outer rings and require re-lubrication via a pathway through the shaft. The FGU heavy series uses a thicker outer ring section and is capable of higher loads.

Both FGU series are only available with a metal shield for a roller sealing option.

YOKE-TYPE TRACK ROLLERS – SERIES RNA, RNAB, RNAL

The RNA and RNAB Series design uses a full complement of needle rollers retained with a pair of end washers. A separate, matching inner ring is listed in the tables of part numbers. The RNAL Series uses a cylindrical outer ring and is only offered in limited sizes.

DIMENSIONAL ACCURACY

The tolerances of the basic metric series caged roller and NUKR stud-type and yoke-type track rollers, whose outer rings have a cylindrical outer diameter, correspond to tolerances specified in ISO 492 Radial bearings tolerances. The outer ring tolerances given in Table B5-4 apply to the outer rings used in the caged roller and NUKR stud-type and caged roller and NUTR yoke-type, metric series, track rollers. Metric series track rollers with a crowned outer diameter are the exception – their outer diameter tolerance is 0-0.05 for all caged roller sizes and NUTR, NUKR types. The remaining types

have h9 tolerance on profiled outer diameters and h7 for straight diameters. Stud diameter and stud length tolerances are given in Table B5-5. The inner ring tolerances, given in Table B5-6 on page B-5-12, apply to inner rings used in metric series caged roller, NUKR Series yoke-type track rollers.

MOUNTING STUD-TYPE TRACK ROLLERS

When the stud shank of a metric series stud-type track roller is mounted in a hole of tolerance H7, the installation force should be applied only to the center portion of the flanged end of the stud – preferably with an arbor press. The surface of the hole in the machine element which supports the stud must not deform under the expected load. And the support should be sufficiently rigid to resist bending loads. Deformation and bending will cause uneven loading of the outer ring.

Table B5-5. Tolerances for stud diameter and stud length – metric series

d ₁		Δd _{1s}		B ₂		ΔB ₂	
Stud diameter		Stud length					
>	≤	Max.	Min.	Max.	Min.	Max.	Min.
mm		μm		mm			
3	6	0	-12	all lengths	0	-1	
6	10	0	-15				
10	18	0	-18				
18	30	0	-21				
30	50	0	-25				
50	80	0	-30				
80	100	0	-35				

Table B5-4. Outer ring – metric series (caged roller and NUKR, NUTR types)

D		Δ _{omp}				Δ _{cs}		K _{ea}
>	≤	Cylindrical		Crowned		Max.	Min.	Max.
		Max.	Min.	Max.	Min.			
mm in	mm in	mm in	mm in	mm in	mm in	mm in	mm in	mm in
10.000 0.3937	18.000 0.7087	0.000 0.0000	-0.008 -0.0003	0.000 0.0000	-0.050 -0.0020	0.000 0.0000	-0.120 -0.0047	0.015 0.0006
18.000 0.7087	30.000 1.1811	0.000 0.0000	-0.009 -0.00035	0.000 0.0000	-0.050 -0.0020	0.000 0.0000	-0.120 -0.0047	0.015 0.0006
30.000 1.1811	50.000 1.9685	0.000 0.0000	-0.011 -0.0004	0.000 0.0000	-0.050 -0.0020	0.000 0.0000	-0.120 -0.0047	0.020 0.0008
50.000 1.9685	80.000 3.1496	0.000 0.0000	-0.013 -0.0005	0.000 0.0000	-0.050 -0.0020	0.000 0.0000	-0.120 -0.0047	0.025 0.0010
80.000 3.1496	120.000 4.7244	0.000 0.0000	-0.015 -0.0006	0.000 0.0000	-0.050 -0.0020	0.000 0.0000	-0.120 -0.0047	0.035 0.0014
120.000 4.7244	150.000 5.9055	0.000 0.0000	-0.018 -0.0007	0.000 0.0000	-0.050 -0.0020	0.000 0.0000	-0.120 -0.0047	0.040 0.0016
150.000 5.9055	180.000 7.0866	0.000 0.0000	-0.025 -0.0010	0.000 0.0000	-0.050 -0.0020	0.000 0.0000	-0.150 -0.0059	0.045 0.0018
180.000 7.0866	240.000 9.4488	0.000 0.0000	-0.030 -0.0012	0.000 0.0000	-0.050 -0.0020	0.000 0.0000	-0.200 -0.0079	0.050 0.0020



Table B5-6. Inner ring – metric series (caged roller types)

d		Δ _{amp}		Δ _{bs}	
>	≤	Max.	Min.	Max.	Min.
mm in	mm in	mm in	mm in	mm in	mm in
2.500 0.0984	18.000 0.7087	0.000 0.0000	-0.008 -0.0003	0.000 0.0000	-0.180 -0.0071
18.000 0.7087	30.000 1.1811	0.000 0.0000	0.010 -0.0004	0.000 0.0000	-0.210 -0.0083
30.000 1.1811	50.000 1.9685	0.000 0.0000	-0.012 -0.0005	0.000 0.0000	-0.250 -0.0098
50.000 1.9685	80.000 3.1496	0.000 0.0000	-0.015 -0.0006	0.000 0.0000	-0.300 -0.0118
80.000 3.1496	120.000 4.7244	0.000 0.0000	-0.020 -0.0008	0.000 0.0000	-0.350 -0.0138

In mounting the stud-type track roller, the retaining washer must be firmly backed up by a flat shoulder which is square with the stud center line. The shoulder diameter must be no smaller than the minimum clamping diameter, d_a listed in the bearing tables.

The maximum inherent strength of the stud is obtained when the track roller is supported, as close as possible, to the retaining washer – which minimizes the bending moment. For this reason the edge of the housing – which supports the stud shank – should be kept as sharp as practical but free from burrs.

The clamping nut should not be tightened with a torque value higher than the maximum listed. A screwdriver slot, or hexagonal wrench socket in the flanged end of the stud, is provided for a tool to prevent the stud from turning when the nut is being tightened. Since the bottom of the screwdriver slot is not flat, it is helpful to put a radius on the tip of the screwdriver being used to hold the stud more securely. Hexagonal nuts are supplied with all metric series stud-type track rollers.

YOKE-TYPE TRACK ROLLERS

The machine element with the holes in which the mounting bolt or shaft is supported must be sufficiently rigid to resist local crushing under the applied load and to resist bending which can cause uneven loading of the needle rollers.

When applied loads are high, the h6 or j6 tolerance should be used in conjunction with a high strength shaft or bolt for mounting metric series yoke-type track rollers. When loads are moderate, a g6 tolerance may be used with a high strength shaft or bolt. For light loads, the loose transition fit with the f6 tolerance may be used with an unhardened shaft or bolt.

The yoke-type track rollers with inner rings – including those with end washers as well as inner rings – should be clamped endwise between parallel faces, perpendicular to the axis to prevent the retaining washers from coming off under load. The dimensions of machine parts, adjoining the metric series yoke-type track rollers, should be based on the minimum clamping diameter d_a to ensure that the washers are adequately supported. If the track roller cannot be end clamped, a close axial fit in the yoke is required. Care should be taken to assure that the lubricating hole is located in the unloaded zone of the raceway.

The metric series yoke-type track rollers without inner rings require a hardened and ground shaft, or bolt with a k5 tolerance. Inner raceway quality requirements are given in the engineering section.

**LOAD RATINGS
DYNAMIC LOADING AS A TRACK ROLLER**

When the outer ring of a stud-type or yoke-type track roller runs on a track, the contact – under a radial load – causes elastic (oval) deformation of the outer ring. As a result, a smaller zone of the raceway is loaded and the load is distributed on fewer needle rollers. This, in turn, affects the dynamic and static load ratings of the track rollers. Also, this deformation generates bending stress in the outer ring which must not exceed the maximum permitted for the material of the outer ring. The maximum permissible dynamic (F_{rperm}) radial load condition is determined by this requirement.

The rating life of stud-type or yoke-type track rollers should be calculated using the dynamic load ratings, C_w , shown in the following tables. The tables also show the maximum permissible radial load, F_{rperm} , that can be dynamically applied on stud-type or yoke-type track rollers. However, to calculate the L_{10} life of a track roller, the applied radial load must not be greater than $C_w/2$ based on ideal operating conditions of alignment, lubrication, temperature, speed and accelerations.

Example:

Given: A track roller application for a linear slide in which each roller supports a 453.59 kg (1000 lbs.) load and travels at 609.600 mm (24.0000 in) per second.

Select a track roller and calculate the L_{10} life in hours assuming continuous operation at the given speed. Assume conditions of alignment, lubrication and temperature are ideal.

Solution: Calculate the minimum C_w required.

The applied radial load must not be greater than $C_w/2$ based on ideal operating conditions.

Therefore, $Fr < C_w/2$ or $C_w > 907.18$ kN (2000 lbs.)

For a KRV30, $C_w = 1002.4$ kN (2210 lbs.)

To calculate the speed in min^{-1} , $V = \pi \cdot D \cdot n$

Where:

- V = linear velocity
- π = 3.14
- D = outside diameter of the track roller assembly

Therefore, 609.600 mm (24.000 in)/sec. = $3.14 \cdot 30.000$ mm $\cdot n$

Making appropriate substitutions and solving for n yields a value of approximately 388 min^{-1} .

The standard catalog life equation of a roller bearing is:

$L_{10} = (C/P)^{10/3} \cdot (16667/n)$

Where:

- L_{10} = calculated fatigue life in hours
- C = the dynamic radial load ratings based on 1000000 revolutions
- P = the dynamic equivalent radial load
- n = speed in min^{-1}

Substituting C_w for C and solving:

$L_{10} = (2210/1000)^{10/3} \cdot (16667/388) = 604$ hours

STATIC RATING AS A TRACK ROLLER

In addition to the basic static load rating, C_0 , the tables also list the maximum permissible static radial load, F_{0rperm} , that may be applied to a stud-type or yoke-type metric series track roller. The values of F_{0rperm} result in a calculated minimum static factor f_s of 0.7 for the worst condition of internal load distribution in metric series track roller operation. **The F_{0rperm} values must not be exceeded.** Exceeding F_{0rperm} may cause permanent damage to the track roller. A damaged track roller could cause the equipment in which the track roller is installed to malfunction. The static factor f_s can be calculated using the following formula:

$f_s \geq 0.7 \left(\frac{F_{0rperm}}{P_{0r}} \right)$

Where:

- F_{0rperm} = Maximum permissible static radial load
- P_{0r} = Equivalent static load (F_{0r} for yoke-type track rollers)
- F_{0r} = Static radial load
- f_s = Static factor whose values should not be smaller than those suggested in Table B5-7.

Table B5-7. Suggested values for static factors f_s for metric series track rollers

Requirements for yoke – type track rollers and stud – type track rollers	Suggested f_s values	
	Max.	Min.
High shock-type loads Quiet running	2.5	1.5
Normal loading Normal quietness of running	1.5	1
Minor impact loads and rotary motion particularly quiet running not required	1	0.7

LUBRICATION OF STUD-TYPE TRACK ROLLERS

JTEKT metric series stud-type track rollers are supplied with a lithium soap-based, general-purpose grease. When the caged KR Series track rollers are operated at low speeds, with light loads and in clean environments, there is often no need to re-lubricate the track roller. In other applications, periodic re-lubrication may be necessary to obtain optimum performance. The full complement series of track rollers have less internal volume available for grease storage. Therefore, they may require more frequent lubrication than caged-type track rollers. Stud-type track rollers – with a screwdriver slot in the flanged end of the stud – have provisions for re-lubrication through the flanged end of the stud. Metric series stud-type track rollers, with hexagonal sockets, can not be re-lubricated from the flanged end of the stud. Both types of metric series stud-type track rollers – with outer diameters larger than 22.000 mm (0.8661 in) (28.000 mm [1.1024 in] for all GC variations) – allow for re-lubrication through the threaded end of the stud. In addition, caged roller and NUKR Series stud-type track rollers – with 30.000 mm (1.8110 in) and larger outer diameters – allow for re-lubrication through a cross-drilled hole in the stud shank. The ends of the axial holes are counterbored to accept press-fit grease fittings of series VENN. The grease fittings are supplied with metric series stud-type track rollers. Hole diameters (d_4) for these grease fittings are listed in the tables of dimensions on pages later in this chapter as it applies. Note that the GC small series has no axial hole.

One or more plugs are supplied with every metric series stud-type track roller, to close off unused holes. At the flanged end, the plug must not be pushed in too deeply, as it may cover the cross-drilled lubricating hole. The plug should be pressed in using an installation tool whose dimensions are given in Table B5-9. If the cross-drilled hole in the stud shank is not used, it will be covered when the track roller is properly installed.

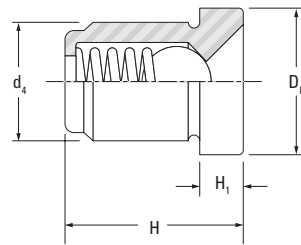


Fig. B5-14. Metric series grease fittings

Table B5-8. Metric series grease fittings, series VENN

Designation	d_4	D_k	H	H_1	Approx. wt.
	mm in	mm in	mm in	mm in	g lbs
VENN 4	4.000 0.1575	6.000 0.2362	6.000 0.2362	1.500 0.0591	0.4 0.0009
VENN 6	6.000 0.2362	8.000 0.3147	7.000 0.2756	2.000 0.0787	1.6 0.0035
VENN 8	8.000 0.3150	10.000 0.3937	12.000 0.4724	3.000 0.1181	4.7 0.0104

During installation of the track roller it is desirable to ensure that the cross-drilled hole is positioned in the unloaded zone of the track roller raceway. The location of the cross-drilled hole can be best recognized by its alignment with the manufacturer's stamp, parallel to the screwdriver slot (when applicable).

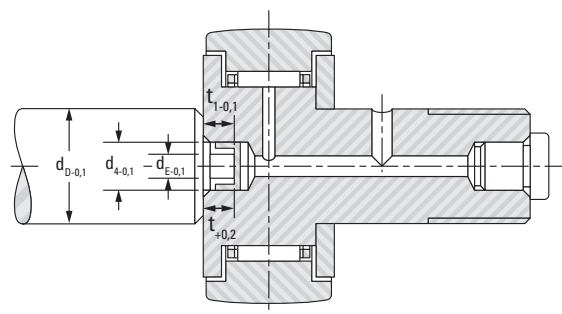


Fig. B5-15. Installation tool for metric series plug

Table B5-9. Installation tool for metric series plug

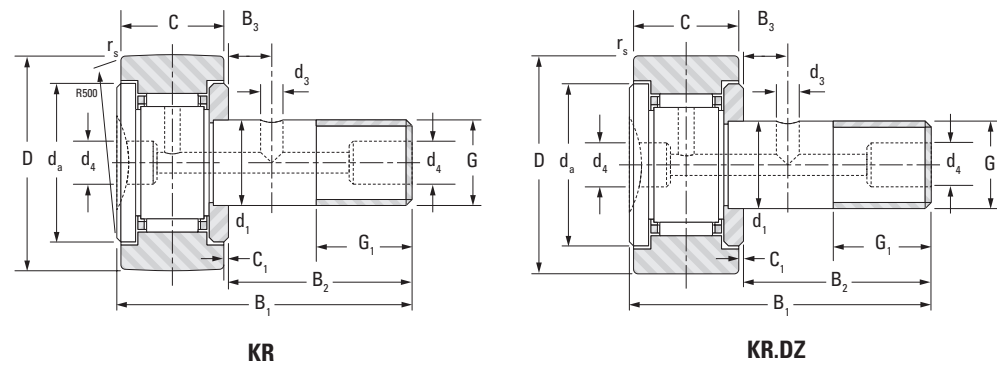
Stud-type track roller O.D.		d_4	d_D	d_E	t	t_1
>	≤	mm in	mm in	mm in	mm in	mm in
16.000 0.6299	26.000 1.0236	3.900 0.1535	10.000 0.3937	2.700 0.1063	3.700 0.1457	4.500 0.1772
30.000 1.1811	40.000 1.5748	5.900 0.2323	12.000 0.4724	4.700 0.1850	4.700 0.1850	7.000 0.2756
47.000 1.8504	90.000 3.5433	7.900 0.3110	15.000 0.5905	6.700 0.2638	6.700 0.2638	10.000 0.3937

LUBRICATION OF YOKE-TYPE TRACK ROLLERS

Yoke-type track rollers are produced with a lubricating hole in the inner ring so they can be re-lubricated through a cross-drilled hole in the supporting shaft or bolt. When mounting yoke-type track rollers, care should be taken that the lubrication hole is located in the unloaded raceway zone.

Oil is the preferred lubricant for yoke-type track rollers. Continuous oil lubrication, or frequent grease lubrication should be used for steady rotating conditions. Applications involving slow, intermittent oscillations are not as critical, and longer intervals between re-lubrication are permitted. Sealed yoke-type track rollers are normally supplied with an initial charge of a medium-temperature grease. Caged yoke-type track rollers have maximum grease storage capacity and, consequently, longer pregreased life than full complement types.

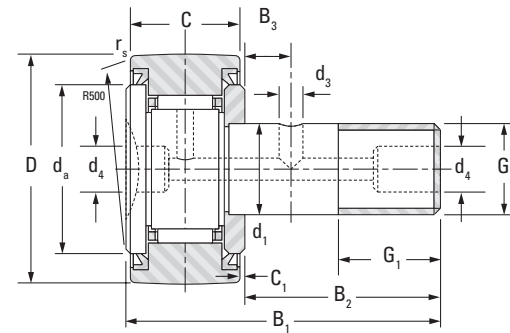
**NEEDLE ROLLER AND CAGE ASSEMBLIES,
STUD-TYPE (KR SERIES)
METRIC SERIES**



Outer Dia.	d ₁	D, h7	C	r _{s min}	B ₁	B ₂	B ₃	G ₁	d ₄	d ₃	G		d _a
											Thread	C ₁	
16 0.6299	6 0.2362	16 0.6299	11 0.433	0.3 0.012	28.2 1.110	16 0.630		8 0.315	4 0.157		M6x1	0.6 0.024	11 0.433
19 0.7480	8 0.3150	19 0.7480	11 0.433	0.3 0.012	32.2 1.268	20 0.787		10 0.394	4 0.157		M8x1.25	0.6 0.024	13 0.512
22 0.8661	10 0.3937	22 0.8661	12 0.472	0.3 0.012	36.0 1.417	23 0.906		12 0.472	4 0.157		M10x1	0.6 0.024	15 0.591
26 1.0236	10 0.3937	26 1.0236	12 0.472	0.3 0.012	36.0 1.417	23 0.906		12 0.472	4 0.157		M10x1	0.6 0.024	15 0.591
30 0.551	12 0.4724	30 1.1811	14 0.551	0.6 0.024	40.0 1.575	25 0.984	6 0.236	13 0.512	6 0.236	3 0.118	M12x1.5	0.6 0.024	21 0.827
32 0.551	12 0.4724	32 1.2598	14 0.551	0.6 0.024	40.0 1.575	25 0.984	6 0.236	13 0.512	6 0.236	3 0.118	M12x1.5	0.6 0.024	21 0.827

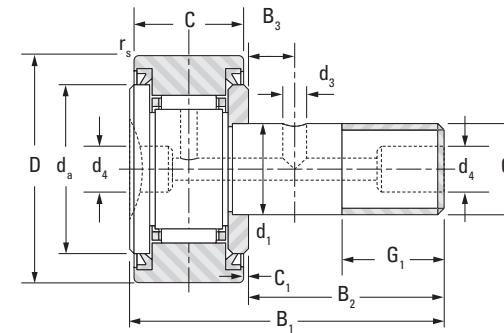
Crowned Designation	Cylindrical Designation	Load Ratings					Tightening Torque	Speed Rating Grease	Wt.
		As a Bearing		As a Track Roller					
		Dynamic C	Static C ₀	Dynamic C _w	Dynamic F _{r perm}	Static F _{0r perm}			
		kN lbf		kN lbf			N-m lb-in	min⁻¹	kg lbs
KR16	KR16.DZ	3.60 810	3.58 800	2.97 670	2.85 640	3.58 800	7 62.0	17000	0.019 0.042
KR19	KR19.DZ	4.18 940	4.65 1050	3.28 740	3.29 740	4.22 950	16 142	13000	0.031 0.068
KR22	KR22.DZ	5.35 1200	6.79 1530	3.94 890	4.04 910	5.45 1230	28 248	10000	0.046 0.101
KR26	KR26.DZ	5.35 1200	6.79 1530	4.55 1020	6.78 1520	7.24 1630	28 248	10000	0.059 0.130
KR30	KR30.DZ	7.89 1770	9.79 2200	6.32 1420	7.74 1740	9.31 2090	45 398	8200	0.087 0.192
KR32	KR32.DZ	7.89 1770	9.79 2200	6.65 1490	9.62 2160	10.3 2320	45 398	8200	0.095 0.209

**NEEDLE ROLLER AND CAGE ASSEMBLIES, SEALED,
STUD-TYPE (KR...2S SERIES)
METRIC SERIES**



KR.2RS

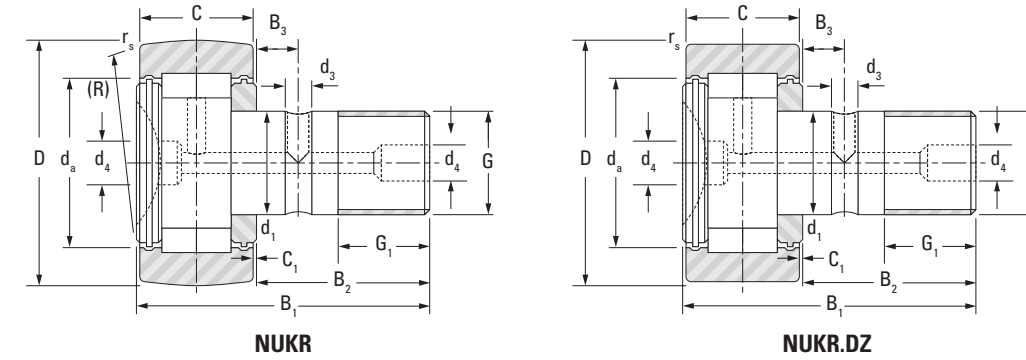
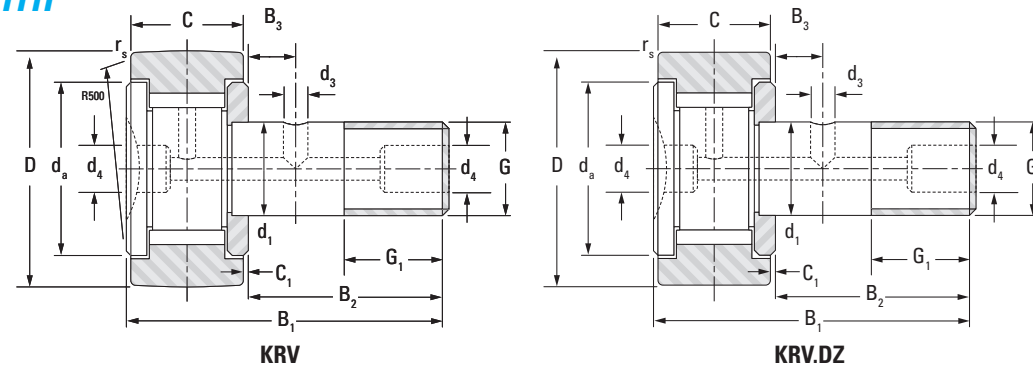
Outer Dia.	d ₁	D, h7	C	r _s min	B ₁	B ₂	B ₃	G ₁	d ₄	d ₃	G		d _a
											Thread	C ₁	
16 0.6299	6 0.2362	16 0.6299	11 0.433	0.3 0.012	28.2 1.110	16 0.630		8 0.315	4 0.157		M6x1	0.6 0.024	11 0.433
19 0.7480	8 0.3150	19 0.7480	11 0.433	0.3 0.012	32.2 1.268	20 0.787		10 0.394	4 0.157		M8x1.25	0.6 0.024	13 0.512
22 0.8661	10 0.3937	22 0.8661	12 0.472	0.3 0.012	36.2 1.425	23 0.906		12 0.472	4 0.157		M10x1	0.6 0.024	15 0.591
26 1.0236	10 0.3937	26 1.0236	12 0.472	0.3 0.012	36.2 1.425	23 0.906		12 0.472	4 0.157		M10x1	0.6 0.024	15 0.591
30 1.1811	12 0.4724	30 1.1811	14 0.551	0.6 0.024	40.2 1.583	25 0.984	6 0.236	13 0.512	6 0.236	3 0.118	M12x1.5	0.6 0.024	21 0.827
32 1.2598	12 0.4724	32 1.2598	14 0.551	0.6 0.024	40.2 1.583	25 0.984	6 0.236	13 0.512	6 0.236	3 0.118	M12x1.5	0.6 0.024	21 0.827



KR.DZ.2RS

Crowned Designation	Cylindrical Designation	Load Ratings					Tightening Torque	Speed Rating Grease	Wt.
		As a Bearing		As a Track Roller					
		Dynamic	Static	Dynamic		Static			
		C	C ₀	C _w	F _{r perm}	F _{Dr perm}			
		kN lbf		kN lbf			N-m lb-in	min⁻¹	kg lbs
KR16.2RS	KR16.DZ.2RS	3.60 810	3.58 800	2.97 670	2.85 640	3.58 800	7.0 61.96	17000	0.019 0.042
KR19.2RS	KR19.DZ.2RS	4.18 940	4.65 1050	3.28 740	3.29 740	4.22 950	16 141.61	13000	0.031 0.068
KR22.2RS	KR22.DZ.2RS	5.35 1200	6.79 1530	3.94 890	4.04 910	5.45 1230	28 247.82	10000	0.046 0.101
KR26.2RS	KR26.DZ.2RS	5.35 1200	6.79 1530	4.55 1020	6.78 1520	7.24 1630	28 247.82	10000	0.059 0.130
KR30.2RS	KR30.DZ.2RS	7.89 1770	9.79 2200	6.32 1420	7.74 1740	9.31 2090	45 398.28	8200	0.087 0.192
KR32.2RS	KR32.DZ.2RS	7.89 1770	9.79 2200	6.65 1490	9.62 2160	10.3 2320	45 398.28	8200	0.098 0.216

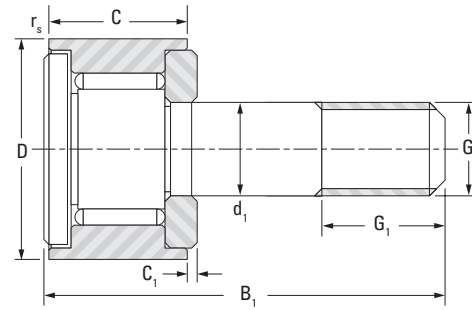
**FULL COMPLEMENT WITH
NEEDLE ROLLERS
(KRV SERIES)
OR CYLINDRICAL
ROLLERS, STUD-TYPE
(NUKR SERIES)
METRIC SERIES**



Outer Dia.	d ₁	D, h7	C	r _s min	B ₁	B ₂	B ₃	G ₁	d ₄	d ₃	G		d _a
											Thread	C ₁	
16 0.6299	6 0.2362	16 0.6299	11 0.433	0.3 0.012	28.2 1.110	16 0.630		8 0.315	4 0.157		M6x1	0.6 0.024	11 0.433
19 0.7480	8 0.3150	19 0.7480	11 0.433	0.3 0.012	32.2 1.268	20 0.787		10 0.394	4 0.157		M8x1.25	0.6 0.024	13 0.512
22 0.8661	10 0.3937	22 0.8661	12 0.472	0.3 0.012	36.2 1.425	23 0.906		12 0.472	4 0.157		M10x1	0.6 0.024	15 0.591
26 1.0236	10 0.3937	26 1.0236	12 0.472	0.3 0.012	36.2 1.425	23 0.906		12 0.472	4 0.157		M10x1	0.6 0.024	15 0.591
30 1.1811	12 0.4724	30 1.1811	14 0.551	0.6 0.024	40.2 1.583	25 0.984	6 0.236	13 0.512	6 0.236	3 0.118	M12x1.5	0.6 0.024	21 0.827
32 1.2598	12 0.4724	32 1.2598	14 0.551	0.6 0.024	40.2 1.583	25 0.984	6 0.236	13 0.512	6 0.236	3 0.118	M12x1.5	0.6 0.024	21 0.827
35 1.3780	16 0.6299	35 1.3780	18 0.709	0.6 0.024	52 2.047	32.5 1.280	8 0.315	17 0.669	6 0.236	3 0.118	M16x1.5	0.8 0.031	25 0.984
40 1.5748	18 0.7087	40 1.5748	20 0.787	1 0.039	58 2.283	36.5 1.437	8 0.315	19 0.748	6 0.236	3 0.118	M18x1.5	0.8 0.031	27 1.063
47 1.8504	20 0.7874	47 1.8504	24 0.945	1 0.039	66 2.598	40.5 1.594	9 0.354	21 0.827	6 0.236	4 0.157	M20x1.5	0.8 0.031	33 1.299
52 2.0472	20 0.7874	52 2.0472	24 0.945	1 0.039	66 2.598	40.5 1.594	9 0.354	21 0.827	6 0.236	4 0.157	M20x1.5	0.8 0.031	37 1.457
62 2.4409	24 0.9449	62 2.4409	29 1.142	1 0.039	80 3.150	49.5 1.949	11 0.433	25 0.984	8 0.315	4 0.157	M24x1.5	0.8 0.031	45 1.772
72 2.8346	24 0.9449	72 2.8346	29 1.142	1.1 0.043	80 3.150	49.5 1.949	11 0.433	25 0.984	8 0.315	4 0.157	M24x1.5	0.8 0.031	51 2.008
80 3.1496	30 1.1811	80 3.1496	35 1.378	1.1 0.043	100 3.937	63 2.480	15 0.591	32 1.260	8 0.315	4 0.157	M30x1.5	1.0 0.039	52 2.047
90 3.5433	30 1.1811	90 3.5433	35 1.378	1.1 0.043	100 3.937	63 2.480	15 0.591	32 1.260	8 0.315	4 0.157	M30x1.5	1.0 0.039	52 2.047

Crowned Designation	Cylindrical Designation	Load Ratings					Tightening Torque	Speed Rating Grease	Wt.
		As a Bearing		As a Track Roller					
		Dynamic	Static	Dynamic	Static				
C	C ₀	C _w	F _{r perm}	F _{0r perm}	N-m lb-in	min ⁻¹	kg lbs		
KRV16	KRV16.DZ	6.90 1550	8.40 1890	5.11 1150	3.49 780	6.28 1410	7 62.0	5700	0.019 0.042
KRV19	KRV19.DZ	8.08 1820	11.0 2470	5.66 1270	4.13 930	7.43 1670	16 142	4300	0.031 0.068
KRV22	KRV22.DZ	9.45 2120	14.3 3210	6.32 1420	5.04 1130	9.07 2040	28 248	3400	0.046 0.101
KRV26	KRV26.DZ	9.45 2120	14.3 3210	7.30 1640	8.60 1930	12.7 2860	28 248	3400	0.059 0.130
KRV30	KRV30.DZ	13.4 3010	19.8 4450	9.85 2210	9.20 2070	15.7 3530	45 398	2800	0.087 0.192
KRV32	KRV32.DZ	13.4 3010	19.8 4450	10.4 2340	11.3 2540	17.4 3910	45 398	2800	0.098 0.216
NUKR35.2SK		24.7 5550	29.4 6610	16.2 3640	10.1 2270	16.1 3620	53.2 471	6100	0.170 0.375
NUKR40.2SK		26.6 5980	33.3 7490	18.7 4200	15.0 3370	23.9 5370	77.5 686	5300	0.250 0.551
NUKR47.2SK		41.4 9310	53.2 12000	28.1 6320	20.5 4610	32.7 7350	109 965	4500	0.380 0.838
NUKR52.2SK		45.8 10300	63.1 14200	29.6 6650	22.2 4990	35.4 7960	109 965	3700	0.461 1.016
NUKR62.2SK		62.7 14100	83.1 18700	40.9 9190	29.6 6650	47.2 10600	193 1708	3200	0.790 1.742
NUKR72.2SK		68.9 15500	97.8 22000	46.1 10400	39.6 8900	63.1 14200	193 1708	2600	1.040 2.293
NUKR80.2SK		95.4 21400	130 29200	69.7 15700	63.2 14200	101 22700	390 3452	2900	1.550 3.417
NUKR90.2SK		95.4 21400	130 29200	77.8 17500	97.8 22000	128 28800	390 3452	2900	2.020 4.453

**FULL COMPLEMENT, SMALL SERIES,
UNSEALED,
STUD-TYPE (GC SERIES)
METRIC SERIES**



GC10-15/GCL10-15 Series

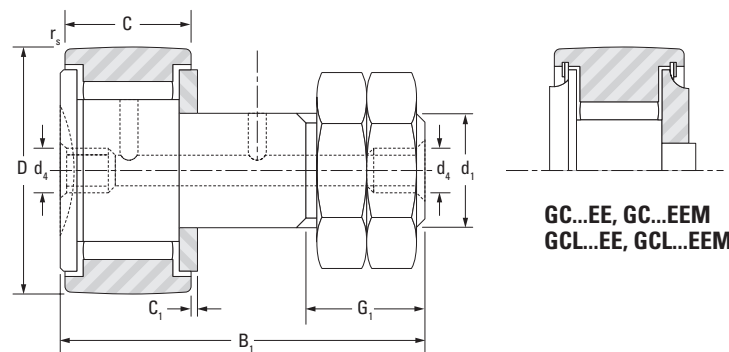
GC: crowned outer ring
GCL: cylindrical outer ring

Outer Dia.	D	d ₁	Thread	C	C ₁	r _s min	B ₁	G ₁
mm in	mm in	mm in		mm in	mm in	mm in	mm in	mm in
10 0.3937	10 0.3937	4 0.1575	M4 x 0.7	8 0.315	0.25 0.010	0.2 0.008	19.5 0.768	6 0.236
11 0.4331	11 0.4331	4 0.1575	M4 x 0.7	8 0.315	0.25 0.010	0.2 0.008	19.5 0.768	6 0.236
12 0.4724	12 0.4724	5 0.1969	M5 x 0.8	9 0.354	0.25 0.010	0.2 0.008	22.5 0.886	7 0.276
13 0.5118	13 0.5118	5 0.1969	M5 x 0.8	9 0.354	0.25 0.010	0.2 0.008	22.5 0.886	7 0.276
14 0.5512	14 0.5512	6 0.2362	M6 x 1	9.5 0.374	0.25 0.010	0.3 0.012	26 1.024	8 0.315
15 0.5906	15 0.5906	6 0.2362	M6 x 1	9.5 0.374	0.25 0.010	0.3 0.012	26 1.024	8 0.315

Crowned Designation	Cylindrical Designation	Tightening Torque	Load Ratings					Speed Rating Grease	Wt.
			As a Bearing		As a Track Roller				
			C	C ₀	C _w	F _{r perm}	F _{0r perm}		
		N-m lb-in	kN lbf		kN lbf			min ⁻¹	kg lbs
GC 10	GCL 10	0.9 7.97	2.80 629	3.09 695	1.92 432	1.01 227	1.82 409	8500	0.006 0.014
GC 11	GCL 11	0.9 7.97	2.8 629	3.09 695	2.12 477	1.43 321	2.58 580	8500	0.007 0.016
GC 12	GCL 12	1.8 15.93	3.74 841	4.74 1070	2.54 571	1.63 366	2.94 661	6600	0.011 0.024
GC 13	GCL 13	1.8 15.93	3.74 841	4.74 1070	2.16 486	2.75 618	3.89 874	6600	0.011 0.024
GC 14	GCL 14	3.0 26.55	4.05 910	5.44 1220	2.86 643	2.26 508	4.07 915	5700	0.016 0.035
GC 15	GCL 15	3.0 26.55	4.05 910	5.44 1220	3.04 683	2.83 636	4.65 1050	5700	0.018 0.039

**FULL COMPLEMENT,
STANDARD SERIES,
WITH OR WITHOUT SEALS,
STUD-TYPE (GC SERIES)
METRIC SERIES**

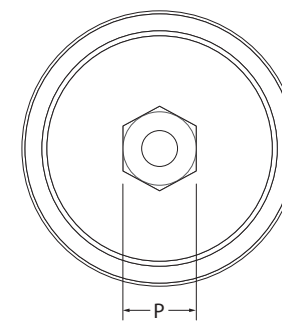
GC: crowned outer ring
GCL: cylindrical outer ring
EE: with plastic seals
EEM: with metal seals



GC16-90/GCL16-90 Series

**GC...EE, GC...EEM
GCL...EE, GCL...EEM**

Outer Dia.	D	d ₁	Pitch	C	C ₁	r _{s min}	B ₁	G ₁	Crowned Designation	Cylindrical Designation
mm in	mm in	mm in	mm	mm in	mm in	mm in	mm in	mm in		
16 0.6299	16 0.6299	6 0.2362	1.0	11 0.433	0.60 0.024	0.3 0.012	28.3 1.114	8 0.315	GC 16	GCL 16
19 0.748	19 0.748	8 0.315	1.25	11 0.433	0.60 0.024	0.3 0.012	32.3 1.272	10 0.394	GC 19	GCL 19
22 0.8661	22 0.8661	10 0.3937	1.25	12 0.472	0.60 0.024	0.3 0.012	36.3 1.429	12 0.472	GC 22	GCL 22
24 0.9449	24 0.9449	10 0.3937	1.25	12 0.472	0.60 0.024	0.3 0.012	36.3 1.429	12 0.472	GC 24	GCL 24
26 1.0236	26 1.0236	10 0.3937	1.25	12 0.472	0.60 0.024	0.3 0.012	36.3 1.429	12 0.472	GC 26	GCL 26
28 1.1024	28 1.1024	10 0.3937	1.25	12 0.472	0.60 0.024	0.3 0.012	36.3 1.429	12 0.472	GC 28	GCL 28
30 1.1811	30 1.1811	12 0.4724	1.5	14 0.51	0.60 0.024	0.6 0.024	40.3 1.587	13 0.512	GC 30	GCL 30
32 1.2598	32 1.2598	12 0.4724	1.5	14 0.51	0.60 0.024	0.6 0.024	40.3 1.587	13 0.512	GC 32	GCL 32
35 1.378	35 1.378	16 0.6299	1.5	18 0.709	0.80 0.031	0.6 0.024	52.3 2.059	17 0.669	GC 35	GCL 35
47 1.8504	47 1.8504	20 0.7874	1.5	24 0.45	0.80 0.031	1 0.039	66.3 2.61	21 0.827	GC 47	GCL 47
52 2.0472	52 2.0472	20 0.7874	1.5	24 0.45	0.80 0.031	1 0.039	66.3 2.61	21 0.827	GC 52	GCL 52
62 2.4409	62 2.4409	24 0.9449	1.5	29 1.142	0.80 0.031	1 0.039	80.3 3.161	25 0.984	GC 62	GCL 62
72 2.8346	72 2.8346	24 0.9449	1.5	29 1.142	0.80 0.031	1 0.039	80.3 3.161	25 0.984	GC 72	GCL 72
80 3.1496	80 3.1496	30 1.1811	1.5	35 1.378	1.00 0.039	1 0.039	100.3 3.949	32 1.26	GC 80	GCL 80
85 3.3465	85 3.3465	30 1.1811	1.5	35 1.378	1.00 0.039	1 0.039	100.3 3.949	32 1.26	GC 85	GCL 85
90 3.5433	90 3.5433	30 1.1811	1.5	35 1.378	1.00 0.039	1 0.039	100.3 3.949	32 1.26	GC 90	GCL 90

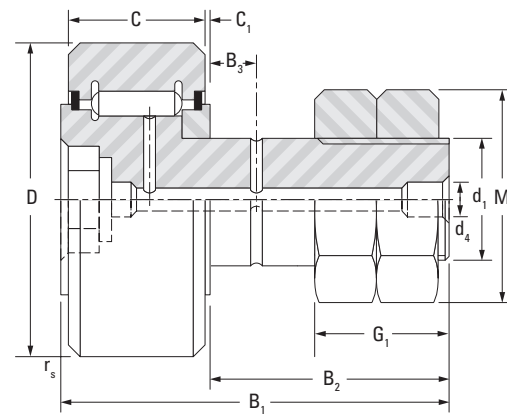


Hex Socket Roller End

Tightening Torque	Load Ratings					Speed Rating Grease	P Wrench	d ₄	Wt.
	As a Bearing		As a Track Roller						
	C	C ₀	C _w	F _{r perm}	F _{0r perm}				
N-m lb-in	kN lbf		kN lbf			min ⁻¹	mm	mm in	kg lbs
3 26.6	5.66 1270	6.51 1460	4.19 942	2.79 627	5.02 1130	5700	N/A	4 0.157	0.021 0.046
8 70.8	6.44 1450	8.15 1830	4.65 1050	3 785	6.28 1410	4400	N/A	4 0.157	0.034 0.075
20 177	7.3 1640	10.2 2290	5.05 1140	4.07 915	7.33 1650	3500	N/A	4 0.157	0.058 0.128
20 177	7.3 1640	10.2 2290	5.45 1230	5.42 1220	8.63 1940	3500	N/A	4 0.157	0.067 0.148
20 177	9.92 2230	12.9 2900	7.09 1590	5.43 1220	9.77 2200	3200	N/A	4 0.157	0.072 0.159
20 177	9.92 2230	12.9 2900	7.57 1700	6.95 1560	11.4 2560	3200	N/A	4 0.157	0.08 0.176
26 230	15.5 3480	20.4 4590	11.2 2520	8.48 1910	15.3 3440	2900	8	4 0.157	0.115 0.254
26 230	15.5 3480	20.4 4590	11.8 2650	10.6 2380	18.1 4070	2900	8	4 0.157	0.12 0.265
64 566	23.6 5310	33.1 7440	15.7 3530	10.8 2430	19.4 4360	2200	10	6 0.236	0.208 0.459
120 1060	36.5 8210	65.5 14700	22.5 5060	20.2 4540	36.4 8180	1400	14	6 0.236	0.477 1.052
120 1060	36.5 8210	65.5 14700	25.2 5670	28 6290	47.5 10700	1400	14	6 0.236	0.542 1.195
220 1950	43.3 9730	85.6 19200	30.5 6860	42.9 9640	64.7 14500	1200	12	6 0.236	0.944 2.081
220 1950	43.3 9730	85.6 19200	33.9 7620	65.8 14800	79.5 17900	1200	12	6 0.236	1.165 2.568
450 3980	65.1 14600	144 32400	42.7 9600	62.9 14100	95.3 21400	870	14	8 0.315	1.915 4.222
450 3980	65.1 14600	144 32400	45.1 10100	75.3 16900	106 23800	870	14	8 0.315	2.096 4.621
450 3980	65.1 14600	144 32400	47.1 10600	88.8 20000	115 25900	870	14	8 0.315	2.287 5.042

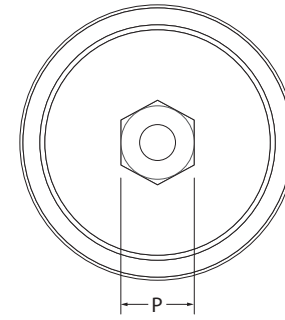
**FULL COMPLEMENT,
WITH METAL SEALS,
STUD-TYPE (GCU...MM SERIES)
METRIC SERIES**

GCU: crowned outer ring
GCUL: cylindrical outer ring



GCU, GCUL

Outer Dia.	D	d ₁	C	C ₁	B ₁	G ₁	r _s min	Crowned Designation	Cylindrical Designation
35 1.3780	35 1.3780	16 0.6299	18 0.709	0.85 0.033	52.3 2.059	17 0.669	0.6 0.024	GCU 35 MM	GCUL 35 MM
40 1.5748	40 1.5748	18 0.7087	20 0.787	0.85 0.033	58.3 2.295	19 0.748	1.0 0.039	GCU 40 MM	GCUL 40 MM
47 1.8504	47 1.8504	20 0.7874	24 0.945	0.85 0.033	66.3 2.610	21 0.827	1.0 0.039	GCU 47 MM	GCUL 47 MM
52 2.0472	52 2.0472	20 0.7874	24 0.945	0.85 0.033	66.3 2.610	21 0.827	1.0 0.039	GCU 52 MM	GCUL 52 MM
62 2.4409	62 2.4409	24 0.9449	29 1.142	0.85 0.033	80.3 3.161	25 0.984	1.0 0.039	GCU 62 MM	GCUL 62 MM
72 2.8346	72 2.8346	24 0.9449	29 1.142	0.85 0.033	80.3 3.161	25 0.984	1.1 0.043	GCU 72 MM	GCUL 72 MM
80 3.1496	80 3.1496	30 1.1811	35 1.378	1.10 0.043	100.3 3.949	32 1.260	1.1 0.043	GCU 80 MM	GCUL 80 MM
90 3.5433	90 3.5433	30 1.1811	35 1.378	1.10 0.043	100.3 3.949	32 1.260	1.1 0.043	GCU 90 MM	GCUL 90 MM
100 3.9370	100 3.9370	36 1.4173	40 1.575	1.10 0.043	117.3 4.618	38 1.496	2.0 0.079	GCU 100 MM	GCUL 100 MM
110 4.3307	110 4.3307	36 1.4173	40 1.575	1.10 0.043	117.3 4.618	38 1.496	2.0 0.079	GCU 110 MM	GCUL 110 MM
120 4.7244	120 4.7244	42 1.6535	46 1.811	1.10 0.043	136.3 5.366	44 1.732	2.0 0.079	GCU 120 MM	GCUL 120 MM
130 5.1181	130 5.1181	42 1.6535	46 1.811	1.10 0.043	136.3 5.366	44 1.732	2.0 0.079	GCU 130 MM	GCUL 130 MM

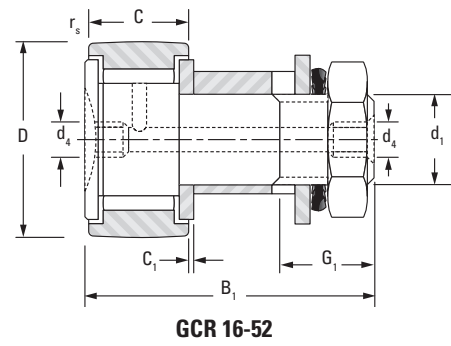


Hex Socket Roller End

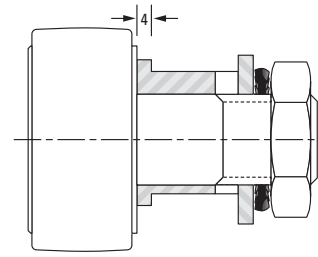
Tightening Torque	Load Ratings					Speed Rating Grease	P Wrench	B ₂	B ₃	d ₄	M	Wt.
	As a Bearing		As a Track Roller									
	C	C ₀	C _w	F _r perm	F _{0r} perm							
64 566	26.4 5930	32.4 7280	15.4 3460	7.25 1630	13.1 2940	2200	10	32.8 1.291	8 0.315	6 0.236	26.0 1.024	0.200 0.441
90 797	26.4 5930	32.4 7280	18.7 4200	12.1 2720	21.8 4900	2200	12	36.8 1.449	8 0.315	6 0.236	28.6 1.126	0.289 0.637
120 1060	43.8 9850	57.9 13000	26.7 6000	14.3 3210	25.8 5800	1600	14	40.8 1.606	9 0.354	6 0.236	33.6 1.323	0.450 0.992
120 1060	43.8 9850	57.9 13000	30.6 6880	21.2 4770	38.2 8590	1600	14	40.8 1.606	9 0.354	6 0.236	33.6 1.323	0.520 1.146
220 1950	63.7 14300	87.4 19600	44.1 9910	30.9 6950	55.6 12500	1400	12	49.8 1.961	11 0.433	6 0.236	38.9 1.531	0.910 2.006
220 1950	63.7 14300	87.4 19600	50.8 11400	52.7 11800	84.1 18900	1400	12	49.8 1.961	11 0.433	6 0.236	38.9 1.531	1.140 2.513
450 3980	100 22500	140 31500	66.8 15000	43.8 9850	78.8 17700	1000	14	63.3 2.492	15 0.591	8 0.315	51.8 2.039	1.870 4.123
450 3980	100 22500	140 31500	75.8 17000	68.1 15300	122 27400	1000	14	63.3 2.492	15 0.591	8 0.315	51.8 2.039	2.230 4.914
740 6550	115 25900	175 39300	82.1 18500	76.6 17200	135 30300	840	17	75.3 2.965	20 0.787	8 0.315	61.0 2.402	3.290 7.253
740 6550	115 25900	175 39300	89.7 20200	107 24100	161 36200	840	17	75.3 2.965	20 0.787	8 0.315	61.0 2.402	3.800 8.378
1 200 10620	167 37500	240 54000	124 27900	107 24100	193 43400	740	19	88.3 3.476	24 0.945	8 0.315	71.0 2.795	5.422 11.953
1 200 10620	167 37500	240 54000	133 30000	142 31900	228 51300	740	19	88.3 3.476	24 0.945	8 0.315	71.0 2.795	5.780 12.743

**FULL COMPLEMENT,
ECCENTRIC, STUD-TYPE
(GCR SERIES)
METRIC SERIES**

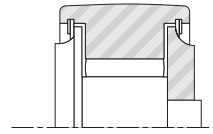
GCR: crowned outer ring
GCRL: cylindrical outer ring
EE: polymer shields
EEM: metal shields



GCR 16-52



GCR 62-90



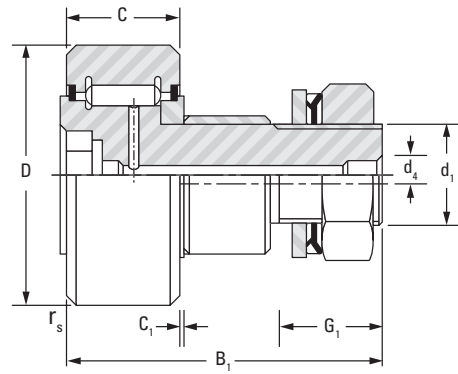
**GCR..EE, GCR..EEM
GCRL..EE, GCRL..EEM**

Outer Dia.	D	d ₁	C	C ₁	B ₁	G ₁	r _s min	Crowned Designation	Cylindrical Designation
mm in	mm in	mm in	mm in	mm in	mm in	mm in	mm in		
16 0.6299	16 0.6299	6 0.2362	11 0.433	0.60 0.024	28.3 1.114	8 0.315	0.3 0.012	GCR 16	
19 0.748	19 0.748	8 0.315	11 0.433	0.60 0.024	32.3 1.272	10 0.394	0.3 0.012	GCR 19	
22 0.8661	22 0.8661	10 0.3937	12 0.472	0.60 0.024	36.3 1.429	12 0.472	0.3 0.012	GCR 22	GCRL 22
24 0.9449	24 0.9449	10 0.3937	12 0.472	0.60 0.024	36.3 1.429	12 0.472	0.3 0.012	GCR 24	
26 1.0236	26 1.0236	10 0.3937	12 0.472	0.60 0.024	36.3 1.429	12 0.472	0.3 0.012	GCR 26	GCRL 26
28 1.1024	28 1.1024	10 0.3937	12 0.472	0.60 0.024	36.3 1.429	12 0.472	0.3 0.012	GCR 28	GCRL 28
30 1.1811	30 1.1811	12 0.4724	14 0.551	0.60 0.024	40.3 1.587	13 0.512	0.6 0.024	GCR 30	GCRL 30
32 1.2598	32 1.2598	12 0.4724	14 0.551	0.60 0.024	40.3 1.587	13 0.512	0.6 0.024	GCR 32	GCRL 32
35 1.378	35 1.378	16 0.6299	18 0.709	0.80 0.031	52.3 2.059	17 0.669	0.6 0.024	GCR 35	GCRL 35
40 1.5748	40 1.5748	18 0.7087	20 0.787	0.80 0.031	58.3 2.295	19 0.748	1 0.039	GCR 40	GCRL 40
47 1.8504	47 1.8504	20 0.7874	24 0.945	0.80 0.031	66.3 2.61	21 0.827	1 0.039	GCR 47 EE	GCRL 47
52 2.0472	52 2.0472	20 0.7874	24 0.945	0.80 0.031	66.3 2.61	21 0.827	1 0.039	GCR 52	GCRL 52
62 2.4409	62 2.4409	24 0.9449	29 1.142	0.80 0.031	80.3 3.161	25 0.984	1 0.039	GCR 62	GCRL 62
72 2.8346	72 2.8346	24 0.9449	29 1.142	0.80 0.031	80.3 3.161	25 0.984	1 0.039	GCR 72	GCRL 72
80 3.1496	80 3.1496	30 1.1811	35 1.378	1.00 0.039	100.3 3.949	32 1.26	1 0.039	GCR 80	
90 3.5433	90 3.5433	30 1.1811	35 1.378	1.00 0.039	100.3 3.949	32 1.26	1 0.039	GCR 90	GCRL 90

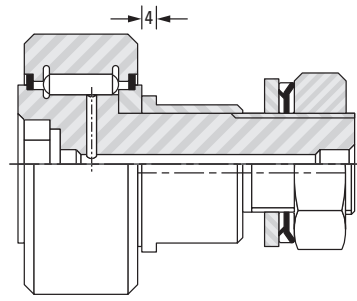
Tightening Torque	Load Ratings					Speed Rating Grease	d ₄	Wt.
	As a Bearing		As a Track Roller					
	C	C ₀	C _w	F _{r perm}	F _{0r perm}			
N-m lb-in	kN lbf		kN lbf			min⁻¹	mm in	kg lbs
2 17.7	5.66 1270	6.51 1460	4.19 942	2.79 627	5.02 1130	5700	4 0.157	0.024 0.053
5 44.3	6.44 1450	8.15 1830	4.65 1050	3 785	6.28 1410	4400	4 0.157	0.039 0.086
16 142	7.3 1640	10.2 2290	5.05 1140	4.07 915	7.33 1650	3500	4 0.157	0.057 0.126
16 142	7.3 1640	10.2 2290	5.45 1230	5.42 1220	8.63 1940	3500	4 0.157	0.072 0.159
16 142	9.92 2230	12.9 2900	7.09 1590	5.43 1220	9.77 2200	3200	4 0.157	0.080 0.176
16 142	9.92 2230	12.9 2900	7.57 1700	6.95 1560	11.4 2560	3200	4 0.157	0.088 0.194
22 195	15.5 3480	20.4 4590	11.2 2520	8.48 1910	15.3 3440	2900	4 0.157	0.118 0.260
22 195	15.5 3480	20.4 4590	11.8 2650	10.6 2380	18.1 4070	2900	4 0.157	0.126 0.278
55 487	23.6 5310	33.1 7440	15.7 3530	10.8 2430	19.4 4360	2200	6 0.236	0.220 0.485
75 664	29.9 6720	48 10800	18.5 4160	13.8 3100	24.8 5580	1800	6 0.236	0.321 0.708
100 885	36.5 8210	65.5 14700	22.5 5060	20.2 4540	36.4 8180	1400	6 0.236	0.500 1.102
100 885	36.5 8210	65.5 14700	25.2 5670	28 6290	47.5 10700	1400	6 0.236	0.568 1.252
180 1590	43.3 9730	85.6 19200	30.5 6860	42.9 9640	64.7 14500	1200	8 0.315	1.035 2.282
180 1590	43.3 9730	85.6 19200	33.9 7620	65.8 14800	79.5 17900	1200	8 0.315	1.278 2.818
370 3270	65.1 14600	144 32400	42.7 9600	62.9 14100	95.3 21400	870	8 0.315	2.074 4.572
370 3270	65.1 14600	144 32400	47.1 10600	88.8 20000	115 25900	870	8 0.315	2.435 5.368

**FULL COMPLEMENT,
ECCENTRIC, WITH METAL
SEALS, STUD-TYPE
(G CUR...MM SERIES)
METRIC SERIES**

G CUR: crowned outer ring
G CURL: cylindrical outer ring

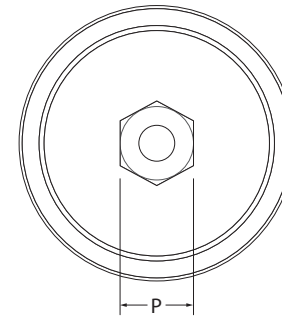


G CUR 35-52



G CUR 62-130

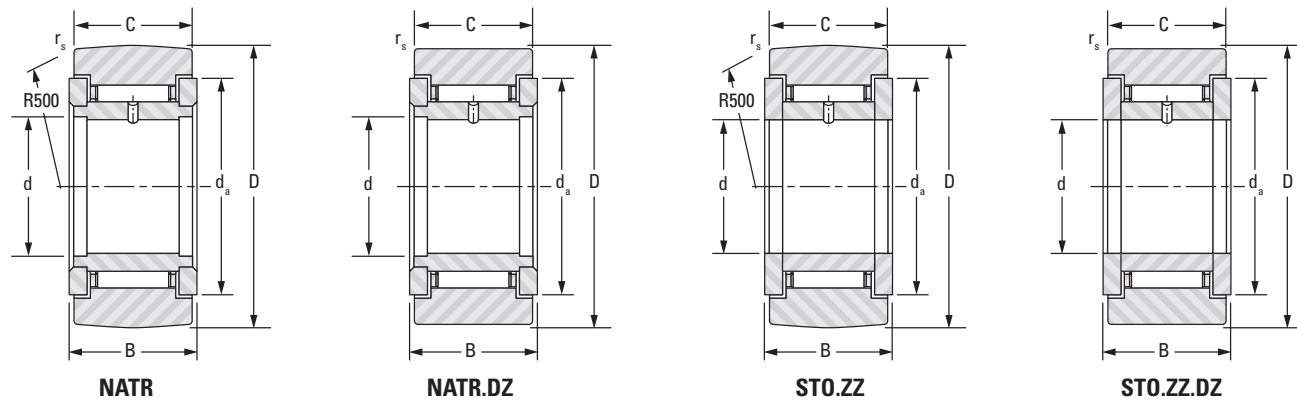
Outer Dia.	D	d ₁	C	C ₁	B ₁	G ₁	r _s min	Crowned Designation	Cylindrical Designation
mm in	mm in	mm in	mm in	mm in	mm in	mm in	mm in		
35 1.3780	35 1.3780	16 0.6299	18 0.709	0.85 0.033	52.3 2.059	17 0.669	0.6 0.024	G CUR 35 MM	
40 1.5748	40 1.5748	18 0.7087	20 0.787	0.85 0.033	58.3 2.295	19 0.748	1.0 0.039		G CURL 40 MM
52 2.0472	52 2.0472	20 0.7874	24 0.945	0.85 0.033	66.3 2.610	21 0.827	1.0 0.039	G CUR 52 MM	
62 2.4409	62 2.4409	24 0.9449	29 1.142	0.85 0.033	80.3 3.161	25 0.984	1.0 0.039	G CUR 62 MM	
72 2.8346	72 2.8346	24 0.9449	29 1.142	0.85 0.033	80.3 3.161	25 0.984	1.1 0.043	G CUR 72 MM	
80 3.1496	80 3.1496	30 1.1811	35 1.378	1.10 0.043	100.3 3.949	32 1.260	1.1 0.043	G CUR 80 MM	
90 3.5433	90 3.5433	30 1.1811	35 1.378	1.10 0.043	100.3 3.949	32 1.260	1.1 0.043	G CUR 90 MM	
100 3.9370	100 3.9370	36 1.4173	40 1.575	1.10 0.043	117.3 4.618	38 1.496	2.0 0.079	G CUR 100 MM	
110 4.3307	110 4.3307	36 1.4173	40 1.575	1.10 0.043	117.3 4.618	38 1.496	2.0 0.079	G CUR 110 MM	
120 4.7244	120 4.7244	42 1.6535	46 1.811	1.10 0.043	136.3 5.366	44 1.732	2.0 0.079	G CUR 120 MM	
130 5.1181	130 5.1181	42 1.6535	46 1.811	1.10 0.043	136.3 5.366	44 1.732	2.0 0.079	G CUR 130 MM	



Hex Socket Roller End

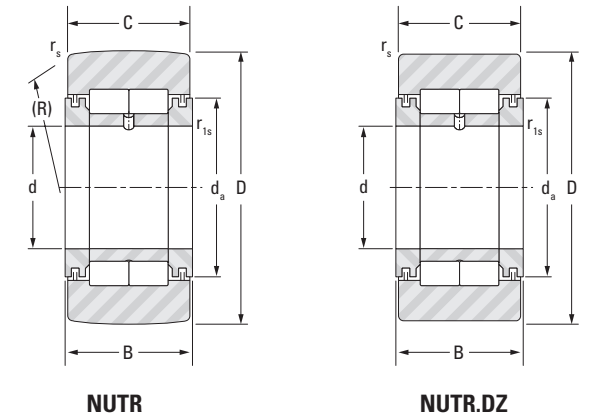
Tightening Torque	Load Ratings					Speed Rating Grease	P Wrench	d ₄	Wt.
	As a Bearing		As a Track Roller						
	C	C ₀	C _w	F _r perm	F _{0r} perm				
N·m lb·in	kN lbf		kN lbf			min ⁻¹	mm	mm in	kg lbs
55 487	26.4 5930	32.4 7280	15.4 3460	7.25 1630	13.1 2940	2200	10	6 0.236	0.215 0.474
75 664	26.4 5930	32.4 7280	18.7 4200	12.1 2720	21.8 4900	2200	12	6 0.236	0.313 0.690
100 885	43.8 9850	57.9 13000	30.6 6880	21.2 4770	38.2 8590	1600	14	6 0.236	0.555 1.224
180 1593	63.7 14300	87.4 19600	44.1 9910	30.9 6950	55.6 12500	1400	12	6 0.236	1.022 2.253
180 1593	63.7 14300	87.4 19600	50.8 11400	52.7 11800	84.1 18900	1400	12	6 0.236	0.113 0.249
370 3275	100 22500	140 31500	66.8 15000	43.8 9850	78.8 17700	1000	14	8 0.315	0.182 0.401
370 3275	100 22500	140 31500	75.8 17000	68.1 15300	122 27400	1000	14	8 0.315	0.182 0.401
610 5399	115 25900	175 39300	82.1 18500	76.6 17200	135 30300	840	17	8 0.315	0.244 0.539
610 5399	115 25900	175 39300	89.7 20200	107 24100	161 36200	840	17	8 0.315	0.245 0.540
1000 8851	167 37500	240 54000	124 27900	107 24100	193 43400	740	19	8 0.315	0.328 0.724
1000 8851	167 37500	240 54000	133 30000	142 31900	228 51300	740	19	8 0.315	0.329 0.725

**CAGED, WITH INNER RING, WITH END WASHERS, YOKE-TYPE (NATR, STO...ZZ SERIES)
METRIC SERIES**



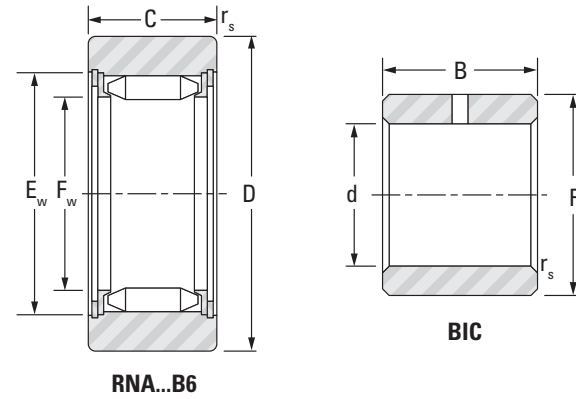
Outer Dia. mm in	D mm in	d mm in	B mm in	C mm in	da mm in	rs min mm in	Bearing Designation		Load Ratings					Speed Rating Grease min ⁻¹	Wt. kg lbs
							Crowned Track Roller	Cylindrical Track Roller	As a Bearing		As a Track Roller				
									Dynamic C	Static Co	Dynamic Cw	Static Fr perm	Static FOr perm		
16	16	5	12	11.0	13	0.3	NATR5	NATR5DZ	4.62	5.19	3.34	2.62	4.01	13000	0.017
19	19	6	12	11.0	16	0.3	NATR6	NATR6DZ	4.84	5.66	3.84	4.28	5.28	12000	0.022
19	19	6	14	13.8	15	0.3	STO6ZZ	STO6ZZ.DZ	5.37	6.47	4.31	5.23	6.17	12000	0.024
24	24	8	14	13.8	18	0.3	STO8ZZ	STO8ZZ.DZ	5.82	7.54	4.97	7.54	8.14	9900	0.040
24	24	8	15	14.0	20	0.3	NATR8	NATR8DZ	8.39	8.67	6.66	5.79	8.08	10000	0.043
30	30	10	15	14.0	24	0.6	NATR10	NATR10DZ	9.57	9.45	8.15	8.58	10.1	9400	0.068
30	30	10	16	15.8	23	0.3	STO10ZZ	STO10ZZ.DZ	10.4	10.6	8.94	9.64	11.4	9400	0.071
32	32	12	15	14.0	26	0.6	NATR12	NATR12DZ	10.2	10.5	8.32	8.50	10.4	8100	0.075
32	32	12	16	15.8	25	0.3	STO12ZZ	STO12ZZ.DZ	11.2	11.9	9.13	9.54	11.7	8100	0.078
35	35	15	16	15.8	30	0.3	STO15ZZ	STO15ZZ.DZ	12.9	15.3	9.47	8.52	12.1	6300	0.089
40	40	17	20	19.8	33	0.3	STO17ZZ	STO17ZZ.DZ	19.0	23.3	14.2	13.4	19.3	5600	0.145
47	47	20	20	19.8	37	0.3	STO20ZZ	STO20ZZ.DZ	20.0	25.4	15.7	19.5	23.5	4900	0.200
52	52	25	20	19.8	42	0.3	STO25ZZ	STO25ZZ.DZ	22.4	31.1	16.4	19.8	25.1	4100	0.240
62	62	30	25	24.8	52	0.6	STO30ZZ	STO30ZZ.DZ	33.3	51.0	23.0	26.9	36.2	3200	0.412
72	72	35	25	24.8	56	0.6	STO35ZZ	STO35ZZ.DZ	35.2	56.6	25.9	39.2	45.5	2900	0.555
80	80	40	26	25.8	64	0.6	STO40ZZ	STO40ZZ.DZ	38.8	67.8	26.8	41.5	48.1	2400	0.700
85	85	45	26	25.8	69	0.6	STO45ZZ	STO45ZZ.DZ	40.3	73.5	26.9	42.4	48.6	2200	0.770

**FULL COMPLEMENT,
WITH INNER RING,
CYLINDRICAL ROLLERS,
YOKE-TYPE (NUTR SERIES)
METRIC SERIES**



Outer Dia. mm in	D mm in	d mm in	B mm in	C mm in	da mm in	rs mm in	rs min mm in	Bearing Designation		Load Ratings					Speed Rating Grease min ⁻¹	Wt. kg lbs
								Crowned Track Roller	Cylindrical Track Roller	As a Bearing		As a Track Roller				
										Dynamic C	Static Co	Dynamic Cw	Static Fr perm	Static FOr perm		
35	35	15	19	18	24	0.6	0.3	NUTR15	NUTR15DZ	24.7	29.3	16.2	10.1	16.1	6100	0.105
40	40	17	21	20	27	1.0	0.3	NUTR17	NUTR17DZ	26.6	33.4	18.7	15.0	23.9	5300	0.154
42	42	15	19	18	24	0.6	0.3	NUTR1542	NUTR1542DZ	22.8	29.4	20.0	21.2	28.4	6100	0.166
47	47	17	21	20	27	1.0	0.3	NUTR1747	NUTR1747DZ	24.5	33.3	22.0	28.1	33.6	5300	0.230
47	47	20	25	24	32	1.0	0.3	NUTR20	NUTR20DZ	39.0	53.2	28.1	20.5	32.7	4500	0.254
52	52	20	25	24	32	1.0	0.3	NUTR2052	NUTR2052DZ	39.0	53.2	31.6	31.0	45.9	4500	0.326
52	52	25	25	24	37	1.0	0.3	NUTR25	NUTR25DZ	43.0	63.1	29.6	22.2	35.4	3700	0.291
62	62	25	25	24	37	1.0	0.3	NUTR2562	NUTR2562DZ	43.0	63.1	36.0	43.9	57.8	3700	0.460
62	62	30	29	28	44	1.0	0.3	NUTR30	NUTR30DZ	60.0	83.1	40.8	29.0	46.2	3200	0.480
72	72	30	29	28	44	1.0	0.3	NUTR3072	NUTR3072DZ	60.0	83.1	48.6	53.2	74.2	3200	0.711
72	72	35	29	28	50	1.1	0.6	NUTR35	NUTR35DZ	65.5	97.8	45.9	38.7	61.7	2600	0.655
80	80	35	29	28	50	1.1	0.6	NUTR3580	NUTR3580DZ	65.5	97.8	51.7	58.7	81.9	2600	0.865
80	80	40	32	30	55	1.1	0.6	NUTR40	NUTR40DZ	88.0	132	60.6	48.0	76.5	2500	0.848
85	85	45	32	30	60	1.1	0.6	NUTR45	NUTR45DZ	93.0	146	62.0	50.2	80.0	2200	0.917
90	90	40	32	30	55	1.1	0.6	NUTR4090	NUTR4090DZ	88.0	132	69.1	75.4	111	2500	1.162
90	90	50	32	30	65	1.1	0.6	NUTR50	NUTR50DZ	98.0	160	63.3	52.9	84.3	2000	0.988
100	100	45	32	30	60	1.1	0.6	NUTR45100	NUTR45100DZ	93.0	146	74.3	92.2	127	2200	1.412
110	110	50	32	30	65	1.1	0.6	NUTR50110	NUTR50110DZ	98.0	160	79.0	110	141	2000	1.727

**FULL COMPLEMENT,
WITHOUT INNER RING,
UNSEALED, YOKE-TYPE
(RNA...B6, RNAB, RNAL SERIES)**



**SEPARATE INNER RINGS
(BIC SERIES)
METRIC SERIES**

RNA...B6: Crowned outer ring to maximum slope of 0.15%. Tolerance h9 on dimension D.
RNAB: Crowned outer ring to maximum slope of 1.5%. Tolerance h9 on dimension D.
RNAL: Cylindrical outer ring. Tolerance h7 on dim. D.

Outer Dia.	D	C	F _w	E _w	r _{smin}	Track Roller Designations			Load Ratings					Speed Rating Grease	Wt.	Inner Ring Designation	F	B	d	r _{1s min}	Shaft Dia.
									As a Bearing		As a Track Roller										
						Dynamic	Static	Dynamic	Static	Dynamic	Static	C	C ₀								
mm in	mm in	mm in	mm in	mm in	mm in	RNA...B6	RNAB	RNAL	kN lbf	kN lbf	kN lbf	kN lbf	min ⁻¹	kg lbs					mm in		
19 0.7480	19 0.7480	12 0.472	7.3 0.287	12.3 0.484	0.35 0.014	RNA 11005 B6	RNAB 11005		5.31 1190	4.44 998	4.82 1080	4.44 998	4.82 1080	6500	0.019 0.042						
22 0.8661	22 0.8661	12 0.472	9.7 0.382	14.7 0.579	0.35 0.014	RNA 11007 B6	RNAB 11007	RNAL 11007	6.42 1440	5.93 1330	5.5 1240	5.26 1180	6.55 1470	4700	0.022 0.049						
28 1.1024	28 1.1024	12 0.472	12.1 0.476	17.1 0.673	0.35 0.014	RNA 11009 B6	RNAB 11009	RNAL 11009	7.37 1660	7.42 1670	6.66 1500	7.42 1670	9.06 2040	3700	0.028 0.062						
32 1.2598	32 1.2598	15 0.591	17.6 0.693	22.6 0.890	0.35 0.014	RNA 11012 B6	RNAB 11012	RNAL 11012	12.7 2850	16.4 3690	9.38 2110	9.48 2130	13.7 3080	2400	0.032 0.071	BIC 1012	17.6 0.693	15 0.591	12 0.472	0.35 0.014	12 0.472
35 1.3780	35 1.3780	15 0.591	20.8 0.819	25.8 1.016	0.65 0.026	RNA 11015 B6	RNAB 11015		13.9 3120	19.4 4360	9.60 2160	9.47 2130	14.1 3170	2000	0.035 0.077	BIC 1015	20.8 0.819	15 0.591	15 0.591	0.65 0.026	15 0.591
42 1.6535	42 1.6535	15 0.591	23.9 0.941	28.9 1.138	0.65 0.026	RNA 11017 B6	RNAB 11017	RNAL 11017	15.0 3370	22.4 5040	11.0 2470	14.4 3240	18.4 4140	1700	0.042 0.093	BIC 1017	23.9 0.941	15 0.591	17 0.669	0.68 0.026	17 0.669
47 1.8504	47 1.8504	18 0.709	28.7 1.130	34.7 1.366	0.65 0.026	RNA 11020 B6	RNAB 11020	RNAL 11020	21.7 4880	33.5 7530	14.6 3280	16.0 3600	23.3 5240	1400	0.047 0.104	BIC 2020	28.7 1.130	18 0.709	20 0.787	0.65 0.026	20 0.787
52 2.0472	52 2.0472	18 0.709	33.5 1.319	39.5 1.555	0.65 0.026	RNA 11025 B6	RNAB 11025		23.6 5310	39.1 8790	15.0 3370	17.1 3840	24.4 5490	1200	0.052 0.115	BIC 1025	33.5 1.319	18 0.709	25 0.984	0.65 0.026	25 0.984
62 2.4409	62 2.4409	22 0.866	38.2 1.504	44.2 1.740	0.65 0.026	RNA 11030 B6	RNAB 11030		34.2 7690	65.8 14800	22.6 5080	32.8 7370	44.3 9960	1100	0.062 0.137	BIC 2030	38.2 1.504	22 0.866	30 1.181	0.65 0.026	30 1.181
72 2.8346	72 2.8346	22 0.866	44.0 1.732	50.0 1.969	0.65 0.026	RNA 11035 B6			36.7 8250	75.7 17000	24.6 5530	42.4 9530	52.2 11700	920	0.072 0.159	BIC 2035	44 1.732	22 0.866	35 1.378	0.65 0.026	35 1.378
80 3.1496	80 3.1496	22 0.866	49.7 1.957	55.7 2.193	0.85 0.033		RNAB 11040		39.2 8810	85.6 19200	25.8 5800	48.7 10900	57.0 12800	810	0.080 0.176	BIC 2040	49.7 1.957	22 0.866	40 1.575	0.85 0.033	40 1.575
90 3.5433	90 3.5433	24 0.945	62.1 2.445	68.1 2.681	0.85 0.033	RNA 11050 B6			44.0 9890	107 24100	25.8 5800	53.1 11900	57.0 12800	640	0.090 0.198	BIC 11050	62.1 2.445	24 0.945	50 1.969	0.85 0.033	50 1.969

THRUST BEARINGS, ASSEMBLIES, WASHERS

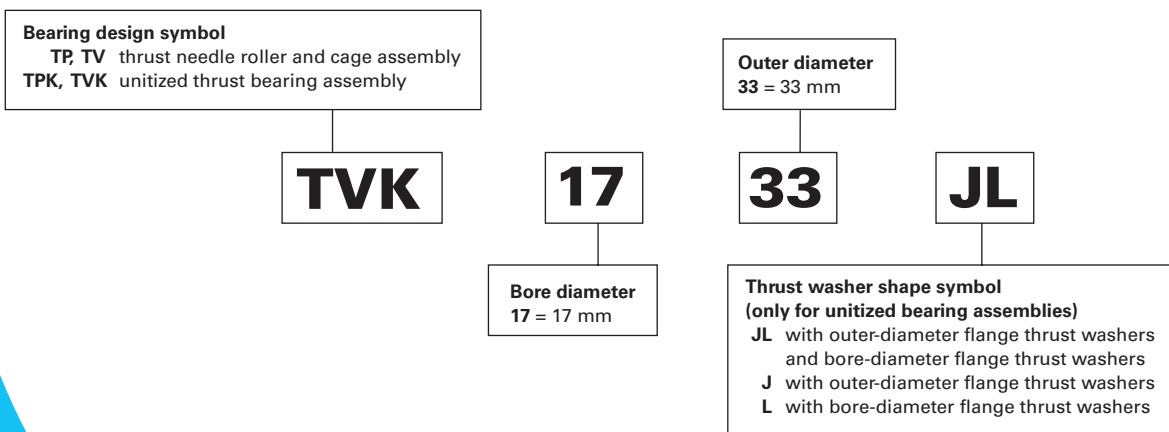
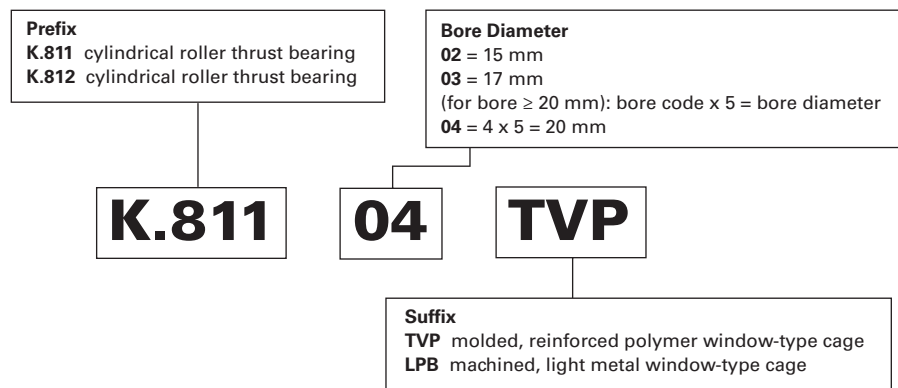
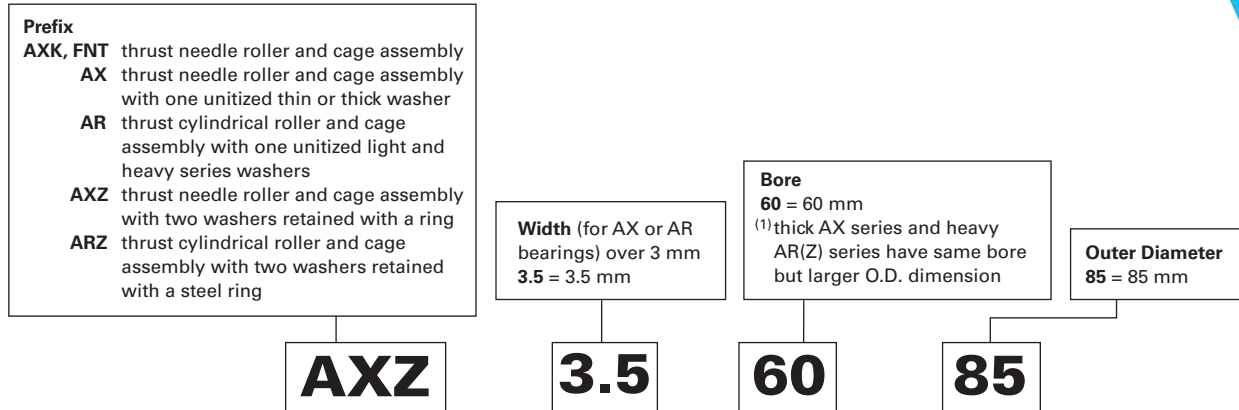
Overview: Thrust needle roller and cage assemblies are complements of small diameter needle rollers, arranged in a spoke-like configuration. Needle rollers are equally spaced by means of a cage, its web section separates the rollers and provides guidance to keep them tracking in an orbital path. The purpose of these assemblies is to transmit a thrust load between two relatively rotating objects while greatly reducing friction.

Thrust needle roller and cage assemblies also can be unitized with lipped washers to serve as raceway surfaces for the needle rollers. Washers can be supplied separately or can be mechanically unitized to the thrust needle roller and cage assemblies for ease of handling.

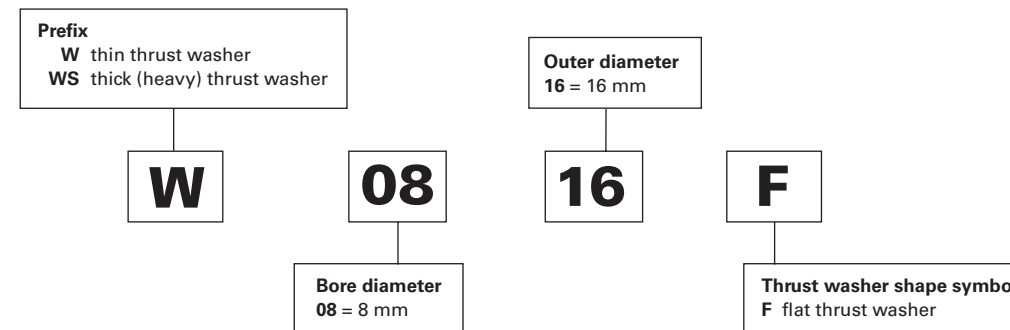
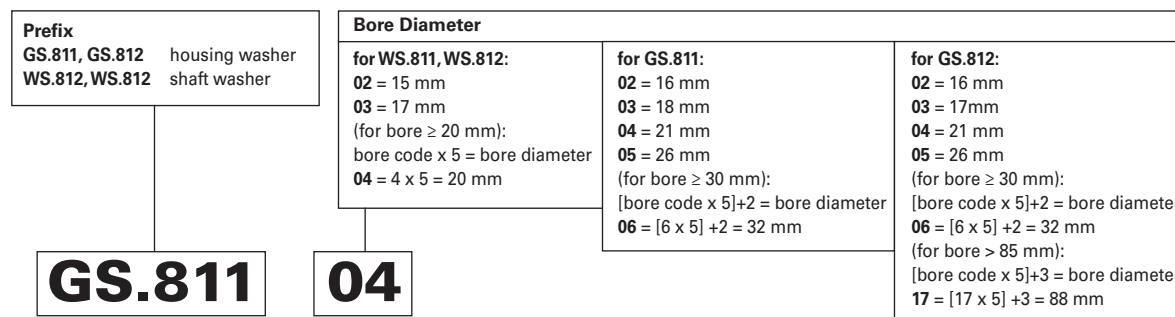
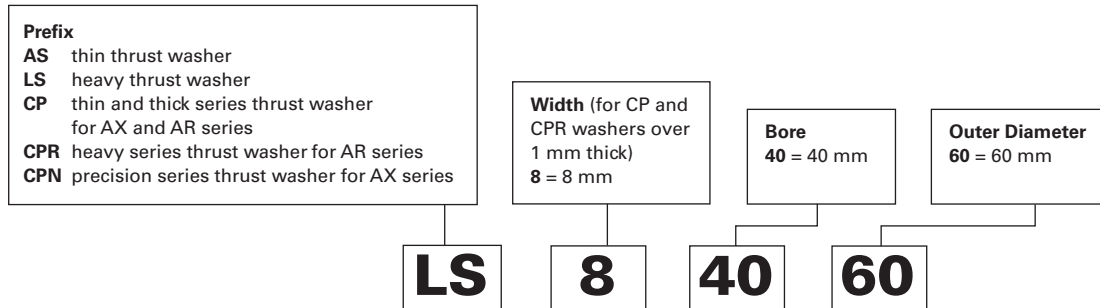
- **Catalogue range:** 5 mm – 240 mm (0.1969 in – 9.4488 in).
- **Markets:** Automotive automatic and manual transmissions, automotive accessories (compressors, steering gears, etc.) agricultural and construction equipment.
- **Features:** One-way fool-proof assembly features, anti-rotation locking features and lubrication flow enhancements.
- **Benefits:** High-speed performance and application flexibility.



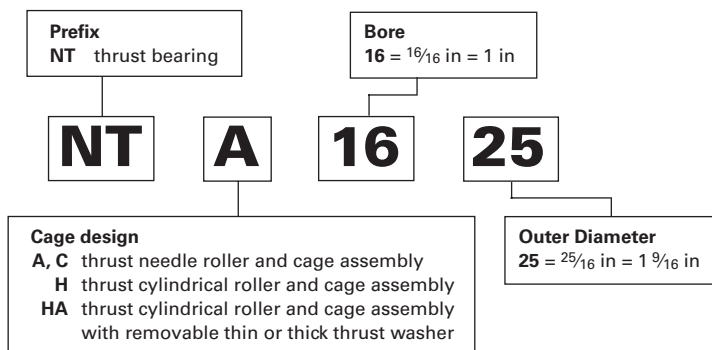
Needle Roller Thrust Bearings – Metric Nominal Dimensions



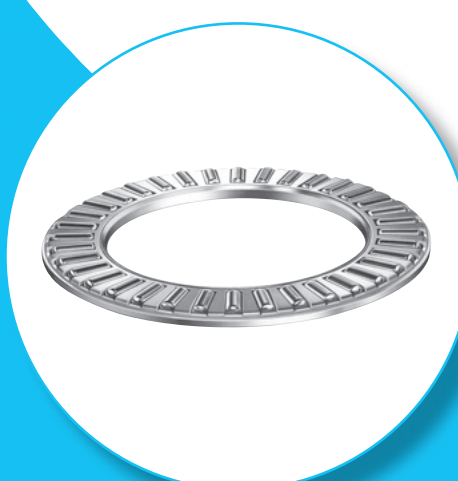
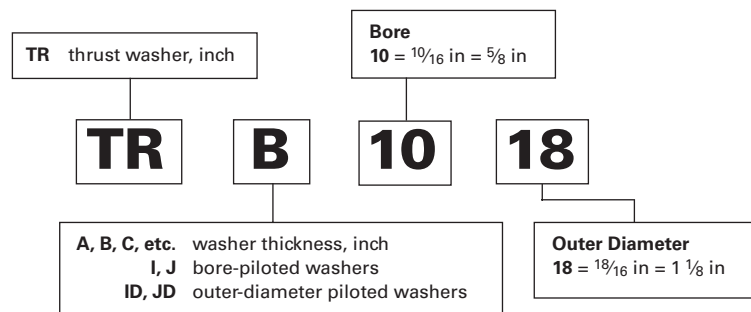
Thrust Washers – Metric Nominal Dimensions



Thrust Bearings – Inch Nominal Dimensions



Thrust Washers – Inch Nominal Dimensions



Thrust Bearings, Assemblies, Washers

THRUST NEEDLE ROLLER AND CAGE ASSEMBLIES AND THRUST WASHERS – METRIC SERIES	Page
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Thrust Needle Roller and Cage Assemblies, Thrust Washers	
AXK, FNT Series	B-6-12
TP, TV Series	B-6-18
Unitized Thrust Bearing	
FNTKF Series	B-6-20
TPK JL, TVK JL Series	B-6-21
Unitized Thrust Bearing	
FNTK Series	B-6-22
TPK J, TVK J Series	B-6-23
Unitized Thrust Bearing	
FNTF Series	B-6-24
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THRUST NEEDLE ROLLER AND CAGE ASSEMBLIES AND THRUST WASHERS

METRIC SERIES

Thrust needle roller and cage assemblies are available in a variety of sizes. They all have very small cross sections. This catalog includes the most popular, standardized designs.

REFERENCE STANDARDS ARE:

- **ISO 3031** – rolling bearings – thrust needle roller and cage assemblies, thrust washers – dimensions and tolerances.
- **DIN 5405 Part 2** – rolling bearings – needle roller bearings – thrust needle roller and cage assemblies.
- **DIN 5405 Part 3** – rolling bearings – needle roller bearings – thrust washers.
- **ANSI/ABMA Std. 21.1-1988** – thrust needle roller and cage assemblies and thrust washers – metric design.
- **JIS B 1536** – roller bearings – boundary dimensions and tolerances of needle roller bearings.

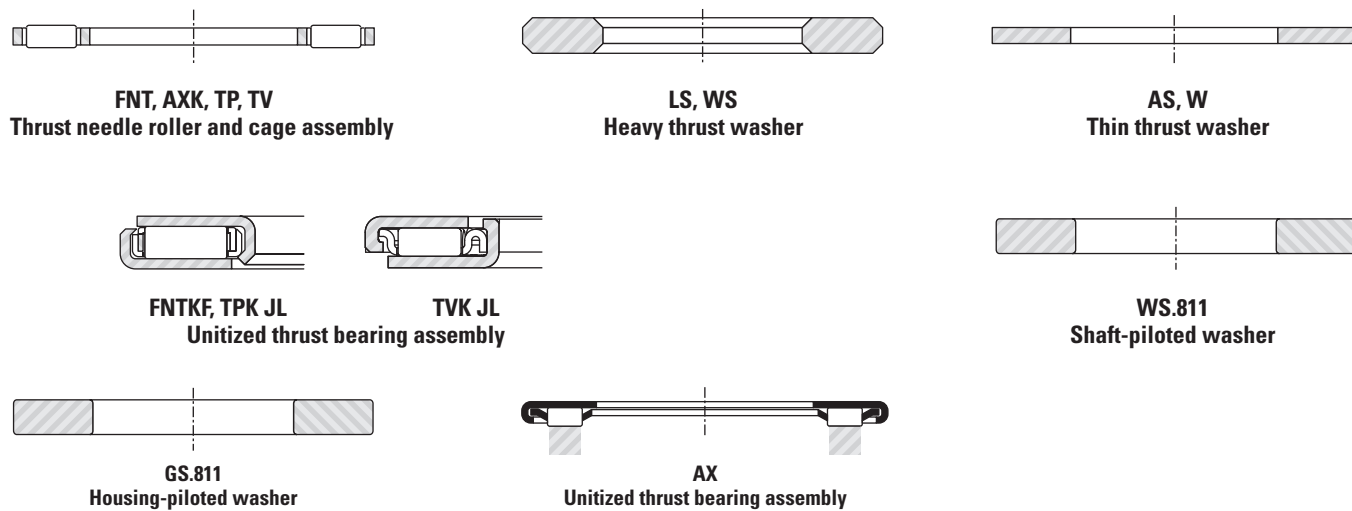


Fig. B6-1. Types of metric series thrust needle roller and cage assemblies and thrust washers

CONSTRUCTION

THRUST NEEDLE ROLLER AND CAGE ASSEMBLIES

The thrust needle roller and cage assembly (FNT and TP series) has a two-piece steel cage and through-hardened needle rollers that are precision finished to close tolerances for optimum load distribution. The cage is comprised of two mating pieces that are securely fastened together.

AXK and TV series thrust needle roller and cage assembly, which can be used interchangeably with the FNT assembly, has a one-piece cage. The cage is similar in design to the successful profiled radial steel cages.

These cage assemblies have a very thin section and when they must run directly against the backup surface raceways, their section may be 2.000 to 5.000 mm (0.0787 to 0.1969 in) – equivalent to the diameter of the needle rollers used.

When the backup surfaces cannot be hardened and ground, hardened washers of different thicknesses are available.

UNITIZED THRUST BEARING ASSEMBLIES

Thrust bearing assemblies of the FNTK, FNTF, FNTKF, TPK and TVK series have been specially designed for use in applications where a unitized assembly allows for easy installation and eliminates the need for heat treatment and precision finishing of one or both thrust bearing backup surfaces.

Each FNTK, FNTF, FNTKF, TPK and TVK assembly consists of a FNT, TP or TV thrust needle roller and cage assembly – with one or two special-lipped washers that snap over the cage to produce a unitized thrust bearing assembly. The FNTK, FNTF, TPK J, TPK L, TVK J and TVK L assembly has one such washer. The FNTKF, TPK JL and TVK JL assembly has a washer on each side of the bearing.

The backup surfaces for these unitized thrust bearing assemblies should meet the limits of permissible out-of-squareness and coning or dishing, as shown in Fig. B6-2 on page B-6-10. Oil is the preferred lubricant for these assemblies. However they also are available pre-greased for applications that do not allow for oil lubrication.

The rolling elements of the AX series thrust bearings are retained and guided in radial pockets within the cage. The cage is retained in relation to the thrust washer by means of a retaining cap. The design of a one-piece steel cage employs a special curvature that guides the rolling elements, by their ends, along their centerlines.

In addition, this special curvature gives the steel cage great rigidity, while providing maximum lubricant space. This unitized assembly of components facilitates installation and provides a high-axial-load capacity, while occupying only minimal space. Note that the AX series is not interchangeable with the AXK series or FNT, TP and TV series thrust needle roller and cage assemblies.

THRUST WASHERS

Ideally, a thrust washer should be stationary with respect to, and piloted by, its supporting or backing member – whether or not this is an integral part of the shaft or housing. There should be no rubbing action between the thrust washer and any other machine member. Some thrust washers are designed for bore piloting and others may be piloted by their outer diameter.

THIN THRUST WASHERS (AS, W)

The metric series thin thrust washers are made of hardened spring steel. Thin washers are used when the supporting or backing members cannot be adequately prepared as raceways for the needle rollers. These washers are only 1.000 mm (0.0394 in) thick, and provide a very compact and cost-effective bearing arrangement. Although they are usually guided on the shaft, they may be housing-guided, when required by the application.

HEAVY THRUST WASHERS (LS, WS)

These metric series thrust washers are made of bearing quality steel, hardened and precision-ground on the flat raceway surfaces. Their bores and outer diameters are not ground, but provide satisfactory surfaces for shaft-piloting or housing-piloting arrangements.

SHAFT-PILOTED WASHERS (WS.811) AND HOUSING-PILOTED WASHERS (GS.811)

These shaft-piloted and housing-piloted metric series thrust washers are primarily for use with metric series cylindrical roller thrust bearings of series 811. They are made of bearing-quality steel with hardened and precision-ground, lapped-flat raceway surfaces. The tolerances of the thrust bearing bore and outer diameter shown, in the engineering section of this catalog, apply to shaft-and housing-piloted washers.

THIN/THICK (CP) AND HEAVY (CPR) THRUST WASHERS

The washer incorporated in the AX series thrust bearing is made from hardened bearing steel. It forms one of the raceways for the rolling elements. The opposing raceway is generally provided by a separate thrust washer of similar design supplied by JTEKT. When the AX series thrust bearing is piloted by the revolving part, the thrust washer must be piloted by the stationary part and vice versa. If the revolving part and the stationary part are noticeably eccentric to each other, the thrust bearing with integral washer must, without exception, be piloted by the revolving part.

The second raceway for the rolling elements also may be formed by the face of a shoulder or an inserted washer, provided these have the correct hardness and geometric dimensions.

DIMENSIONAL ACCURACY

TOLERANCES FOR THRUST NEEDLE ROLLER AND CAGE ASSEMBLIES

Pages B-6-12 to B-6-19 list the nominal outer diameter, bore diameter and needle roller diameter for the FNT, AXK, TP and TV series of thrust needle roller and cage assemblies and also the nominal outer diameter and bore diameter of the series AS, LS, WS.811, GS.811, W and WS thrust washers. Thickness tolerances for the AS and LS thrust washers also are included.

Tolerances for the outer and bore diameters of series FNT, AXK, TP and TV thrust needle roller and cage assemblies are given in Table B6-1 on page B-6-7, Table B6-2 on page B-6-8 and Table B6-6 on page B-6-9.

Table B6-1. Tolerances for outer diameter (D_c) and bore diameter (D_{c1}) of series FNT thrust needle roller and cage assemblies

D _c		Deviations of max. outside diameter (c12)		D _{c1}		Deviations of min. bore diameter (E11)	
>	≤	Max.	Min.	>	≤	Max.	Min.
mm in	mm in	mm in	mm in	mm in	mm in	mm in	mm in
18.000 0.7087	30.000 1.1811	-0.110 -0.0043	-0.320 -0.0126	3.000 0.1181	6.000 0.2362	+0.095 +0.0037	+0.020 +0.0008
30.000 1.1811	40.000 1.5748	-0.120 -0.0047	-0.370 -0.0146	6.000 0.2362	10.000 0.3937	+0.115 +0.0045	+0.025 +0.0010
40.000 1.5748	50.000 1.9685	-0.130 -0.0051	-0.380 -0.0150	10.000 0.3937	18.000 0.7087	+0.142 +0.0056	+0.032 +0.0013
50.000 1.9685	65.000 2.5591	-0.140 -0.0055	-0.440 -0.0173	18.000 0.7087	30.000 1.1811	+0.170 +0.0067	+0.040 +0.0016
65.000 2.5591	80.000 3.1496	-0.150 -0.0059	-0.450 -0.0177	30.000 1.1811	50.000 1.9685	+0.210 +0.0083	+0.050 +0.0020
80.000 3.1496	100.000 3.9370	-0.170 -0.0067	-0.520 -0.0205	50.000 1.9685	80.000 3.1496	+0.250 +0.0098	+0.060 +0.0024
100.000 3.9370	120.000 4.7244	-0.180 -0.0071	-0.530 -0.0209	80.000 3.1496	120.000 4.7244	+0.292 +0.0115	+0.072 +0.0028
120.000 4.7244	140.000 5.5118	-0.200 -0.0079	-0.600 -0.0236	120.000 4.7244	180.000 7.0866	+0.335 +0.0132	+0.085 +0.0033
140.000 5.5118	160.000 6.2992	-0.210 -0.0083	-0.610 -0.0240				
160.000 6.2992	180.000 7.0866	-0.230 -0.0091	-0.630 -0.0248				
180.000 7.0866	200.000 7.8740	-0.240 -0.0094	-0.700 -0.0276				

Table B6-7. Mounting tolerances for shafts and housings for metric series components

Bearing components	Shaft tolerance (shaft piloting)	Housing tolerance (housing piloting)
Needle roller and cage assembly. Types: AXK, FNT, TP and TV	h8	H8
Needle roller and cage assembly. Type: AX	h10	H10
Thin thrust washer. Types: AS and W	h8	H8
Heavy thrust washer. Types: LS and WS	h8	H8
Shaft-piloted thrust washer. Type: WS.811	h6 (j6)	Clearance
Housing-piloted thrust washer. Type: GS.811	Clearance	H7 (K7)
Thick, thin and heavy series thrust washers. Types: CP and CPR	h10	H10 required
Unitized thrust bearing assembly. Types: FNTKF (FNTK, FNTF) and TPK/TVK series	h8	H8

MOUNTING TOLERANCES

THRUST NEEDLE ROLLER AND CAGE ASSEMBLIES – METRIC SERIES

On FNT and AXK series thrust needle roller and cage assemblies, the cage bore has a closer tolerance than the outer diameter. Therefore bore piloting is preferred for these assemblies. To reduce wear, it is suggested that the piloting surface for the cage be hardened to an equivalent of at least 55 HRC. Where design requirements prevent bore piloting, the FNT or AXK series thrust needle roller and cage assemblies may be piloted on the outer diameters. For such cases, suitable O.D. piloting dimensions should be determined. Mounting tolerances are given in Table B6-7 on page B-6-10.

THRUST WASHERS

The mounting tolerances for series AS, W, LS, WS, WS.811 and GS.811 thrust washers for use with thrust needle roller and cage assemblies are given in Table B6-7 on page B-6-10.

To reduce the wear in the FNT and AXK series thrust assemblies, the piloting surface for the thrust washers should also be hardened to an equivalent of at least 55 HRC.

BACKUP SURFACES

In some applications, it is desirable to use the backup surfaces as raceways for the needle rollers of the thrust needle roller and cage assemblies. In such designs, these surfaces should be parallel and must be hardened to at least 58 HRC. If this hardness cannot be achieved and thrust washers cannot be used, the load ratings must be reduced as explained in the engineering section of this catalog.

Thrust raceway surfaces must be ground to a surface finish of 0.2 µm Ra (8 µin Ra). When this requirement cannot be met, thrust washers must be used.

The raceways against which the needle rollers operate, or the surface against which the thrust washers bear, must be square with the axis of the shaft. Equally important, the raceway or surface backing of the thrust washer must not be dished or coned. The permissible limits of out-of-squareness and dishing or coning are shown in the figures below.

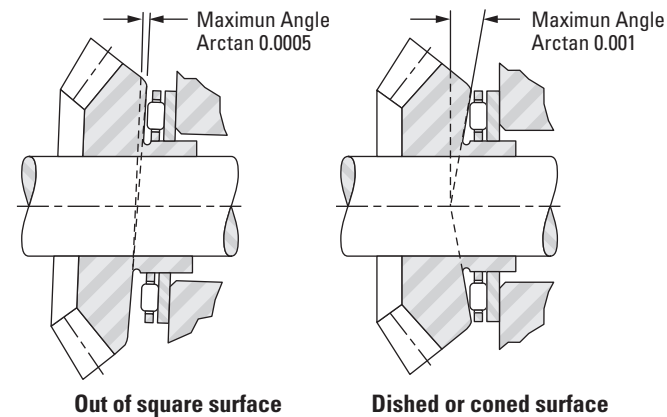


Fig. B6-2. Permissible limits

For the thin series washers AS thrust washers, full backup should be provided across the whole area of circulation of the rolling elements.

Thick series needle thrust bearings and thick thrust washers can be supported on a more restricted or discontinuous shoulder – provided that the deflection of the washer under load does not impede the smooth operation of the thrust bearing or the required axial run-out.

When an application does not involve the use of a thrust washer, the surface forming the second raceway must:

- Possess a suitable surface finish 0.2 µm Ra (8 µin Ra) and sufficient hardness in relation to the load to be supported. A minimum hardness of 58 HRC, enables thrust bearings to carry their full load capacity. Lower hardness values reduce the capacities shown in the tables of dimensions (see tabulated sizes).

TOLERANCES FOR PILOTING SURFACES (AX SERIES)

- Piloting on the shaft: h10 on dimensions D_{c1} for thrust bearings or dimension d for thrust washers.
- Piloting in the housing: H10 on dimensions D for thrust bearings or dimension d₁ for thrust washers.

LOAD RATINGS

MINIMUM AXIAL LOAD

Slippage can occur if the applied axial load is too light and the operating speed of the thrust needle roller and cage assembly is high – particularly if accompanied by inadequate lubrication. For satisfactory operation, a certain minimum load must be applied to a thrust needle roller and cage assembly which can be calculated from:

$$F_{a \text{ min}} = C_0/2200 \text{ [kN]}$$

Where:

- C₀ = static load rating [kN]
- F_{a min} = minimum axial load [kN]

LUBRICATION

Oil is the preferred lubricant for thrust needle roller and cage assemblies and an ample oil flow is absolutely necessary for high speeds or for moderate speeds when the load is relatively high.

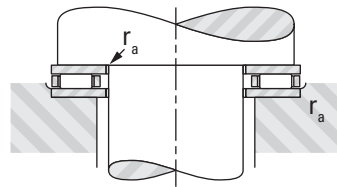
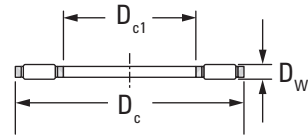
SPECIAL DESIGNS

Thrust needle roller and cage assemblies and thrust washers are made to special dimensions and configurations, as well as from special materials – when quantities permit economical manufacture.

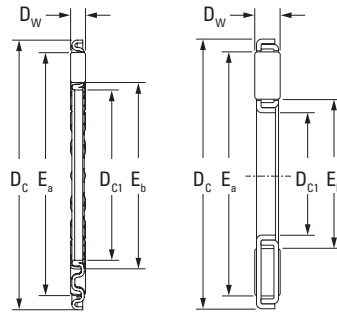
Thrust needle roller and cage assemblies are particularly adaptable to low-cost integral combination with special thrust washers. When the use of such special designs is considered, the following pages should be reviewed for evaluation of proposed arrangements.

THRUST NEEDLE ROLLER AND CAGE ASSEMBLIES, THRUST WASHERS

METRIC SERIES
AXK, FNT SERIES



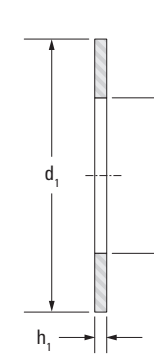
CAGE DESIGN



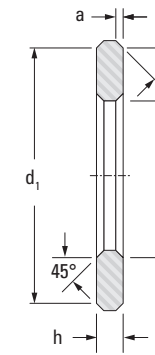
AXK

FNT

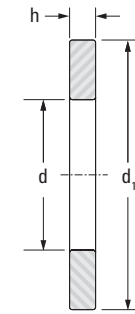
Shaft Dia.	D _{c1}	D _c	D _w	E _a	E _b	r _{a max}	Assembly Designation	Load Ratings		Speed Rating	Approx. Wt.
								Dynamic	Static		
								C	C ₀	Oil	
mm	mm in	mm in	mm in	mm in	mm in	mm in		kN lbf		min⁻¹	kg lbs
6	6 0.2362	19 0.7480	2 0.0787	16.9 0.665	7.8 0.307	0.3 0.012	AXK0619TN	6.37 1432	14.3 3215	23000	0.001 0.002
				18.0 0.709	8.0 0.315	0.3 0.012	FNT-619	6.82 1530	15.6 3510	21000	0.002 0.004
8	8 0.3150	21 0.8268	2 0.0787	18.6 0.732	9.6 0.378	0.3 0.012	AXK0821TN	8.34 1870	21.1 4740	20000	0.001 0.002
				20.0 0.787	10.0 0.394	0.3 0.012	FNT-821	7.67 1720	19.1 4290	20000	0.002 0.004
10	10 0.3937	24 0.9449	2 0.0787	22.5 0.886	11.0 0.433	0.3 0.012	AXK1024	9.32 2100	25.9 5820	17000	0.003 0.007
				23.0 0.906	12.0 0.472	0.3 0.012	FNT-1024	9.14 2060	25.2 5670	17000	0.002 0.004
12	12 0.4724	26 1.0236	2 0.0787	24.5 0.965	13.0 0.512	0.3 0.012	AXK1226	10.8 2430	32.3 7260	15000	0.004 0.009
				25.0 0.984	14.0 0.551	0.3 0.012	FNT-1226	9.92 2230	29.0 6520	15000	0.004 0.009
15	15 0.5906	28 1.1024	2 0.0787	27.0 1.063	17.0 0.669	0.3 0.012	AXK1528	11.1 2500	35.2 7910	15000	0.004 0.009
				27.0 1.063	17.0 0.669	0.3 0.012	FNT-1528	10.2 2290	31.3 7040	15000	0.004 0.009
17	17 0.6693	30 1.1811	2 0.0787	28.7 1.130	18.3 0.721	0.3 0.012	AXK1730TN	11.7 2630	38.7 8700	14000	0.004 0.009
				29.0 1.142	19.0 0.748	0.3 0.012	FNT-1730	10.8 2430	34.8 7820	14000	0.004 0.009
20	20 0.7874	35 1.3780	2 0.0787	34.0 1.339	22.0 0.866	0.3 0.012	AXK2035	12.8 2880	45.4 10200	12000	0.006 0.013
				34.0 1.339	22.0 0.866	0.3 0.012	FNTA-2035	13.8 3100	50.7 11400	12000	0.005 0.011
25	25 0.9843	42 1.6535	2 0.0787	41.0 1.614	29.0 1.142	0.6 0.024	AXK2542	14.3 3210	56.8 12800	10000	0.007 0.015
				41.0 1.614	27.0 1.063	0.6 0.024	FNT-2542	18.0 4050	75.3 16900	9700	0.008 0.018
30	30 1.1811	47 1.8504	2 0.0787	46.0 1.811	35.0 1.378	0.6 0.024	AXK3047	16.0 3600	68.1 15300	9000	0.009 0.020
				46.0 1.811	32.0 1.260	0.6 0.024	FNTA-3047	18.6 4180	82.4 18500	8900	0.009 0.020
35	35 1.3780	52 2.0472	2 0.0787	51.0 2.008	40.0 1.575	0.6 0.024	AXK3552	17.4 3910	79.5 17900	8100	0.010 0.022
				51.0 2.008	37.0 1.457	0.6 0.024	FNT-3552	21.7 4880	104.0 23400	7900	0.010 0.022



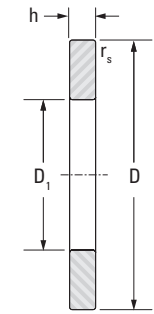
AS
(h₁ = 1.0)



LS



WS.811



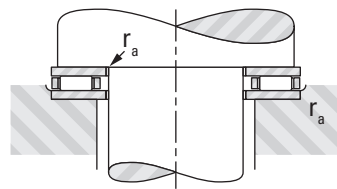
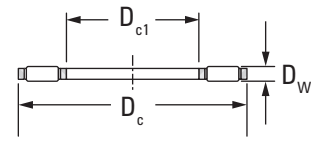
GS.811

Washer Dimensions			Thin		Heavy (LS)				Heavy					
d	D, d ₁	D ₁	h ₁	Washer Designation	Approx. Wt.	h	a	Washer Designation	Approx. Wt.	h	r _{s min}	Washer Designation		Approx. Wt.
mm in	mm in	mm in	mm in		kg lbs	mm in	mm in		kg lbs	mm in	mm in	Shaft Piloted	Housing Piloted	kg lbs
6 0.2362	19 0.7480		1.00 0.0394	AS0619	0.001 0.002									
8 0.3150	21 0.8268		1.00 0.0394	AS0821	0.002 0.004	2.75 0.108	0.30 0.012	LS0821	0.004 0.009					
10 0.3937	24 0.9449		1.00 0.0394	AS1024	0.003 0.007	2.75 0.108	0.50 0.020	LS1024	0.008 0.018					
12 0.4724	26 1.0236		1.00 0.0394	AS1226	0.003 0.007	2.75 0.108	0.50 0.020	LS1226	0.009 0.020					
15 0.5906	28 1.1024	16 0.6299	1.00 0.0394	AS1528	0.003 0.007	2.75 0.108	0.50 0.020	LS1528	0.010 0.022	2.75 0.108	0.30 0.012	WS.81102	GS.81102	0.0100 0.0220
17 0.6693	30 1.1811	18 0.7087	1.00 0.0394	AS1730	0.003 0.007	2.75 0.108	0.50 0.020	LS1730	0.011 0.024	2.75 0.108	0.30 0.012	WS.81103	GS.81103	0.011 0.024
20 0.7874	35 1.3780	21 0.8268	1.00 0.0394	AS2035	0.005 0.011	2.75 0.108	0.50 0.020	LS2035	0.014 0.031	2.75 0.108	0.30 0.012	WS.81104	GS.81104	0.014 0.031
25 0.9843	42 1.6535	26 1.0236	1.00 0.0394	AS2542	0.007 0.015	3.00 0.118	1.00 0.039	LS2542	0.021 0.046	3.00 0.118	0.60 0.024	WS.81105	GS.81105	0.021 0.046
30 1.1811	47 1.8504	32 1.2598	1.00 0.0394	AS3047	0.008 0.018	3.00 0.118	1.00 0.039	LS3047	0.023 0.051	3.00 0.118	0.60 0.024	WS.81106	GS.81106	0.023 0.051
35 1.3780	52 2.0472	37 1.4567	1.00 0.0394	AS3552	0.009 0.020	3.50 0.138	1.00 0.039	LS3552	0.030 0.066	3.50 0.138	0.60 0.024	WS.81107	GS.81107	0.032 0.071

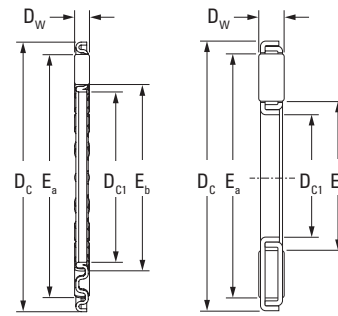
Continued on next page.

THRUST NEEDLE ROLLER AND CAGE ASSEMBLIES, THRUST WASHERS

METRIC SERIES
AXK, FNT SERIES



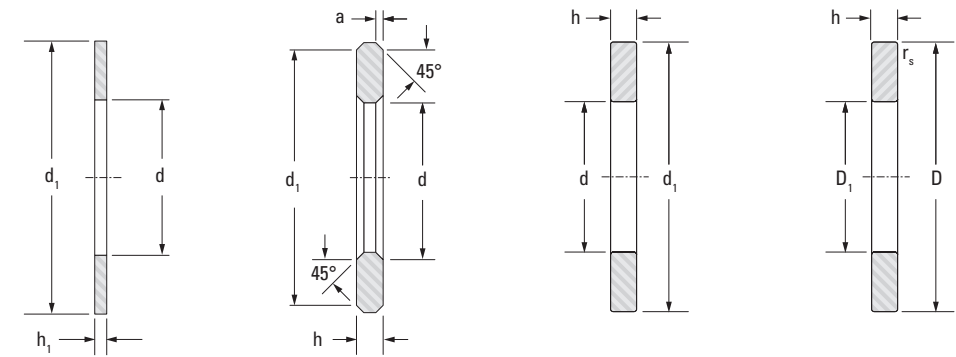
CAGE DESIGN



AXK

FNT

Shaft Dia.	D _{c1}	D _c	D _w	E _a	E _b	r _a max	Assembly Designation	Load Ratings		Speed Rating	Approx. Wt.
								Dynamic	Static		
								C	C ₀	Oil	
mm	mm	mm	mm	mm	mm	mm		kN		min⁻¹	kg
in	in	in	in	in	in	in		lbf			lbs
120	120 4.7244	155 6.1024	4 0.1575	153.0 6.024	125.0 4.921	0.6 0.024	AXK120155	98.5 22100	650 146000	2700	0.126 0.278
130	130 5.1181	170 6.6929	5 0.1969	167.0 6.575	136.0 5.354	0.6 0.024	AXK130170	132 29700	829 186000	2400	0.198 0.437
140	140 5.5118	180 7.0866	5 0.1969	177.0 6.969	146.0 5.748	0.6 0.024	AXK140180	136 30600	887 199000	2300	0.221 0.487
150	150 5.9055	190 7.4803	5 0.1969	187.0 7.362	156.0 6.142	0.6 0.024	AXK150190	141 31700	944 212000	2200	0.225 0.496
160	160 6.2992	200 7.8740	5 0.1969	197.0 7.756	166.0 6.535	0.6 0.024	AXK160200	146 32800	1000 225000	2100	0.249 0.549



AS
(h₁ = 1.0)

LS

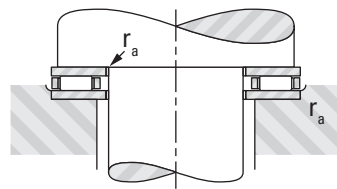
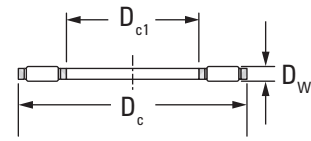
WS.811

GS.811

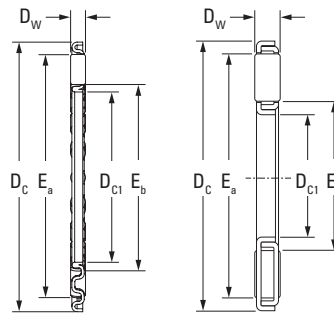
Washer Dimensions			Thin			Heavy (LS)				Heavy				
d	D, d ₁	D ₁	h ₁	Washer Designation	Approx. Wt.	h	a	Washer Designation	Approx. Wt.	h	r _s min	Washer Designation		Approx. Wt.
mm	mm	mm	mm		kg	mm	mm		kg	mm	mm	Shaft Piloted	Housing Piloted	kg
in	in	in	in		lbs	in	in		lbs	in	in			lbs
120 4.7244	155 6.1024		1.00 0.0394	AS120155	0.059 0.130									
130 5.1181	170 6.6929		1.00 0.0394	AS130170	0.074 0.163	9.00 0.354	1.50 0.059	LS130170	0.065 0.143					
140 5.5118	180 7.0866		1.00 0.0394	AS140180	0.078 0.172									
150 5.9055	190 7.4803		1.00 0.0394	AS150190	0.083 0.183									
160 6.2992	200 7.8740		1.00 0.0394	AS160200	0.089 0.196									

THRUST NEEDLE ROLLER AND CAGE ASSEMBLIES, THRUST WASHERS

METRIC SERIES
TP, TV SERIES



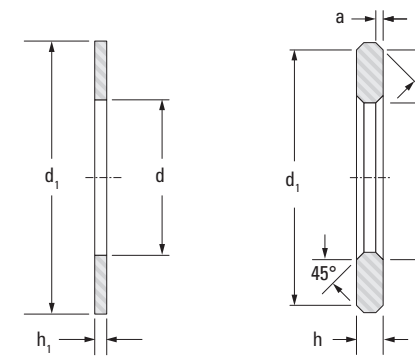
CAGE DESIGN



TV

TP

Shaft Dia.	D _{c1}	D _c	D _w	E _a	E _b	r _a max	Assembly Designation	Load Ratings		Speed Rating	Approx. Wt.
								Dynamic	Static	Oil	
								C	C ₀		
mm	mm in	mm in	mm in	mm in	mm in	mm in		kN lbf	min ⁻¹	kg lbs	
10	10	23	2	22	12		TV1023	9	25	18000	0.003
12	12	26	2	24	14		TV1226	10	29	16000	0.004
15	15	32	2	31	22		TP1532-1	13	45	13000	0.006
17	17	34	3	33	21		TV1734	16	52	12000	0.008
18	18	31	2	29	20		TP1831	12	41	14000	0.005
20	20	35	2	32	22		TP2035	15	57	12000	0.006
21	21	32	2	30	23		TP2132D	11	37	13000	0.005
22	22	34	2	32	25		TP2234	11	36	13000	0.005
25	25	42	2	40	28		TP2542	18	75	10000	0.009
30	30	47	2	45	34		TP3047-1	20	89	9000	0.010
34	34	45	2	43	37		TP3445A	12	48	9000	0.007
39.6	39.6	58.1	3	56	43		TP4058-1	29	120	7000	0.022
41	41	68	9	64	45		TP4168	87	233	6000	0.104
42	42	62	3	57	47		TP4262	23	91	7000	0.023
45	45	56	2	54	47		TP4556	12	49	7000	0.008
46	46	68	4	65	49		TP4668-2	47	210	6000	0.035
50	50	70	3	66	54		TP5070	34	153	6000	0.028
70	70	95	4	91	74		TP7095	57	275	4000	0.070



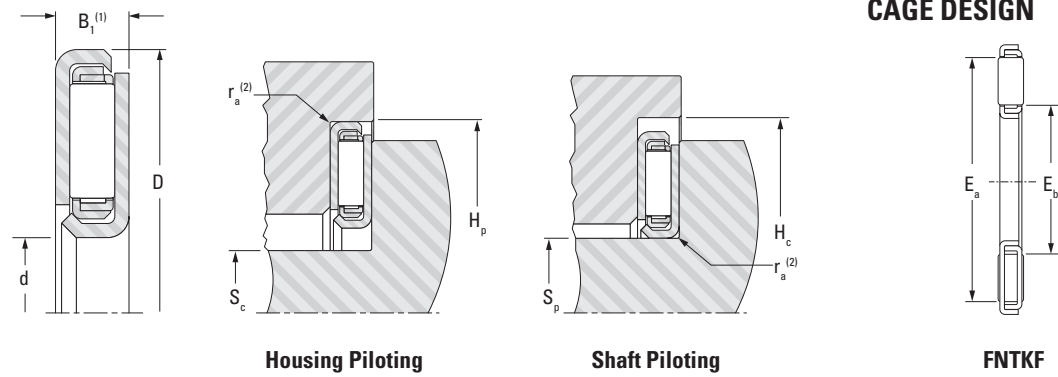
WF
(h₁ = 1.0)

WS F

Washer Dimensions			Thin			Heavy (WS)				Heavy				
d	D, d ₁	D ₁	h ₁	Washer Designation	Approx. Wt.	h	a	Washer Designation	Approx. Wt.	h	r _s min	Washer Designation		Approx. Wt.
mm in	mm in	mm in	mm in		kg lbs	mm in	mm in		kg lbs	mm in	mm in	Shaft Piloted	Housing Piloted	kg lbs
15	32		1.00	W1532F	0.005									
18	31		1.00	W1831F	0.004									
25	42		1.00	W2542F	0.007	4.00		WS2542KF	0.021					
70	95					3.00		WS7095F	0.075					

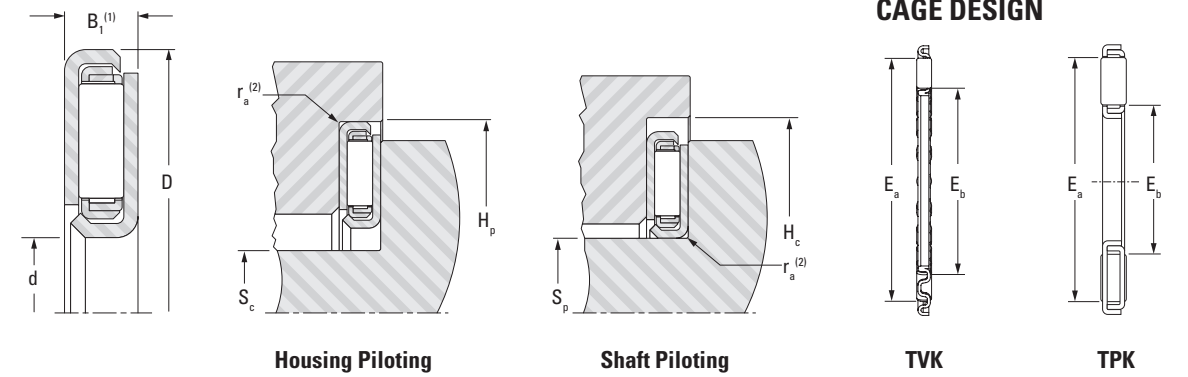
UNITIZED THRUST BEARING

METRIC SERIES
FNTKF SERIES



UNITIZED THRUST BEARING

METRIC SERIES
TPK JL,
TVK JL SERIES



Shaft Dia.	d	D	B ₁	Assembly Designation	Load Ratings		Speed Rating	Mounting Dimensions				Contact Dimensions Nominal		Approx. Wt.
					Dynamic C	Static C ₀		Housing Piloting		Shaft Piloting		E _a	E _b	
								H _p	S _c ⁽³⁾ Max.	S _p	H _c ⁽³⁾ Min.			
10	10 0.3937	28 1.1024	3.7 ⁽¹⁾ 0.146	FNTKF-1028	9.88 2220	29.0 6520	16000	28 1.102	8 0.31496	10 0.394	30 1.181	25 0.984	14 0.551	0.010
13	13 0.5118	30 1.1811	3.7 ⁽¹⁾ 0.146	FNTKF-1330	10.1 2270	31.3 7040	15000	30 1.181	11 0.433	13 0.512	32 1.260	27 1.063	17 0.669	0.011
15	15 0.5906	32 1.2598	3.7 ⁽¹⁾ 0.146	FNTKF-1532	10.8 2430	34.8 7820	14000	32 1.260	13 0.512	15 0.591	34 1.339	29 1.142	19 0.748	0.012
18	18 0.7087	37 1.4567	3.7 ⁽¹⁾ 0.146	FNTKF-1837	13.8 3100	50.3 11300	12000	37 1.457	16 0.630	18 0.709	39 1.535	34 1.339	22 0.866	0.017
23	23 0.9055	44 1.7323	3.7 ⁽¹⁾ 0.146	FNTKF-2344	18.0 4050	75.3 16900	9700	44 1.732	21 0.827	23 0.906	46 1.811	41 1.614	27 1.063	0.021
28	28 1.1024	49 1.9291	3.7 ⁽¹⁾ 0.146	FNTKF-2849	18.6 4180	82.4 18500	8900	49 1.929	26 1.024	28 1.102	51 2.008	46 1.811	32 1.260	0.024
33	33 1.2992	54 2.126	3.7 ⁽¹⁾ 0.146	FNTKF-3354	21.6 4860	104 23400	7900	54 2.126	31 1.220	33 1.299	56 2.205	51 2.008	37 1.457	0.029
38	38 1.4961	62 2.4409	4.7 ⁽¹⁾ 0.185	FNTKF-3862	31.4 7060	132 29700	7100	62 2.441	36 1.417	38 1.496	64 2.520	57 2.244	43 1.693	0.047
43	43 1.6929	67 2.6378	4.7 ⁽¹⁾ 0.185	FNTKF-4367	37.8 8500	173 38900	6400	67 2.638	41 1.614	43 1.693	69 2.717	63 2.480	47 1.850	0.051
48	48 1.890	72 2.8346	4.7 ⁽¹⁾ 0.185	FNTKF-4872	37.9 8520	179 40200	5900	72 2.835	46 1.811	48 1.890	74 2.913	68 2.677	52 2.047	0.056
53	53 2.0866	80 3.150	4.7 ⁽¹⁾ 0.185	FNTKF-5380	48.5 10900	254 57100	5300	80 3.150	51 2.008	53 2.087	82 3.228	76 2.992	57 2.244	0.070

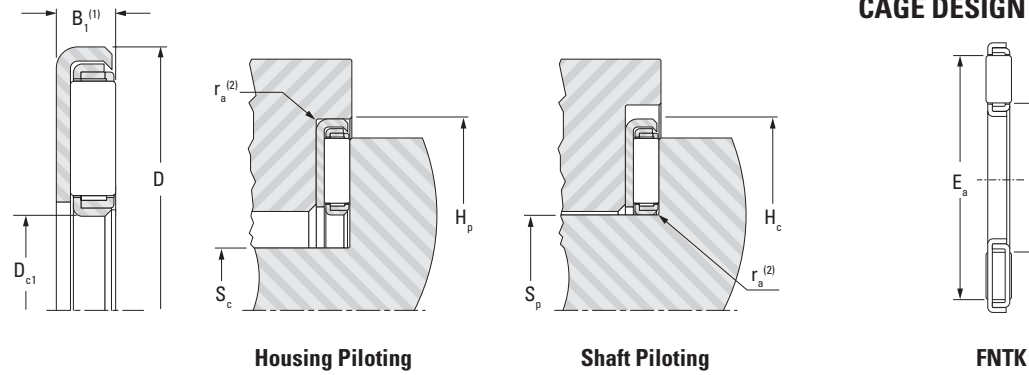
Shaft Dia.	d	D	B ₁	Assembly Designation	Load Ratings		Speed Rating	Mounting Dimensions				Contact Dimensions Nominal		Approx. Wt.
					Dynamic C	Static C ₀		Housing Piloting		Shaft Piloting		E _a	E _b	
								H _p	S _c ⁽³⁾ Max.	S _p	H _c ⁽³⁾ Min.			
17	17	33	3.4	TVK1733JL	8.95	27.7	14000	33	15	17	35	30	21	0.011
22.6	22.6	40	3.6	TVK2340JL-3	11.8	43.1	11000	40	20.6	22.6	42	36	28	0.016
30.7	30.7	47.1	4.184	TPK3147JL-2	14.4	59.6	9000	47.1	28.7	30.7	49.1	43	34	0.024
34	34	51.4	3.6	TPK3451JL	14.5	61.6	9000	51.4	32	34	53.4	47	38	0.023
38	38	53	3.6	TPK3853JL	13.5	57.9	8000	53	36	38	55	49	42	0.022
	38	58	4.8	TPK3858JL	24.7	95.8	8000	58	36	38	60	54	43	0.041
54	54	77	6	TVK5477JL	31.4	144	6000	77	52	54	79	72	60	0.076
55.9	55.9	76	3.584	TVK5676JL	18.5	96.6	6000	76	53.9	55.9	78	70	60	0.040
60.4	60.4	77.9	3.8	TPK6078JL	20.6	114	5000	77.9	58.4	60.4	79.9	74	65	0.038
	60.4	78	3.6	TVK6078JL	15.8	80.1	5000	78	58.4	60.4	80	74	65	0.037
63.8	63.8	83.6	4.6	TPK6484JL	29.9	141	5000	83.6	61.8	63.8	85.6	79	69	0.058
67.6	67.6	92	5.4	TVK6892JL-1	34.7	175	5000	92	65.6	67.6	94	86	74	0.086
73.6	73.6	89.6	3.6	TPK7490JL	11.7	56.7	5000	89.6	71.6	73.6	91.6	85	78	0.041
110	110	132.2	4.3	TPK110132JL-1	22.9	131	3000	132.2	108	110	134.2	126	116	0.091

(1) To be measured under a 2.0 kN (450 lbf) load.
 (2) r_a = 0.500 mm max. (0.0197 in max.).
 (3) S_c=d-2mm, H_c=D+2mm

(1) To be measured under a 2.0 kN (450 lbf) load.
 (2) r_a = 0.500 mm max. (0.0197 in max.).
 (3) S_c=d-2mm, H_c=D+2mm

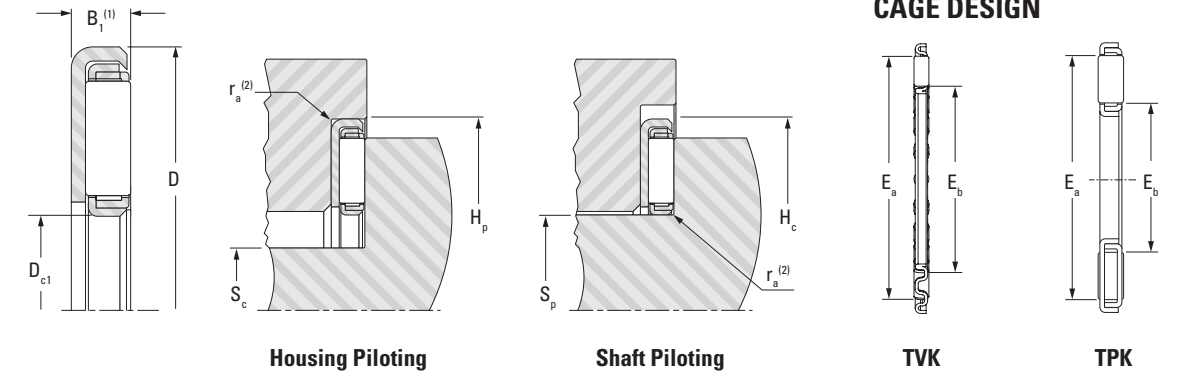
UNITIZED THRUST BEARING

METRIC SERIES
FNTK SERIES



UNITIZED THRUST BEARING

METRIC SERIES
TPK J,
TVK J SERIES



Shaft Dia.	D _{c1}	D	B ₁	Assembly Designation	Load Ratings		Speed Rating Oil	Mounting Dimensions				Contact Dimensions Nominal		Approx. Wt.
					Dynamic C	Static C ₀		Housing Piloting		Shaft Piloting		E _a	E _b	
								H _p	S _c ⁽³⁾	S _p	H _c ⁽³⁾			
					kN lbf			—	Max.	—	Min.	mm in	mm in	
12	12 0.4724	28 1.1024	2.85 ⁽¹⁾ 0.1122	FNTK-1228	9.88 2220	29.0 6520	16000	28 1.102	10.5 0.413	12 0.4724	29.5 1.161	25 0.9843	14 0.5512	0.007
15	15 0.5906	30 1.1811	2.85 ⁽¹⁾ 0.1122	FNTK-1530	10.1 2270	31.3 7040	15000	30 1.181	13.5 0.531	15 0.5906	31.5 1.240	27 1.063	17 0.6693	0.008
17	17 0.6693	32 1.260	2.85 ⁽¹⁾ 0.1122	FNTK-1732	10.8 2430	34.8 7820	14000	32 1.260	15.5 0.610	17 0.6693	33.5 1.319	29 1.1417	19 0.748	0.008
20	20 0.7874	37 1.4567	2.85 ⁽¹⁾ 0.1122	FNTK-2037	13.8 3100	50.3 11300	12000	37 1.457	18.5 0.728	20 0.7874	38.5 1.516	34 1.3386	22 0.8661	0.012
25	25 0.9843	44 1.7323	2.85 ⁽¹⁾ 0.1122	FNTK-2544	18.0 4050	75.3 16900	9700	44 1.732	23.5 0.925	25 0.9843	45.5 1.791	41 1.6142	27 1.063	0.015
30	30 1.1811	49 1.9291	2.85 ⁽¹⁾ 0.1122	FNTK-3049	18.6 4180	82.4 18500	8900	49 1.929	28.5 1.122	30 1.1811	50.5 1.988	46 1.811	32 1.260	0.018
35	35 1.378	54 2.126	2.85 ⁽¹⁾ 0.1122	FNTK-3554	21.6 4860	104 23400	7900	54 2.126	33.5 1.319	35 1.378	55.5 2.185	51 2.0079	37 1.4567	0.021
40	40 1.5748	62 2.4409	3.85 ⁽¹⁾ 0.1516	FNTK-4062	31.4 7060	132 29700	7100	62 2.441	38.5 1.516	40 1.5748	63.5 2.500	57 2.2441	43 1.6929	0.035
45	45 1.7717	67 2.6378	3.85 ⁽¹⁾ 0.1516	FNTK-4567	37.8 8500	173 38900	6400	67 2.638	43.5 1.713	45 1.7717	68.5 2.697	63 2.480	47 1.850	0.039
50	50 1.9685	72 2.8346	3.85 ⁽¹⁾ 0.1516	FNTK-5072	37.9 8520	179 40200	5900	72 2.835	48.5 1.909	50 1.9685	73.5 2.894	68 2.6772	52 2.0472	0.042
55	55 2.1654	80 3.150	3.85 ⁽¹⁾ 0.1516	FNTK-5580	48.5 10900	254 57100	5300	80 3.150	53.5 2.106	55 2.1654	81.5 3.209	76 2.9921	57 2.2441	0.053

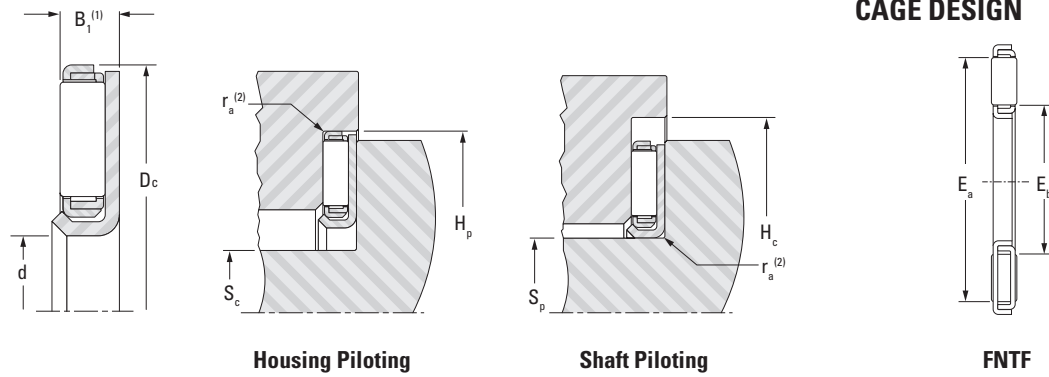
Shaft Dia.	D _{c1}	D	B ₁	Assembly Designation	Load Ratings		Speed Rating Oil	Mounting Dimensions				Contact Dimensions Nominal		Approx. Wt.		
					Dynamic C	Static C ₀		Housing Piloting		Shaft Piloting		E _a	E _b			
								H _p	S _c ⁽³⁾	S _p	H _c ⁽³⁾					
					kN lbf			—	Max.	—	Min.	mm in	mm in			
25	25	39.5	3.3	TVK2540J	16	54.1	11000	39.5	23.5					36	26	0.012
25.8	25.8	42	2.784	TVK2642J	14.6	57	11000	42	24.3					37	27	0.013
33.7	33.7	48.2	2.784	TVK3448J-1	15.6	66.2	9000	48.2	32.2					45	35	0.014
35	35	53	2.8	TVK3553J-1	13.8	57.2	5000	53	33.5					49	37	0.017
38	38	52	2.8	TVK3852J-1	13.9	58.5	8000	52	36.5					48	39	0.015

(1) To be measured under a 2.0 kN (450 lbf) load.
 (2) r_a = 0.500 mm max. (0.0197 in max.).
 (3) S_c=D_{c1}-1.5mm, H_c=D+1.5mm

(1) To be measured under a 2.0 kN (450 lbf) load.
 (2) r_a = 0.500 mm max. (0.0197 in max.).
 (3) S_c=D_{c1}-1.5mm, H_c=D+1.5mm

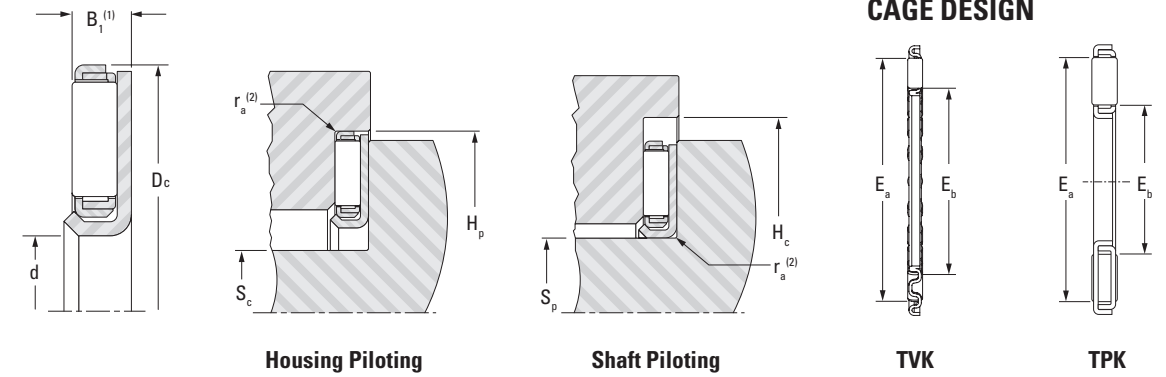
UNITIZED THRUST BEARING

METRIC SERIES
FNTF SERIES



UNITIZED THRUST BEARING

METRIC SERIES
TPK L,
TVK L SERIES



Shaft Dia.	d	Dc	B1	Assembly Designation	Load Ratings		Speed Rating	Mounting Dimensions				Contact Dimensions Nominal		Approx. Wt.
					Dynamic	Static		Housing Piloting		Shaft Piloting		Ea	Eb	
								Hp	Sc ⁽³⁾	Sp	Hc ⁽³⁾			
					C	Co		—	Max.	—	Min.	mm in	mm in	
10	10 0.394	26 1.024	2.85 ⁽¹⁾ 0.112	FNTF-1026	9.88 2220	29.0 6520	16000	26 1.024	8.5 0.335	10 0.394	27.5 1.083	25 0.984	14 0.551	0.006
13	13 0.512	28 1.102	2.85 ⁽¹⁾ 0.112	FNTF-1328	10.1 2270	31.3 7040	15000	28 1.102	11.5 0.453	13 0.512	29.5 1.161	27 1.063	17 0.669	0.007
15	15 0.591	30 1.181	2.85 ⁽¹⁾ 0.112	FNTF-1530	10.8 2430	34.8 7820	14000	30 1.181	13.5 0.531	15 0.591	31.5 1.240	29 1.142	19 0.748	0.008
18	18 0.709	35 1.378	2.85 ⁽¹⁾ 0.112	FNTF-1835	13.8 3100	50.3 11300	12000	35 1.378	16.5 0.650	18 0.709	36.5 1.437	34 1.339	22 0.866	0.011
23	23 0.906	42 1.654	2.85 ⁽¹⁾ 0.112	FNTF-2342	18.0 4050	75.3 16900	9700	42 1.654	21.5 0.846	23 0.906	43.5 1.713	41 1.614	27 1.063	0.014
28	28 1.102	47 1.850	2.85 ⁽¹⁾ 0.112	FNTF-2847	18.6 4180	82.4 18500	8900	47 1.850	26.5 1.043	28 1.102	48.5 1.909	46 1.811	32 1.260	0.017
33	33 1.299	52 2.047	2.85 ⁽¹⁾ 0.112	FNTF-3352	21.6 4860	104 23400	7900	52 2.047	31.5 1.240	33 1.299	53.5 2.106	51 2.008	37 1.457	0.019
38	38 1.496	60 2.362	3.85 ⁽¹⁾ 0.152	FNTF-3860	31.4 7060	132 29700	7100	60 2.362	36.5 1.437	38 1.496	61.5 2.421	57 2.244	43 1.693	0.033
43	43 1.693	65 2.559	3.85 ⁽¹⁾ 0.152	FNTF-4365	37.8 8500	173 38900	6400	65 2.559	41.5 1.634	43 1.693	66.5 2.618	63 2.480	47 1.850	0.038
48	48 1.890	70 2.756	3.85 ⁽¹⁾ 0.152	FNTF-4870	37.9 8520	179 40200	5900	70 2.756	46.5 1.831	48 1.890	71.5 2.815	68 2.677	52 2.047	0.041
53	53 2.087	78 3.071	3.85 ⁽¹⁾ 0.152	FNTF-5378	48.5 10900	254 57100	5300	78 3.071	51.5 2.028	53 2.087	79.5 3.130	76 2.992	57 2.244	0.053

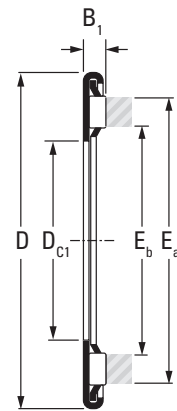
Shaft Dia.	d	Dc	B1	Assembly Designation	Load Ratings		Speed Rating	Mounting Dimensions				Contact Dimensions Nominal		Approx. Wt.	
					Dynamic	Static		Housing Piloting		Shaft Piloting		Ea	Eb		
								Hp	Sc ⁽³⁾	Sp	Hc ⁽³⁾				
					C	Co		—	Max.	—	Min.	mm in	mm in		
18.1	18.1	31.6	2.8	TPK1832L	8.70	27.1	14000				18.1	33.1	30	22	0.008
22	22	41	2.8	TPK2241L	15.0	59.4	10000				22	42.5	38	28	0.015
29	29	49	3.8	TVK2949L	24.7	90.8	8000				29	50.5	47	35	0.022
30.1	30.1	45.5	2.784	TPK3046L-3	14.1	58	9000				30.1	47	43	35	0.014
30.5	30.5	55.68	5.3	TPK3156L	40.7	135	8000				30.5	57.18	53	38	0.050
32.9	32.9	53.1	2.784	TVK3353L	20.8	101	8000				32.9	54.6	51	40	0.020
37.4	37.4	57.3	2.784	TVK3757L	21.9	110	7000				37.4	58.8	56	44	0.023
57	57	71	2.784	TVK5771L	16.8	85.6	6000				57	72.5	70	61	0.020
63	63	78	2.8	TVK6378L	15.7	80.1	5000				63	79.5	76	68	0.023

(1) To be measured under a 2.0 kN (450 lbf) load.
 (2) ra = 0.500 mm max. (0.0197 in max.).
 (3) Sc=d-1.5mm, Hc=Dc+1.5mm

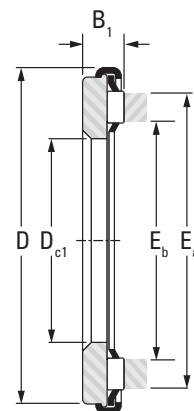
(1) To be measured under a 2.0 kN (450 lbf) load.
 (2) ra = 0.500 mm max. (0.0197 in max.).
 (3) Sc=d-1.5mm, Hc=Dc+1.5mm

UNITIZED THRUST BEARING TYPE AX

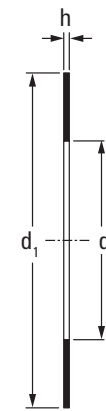
METRIC SERIES



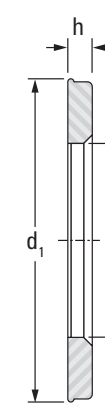
AX Thin series



AX Thick series



CP Thin series



CP Thick series

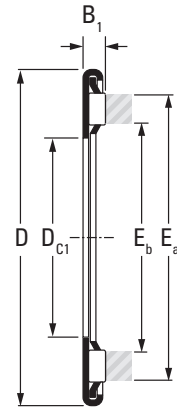
Shaft Dia.	D _{c1}	D	E _a	E _b	B ₁	Bearing Designation		Wt.	C		Speed Rating Oil
						Thin	Thick		Load Ratings		
									Dynamic	Static	
mm	mm in	mm in	mm in	mm in	mm in			kg lbs	kN lbf	min⁻¹	
5	5 0.197	13 0.512	10.9 0.43	6.3 0.25	2.3 0.091	AX 5 13		0.001 0.002	3.00 670	5.70 1280	25000
	5 0.197	13 0.512	10.9 0.43	6.3 0.25	3.5 0.138		AX 3,5 5 13	0.002 0.004	3.00 670	5.70 1280	25000
6	6 0.236	14 0.551	11.9 0.47	7.3 0.29	2.3 0.091	AX 6 14		0.001 0.002	3.15 710	6.35 1430	22000
	6 0.236	14 0.551	11.9 0.47	7.3 0.29	3.5 0.138		AX 3,5 6 14	0.002 0.004	3.15 710	6.35 1430	22000
7	7 0.276	15 0.591	12.9 0.51	8.3 0.33	2.3 0.091	AX 7 15		0.002 0.004	3.55 800	7.60 1710	22000
	7 0.276	15 0.591	12.9 0.51	8.3 0.33	3.5 0.138		AX 3,5 7 15	0.003 0.007	3.55 800	7.60 1710	22000
8	8 0.315	16 0.630	13.9 0.55	9.3 0.37	2.3 0.091	AX 8 16		0.002 0.004	3.70 830	8.30 1870	22000
	8 0.315	16 0.630	13.9 0.55	9.3 0.37	3.5 0.138		AX 3,5 8 16	0.003 0.007	3.70 830	8.30 1870	22000
9	9 0.354	17 0.669	14.9 0.59	10.3 0.41	2.3 0.091	AX 9 17		0.002 0.004	4.05 910	9.50 2140	19000
	9 0.354	17 0.669	14.9 0.59	10.3 0.41	3.5 0.138		AX 3,5 9 17	0.004 0.009	4.05 910	9.50 2140	19000
10	10 0.394	22 0.866	18.6 0.73	12.0 0.47	4.0 0.158		AX 4 10 22	0.007 0.015	5.00 1120	10.90 2450	15500
12	12 0.472	26 1.024	22.6 0.89	15.0 0.59	2.8 0.110	AX 12 26		0.006 0.013	6.90 1550	17.70 3980	13000
	12 0.472	26 1.024	22.6 0.89	15.0 0.59	4.0 0.158		AX 4 12 26	0.010 0.022	6.90 1550	17.70 3980	13000
13	13 0.512	26 1.024	22.6 0.89	15.0 0.59	2.8 0.110	AX 13 26		0.006 0.013	6.90 1550	17.70 3980	13000
	13 0.512	26 1.024	22.6 0.89	15.0 0.59	4.0 0.158		AX 4 13 26	0.010 0.022	6.90 1550	17.70 3980	13000
15	15 0.591	28 1.102	24.6 0.97	17.0 0.67	2.8 0.110	AX 15 28		0.007 0.015	7.40 1660	20.00 4500	11500

d	d ₁	h	Wt.	Washer Designation		Washer Designation Precision	h	Precision Wt.	Shaft Dia.
				Thin	Thick				
mm in	mm in	mm in	kg lbs				mm in	kg lbs	mm
5 0.197	12.4 0.488	0.8 0.032	0.001 0.002	CP 5 13					5
5 0.197	12.4 0.488	2.0 0.079	0.002 0.004		CP 2 5 13				
6 0.236	13.4 0.528	0.8 0.032	0.001 0.002	CP 6 14					6
6 0.236	13.4 0.528	2.0 0.079	0.002 0.004		CP 2 6 14				
7 0.276	14.4 0.567	0.8 0.032	0.001 0.002	CP 7 15					7
7 0.276	14.4 0.567	2.0 0.079	0.002 0.004		CP 2 7 15				
8 0.315	15.4 0.606	0.8 0.032	0.001 0.002	CP 8 16					8
8 0.315	15.4 0.606	2.0 0.079	0.002 0.004		CP 2 8 16				
9 0.354	16.4 0.646	0.8 0.032	0.001 0.002	CP 9 17					9
9 0.354	16.4 0.646	2.0 0.079	0.002 0.004		CP 2 9 17				
10 0.394	21.5 0.847	2.0 0.079	0.002 0.004		CP 2 10 22				10
12 0.472	25.5 1.004	0.8 0.032	0.003 0.007	CP 12 26		CPN 2 12 26	2.0 0.079	0.006 0.013	12
12 0.472	25.5 1.004	2.0 0.079	0.006 0.013		CP 2 12 26				
13 0.512	25.5 1.004	0.8 0.032	0.002 0.004	CP 13 26					13
13 0.512	25.5 1.004	2.0 0.079	0.006 0.013		CP 2 13 26				
15 0.591	27.5 1.083	0.8 0.032	0.003 0.007	CP 15 28		CPN 2 15 28	2.0 0.079	0.006 0.013	15

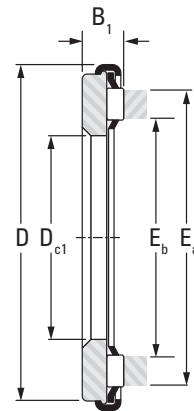
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UNITIZED THRUST BEARING TYPE AX

METRIC SERIES



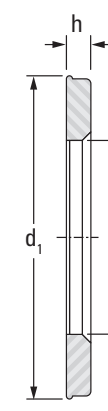
AX Thin series



AX Thick series



CP Thin series



CP Thick series

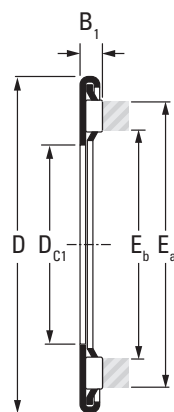
Shaft Dia.	D _{c1}	D	E _a	E _b	B ₁	Bearing Designation		Wt.	C		Speed Rating Oil
						Thin	Thick		Load Ratings		
									Dynamic	Static	
mm	mm in	mm in	mm in	mm in	mm in			kg lbs	kN lbf	min⁻¹	
15	15 0.591	28 1.102	24.6 0.97	17.0 0.67	4.0 0.158		AX 4 15 28	0.009 0.020	7.40 1660	20.00 4500	11500
17	17 0.669	30 1.181	26.6 1.05	19.0 0.75	2.8 0.110		AX 17 30	0.008 0.018	7.80 1750	22.00 4950	10500
	17 0.669	30 1.181	26.6 1.05	19.0 0.75	4.0 0.158		AX 4 17 30	0.010 0.022	7.80 1750	22.00 4950	10500
19	19 0.748	32 1.260	28.6 1.13	21.0 0.83	2.8 0.110		AX 19 32	0.009 0.020	8.00 1800	23.30 5240	10000
	19 0.748	32 1.260	28.6 1.13	21.0 0.83	4.0 0.158		AX 4 19 32	0.013 0.029	8.00 1800	23.30 5240	10000
20	20 0.787	35 1.378	31.6 1.24	22.0 0.87	5.0 0.197		AX 5 20 35	0.018 0.040	11.80 2650	39.00 8770	9000
25	25 0.984	42 1.654	37.4 1.47	27.7 1.09	2.8 0.110		AX 25 42	0.012 0.026	13.30 2990	49.00 11000	7500
	25 0.984	42 1.654	37.4 1.47	27.7 1.09	5.0 0.197		AX 5 25 42	0.025 0.055	13.30 2990	49.00 11000	7500
27	27 1.063	44 1.732	39.6 1.56	30.0 1.18	2.8 0.110		AX 27 44	0.012 0.026	13.70 3080	52.00 11700	7200
30	30 1.181	47 1.850	42.4 1.67	32.7 1.29	2.8 0.110		AX 30 47	0.014 0.031	14.50 3260	57.00 12800	6500
	30 1.181	47 1.850	42.4 1.67	32.7 1.29	5.0 0.197		AX 5 30 47	0.029 0.064	14.50 3260	57.00 12800	6500
35	35 1.337	52 2.047	49.0 1.93	37.2 1.47	2.8 0.110		AX 35 52	0.019 0.042	18.90 4250	84.00 18900	5500
	35 1.337	52 2.047	49.0 1.93	37.2 1.47	5.0 0.197		AX 5 35 52	0.035 0.077	18.90 4250	84.00 18900	5500
	35 1.337	53 2.087	49.0 1.93	37.2 1.47	2.8 0.110		AX 35 53	0.019 0.042	18.90 4250	84.00 18900	5500
	35 1.337	53 2.087	49.0 1.93	37.2 1.47	5.0 0.197		AX 5 35 53	0.036 0.079	18.90 4250	84.00 18900	5500

d	d ₁	h	Wt.	Washer Designation		Washer Designation Precision	h	Precision Wt.	Shaft Dia.
				Thin	Thick				
mm in	mm in	mm in	kg lbs				mm in	kg lbs	mm
15 0.591	27.5 1.083	2.0 0.079	0.006 0.013		CP 2 15 28				
17 0.669	29.5 1.161	0.8 0.032	0.003 0.007	CP 17 30		CPN 7 17 30	7.0 0.276	0.025 0.055	17
17 0.669	29.5 1.161	2.0 0.079	0.007 0.015		CP 2 17 30				
19 0.748	31.5 1.240	0.8 0.032	0.004 0.009	CP 19 32					19
19 0.748	31.5 1.240	2.0 0.079	0.009 0.020		CP 2 19 32				
20 0.787	34.5 1.358	3.0 0.118	0.013 0.029		CP 3 20 35	CPN 3 20 35	3.0 0.118	0.013 0.029	20
25 0.984	41.5 1.634	0.8 0.032	0.005 0.011	CP 25 42		CPN 3 25 42	3.0 0.118	0.019 0.042	25
25 0.984	41.5 1.634	3.0 0.118	0.019 0.042		CP 3 25 42				
27 1.063	43.7 1.721	0.8 0.032	0.006 0.013	CP 27 44					27
30 1.181	46.5 1.831	0.8 0.032	0.006 0.013	CP 30 47		CPN 5 30 47	5.0 0.197	0.037 0.082	30
30 1.181	46.5 1.831	3.0 0.118	0.022 0.049		CP 3 30 47				
35 1.378	51.5 2.028	0.8 0.032	0.007 0.015	CP 35 52		CPN 3 35 52	3.0 0.118	0.027 0.060	31
35 1.378	51.5 2.028	3.0 0.118	0.026 0.057		CP 3 35 52				35
35 1.378	52.5 2.067	0.8 0.032	0.007 0.015	CP 35 53					
35 1.378	52.5 2.067	3.0 0.118	0.027 0.060		CP 3 35 53				

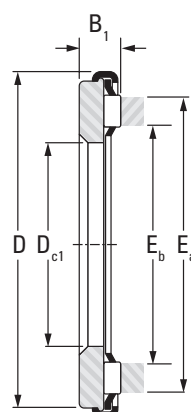
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UNITIZED THRUST BEARING TYPE AX

METRIC SERIES



AX Thin series



AX Thick series



CP Thin series



CP Thick series

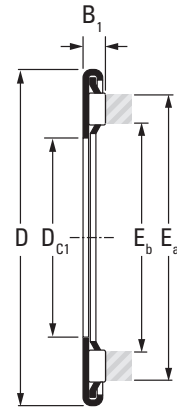
Shaft Dia.	D _{c1}	D	E _a	E _b	B ₁	Bearing Designation		Wt.	C		C ₀	Speed Rating Oil
						Thin	Thick		Load Ratings			
	mm	mm in	mm in	mm in	mm in	mm in			kg lbs	Dynamic	Static	min ⁻¹
40	40 1.557	60 2.362	54.9 2.16	43.0 1.69	2.8 0.110	AX 40 60		0.024 0.053	20.40 4590	96.00 21600	5000	
							AX 5 40 60	0.046 0.101	20.40 4590	96.00 21600		
45	45 1.772	65 2.559	59.9 2.36	48.0 1.89	2.8 0.110	AX 45 65		0.025 0.055	21.80 4900	109 24500	4500	
							AX 5 45 65	0.050 0.110	21.80 4900	109 24500		
50	50 1.969	70 2.756	65.7 2.59	53.3 2.10	2.8 0.110	AX 50 70		0.026 0.057	22.50 5060	118 26500	4000	
							AX 5 50 70	0.055 0.121	22.50 5060	118 26500		
55	55 2.165	78 3.071	72.5 2.85	58.4 2.30	2.8 0.110	AX 55 78		0.034 0.075	28.50 6410	164 36900	3800	
							AX 6 55 78	0.089 0.196	28.50 6410	164 36900		
60	60 2.362	85 3.347	79.2 3.12	63.5 2.50	6.0 0.236		AX 6 60 85	0.106 0.234	31.50 7080	193 43400	3500	
						65	65 2.559	90 3.543	84.2 3.32	68.5 2.70		3.5 0.138
					6.0 0.236							
70	70 2.759	95 3.740	89.2 3.51	73.5 2.89	3.5 0.138	AX 3,5 70 95		0.061 0.135	34.50 7760	223 50100	3000	
												6.0 0.236
75	75 2.953	100 3.937	94.2 3.71	78.5 3.09	3.5 0.138	AX 3,5 75 100		0.065 0.143	36.00 8090	240 54000	2900	
												6.0 0.236
80	80 3.150	105 4.134	99.2 3.91	83.5 3.29	3.5 0.138	AX 3,5 80 105		0.069 0.152	36.50 8210	253 56900	2700	
												6.0 0.236
85	85 3.347	110 4.331	104.2 4.10	88.5 3.48	3.5 0.138	AX 3,5 85 110		0.078 0.172	38.00 8540	270 60700	2600	

d	d ₁	h	Wt.	Washer Designation		Washer Designation Precision	h	Precision Wt.	Shaft Dia.
				Thin	Thick				
	mm in	mm in	mm in	kg lbs			mm in	kg lbs	mm
40 1.575	59.5 2.343	0.8 0.032	0.009 0.020	CP 40 60		CPN 3 40 60	3.0 0.118	0.034 0.075	40
					CP 3 40 60				
45 1.772	64.4 2.535	0.8 0.032	0.010 0.022	CP 45 65		CPN 3 45 65	3.0 0.118	0.037 0.082	45
					CP 3 45 65				
50 1.969	69.4 2.732	0.8 0.032	0.011 0.024	CP 50 70					50
					CP 3 50 70				
55 2.165	77.4 3.047	0.8 0.032	0.014 0.031	CP 55 78					55
					CP 4 55 78				
60 2.362	84.3 3.319	4.0 0.158	0.083 0.183		CP 4 60 85				60
				65 2.559	89.3 3.516	1.5 0.059	0.033 0.073	CP 1,5 65 90	
									4.0 0.158
70 2.756	94.3 3.713	4.0 0.158	0.093 0.205		CP 4 70 95				
				75 2.953	99.3 3.909	1.5 0.059	0.037 0.082	CP 1,5 75 100	
80 3.150	104.3 4.106	1.5 0.059	0.039 0.086	CP 1,5 80 105					
				85 3.347	109.3 4.303	1.5 0.059	0.047 0.104	CP 1,5 85 110	

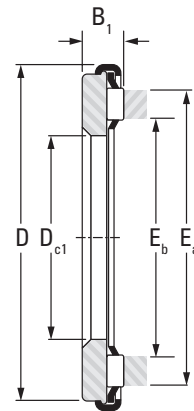
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UNITIZED THRUST BEARING TYPE AX

METRIC SERIES



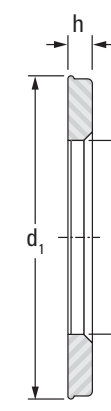
AX Thin series



AX Thick series



CP Thin series



CP Thick series

Shaft Dia.	D _{c1}	D	E _a	E _b	B ₁	Bearing Designation		Wt.	C		C _o	Speed Rating Oil
						Thin	Thick		Load Ratings			
									Dynamic	Static		
mm	mm in	mm in	mm in	mm in	mm in			kg lbs	kN lbf		min ⁻¹	
85	85 3.347	110 4.331	104.2 4.10	88.5 3.48	6.0 0.236		AX 6 85 110	0.142 0.313	38.00 8540	270 60700	2600	
90	90 3.543	120 4.724	112.9 4.45	94.2 3.71	4.5 0.177		AX 4,5 90 120	0.117 0.258	59.00 13300	360 80900	2400	
	90 3.543	120 4.724	112.9 4.45	94.2 3.71	8.0 0.315		AX 8 90 120	0.238 0.525	59.00 13300	360 80900	2400	
100	100 3.937	135 5.315	127.3 5.01	104.2 4.10	9.0 0.354		AX 9 100 135	0.364 0.803	73.00 16400	490 110000	2100	
110	110 4.331	145 5.709	137.3 5.41	114.2 4.50	4.5 0.177		AX 4,5 110 145	0.168 0.370	77.00 17300	550 124000	2000	
	110 4.331	145 5.709	137.3 5.41	114.2 4.50	9.0 0.354		AX 9 110 145	0.393 0.867	77.00 17300	550 124000	2000	
120	120 4.724	155 6.102	147.3 5.80	124.2 4.89	4.5 0.177		AX 4,5 120 155	0.182 0.401	80.00 18000	590 133000	1800	
	120 4.724	155 6.102	147.3 5.80	124.2 4.89	9.0 0.354		AX 9 120 155	0.424 0.935	80.00 18000	590 133000	1800	
130	130 5.118	170 6.693	161.0 6.34	135.0 5.32	11.0 0.433		AX 11 130 170	0.660 1.455	106 23800	710 160000	1700	
140	140 5.512	180 7.087	171.0 6.73	145.0 5.71	9.0 0.354		AX 11 140 180	0.670 1.477	111 25000	770 173000	1600	
150	150 5.906	190 7.480	181.0 7.13	155.0 6.10	9.0 0.354		AX 11 150 190	0.710 1.566	115 25900	830 187000	1500	
160	160 6.299	200 7.874	191.0 7.52	165.0 6.50	9.0 0.354		AX 11 160 200	0.760 1.676	118 26500	870 196000	1400	
170	170 6.693	215 8.465	207.0 8.15	175.0 6.89	12.0 0.472		AX 12 170 215	1.000 2.205	165 37100	1160 261000	1300	
180	180 7.087	225 8.858	217.0 8.54	185.0 7.28	12.0 0.472		AX 12 180 225	1.050 2.315	173 38900	1250 281000	1200	
190	190 7.480	240 9.449	232.0 9.13	196.0 7.72	13.9 0.547		AX 14 190 240	1.400 3.087	230 51700	1650 371000	1200	
200	200 7.874	250 9.843	242.0 9.53	206.0 8.11	13.9 0.547		AX 14 200 250	1.500 3.308	239 53700	1730 389000	1100	
220	220 8.661	270 10.630	262.0 10.32	226.0 8.90	13.9 0.547		AX 14 220 270	1.600 3.528	248 55800	1850 416000	1000	
240	240 9.449	300 11.811	286.0 11.26	246.0 9.69	14.9 0.587		AX 15 240 300	2.300 5.072	280 62900	2240 504000	900	

d	d ₁	h	Wt.	Washer Designation		Washer Designation Precision	h	Precision Wt.	Shaft Dia.
				Thin	Thick				
85	109.3 3.347	4.0 0.158	0.111 0.245		CP 4 85 110				
90	118.8 3.543	1.5 0.059	0.052 0.115		CP 1,5 90 120				90
90	118.8 3.543	5.0 0.197	0.173 0.381		CP 5 90 120				
100	133.8 3.937	6.0 0.236	0.277 0.611		CP 6 100 135				100
110	143.8 4.331	1.5 0.059	0.075 0.165		CP 1,5 110 145				110
110	143.8 4.331	6.0 0.236	0.300 0.662		CP 6 110 145				
120	153.8 4.724	1.5 0.059	0.081 0.179		CP 1,5 120 155				120
120	153.8 4.724	6.0 0.236	0.323 0.712		CP 6 120 155				
130	168.7 5.118	7.0 0.276	0.480 1.058		CP 7 130 170				130
140	178.7 5.512	7.0 0.276	0.500 1.103		CP 7 140 180				140
150	188.7 5.906	7.0 0.276	0.530 1.169		CP 7 150 190				150
160	198.7 6.299	7.0 0.276	0.560 1.235		CP 7 160 200				160
170	213.5 6.693	7.0 0.276	0.700 1.544		CP 7 170 215				170
180	223.5 7.087	7.0 0.276	0.735 1.621		CP 7 180 225				180
190	238.3 7.480	8.0 0.315	0.950 2.095		CP 8 190 240				190
200	248.3 7.874	8.0 0.315	1.000 2.205		CP 8 200 250				200
220	268.3 8.661	8.0 0.315	1.100 2.426		CP 8 220 270				220
240	298.5 9.449	9.0 0.354	1.600 3.528		CP 9 240 300				240

CYLINDRICAL ROLLER THRUST BEARINGS AND THEIR COMPONENTS

METRIC SERIES

Cylindrical roller thrust bearings provide rolling bearing arrangements that accommodate high-dynamic axial loads. The simple geometry of the bearing components allows the use of many design arrangements. As an example, for less demanding applications, it is possible to combine metric series, thrust cylindrical roller and cage assemblies, including the metric series heavy thrust washers (LS, CPR) and even the metric series thin thrust washers (AS, CP). These two thrust washer types are more commonly used with thrust needle roller and cage assemblies. Thrust cylindrical roller and cage assemblies also can be used without bearing thrust washers if the adjacent machine components can be prepared to serve as suitable raceways.

Cylindrical roller thrust bearings may be used where the load carrying capability of thrust needle roller and cage assemblies is insufficient. Also, the bearings can accommodate high-dynamic and static axial loads in one direction, but they are not suitable to transmit radial loads.

REFERENCE STANDARDS ARE:

- **ISO 104** – rolling bearings – thrust bearings – boundary dimensions, general plan.
- **ISO 199** – rolling bearings – thrust bearings – tolerances.
- **DIN 616** – rolling bearings – general plan for boundary dimensions.
- **DIN 722** – rolling bearing – thrust cylindrical roller bearings – single direction.

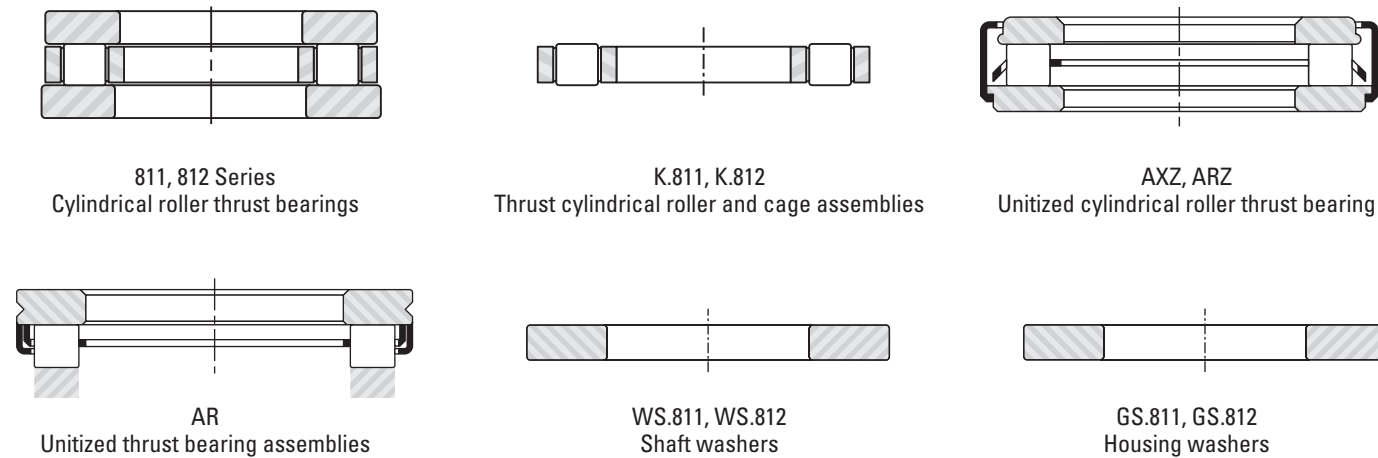


Fig. B6-3. Types of metric series cylindrical roller thrust bearings and their components

Suffixes	
LPB	Machined light metal window-type cage.
TVP	Molded window-type cage of glass reinforced nylon.

CONSTRUCTION

BASIC DESIGNS

Cylindrical roller thrust bearings of dimension series 811 and 812 comprise a thrust cylindrical roller and cage assembly (K), a shaft washer (WS) and a housing washer (GS). Providing the backup surfaces can be hardened and ground, they can be used as raceways for the cylindrical rollers of the thrust cylindrical roller and cage assembly resulting in a compact bearing arrangement.

Series AR is available with thin or thick CP washers or heavy CPR thrust washers.

Thrust bearing types AXZ and ARZ each have two thrust washers retained by an integral cap – giving protection against the entry of dirt and metal particles, while helping to retain the lubricant.

CAGE DESIGNS

Metric series 811 and 812 cylindrical roller thrust bearings use molded cages of glass-fiber reinforced-nylon 6/6 (suffix TVP) or machined cages of light metal (suffix LPB). The cages are designed to be piloted on the shaft. The reinforced nylon cages can be used at temperatures up to 120° C (250° F) continuously for extended periods. When lubricating these bearings with oil, it should be ensured that the oil does not contain additives detrimental to the cage over extended life at operating temperatures higher than 100° C (212° F). Also, care should be exercised that oil change intervals are observed as old oil may reduce cage life at such temperatures.

The rolling elements of the AR series thrust bearings are retained and guided in radial pockets within the cage. The cage is retained in relation to the thrust washer by means of a retaining cap. The design of a one-piece steel cage employs a special curvature that guides the rolling elements, by their ends, along their centerlines.

In addition, this special curvature gives the steel cage great rigidity, while providing maximum lubricant space. This unitized assembly of components facilitates installation and provides a high-axial load capacity while occupying only minimal space.

AR series cylindrical roller thrust bearings with a thin washer are of minimal thickness and provide excellent economy. They should be considered whenever the degree of support and rotational accuracy requirement allow.

BEARING THRUST WASHERS

SHAFT WASHERS AND HOUSING WASHERS

Shaft washers of types WS.811 and WS.812, as well as housing washers of types GS.811 and GS.812, are components of the metric series cylindrical roller thrust bearings of series 811 and 812. They are made of bearing-quality steel – with hardened, precision-ground and lapped-flat raceway surfaces. The tolerances of the thrust bearing bore and outer diameter shown in Table B6-8 and Table B6-9 (see next page) apply to shaft- and housing-piloted metric series washers.

HEAVY THRUST WASHERS (LS), THIN THRUST WASHERS (AS)

These thrust washers are more frequently used with thrust needle roller and cage assemblies of metric series FNT or AXK. They also are suitable for use with the thrust cylindrical roller and cage assemblies K.811. The heavy thrust washer of series LS are made of bearing-quality steel – hardened and precision-ground on the flat raceway surfaces. The bore and outer diameters of the heavy thrust washers are not ground. Therefore, when used with K.811 type assemblies, they are only suggested where accurate centering is not required. The thin thrust washers of series AS may be used in applications where the loads are light. Both types of these washers are listed in the tabular part of the metric series thrust needle roller and cage assemblies section.

THIN/THICK (CP) AND HEAVY (CPR) THRUST WASHERS

The washer incorporated in the AR series thrust bearing is made from hardened bearing steel and forms one of the raceways for the rolling elements. The opposing raceway is generally provided by a separate thrust washer of similar design supplied by JTEKT. When the AR series thrust bearing is piloted by the revolving part, the thrust washer must be piloted by the stationary part and vice versa. If the revolving part and the stationary part are noticeably eccentric to each other, the thrust bearing with integral washer must – without exception – be piloted by the revolving part.

The second raceway for the rolling elements may also be formed by the face of a shoulder or an inserted washer – provided these have the correct hardness and geometrical dimensions.

DIMENSIONAL ACCURACY

The tolerances for the metric series cylindrical roller thrust bearing bore and outer diameter shown in Table B6-8 and B6-9 apply to shaft-piloted washers of series WS.811 and WS.812, as well as housing-piloted washers of series GS.811 and GS.812. Tolerances for the bore diameter of series K.811 and K.812 thrust assemblies are given on page B-6-38.

The tolerances for the bore and outer diameter of series AS thrust washers are shown in Table B6-10 below. The tolerances for the bore and outer diameter of series LS thrust washers are given in Table B6-12 on page B-6-37. Bore inspection procedures for thin thrust washers (AS) and heavy thrust washers (LS) are given on page B-6-8.

Table B6-8. Tolerances of cylindrical roller thrust bearings - shaft piloted washer - metric series

Table with 14 columns: Nominal bore diameter d, Tolerance class PO, P6, P5, and wall thickness variation Si. It provides detailed tolerance data for various bore diameters from 18,000 to 400,000 mm.

* The values of the wall thickness variation Se, for the housing piloted washer are identical to Si for the shaft - piloted washers.

Table B6-9. Tolerances of cylindrical roller thrust bearings - housing piloted washer - metric series

Table with 10 columns: Nominal outside diameter D, Tolerance class PO, P6, P5, and wall thickness variation Si. It provides tolerance data for various outside diameters from 30,000 to 400,000 mm.

Table B6-10. Tolerances for outer diameter (d1) and bore diameter (d) of series AS thrust washers

Table with 6 columns: d1, Deviations of max. O.D. (e13), d, and Deviations of min. bore diameter (E13). It provides tolerance data for AS thrust washers.

Table B6-11. AR Series thickness and axial run-out tolerances

Table with 4 columns: Bore Dc1 mm, Thickness Tolerance μm, Axial run-out μm, and Quality (HP, HSP). It provides tolerance data for AR series bearings.

* High precision quality. 1) Under min. load of 150 N. 2) Under min. load of 250 N.

Table B6-12. Tolerances for outer diameter (d1) and bore diameter (d) of series LS heavy thrust washers

Table with 8 columns: d1, Deviations of max. O.D. (a12), d, and Deviations of min. bore diameter (E12). It provides tolerance data for LS heavy thrust washers.

Thickness tolerances for series LS heavy thrust washers are given in bearing tables.

The backup surfaces for the shaft washers WS.811 and WS.812 as well as the housing washers GS.811 and GS.812 of cylindrical roller thrust bearings must be square with the axis of the shaft. Equally important, the raceway or the surface backing the thrust washer must not be dished or coned. The permissible limits of the squareness and dishing or coning are shown in figures below. When using the thin (AS) thrust washers the cylindrical rollers of the thrust cage assembly must be supported over their entire length.

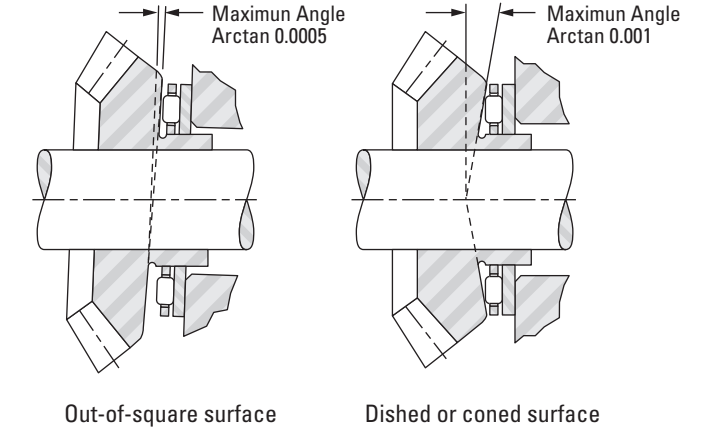


Fig. B6-4. Permissible limits

Bearing thrust washers should make close contact with the shaft or housing shoulder and must not touch the fillet radius. Therefore, the maximum fillet radius ra_max must be no greater than the minimum chamfer rs_min of the shaft washer (WS) and the housing washer (GS). See tabular pages B-6-39 and B-6-41.

Since roller thrust bearings generally run under considerable loads their incorporated washer (and thrust washer) should be supported on a shoulder covering the whole area of circulation of the rollers.

MOUNTING TOLERANCES

Shaft and housing tolerances for mounting metric series thrust cylindrical roller and cage assemblies are given in Table B6-13, shown below. If the cylindrical rollers of the thrust cylindrical roller and cage assemblies are to run directly on the adjacent support surfaces, they must be hardened to at least 58 HRC.

Table B6-13. Mounting tolerances for shafts and housings for metric series components

Table with 3 columns: Bearing components, Shaft tolerance (shaft piloting), and Housing tolerance (housing piloting). It lists tolerances for various bearing types.

LOAD RATINGS

MINIMUM AXIAL LOAD

To prevent slippage, a cylindrical roller thrust bearing must always be axially loaded. For satisfactory operation, a certain minimum load must be applied between the cylindrical rollers and their raceways. This can be calculated from:

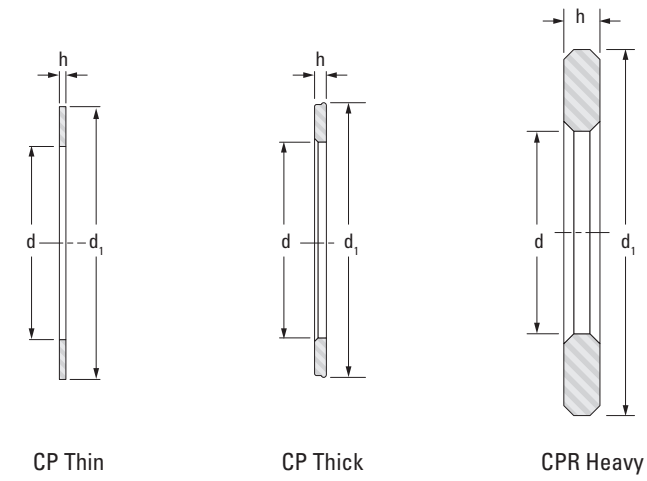
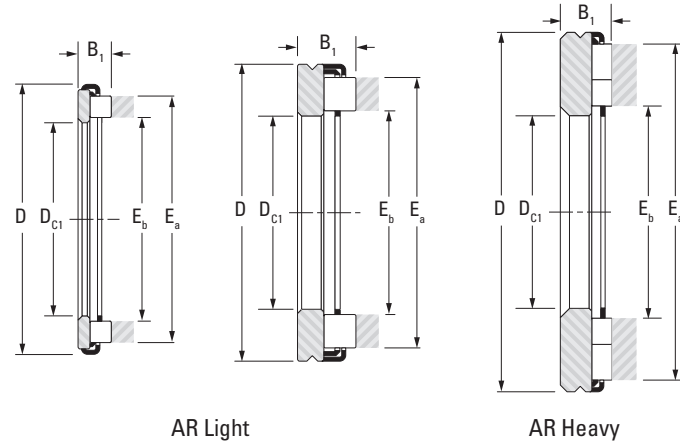
Fa_min = C0/2200 [kN]

Where:

C0 = static load rating [kN]
Fa_min = minimum axial load [kN]

UNITIZED ROLLER THRUST BEARING ASSEMBLIES

METRIC SERIES



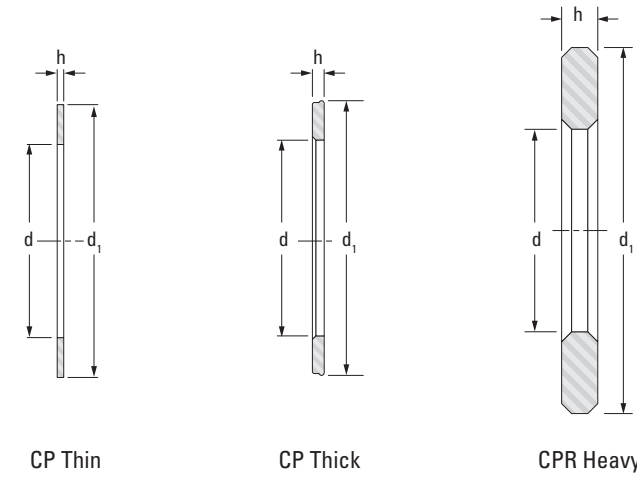
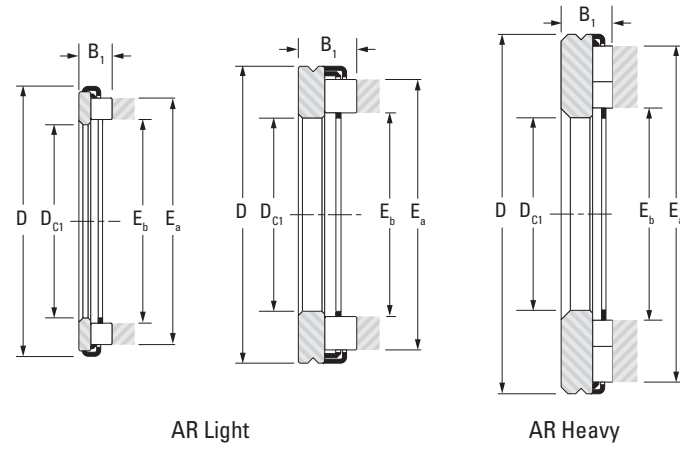
Shaft Dia.	D _{c1}	D	B ₁	E _a	E _b	AR		Wt.	C		Speed Rating Oil
						Assembly Designation			Load Ratings		
						Light Series	Heavy Series		Dynamic	Static	
mm	mm in	mm in	mm in	mm in	mm in			kg lbs	kN lbf		min⁻¹
10	10 0.394	22 0.866	4.5 0.177	18.5 0.73	12.2 0.48	AR 4,5 10 22		0.007 0.016	8.2 1840	17.9 4020	15500
12	12 0.472	26 1.024	5 0.197	22.9 0.90	14.8 0.58	AR 5 12 26		0.011 0.024	12.7 2860	29.5 6630	13000
15	15 0.591	28 1.103	5 0.197	24.9 0.98	16.8 0.66	AR 5 15 28		0.011 0.024	14.0 3150	34.0 7640	11500
17	17 0.669	30 1.181	5 0.197	26.9 1.06	18.8 0.74	AR 5 17 30		0.013 0.028	15.0 3370	39.0 8770	10500
20	20 0.787	35 1.378	7 0.276	31.6 1.24	22.0 0.87	AR 7 20 35		0.022 0.049	22.0 4950	54.0 12100	9000
25	25 0.984	42 1.654	7 0.276	37.3 1.47	27.7 1.09	AR 7 25 42		0.031 0.068	25.5 5730	70.0 15700	7500
	25 0.984	52 2.047	7 0.276	47.0 1.85	29.0 1.14		AR 7 25 52	0.070 0.154	32.5 7310	122.0 27400	6500
30	30 1.181	47 1.851	7 0.276	42.3 1.67	32.7 1.29	AR 7 30 47		0.036 0.079	26.5 5960	77.0 17300	6500
30	30 1.181	60 2.362	9 0.354	53.5 2.11	33.5 1.32		AR 9 30 60	0.113 0.249	46.0 10340	162.0 36400	5600
35	35 1.378	53.4 2.103	8 0.315	47.8 1.88	37.8 1.49	AR 8 35 53,4		0.052 0.115	33.8 7600	94.0 21100	5500
	35 1.378	68 2.677	9 0.354	60.6 2.39	39.0 1.54		AR 9 35 68	0.144 0.317	51.0 11500	194.0 43600	4900
40	40 1.575	60.4 2.378	9 0.354	54.8 2.16	42.8 1.69	AR 9 40 60,4		0.070 0.154	46.0 10300	129.0 29000	5000
	40 1.575	78 3.071	11 0.433	70.0 2.76	44.0 1.73		AR 11 40 78	0.225 0.496	71.0 16000	265.0 59600	4200
45	45 1.772	65.4 2.575	9 0.354	59.8 2.35	47.8 1.88	AR 9 45 65,4		0.077 0.170	49.0 11000	143.0 32100	4500
	45 1.772	85 3.347	14 0.551	77.0 3.03	49.0 1.93		AR 14 45 85	0.350 0.772	92.0 20700	340.0 76400	3800
50	50 1.968	70.4 2.772	9 0.354	64.8 2.55	52.8 2.08	AR 9 50 70,4		0.082 0.181	51.0 11500	157.0 35300	4000
	50 1.968	95 3.740	14 0.551	86.0 3.39	54.0 2.13		AR 14 50 95	0.448 0.988	108.0 24300	430.0 96700	3400
55	55 2.165	78.4 3.087	10 0.394	72.5 2.85	58.5 2.30	AR 10 55 78,4		0.125 0.276	61.0 13700	203.0 45600	3800
	55 2.165	105 4.134	14 0.551	96.2 3.79	60.2 2.37		AR 14 55 105	0.537 1.184	125.0 28100	530.0 119100	3100

d	d ₁	Thin Series	h	Wt.	Thick Series	h	Wt.	Heavy Series	h	Wt.	Shaft Dia.		
												Washer Dimension	
												mm in	mm in
10 0.394	22 0.866	CP 10 22	0.8 0.031	0.002 0.004	CP 2 10 22	2 0.079	0.004 0.009				10 10		
12 0.472	25 0.984	CP 12 26	0.8 0.031	0.003 0.006	CP 2 12 26	2 0.079	0.006 0.014				12 12		
15 0.591	27 1.063	CP 15 28	0.8 0.031	0.003 0.006	CP 2 15 28	2 0.079	0.006 0.013				15 15		
17 0.669	29 1.142	CP 17 30	0.8 0.031	0.003 0.006	CP 2 17 30	2 0.079	0.007 0.015				17 17		
20 0.787	34 1.339	CP 20 35	0.8 0.031	0.004 0.008	CP 3 20 35	3 0.118	0.013 0.029				20 20		
25 0.984	42 1.654	CP 25 42	0.8 0.031	0.005 0.012	CP 3 25 42	3 0.118	0.019 0.042				25 25		
25 0.984	52 2.047							CPR 4 25 52	4 0.157	0.052 0.115	25 25		
30 1.181	46 1.811	CP 30 47	0.8 0.031	0.006 0.013	CP 3 30 47	3 0.118	0.022 0.049				30 30		
30 1.181	60 2.362							CPR 5 30 60	5 0.197	0.083 0.183			
35 1.378	51 2.008	CP 35 52	0.8 0.031	0.007 0.015	CP 3 35 52	3 0.118	0.026 0.057				35 35		
35 1.378	68 2.677							CPR 5 35 68	5 0.197	0.102 0.225			
40 1.575	59 2.323	CP 40 60	0.8 0.031	0.009 0.021	CP 3 40 60	3 0.118	0.034 0.075				40 40		
40 1.575	78 3.071							CPR 6 40 78	6 0.236	0.162 0.357			
45 1.772	64 2.520	CP 45 65	0.8 0.031	0.010 0.022	CP 3 45 65	3 0.118	0.037 0.082				45 45		
45 1.772	85 3.347							CPR 8 45 85	8 0.315	0.245 0.540			
50 1.968	69 2.717	CP 50 70	0.8 0.031	0.011 0.024	CP 3 50 70	3 0.118	0.040 0.088				50 50		
50 1.968	95 3.740							CPR 8 50 95	8 0.315	0.308 0.679			
55 2.165	77 3.031	CP 55 78	0.8 0.031	0.014 0.031	CP 4 55 78	4 0.157	0.069 0.152				55 55		
55 2.165	105 4.134							CPR 8 55 105	8 0.315	0.380 0.838			

Continued on next page.

UNITIZED ROLLER THRUST BEARING ASSEMBLIES

METRIC SERIES



Shaft Dia.	D _{c1}	D	B ₁	E _a	E _b	AR		Wt.	C		Speed Rating Oil
						Assembly Designation			Load Ratings		
						Light Series	Heavy Series		Dynamic	Static	
mm	mm in	mm in	mm in	mm in	mm in			kg lbs	kN lbf		min⁻¹
60	60 2.362	85.4 3.362	10 0.394	79.5 3.13	63.5 2.50	AR 10 60 85,4		0.150 0.331	71.0 16000	255.0 57300	3500
	60 2.362	110 4.331	14 0.551	101.2 3.98	65.2 2.57		AR 14 60 110	0.572 1.261	130.0 29200	580.0 130400	2900
65	65 2.559	90.4 3.559	10 0.394	84.5 3.33	68.5 2.70	AR 10 65 90,4		0.160 0.353	74.0 16600	275.0 61800	3200
	65 2.559	115 4.528	14 0.551	106.2 4.18	70.2 2.76		AR 14 65 115	0.610 1.345	135.0 30300	620.0 139400	2800
70	70 2.756	95.4 3.756	10 0.394	89.5 3.52	73.5 2.89	AR 10 70 95,4		0.170 0.375	77.0 17300	295.0 66300	3000
	70 2.756	125 4.921	16 0.630	116.0 4.57	76.0 2.99		AR 16 70 125	0.775 1.709	174.0 39100	710.0 159600	2600
75	75 2.953	100 3.938	10 0.394	94.5 3.72	78.5 3.09	AR 10 75 100,4 ⁽¹⁾		0.180 0.397	80.0 18000	313.0 70400	2800
	75 2.953	135 5.315	16 0.630	126.0 4.96	82.0 3.23		AR 16 75 135	0.893 1.969	198.0 44500	860.0 193300	2400
80	80 3.150	105.4 4.150	10 0.394	99.5 3.92	83.5 3.29	AR 10 80 105,4		0.190 0.419	82.0 18400	330.0 74200	2700
	80 3.150	140 5.512	16 0.630	131.0 5.16	87.0 3.43		AR 16 80 140	0.960 2.116	208.0 46800	940.0 211300	2300
85	85 3.346	150 5.906	18 0.709	138.0 5.43	92.0 3.62		AR 18 85 150	1.256 2.769	230.0 51700	1010.0 227100	2100
90	90 3.550	155 6.103	18 0.709	143.0 5.63	97.0 3.82	AR 18 90 155		1.330 2.932	245.0 55100	1090.0 245000	2000
100	100 3.937	170 6.693	20 0.787	157.0 6.18	109.0 4.29		AR 20 100 170	1.740 3.836	280.0 62900	1250.0 281000	1800
110	110 4.331	190 7.481	24 0.945	178.0 7.01	118.0 4.65		AR 24 110 190	2.500 5.512	365.0 82100	1600.0 359700	1700
120	120 4.724	210 8.268	24 0.945	199.0 7.83	127.0 5.00		AR 24 120 210	3.200 7.055	470.0 105700	2300.0 517100	1500
130	130 5.118	225 8.858	24 0.945	214.0 8.43	138.0 5.43		AR 24 130 225	3.600 7.937	510.0 114700	2640.0 593500	1400
140	140 5.511	240 9.449	28 1.102	229.0 9.02	149.0 5.87		AR 28 140 240	4.800 10.582	600.0 134900	2980.0 669900	1300

Washer Dimension		Thin Series	h	Wt.	Thick Series	h	Wt.	Heavy Series	h	Wt.	Shaft Dia.
d	d ₁										
mm in	mm in		mm in	kg lbs		mm in	kg lbs		mm in	kg lbs	mm
60 2.362	84 3.307	CP 60 85	0.8 0.031	0.017 0.037	CP 4 60 85	4 0.157	0.083 0.183				60
60 2.362	110 4.331							CPR 8 60 110	8 0.315	0.405 0.893	
65 2.559	89 3.504	CP 1,5 65 90	1.5 0.059	0.033 0.073	CP 4 65 90	4 0.157	0.088 0.194				65
65 2.559	115 4.528							CPR 8 65 115	8 0.315	0.430 0.948	
70 2.756	94 3.701	CP 1,5 70 95	1.5 0.059	0.034 0.076	CP 4 70 95	4 0.157	0.093 0.205				70
70 2.756	125 4.921							CPR 8 70 125	8 0.315	0.510 1.12	
75 2.953	99 3.898	CP 1,5 75 100	1.5 0.059	0.037 0.082	CP 4 75 100	4 0.157	0.099 0.218				75
75 2.953	135 5.315							CPR 8 75 135	8 0.315	0.595 1.31	
80 3.150	104 4.094	CP 1,5 80 105	1.5 0.059	0.039 0.086	CP 4 80 105	4 0.157	0.104 0.229				80
80 3.150	140 5.512							CPR 8 80 140	8 0.315	0.630 1.39	
85 3.346	150 5.906							CPR 9 85 150	9 0.354	0.815 1.80	85
90 3.550	155 6.103							CPR 9 90 155	9 0.354	0.840 1.85	90
100 3.937	170 6.693							CPR 10 100 170	10 0.394	1.13 2.49	100
110 4.331	190 7.481							CPR 12 110 190	12 0.472	1.70 3.75	110
120 4.724	210 8.268							CPR 12 120 210	12 0.472	2.10 4.63	120
130 5.118	225 8.858							CPR 12 130 225	12 0.472	2.40 5.29	130
140 5.511	240 9.449							CPR 14 140 240	14 0.550	3.20 7.05	140

⁽¹⁾Assembly designation shows 100,4 as D, but D dimension is 100.

THRUST ASSEMBLIES AND THRUST BEARINGS – INCH SERIES

Thrust assemblies and thrust bearings of inch series are available in a variety of sizes. This catalog includes the most popular, standardized designs. If the backup surfaces cannot be used as raceways, hardened thrust washers are available.

REFERENCE STANDARDS ARE:

- **ANSI/ABMA Std. 21.2** – thrust needle roller and cage assemblies and thrust washers – inch design.
- **ANSI/ABMA Std. 24.2** – thrust bearings of ball and cylindrical roller types – inch design.

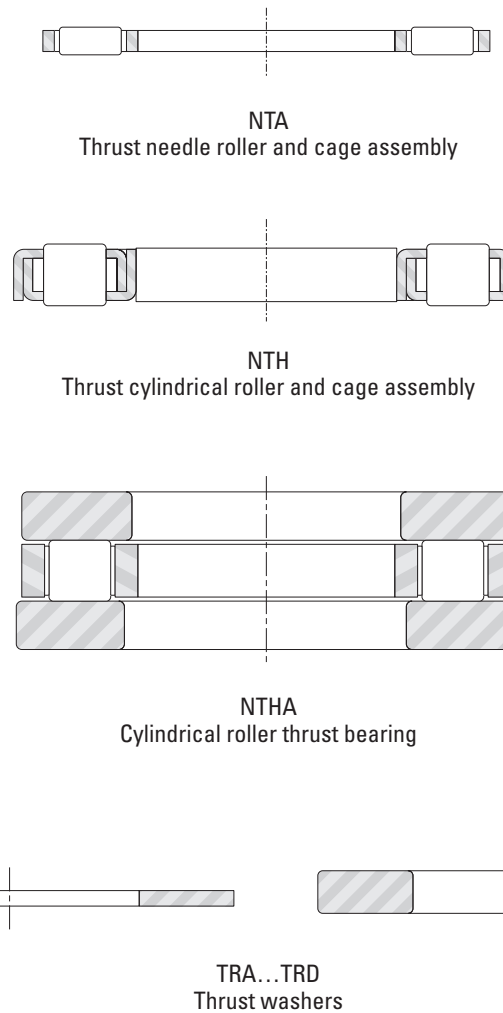


Fig. B6-5. Types of inch series thrust assemblies, thrust bearings and thrust washers

IDENTIFICATION

NTA is the complete prefix code for a thrust needle roller and cage assembly with inch nominal dimensions using needle rollers of the smallest practical diameter.

Thrust cylindrical roller and cage assemblies with inch nominal dimensions are identified by the prefix letters NTH. They use large diameter cylindrical rollers, providing higher load ratings.

Thrust washers of inch nominal dimensions are identified by the prefix letters TR followed by another letter such as A, B or C etc. – indicating washer thickness. TRA is the complete prefix code for the thinnest thrust washer made to inch nominal dimensions.

Most thrust washers are intended to be piloted on their bores. Some washers, however, are designed to be piloted on their outer diameters. Such washers are identified by the letter D, following the thickness code letter. Thus TRJD is the complete prefix code for a thrust washer with inch nominal dimensions of J thickness and designed to be piloted by its outer diameter.

Cylindrical roller thrust bearings, with prefix code NTHA, are made up of one NTH assembly – one TRI or TRJ bore-piloted washer and one TRID or TRJD outer-diameter piloted washer.

Because the bearing designation for thrust assemblies does not appear on the bearing itself, the manufacturer's parts list or another reliable source should always be consulted when ordering bearings for service or field replacement – to make certain that the correct bearing with the correct lubricant is used.

CONSTRUCTION

Thrust needle roller and cage assemblies (NTA) and thrust cylindrical roller and cage assemblies (NTH) have hardened cages and through-hardened, precision-ground rollers. The cages are securely fastened assemblies of two mating pieces. This construction minimizes cage stress and assures that the roller retaining function of the cage is unaffected by normal wear. The needle rollers and the cylindrical rollers are precision ground and lapped to close tolerance for optimum load distribution.

Thrust washers for the thrust needle roller and cage assemblies are designed for bore piloting. The thinner thrust washers are tumble burnished and may be out-of-flat due to heat treatment – but will flatten under load. The raceway surfaces of thick thrust washers are ground and lapped.

Thrust washers for the thrust cylindrical roller and cage assemblies are available in both bore-piloted and outer-diameter piloted types. Their piloting surfaces are ground and raceway surfaces are ground and lapped.

DIMENSIONAL ACCURACY

TOLERANCES FOR THRUST NEEDLE ROLLER AND CAGE ASSEMBLIES

Pages B-6-52 to B-6-61, list the nominal outer diameter, bore diameter and the needle roller diameter for the inch thrust needle roller and cage assemblies and their corresponding thrust washers appear in the bearing tables.

Tolerances for the bore diameters and outer diameters of inch thrust assemblies are given in Table B6-14.

Table B6-14. Tolerances for bore (D_{c1}) and outer (D_c) diameters of nominal inch thrust needle (NTA) and cylindrical (NTH) roller and cage assemblies

NTA thrust needle roller and cage assemblies				
D_w	Deviations			
	D_{c1}		D_c	
	Bore diameter		Outer diameter	
Needle roller diameter (nominal)	Max.	Min.	Max.	Min.
mm in	mm in	mm in	mm in	mm in
1.981 0.078	+0.178 +0.007	+0.051 +0.002	-0.254 -0.010	-0.508 -0.020
3.175 0.125	+0.254 +0.010	+0.051 +0.002	-0.254 -0.010	-0.635 -0.025
NTH thrust cylindrical roller and cage assemblies				
All diameters	+0.381 +0.015	0.000 0.000	-0.127 -0.005	-0.508 -0.020

BORE INSPECTION PROCEDURE FOR ASSEMBLY

The bore diameter (D_{c1}) of the assembly should be checked with "go" and "no go" plug gages. The "go" plug gage size is the minimum bore diameter of the assembly. The "no go" plug gage size is the maximum bore diameter of the assembly.

The assembly must fall freely from the "go" plug gage under its own free weight. The "no go" plug gage must not enter the bore. Where the "no go" plug gage can be forced through the bore, the assembly must not fall from the gage under its own weight.

TOLERANCES FOR THRUST WASHERS

Tolerances for the outer diameters and bore diameters of nominal inch thrust washers are given in Tables B6-15 and B6-16.

Table B6-15. Tolerances for outer diameter (d_1) of nominal inch (TRA, TRB, etc.) thrust washers

d_1 :Nominal outer diameter				Deviations			
>		≤		Max.		Min.	
mm	in	mm	in	mm	in	mm	in
6.000	0.24	133.400	5.25	-0.025	-0.010	-0.760	-0.030

Table B6-16. Tolerances for bore diameter (d) of nominal inch (TRA, TRB, etc.) thrust washers

d :Nominal bore diameter				Deviations			
>		≤		Max.		Min.	
mm	in	mm	in	mm	in	mm	in
6.000	0.24	57.200	2.25	+0.300	+0.012	+0.050	+0.002
57.200	2.25	133.400	5.25	+0.430	+0.017	+0.050	+0.002

BORE INSPECTION PROCEDURE FOR THRUST WASHER

The bore diameter (d) of the thrust washer should be checked with “go” and “no go” plug gages. The “go” plug gage size is the minimum bore diameter of the thrust washer. The “no go” plug gage size is the maximum bore diameter of the thrust washer.

The thrust washer, under its own weight, must fall freely from the “go” plug gage. The “no go” plug gage must not enter the bore. Where the “no go” plug gage can be forced through the bore, the thrust washer must not fall from the gage under its own weight.

TOLERANCES FOR CYLINDRICAL ROLLER THRUST BEARINGS

The tolerances for inch series cylindrical roller thrust bearings, cylindrical roller cage and thrust assemblies and their corresponding component thrust washers appear in the bearing tables.

MOUNTING TOLERANCES

THRUST NEEDLE ROLLER AND CAGE ASSEMBLIES

On NTA inch type thrust needle roller and cage assemblies, the cage bore has a larger contact area and a closer tolerance than the outer diameter. Therefore, bore piloting is preferred for these assemblies. To reduce wear, it is suggested that the piloting surface for the cage be hardened to an equivalent of at least 55 HRC.

Where design requirements prevent bore piloting, the NTA thrust needle roller and cage assemblies may be piloted on the outer diameters. It should be noted that the “diameter to clear washer O.D.” given in the bearing tables is not suitable for outer diameter piloting. For such cases, suitable O.D. piloting dimensions should be determined in consultation with your representative.

THRUST WASHERS FOR USE WITH NTA THRUST NEEDLE ROLLER AND CAGE ASSEMBLIES

Ideally, a thrust washer should be stationary with respect to and piloted by its supporting or backing member – whether or not this is an integral part of the shaft or housing. There should be no rubbing action between the thrust washer and any other machine member. The economics of design, however, often preclude these ideal conditions and thrust washers must be employed in another manner. In such cases, design details should be determined in consultation with your representative.

THRUST CYLINDRICAL ROLLER AND CAGE ASSEMBLIES

Type NTH assembly cage has a relatively large contact area on both the bore and the outer diameter. Thus, these assemblies can be piloted by either the shaft or the housing. In order to reduce wear, it is suggested that the piloting surface for the cage be hardened to an equivalent of at least 55 HRC.

When the shaft is used as the piloting surface the outer diameter of the cage must clear the housing under all conditions. Conversely, when the housing is the piloting surface, the shaft must clear the cage bore under all conditions. The mounting dimensions are given in the bearing tables for both shaft and housing piloting. Bore inspection procedure for the assembly given on page B-6-49 should be used for checking the bore of NTH assemblies.

THRUST WASHERS FOR USE WITH THRUST CYLINDRICAL ROLLER AND CAGE ASSEMBLIES

Types TRID and TRJD thrust washers for use with thrust cylindrical roller and cage assemblies are designed to pilot from the housing and to clear the shaft. Types TRI and TRJ thrust washers are designed to pilot from the shaft and clear the housing. The thrust washers should be stationary with respect to their piloting (or locating) machine members. There should be no rubbing action between the washer and any other machine member.

BACKUP SURFACES

In some applications, it is desirable to use the backup surfaces as raceways for the rollers of the thrust assemblies. When this is done, these surfaces must be hardened to an equivalent of at least 58 HRC. If this hardness cannot be achieved and thrust washers cannot be used, the load ratings must be reduced as explained in the engineering section of this catalog.

Thrust raceway surfaces must be ground to a surface of 8 µin Ra (0.20 µm Ra). When this requirement cannot be met, thrust washers must be used.

The raceways against which the rollers operate or the surfaces against which the thrust washers bear must be square with the axis of the shaft. Equally important, the raceway or surface backing the thrust washer must not be dished or coned. The permissible limits of out-of-squareness and dishing or coning are shown in the figures below.

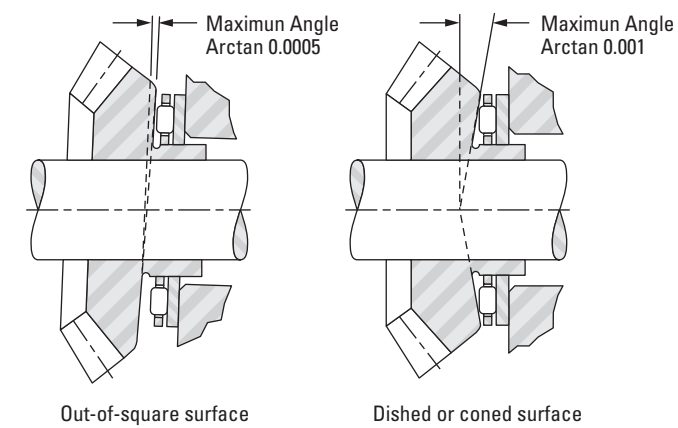


Fig. B6-6. Permissible limits

TYPE NTHA CYLINDRICAL ROLLER THRUST BEARING

The NTHA cylindrical roller thrust bearing consists of the NTH thrust cylindrical roller and cage assembly and two thrust washers. This bearing is sold as a unit.

A typical mounting of the thrust bearing on a rotating shaft is shown in Fig. B6-7. The bore of the rotating shaft supported thrust washer is ground for an accurate fit on the shaft. The outer diameter of the stationary housing supported thrust washer is ground for a proper fit in the housing.

The NTHA cylindrical roller thrust bearing cage is normally shaft piloted. In the event it is necessary to pilot the cage by the housing – Fig. B6-8 illustrates a possible mounting arrangement. When other mounting arrangements are dictated by the application, they should be determined in consultation with your representative.

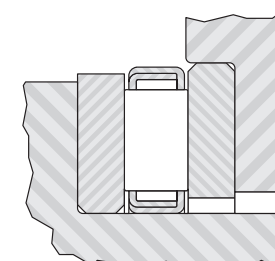


Fig. B6-7. Typical mounting of a thrust bearing when the shaft rotates

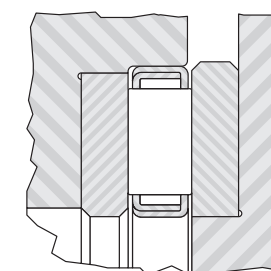


Fig. B6-8. NTHA possible mounting arrangement

LOAD RATINGS

MINIMUM AXIAL LOAD

Slippage can occur if the applied axial load is too light and the operating speed of the thrust needle roller and cage assembly is high – particularly if accompanied by inadequate lubrication. For satisfactory operation, a certain minimum load must be applied to a thrust needle roller and cage assembly which can be calculated from:

$$F_{a \text{ min}} = C_0/2200 \text{ [kN]}$$

Where:

$$C_0 = \text{static load rating [kN]}$$

$$F_{a \text{ min}} = \text{minimum axial load [kN]}$$

LUBRICATION

Oil is the preferred lubricant for thrust needle or cylindrical roller and cage assemblies. An ample oil flow is absolutely necessary for high speeds or for moderate speeds when the load is relatively high.

SPECIAL DESIGNS

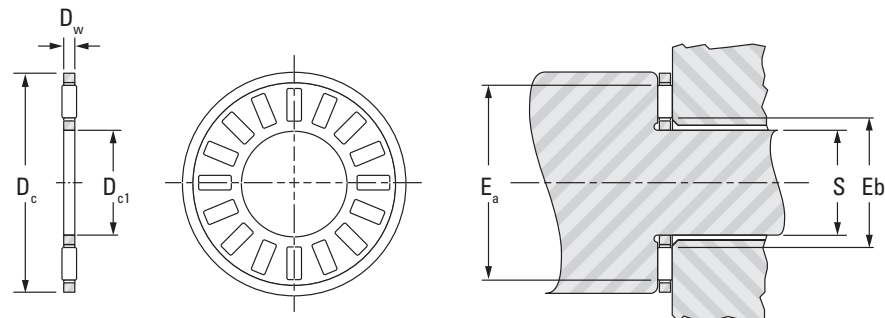
Thrust needle roller and cage assemblies and thrust washers are also made to special dimensions and configurations, as well as from special materials – when quantities permit economical manufacture.

Thrust needle roller and cage assemblies are particularly adaptable to low-cost integral combinations, with special thrust washers. When the use of such special designs are considered, the following pages should be reviewed for evaluation of proposed arrangements.

THRUST NEEDLE ROLLER AND CAGE ASSEMBLIES, THRUST WASHERS

INCH SERIES

- Dimensions for bore and O.D. of thrust assemblies and washers are nominal.
- See page B-6-50 for details on piloting and backup surfaces.
- Thrust washers burnished at least one-quarter of bore area (remainder is rough breakaway finish).
- O.D. finish of washers will be as blanked.

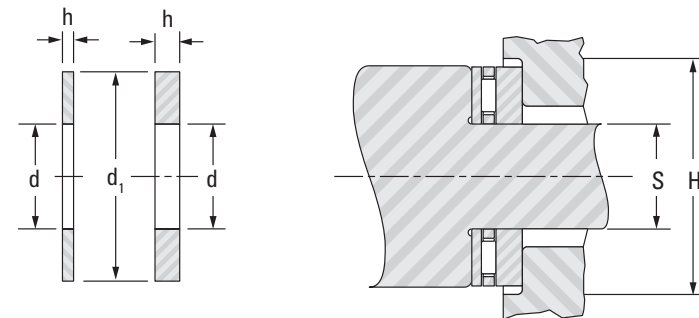


NTA

Raceway hardness to be 58 HRC or equivalent

Shaft Dia.	D _{c1}	D _c	D _w	E _b	E _a	Assembly Designation	Load Ratings		Speed Rating ⁽¹⁾	Wt.
							C	C ₀		
							Dynamic	Static		
in	mm in	mm in	mm in	mm in	mm in		kN lbf	min ⁻¹	kg lbs	
1/4	6.35 0.250	17.45 0.687	1.984 0.0781	8.636 0.340	14.732 0.580	NTA-411	5.12 1150	10.76 2420	26000	0.001 0.003
5/16	7.92 0.312	19.05 0.75	1.984 0.0781	10.16 0.400	16.256 0.640	NTA-512	5.83 1310	13.17 2960	24000	0.002 0.004
3/8	9.53 0.375	20.625 0.812	1.984 0.0781	11.68 0.460	18.034 0.710	NTA-613	6.05 1360	14.32 3220	22000	0.002 0.004
1/2	12.70 0.500	23.80 0.937	1.984 0.0781	14.99 0.590	21.08 0.830	NTA-815	7.16 1610	19.13 4300	19000	0.002 0.005
9/16	14.275 0.562	25.40 1.000	1.9837 0.0781	16.51 0.650	22.606 0.890	NTA-916	7.70 1730	21.53 4840	18000	0.003 0.006
5/8	15.88 0.625	28.575 1.125	1.9837 0.0781	18.03 0.710	25.908 1.020	NTA-1018	9.79 2200	30.38 6830	15000	0.003 0.007

⁽¹⁾Speed ratings listed are based on adequate oil lubrication. See page B-6-51 for lubrication information. Suggestions for an application requiring O.D. piloting should be determined in consultation with your representative.



Thrust Washer Designation	d	d ₁	h		S		H ⁽²⁾ Dia. To Clear O.D.	Washer Wt.	Shaft Dia.
			Max.	Min.	Max.	Min.			
			mm in	mm in	mm in	mm in			
TRA-411	6.35 0.250	17.45 0.687	0.81 0.032	0.76 0.030	6.35 0.250	6.27 0.247	18.26 0.719	0.001 0.003	1/4
TRB-411	6.35 0.250	17.45 0.687	1.60 0.063	1.52 0.060	6.35 0.250	6.27 0.247	18.26 0.719	0.002 0.005	
TRC-411	6.35 0.250	17.45 0.687	2.41 0.095	2.34 0.092	6.35 0.250	6.27 0.247	18.26 0.719	0.004 0.008	
TRA-512	7.92 0.312	19.05 0.750	0.81 0.032	0.76 0.030	7.92 0.312	7.85 0.309	19.84 0.781	0.001 0.003	5/16
TRB-512	7.92 0.312	19.05 0.750	1.60 0.063	1.52 0.060	7.92 0.312	7.85 0.309	19.84 0.781	0.003 0.006	
TRA-613	9.53 0.375	20.62 0.812	0.81 0.032	0.76 0.030	9.53 0.375	9.45 0.372	21.44 0.844	0.001 0.003	3/8
TRB-613	9.53 0.375	20.62 0.812	1.60 0.063	1.52 0.060	9.53 0.375	9.45 0.372	21.44 0.844	0.003 0.006	
TRC-613	9.53 0.375	20.62 0.812	2.41 0.095	2.34 0.092	9.53 0.375	9.45 0.372	21.44 0.844	0.004 0.009	
TRA-815	12.70 0.500	23.80 0.937	0.81 0.032	0.76 0.030	12.70 0.500	12.62 0.497	24.61 0.969	0.002 0.004	1/2
TRB-815	12.70 0.500	23.80 0.937	1.60 0.063	1.52 0.060	12.70 0.500	12.62 0.497	24.61 0.969	0.004 0.008	
TRC-815	12.70 0.500	23.80 0.937	2.41 0.095	2.34 0.092	12.70 0.500	12.62 0.497	24.61 0.969	0.005 0.012	
TRA-916	14.27 0.562	25.40 1.000	0.81 0.032	0.76 0.030	14.27 0.562	14.20 0.559	26.19 1.031	0.002 0.005	9/16
TRB-916	14.27 0.562	25.40 1.000	1.60 0.063	1.52 0.060	14.27 0.562	14.20 0.559	26.19 1.031	0.004 0.008	
TRC-916	14.27 0.562	25.40 1.000	2.41 0.095	2.34 0.092	14.27 0.562	14.20 0.559	26.19 1.031	0.006 0.013	
TRA-1018	15.88 0.625	28.58 1.125	0.81 0.032	0.76 0.030	15.88 0.625	15.80 0.622	29.36 1.156	0.003 0.006	5/8
TRB-1018	15.88 0.625	28.58 1.125	1.60 0.063	1.52 0.060	15.88 0.625	15.80 0.622	29.36 1.156	0.005 0.012	
TRC-1018	15.88 0.625	28.58 1.125	2.41 0.095	2.34 0.092	15.88 0.625	15.80 0.622	29.36 1.156	0.008 0.018	
TRD-1018	15.88 0.625	28.58 1.125	3.20 0.126	3.12 0.123	15.88 0.625	15.80 0.622	29.36 1.156	0.011 0.024	
TRE-1018	15.88 0.625	28.58 1.125	3.99 0.157	3.91 0.154	15.88 0.625	15.80 0.622	29.36 1.156	0.013 0.029	

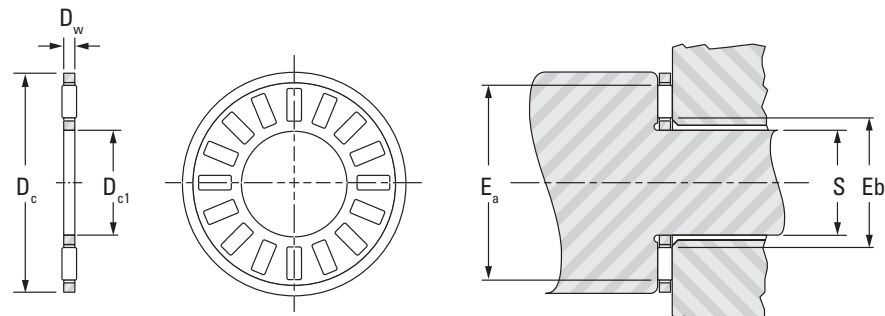
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⁽²⁾If the shaft and the housing adjacent to the bearing O.D. are not concentric, the T.I.R. between the shaft and housing should be added to this dimension.

THRUST NEEDLE ROLLER AND CAGE ASSEMBLIES, THRUST WASHERS

INCH SERIES

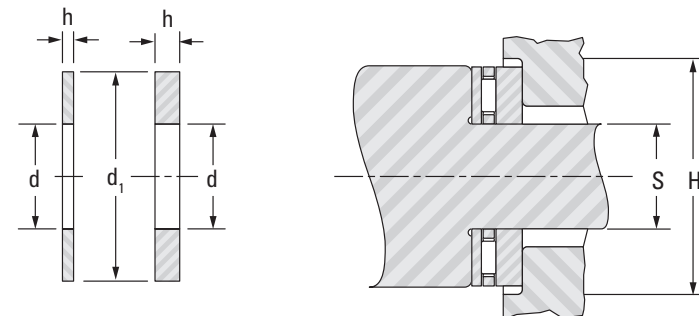
- Dimensions for bore and O.D. of thrust assemblies and washers are nominal.
- See page B-6-50 for details on piloting and backup surfaces.
- Thrust washers burnished at least one-quarter of bore area (remainder is rough breakaway finish).
- O.D. finish of washers will be as blanked.



NTA

Raceway hardness to be 58 HRC or equivalent

Shaft Dia.	D _{c1}	D _c	D _w	E _b	E _a	Assembly Designation	Load Ratings		Speed Rating ⁽¹⁾	Wt.
							Dynamic	Static		
							kN lbf			
3/4	19.05 0.750	31.75 1.250	1.9837 0.0781	21.34 0.840	28.956 1.140	NTA-1220	10.90 2450	36.48 8200	14000	0.004 0.009
7/8	22.23 0.875	36.50 1.437	1.984 0.0781	24.38 0.960	33.782 1.330	NTA-1423	13.43 3020	49.82 11200	12000	0.005 0.011
7/8	22.23 0.875	42.85 1.687	1.984 0.0781	25.91 1.020	39.878 1.570	NTC-1427	18.46 4150	78.29 17600	9800	0.008 0.017
1	25.40 1.000	39.675 1.562	1.984 0.0781	27.69 1.090	36.83 1.450	NTA-1625	13.83 3110	53.82 12100	11000	0.006 0.013
1 1/8	28.58 1.125	44.45 1.75	1.9837 0.0781	30.73 1.210	41.656 1.640	NTA-1828	16.68 3750	71.17 16000	9600	0.009 0.019



Thrust Washer Designation	d	d ₁	h		S		H ⁽²⁾ Dia. To Clear O.D.	Washer Wt. kg lbs	Shaft Dia. in
			Max.	Min.	Max.	Min.			
			mm in	mm in	mm in	mm in			
TRA-1220	19.05 0.750	31.75 1.250	0.81 0.032	0.76 0.030	19.05 0.750	18.97 0.747	32.54 1.281	0.003 0.007	3/4
TRB-1220	19.05 0.750	31.75 1.250	1.60 0.063	1.52 0.060	19.05 0.750	18.97 0.747	32.54 1.281	0.006 0.013	
TRC-1220	19.05 0.750	31.75 1.250	2.41 0.095	2.34 0.092	19.05 0.750	18.97 0.747	32.54 1.281	0.010 0.021	
TRD-1220	19.05 0.750	31.75 1.250	3.20 0.126	3.12 0.123	19.05 0.750	18.97 0.747	32.54 1.281	0.012 0.026	
TRE-1220	19.05 0.750	31.75 1.250	3.99 0.157	3.91 0.154	19.05 0.750	18.97 0.747	32.54 1.281	0.015 0.033	
TRA-1423	22.23 0.875	36.50 1.437	0.81 0.032	0.76 0.030	22.23 0.875	22.15 0.872	37.31 1.469	0.004 0.009	7/8
TRB-1423	22.23 0.875	36.50 1.437	1.60 0.063	1.52 0.060	22.23 0.875	22.15 0.872	37.31 1.469	0.008 0.017	
TRC-1423	22.23 0.875	36.50 1.437	2.41 0.095	2.34 0.092	22.23 0.875	22.15 0.872	37.31 1.469	0.012 0.026	
TRD-1423	22.23 0.875	36.50 1.437	3.20 0.126	3.12 0.123	22.23 0.875	22.15 0.872	37.31 1.469	0.015 0.034	
TRB-1427	22.23 0.875	42.86 1.688	1.60 0.063	1.52 0.060	22.23 0.875	22.15 0.872	43.66 1.719	0.013 0.029	
TRC-1427	22.23 0.875	42.86 1.688	2.41 0.095	2.34 0.092	22.23 0.875	22.15 0.872	43.66 1.719	0.020 0.044	
TRD-1427	22.23 0.875	42.86 1.688	3.20 0.126	3.12 0.123	22.23 0.875	22.15 0.872	43.66 1.719	0.026 0.057	
TRA-1625	25.40 1.000	39.67 1.562	0.81 0.032	0.76 0.030	25.40 1.000	25.32 0.997	40.49 1.594	0.005 0.010	1
TRB-1625	25.40 1.000	39.67 1.562	1.60 0.063	1.52 0.060	25.40 1.000	25.32 0.997	40.49 1.594	0.009 0.019	
TRD-1625	25.40 1.000	39.67 1.562	3.20 0.126	3.12 0.123	25.40 1.000	25.32 0.997	40.49 1.594	0.017 0.038	
TRE-1625	25.40 1.000	39.67 1.562	3.99 0.157	3.91 0.154	25.40 1.000	25.32 0.997	40.49 1.594	0.021 0.047	
TRA-1828	28.58 1.125	44.45 1.750	0.81 0.032	0.76 0.030	28.58 1.125	28.50 1.122	45.24 1.781	0.006 0.013	1 1/8
TRB-1828	28.58 1.125	44.45 1.750	1.60 0.063	1.52 0.060	28.58 1.125	28.50 1.122	45.24 1.781	0.011 0.024	
TRC-1828	28.58 1.125	44.45 1.750	2.41 0.095	2.34 0.092	28.58 1.125	28.50 1.122	45.24 1.781	0.017 0.037	

⁽¹⁾Speed ratings listed are based on adequate oil lubrication. See page B-6-51 for lubrication information. Suggestions for an application requiring O.D. piloting should be determined in consultation with your representative.

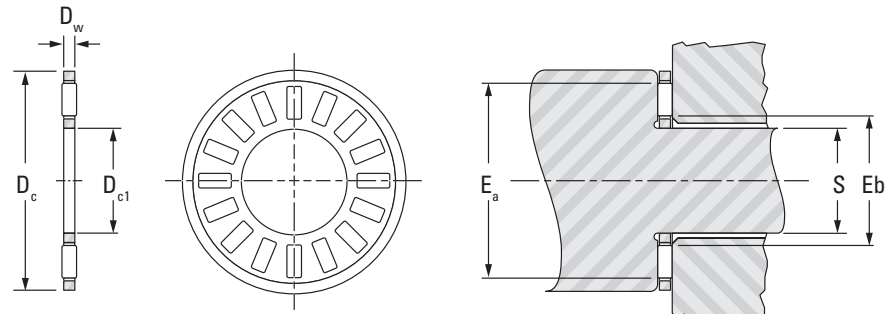
⁽²⁾If the shaft and the housing adjacent to the bearing O.D. are not concentric, the T.I.R. between the shaft and housing should be added to this dimension.

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THRUST NEEDLE ROLLER AND CAGE ASSEMBLIES, THRUST WASHERS

INCH SERIES

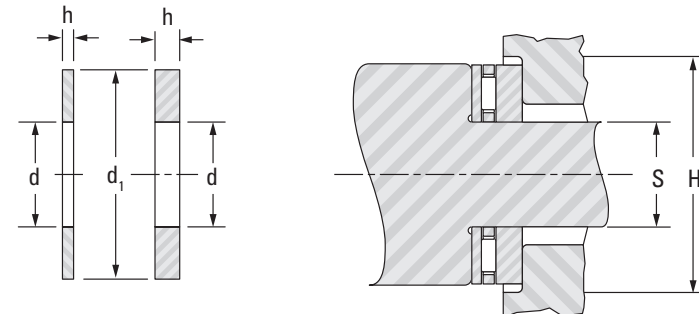
- Dimensions for bore and O.D. of thrust assemblies and washers are nominal.
- See page B-6-50 for details on piloting and backup surfaces.
- Thrust washers burnished to at least one-quarter of bore area (remainder is rough breakaway finish).
- O.D. finish of washers will be as blanked.



NTA
Raceway hardness to be 58 HRC or equivalent

Shaft Dia.	D _{c1}	D _c	D _w	E _b	E _a	Assembly Designation	Load Ratings		Speed Rating ⁽¹⁾	Wt.
							Dynamic	Static		
							kN lbf			
in	mm in	mm in	mm in	mm in	mm in				min ⁻¹	kg lbs
1 1/4	31.75 1.250	49.20 1.937	1.9837 0.0781	34.04 1.340	46.228 1.820	NTA-2031	20.15 4530	93.41 21000	8600	0.010 0.021
1 3/8	34.93 1.375	52.375 2.062	1.9837 0.0781	37.08 1.460	49.53 1.950	NTA-2233	21.35 4800	103.20 23200	8000	0.010 0.023
1 1/2	38.10 1.500	55.55 2.187	1.9837 0.0781	40.39 1.590	52.578 2.070	NTA-2435	23.22 5220	117.88 26500	7600	0.011 0.025
1 3/4	44.45 1.750	63.50 2.500	1.984 0.0781	46.74 1.840	58.928 2.320	NTA-2840	25.31 5690	137.45 30900	6800	0.014 0.031

⁽¹⁾Speed ratings listed are based on adequate oil lubrication. See page B-6-51 for lubrication information. Suggestions for an application requiring O.D. piloting should be determined in consultation with your representative.



Thrust Washer Designation	d	d ₁	h		S		H ⁽²⁾ Dia. To Clear O.D.	Washer Wt.	Shaft Dia.
			Max.	Min.	Max.	Min.			
			mm in	mm in	mm in	mm in			
TRD-1828	28.58 1.125	44.45 1.750	3.20 0.126	3.12 0.123	28.58 1.125	28.50 1.122	45.24 1.781	0.022 0.048	
TRA-2031	31.75 1.250	49.20 1.937	0.81 0.032	0.76 0.030	31.75 1.250	31.67 1.247	50.01 1.969	0.007 0.015	1 1/4
TRB-2031	31.75 1.250	49.20 1.937	1.60 0.063	1.52 0.060	31.75 1.250	31.67 1.247	50.01 1.969	0.014 0.030	
TRC-2031	31.75 1.250	49.20 1.937	2.41 0.095	2.34 0.092	31.75 1.250	31.67 1.247	50.01 1.969	0.020 0.044	
TRD-2031	31.75 1.250	49.20 1.937	3.20 0.126	3.12 0.123	31.75 1.250	31.67 1.247	50.01 1.969	0.026 0.058	
TRF-2031	31.75 1.250	49.20 1.937	4.78 0.188	4.70 0.185	31.75 1.250	31.67 1.247	50.01 1.969	0.041 0.090	
TRA-2233	34.93 1.375	52.37 2.062	0.81 0.032	0.76 0.030	34.93 1.375	34.85 1.372	53.19 2.094	0.007 0.016	1 3/8
TRB-2233	34.93 1.375	52.37 2.062	1.60 0.063	1.52 0.060	34.93 1.375	34.85 1.372	53.19 2.094	0.015 0.033	
TRC-2233	34.93 1.375	52.37 2.062	2.41 0.095	2.34 0.092	34.93 1.375	34.85 1.372	53.19 2.094	0.018 0.040	
TRD-2233	34.93 1.375	52.37 2.062	3.20 0.126	3.12 0.123	34.93 1.375	34.85 1.372	53.19 2.094	0.029 0.065	
TRE-2233	34.93 1.375	52.37 2.062	3.99 0.157	3.91 0.154	34.93 1.375	34.85 1.372	53.19 2.094	0.037 0.081	
TRF-2233	34.93 1.375	52.37 2.062	4.78 0.188	4.70 0.185	34.93 1.375	34.85 1.372	53.19 2.094	0.044 0.097	
TRA-2435	38.10 1.500	55.55 2.187	0.81 0.032	0.76 0.030	38.10 1.500	38.02 1.497	56.36 2.219	0.008 0.017	1 1/2
TRB-2435	38.10 1.500	55.55 2.187	1.60 0.063	1.52 0.060	38.10 1.500	38.02 1.497	56.36 2.219	0.015 0.034	
TRC-2435	38.10 1.500	55.55 2.187	2.41 0.095	2.34 0.092	38.10 1.500	38.02 1.497	56.36 2.219	0.023 0.050	
TRD-2435	38.10 1.500	55.55 2.187	3.20 0.126	3.12 0.123	38.10 1.500	38.02 1.497	56.36 2.219	0.030 0.067	
TRF-2435	38.10 1.500	55.55 2.187	4.78 0.188	4.70 0.185	38.10 1.500	38.02 1.497	56.36 2.219	0.045 0.100	
TRA-2840	44.45 1.750	63.50 2.500	0.81 0.032	0.76 0.030	44.45 1.750	44.37 1.747	64.29 2.531	0.010 0.021	1 3/4
TRB-2840	44.45 1.750	63.50 2.500	1.60 0.063	1.52 0.060	44.45 1.750	44.37 1.747	64.29 2.531	0.020 0.044	

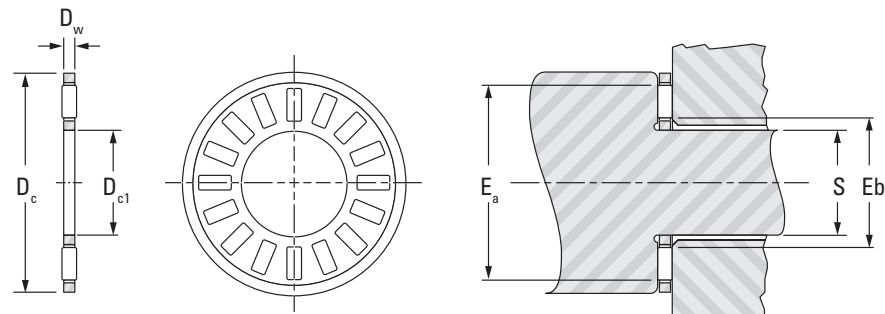
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⁽²⁾If the shaft and the housing adjacent to the bearing O.D. are not concentric, the T.I.R. between the shaft and housing should be added to this dimension.

THRUST NEEDLE ROLLER AND CAGE ASSEMBLIES, THRUST WASHERS

INCH SERIES

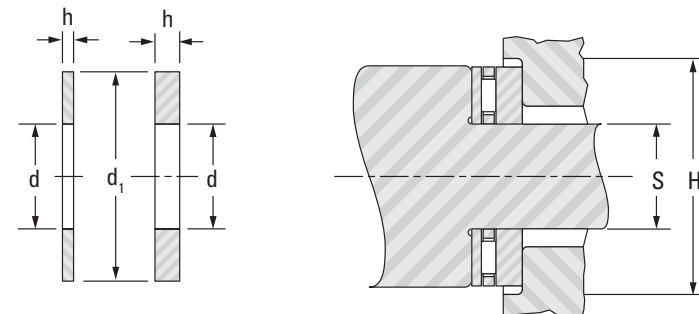
- Dimensions for bore and O.D. of thrust assemblies and washers are nominal.
- See page B-6-50 for details on piloting and backup surfaces.
- Thrust washers burnished at least one-quarter of bore area (remainder is rough breakaway finish).
- O.D. finish of washers will be as blanked.



NTA

Raceway hardness to be 58 HRC or equivalent

Shaft Dia.	D _{c1}	D _c	D _w	E _b	E _a	Assembly Designation	Load Ratings		Speed Rating ⁽¹⁾	Wt.
							Dynamic	Static		
							kN lbf			
in	mm in	mm in	mm in	mm in	mm in					
2	50.80 2.000	69.85 2.750	1.9837 0.0781	53.09 2.090	65.278 2.570	NTA-3244	24.02 5400	132.56 29800	6100	0.015 0.033
2 1/8	53.98 2.125	73.025 2.875	1.984 0.0781	56.39 2.220	68.58 2.700	NTA-3446	24.42 5490	137.45 30900	5800	0.016 0.036
2 1/4	57.15 2.250	76.20 3.000	1.984 0.0781	59.44 2.340	71.628 2.820	NTA-3648	24.78 5570	142.34 32000	5600	0.017 0.038
2 3/4	57.15 2.250	79.375 3.125	3.175 0.1250	59.94 2.360	75.184 2.960	NTA-3650	37.68 8470	177.04 39800	5300	0.029 0.064
2 1/2	63.50 2.500	82.55 3.250	1.9837 0.0781	65.79 2.590	77.978 3.070	NTA-4052	25.53 5740	152.13 34200	5100	0.019 0.041



Thrust Washer Designation	d	d ₁	h		S		H ⁽²⁾ Dia. To Clear O.D.	Washer Wt.	Shaft Dia.
			Max.	Min.	Max.	Min.			
			mm in	mm in	mm in	mm in			
TRC-2840	44.45 1.750	63.50 2.500	2.41 0.095	2.34 0.092	44.45 1.750	44.37 1.747	64.29 2.531	0.029 0.063	
TRD-2840	44.45 1.750	63.50 2.500	3.20 0.126	3.12 0.123	44.45 1.750	44.37 1.747	64.29 2.531	0.038 0.084	
TRF-2840	44.45 1.750	63.50 2.500	4.78 0.188	4.70 0.185	44.45 1.750	44.37 1.747	64.29 2.531	0.057 0.126	
TRA-3244	50.80 2.000	69.85 2.750	0.81 0.032	0.76 0.030	50.80 2.000	50.72 1.997	70.64 2.781	0.011 0.024	2
TRB-3244	50.80 2.000	69.85 2.750	1.60 0.063	1.52 0.060	50.80 2.000	50.72 1.997	70.64 2.781	0.022 0.048	
TRC-3244	50.80 2.000	69.85 2.750	2.41 0.095	2.34 0.092	50.80 2.000	50.72 1.997	70.64 2.781	0.033 0.072	
TRD-3244	50.80 2.000	69.85 2.750	3.20 0.126	3.12 0.123	50.80 2.000	50.72 1.997	70.64 2.781	0.044 0.096	
TRF-3244	50.80 2.000	69.85 2.750	4.78 0.188	4.70 0.185	50.80 2.000	50.72 1.997	70.64 2.781	0.066 0.145	
TRA-3446	53.98 2.125	73.03 2.875	0.81 0.032	0.76 0.030	53.98 2.125	53.90 2.122	73.81 2.906	0.012 0.026	2 1/8
TRB-3446	53.98 2.125	73.03 2.875	1.60 0.063	1.52 0.060	53.98 2.125	53.90 2.122	73.81 2.906	0.024 0.052	
TRC-3446	53.98 2.125	73.03 2.875	2.41 0.095	2.34 0.092	53.98 2.125	53.90 2.122	73.81 2.906	0.035 0.078	
TRD-3446	53.98 2.125	73.03 2.875	3.20 0.126	3.12 0.123	53.98 2.125	53.90 2.122	73.81 2.906	0.047 0.103	
TRA-3648	57.15 2.250	76.20 3.000	0.81 0.032	0.76 0.030	57.15 2.250	57.07 2.247	76.99 3.031	0.012 0.026	2 1/4
TRB-3648	57.15 2.250	76.20 3.000	1.60 0.063	1.52 0.060	57.15 2.250	57.07 2.247	76.99 3.031	0.022 0.048	
TRC-3648	57.15 2.250	76.20 3.000	2.41 0.095	2.34 0.092	57.15 2.250	57.07 2.247	76.99 3.031	0.037 0.081	
TRD-3648	57.15 2.250	76.20 3.000	3.20 0.126	3.12 0.123	57.15 2.250	57.07 2.247	76.99 3.031	0.048 0.105	
TRF-3648	57.15 2.250	76.20 3.000	4.78 0.188	4.70 0.185	57.15 2.250	57.07 2.247	76.99 3.031	0.071 0.157	
					57.15 2.250	57.07 2.247	76.99 3.156		2 1/4
TRA-4052	63.50 2.500	82.55 3.250	0.81 0.032	0.76 0.030	63.50 2.500	63.42 2.497	83.34 3.281	0.013 0.029	2 1/2
TRB-4052	63.50 2.500	82.55 3.250	1.60 0.063	1.52 0.060	63.50 2.500	63.42 2.497	83.34 3.281	0.027 0.059	

⁽¹⁾Speed ratings listed are based on adequate oil lubrication. See page B-6-51 for lubrication information. Suggestions for an application requiring O.D. piloting should be determined in consultation with your representative.

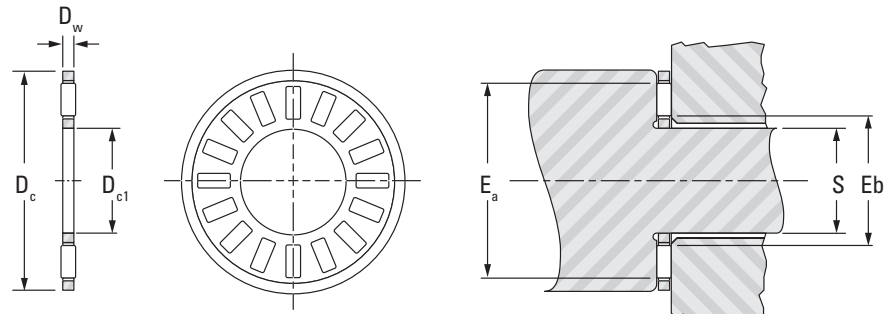
⁽²⁾If the shaft and the housing adjacent to the bearing O.D. are not concentric, the T.I.R. between the shaft and housing should be added to this dimension.

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THRUST NEEDLE ROLLER AND CAGE ASSEMBLIES, THRUST WASHERS

INCH SERIES

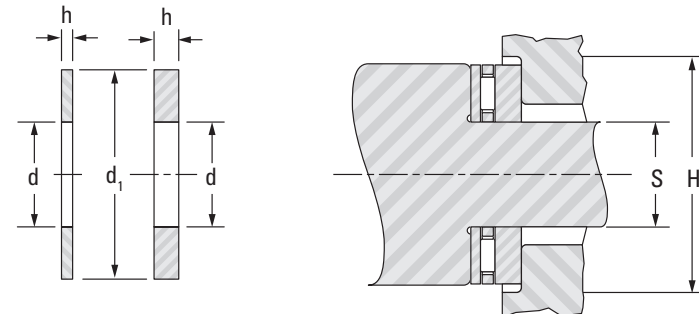
- Dimensions for bore and O.D. of thrust assemblies and washers are nominal.
- See page B-6-50 for details on piloting and backup surfaces.
- Thrust washers burnished at least one-quarter of bore area (remainder is rough breakaway finish).
- O.D. finish of washers will be as blanked.



NTA

Raceway hardness to be 58 HRC or equivalent

Shaft Dia.	D _{c1}	D _c	D _w	E _b	E _a	Assembly Designation	Load Ratings		Speed Rating ⁽¹⁾	Wt.
							Dynamic	Static		
							kN lbf			
in	mm in	mm in	mm in	mm in	mm in				min ⁻¹	kg lbs
2 3/4	69.85 2.750	92.075 3.625	3.175 0.1250	72.64 2.860	87.884 3.460	NTA-4458	47.60 10700	255.8 57500	4600	0.037 0.082
3	76.20 3.000	95.25 3.750	1.9837 0.0781	78.49 3.090	90.678 3.570	NTA-4860	26.96 6060	172.1 38700	4400	0.022 0.048
3 1/4	82.55 3.250	104.78 4.125	3.175 0.1250	85.34 3.360	100.58 3.960	NTA-5266	51.60 11600	294.9 66300	4000	0.042 0.092
3 3/4	95.25 3.750	117.48 4.625	3.175 0.1250	98.04 3.860	113.28 4.460	NTA-6074	56.05 12600	344.3 77400	3500	0.050 0.11
4 1/8	104.78 4.125	128.57 5.062	3.175 0.125	107.44 4.230	124.46 4.900	NTA-6681	63.61 14300	414.6 93200	3200	0.062 0.136



Thrust Washer Designation	d	d ₁	h		S		H ⁽²⁾ Dia. To Clear O.D.	Washer Wt. kg lbs	Shaft Dia. in
			Max.	Min.	Max.	Min.			
			mm in	mm in	mm in	mm in			
TRC-4052	63.50 2.500	82.55 3.250	2.41 0.095	2.34 0.092	63.50 2.500	63.42 2.497	83.34 3.281	0.041 0.09	
TRC-4052	63.50 2.500	82.55 3.250	3.20 0.126	3.12 0.123	63.50 2.500	63.42 2.497	83.34 3.281	0.054 0.119	
TRA-4458	69.85 2.750	92.08 3.625	0.81 0.032	0.76 0.030	69.85 2.750	69.77 2.747	92.86 3.656	0.018 0.039	2 3/4
TRB-4458	69.85 2.750	92.08 3.625	1.60 0.063	1.52 0.060	69.85 2.750	69.77 2.747	92.86 3.656	0.035 0.077	
TRC-4458	69.85 2.750	92.08 3.625	2.41 0.095	2.34 0.092	69.85 2.750	69.77 2.747	92.86 3.656	0.051 0.113	
TRD-4458	69.85 2.750	92.08 3.625	3.20 0.126	3.12 0.123	69.85 2.750	69.77 2.747	92.86 3.656	0.069 0.152	
TRF-4458	69.85 2.750	92.08 3.625	4.78 0.188	4.70 0.185	69.85 2.750	69.77 2.747	92.86 3.656	0.104 0.229	
TRA-4860	76.20 3.000	95.25 3.750	0.81 0.032	0.76 0.030	76.20 3.000	76.12 2.997	96.04 3.781	0.015 0.034	3
TRB-4860	76.20 3.000	95.25 3.750	1.60 0.063	1.52 0.060	76.20 3.000	76.12 2.997	96.04 3.781	0.032 0.07	
TRD-4860	76.20 3.000	95.25 3.750	3.20 0.126	3.12 0.123	76.20 3.000	76.12 2.997	96.04 3.781	0.061 0.135	
TRA-5266	82.55 3.250	104.78 4.125	0.81 0.032	0.76 0.030	82.55 3.250	82.47 3.247	105.56 4.156	0.020 0.044	3 1/4
TRD-5266	82.55 3.250	104.78 4.125	3.20 0.126	3.12 0.123	82.55 3.250	82.47 3.247	105.56 4.156	0.080 0.176	
TRA-6074	95.25 3.750	117.48 4.625	0.81 0.032	0.76 0.030	95.25 3.750	95.17 3.747	118.26 4.656	0.023 0.05	3 3/4
TRB-6074	95.25 3.750	117.48 4.625	1.60 0.063	1.52 0.060	95.25 3.750	95.17 3.747	118.26 4.656	0.046 0.101	
TRC-6074	95.25 3.750	117.48 4.625	2.41 0.095	2.34 0.092	95.25 3.750	95.17 3.747	118.26 4.656	0.069 0.152	
TRD-6074	95.25 3.750	117.48 4.625	3.20 0.126	3.12 0.123	95.25 3.750	95.17 3.747	118.26 4.656	0.092 0.202	
TRA-6681	104.78 4.125	128.57 5.062	0.81 0.032	0.76 0.030	104.78 4.125	104.70 4.122	129.39 5.094	0.027 0.059	4 1/8
TRC-6681	104.78 4.125	128.57 5.062	2.41 0.095	2.34 0.092	104.78 4.125	104.70 4.122	129.39 5.094	0.081 0.178	
TRD-6681	104.78 4.125	128.57 5.062	3.20 0.126	3.12 0.123	104.78 4.125	104.70 4.122	129.39 5.094	0.109 0.24	
TRF-6681	104.78 4.125	128.57 5.062	4.78 0.188	4.70 0.185	104.78 4.125	104.70 4.122	129.39 5.094	0.161 0.354	

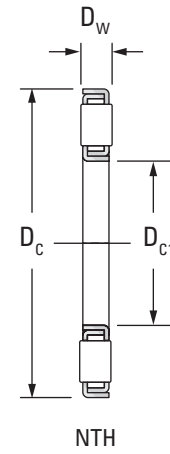
⁽¹⁾Speed ratings listed are based on adequate oil lubrication. See page B-6-51 for lubrication information. Suggestions for an application requiring O.D. piloting should be determined in consultation with your representative.

⁽²⁾If the shaft and the housing adjacent to the bearing O.D. are not concentric, the T.I.R. between the shaft and housing should be added to this dimension.

THRUST CYLINDRICAL ROLLER AND CAGE ASSEMBLIES

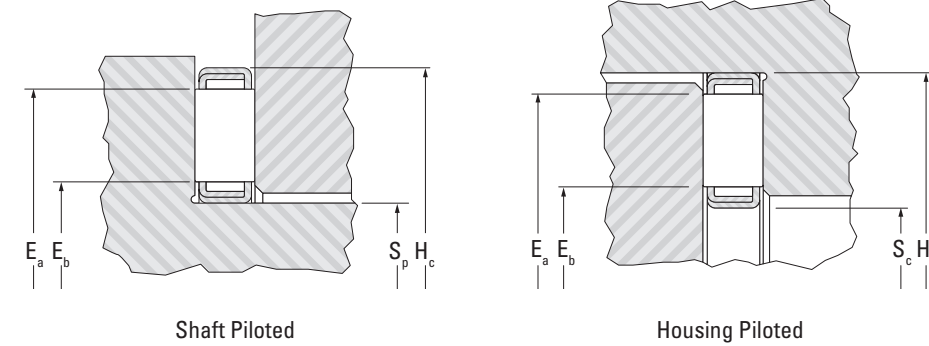
INCH SERIES

- Backup surfaces should be flat and square with the centerline of the shaft.
- See pages B-6-50 for details on piloting and backup surfaces.



Shaft Dia.	D _{c1}	D _c	D _w	Assembly Designation	C		Speed Rating ⁽¹⁾
					Load Ratings		
					Dynamic	Static	
in	mm in	mm in	mm in		kN lbf		min ⁻¹
1 1/2	38.15 1.502	75.44 2.970	6.35 0.250	NTH-2448	81.8 18400	280 62900	5700
2	50.85 2.002	91.31 3.595	9.53 0.375	NTH-3258	129 29000	407 91600	4700
2 1/8	54.03 2.127	94.49 3.720	9.53 0.375	NTH-3460	133 30000	433 97400	4500
2 1/4	57.20 2.252	97.66 3.845	9.53 0.375	NTH-3662	138 31100	458 103000	4400
2 3/8	60.38 2.377	100.84 3.970	9.53 0.375	NTH-3864	143 32100	484.9 109000	4200
2 1/2	63.55 2.502	104.01 4.095	9.53 0.375	NTH-4066	147 33000	511 115000	4100
2 5/8	66.73 2.627	109.60 4.315	9.53 0.375	NTH-4270	156 35100	556 125000	3900
2 3/4	69.98 2.755	112.78 4.440	9.53 0.375	NTH-4472	161 36100	587 132000	3800
3	76.33 3.005	119.13 4.690	9.53 0.375	NTH-4876	169 38000	641 144000	3600
3 1/4	82.68 3.255	125.48 4.940	9.53 0.375	NTH-5280	178 39900	698 157000	3400
3 1/2	89.03 3.505	132.26 5.207	9.53 0.375	NTH-5684	180 40500	725 163000	3200

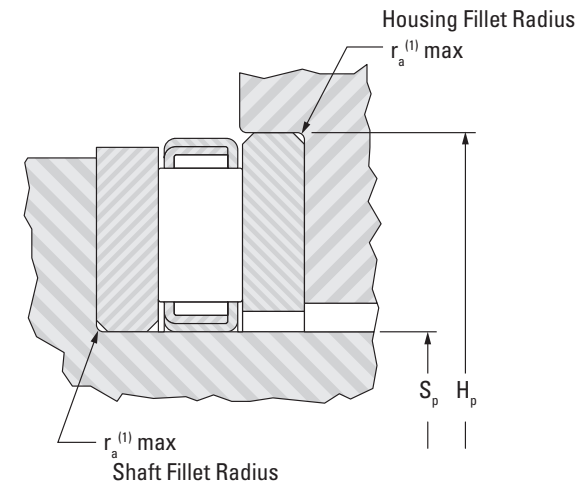
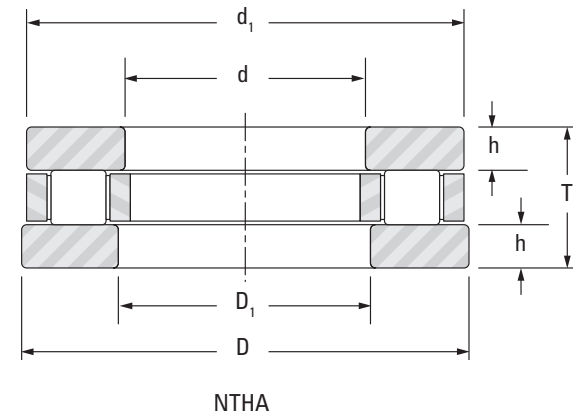
⁽¹⁾Speed ratings listed are based on adequate oil lubrication. See page B-6-51 for lubrication information.



Assembly Wt.	S _p	H _c	S _c	H _p	E _b	E _a	Shaft Dia.
	Piloting Dimensions						
	Shaft Piloting			Housing Piloting			
	+0, +0.000			+0.13, +0.005	Raceway Contact		
	-0.13, -0.005	Min.	Max.	-0, -0.000	mm in	mm in	
kg lbs	mm in	mm in	mm in	mm in	mm in	mm in	in
0.10 0.23	38.10 1.500	76.96 3.030	36.63 1.442	75.57 2.975	44.70 1.760	68.83 2.710	1 1/2
0.21 0.47	50.80 2.000	92.84 3.655	49.33 1.942	91.44 3.600	57.40 2.260	84.33 3.320	2
0.22 0.49	53.98 2.125	96.01 3.780	52.5 2.067	94.62 3.725	60.71 2.390	87.38 3.440	2 1/8
0.24 0.52	57.15 2.250	99.19 3.905	55.68 2.192	97.79 3.850	63.75 2.510	90.68 3.570	2 1/4
0.24 0.54	60.33 2.375	102.36 4.030	58.85 2.317	100.97 3.975	67.06 2.640	93.73 3.690	2 3/8
0.26 0.57	63.50 2.500	105.54 4.155	62.03 2.442	104.14 4.100	70.10 2.760	97.03 3.820	2 1/2
0.28 0.62	66.68 2.625	111.13 4.375	65.2 2.567	109.73 4.320	73.41 2.890	102.36 4.030	2 5/8
0.29 0.64	69.85 2.750	114.30 4.500	68.45 2.695	112.90 4.445	76.45 3.010	105.66 4.160	2 3/4
0.31 0.69	76.20 3.000	120.65 4.750	74.8 2.945	119.25 4.695	82.80 3.260	112.01 4.410	3
0.34 0.75	82.55 3.250	127.00 5.000	81.15 3.195	125.60 4.945	89.15 3.510	118.36 4.660	3 1/4
0.37 0.81	88.90 3.500	133.78 5.267	87.5 3.445	132.38 5.212	95.76 3.770	125.73 4.950	3 1/2

CYLINDRICAL ROLLER THRUST BEARINGS

- The NTHA thrust cylindrical roller bearing consists of an NTH roller and cage assembly, one bore piloted washer and one O.D. piloted washer. The NTHA bearing is identified and sold as a unit and is manufactured to inch-nominal dimensions only.
- Load ratings given are identical to the corresponding NTH thrust cylindrical roller and cage assembly.
- It is suggested that the roller and cage assembly be bore piloted when applying NTHA bearings. When different arrangements of piloting are required, please contact your representative.
- Backup surfaces should be flat and square with the center line of the shaft.
- To order individual thrust washers, see washer designation below.



Shaft Dia.	d		d ₁	D		D ₁	T +0.000 -0.006	Bearing Designation	Bearing Wt.
	Shaft-Piloted Washer			Housing-Piloted Washer					
	Max.	Min.	Nom.	Max.	Min.	Nom.			
in	mm in	mm in	mm in	mm in	mm in	mm in	mm in		kg lbs
1 1/2	38.100 1.5000	38.082 1.4993	74.613 2 15/16	76.218 3.0007	76.200 3.0000	39.688 1 9/16	20.62 0.812	NTHA-2448	0.47 1.03
2	50.800 2.0000	50.775 1.9990	90.488 3 9/16	92.098 3.6259	92.075 3.6250	52.388 2 1/16	25.40 1.000	NTHA-3258	0.76 1.68
2 1/8	53.975 2.1250	53.950 2.1240	93.663 3 11/16	95.278 3.7511	95.250 3.7500	55.563 2 3/16	25.40 1.000	NTHA-3460	0.80 1.76
2 1/4	57.150 2.2500	57.122 2.2489	96.838 3 13/16	98.453 3.8761	98.425 3.8750	58.738 2 5/16	25.40 1.000	NTHA-3662	0.83 1.84
2 3/8	60.325 2.3750	60.297 2.3739	100.013 3 15/16	101.628 4.0011	101.600 4.0000	61.913 2 7/16	25.40 1.000	NTHA-3864	0.87 1.91
2 1/2	63.500 2.5000	63.472 2.4989	103.188 4 1/16	104.808 4.1263	104.775 4.1250	65.088 2 9/16	25.40 1.000	NTHA-4066	0.90 1.99
2 5/8	66.675 2.6250	66.645 2.6238	108.744 4 9/32	110.345 4.3443	110.312 4.3430	68.263 2 11/16	25.40 1.000	NTHA-4270	1.01 2.22
2 3/4	69.850 2.7500	69.820 2.7488	111.919 4 13/32	113.520 4.4693	113.487 4.4680	71.438 2 13/16	25.40 1.000	NTHA-4472	1.04 2.29
3	76.200 3.0000	76.170 2.9988	118.269 4 21/32	119.875 4.7195	119.837 4.7180	77.788 3 1/16	25.40 1.000	NTHA-4876	1.12 2.46
3 1/4	82.550 3.2500	82.517 3.2487	124.619 4 29/32	126.225 4.9695	126.187 4.9680	84.138 3 5/16	25.40 1.000	NTHA-5280	1.19 2.62
3 1/2	88.900 3.5000	88.867 3.4987	130.969 5 5/32	132.575 5.2195	132.537 5.2180	90.488 3 9/16	25.40 1.000	NTHA-5684	1.27 2.80

C	C ₀	Speed Rating Oil	S _p	H _p	r _{s min}	h	Bore Piloted Washer	Washer Wt.	O.D. Piloted Washer	Washer Wt.	Shaft Dia.
			Piloting Dimensions								
			+0, +0.000	+0.13, +0.005	-0.13, -0.005	-0, -0.000					
81.8 18400	280 62900	5700	38.082 1.4993	76.218 3.0007	0.81 0.032	7.137 0.2810	TRI-2448	0.18 0.39	TRID-2448	0.18 0.39	1 1/2
129 29000	408 91600	4700	50.775 1.9990	92.098 3.6259	1.57 0.062	7.938 0.3125	TRJ-3258	0.26 0.57	TRJD-3258	0.27 0.59	2
133 30000	433 97400	4500	53.950 2.1240	95.278 3.7511	1.57 0.062	7.938 0.3125	TRJ-3460	0.27 0.60	TRJD-3460	0.28 0.61	2 1/8
138 31100	458 103000	4400	57.122 2.2489	98.453 3.8761	1.57 0.062	7.938 0.3125	TRJ-3662	0.28 0.62	TRJD-3662	0.29 0.64	2 1/4
143 32100	485 109000	4200	60.297 2.3739	101.628 4.0011	1.57 0.062	7.938 0.3125	TRJ-3864	0.29 0.65	TRJD-3864	0.30 0.66	2 3/8
147 33000	512 115000	4100	63.472 2.4989	104.808 4.1263	1.57 0.062	7.938 0.3125	TRJ-4066	0.30 0.67	TRJD-4066	0.31 0.69	2 1/2
156 35100	556 125000	3900	66.645 2.6238	110.345 4.3443	1.57 0.062	7.938 0.3125	TRJ-4270	0.34 0.75	TRJD-4270	0.35 0.77	2 5/8
161 36100	587 132000	3800	69.820 2.7488	113.520 4.4693	1.57 0.062	7.938 0.3125	TRJ-4472	0.35 0.78	TRJD-4472	0.36 0.80	2 3/4
169 38000	641 144000	3600	76.170 2.9988	119.875 4.7195	1.57 0.062	7.938 0.3125	TRJ-4876	0.38 0.83	TRJD-4876	0.39 0.85	3
177 39900	698 157000	3400	82.517 3.2487	126.225 4.9695	1.57 0.062	7.938 0.3125	TRJ-5280	0.40 0.89	TRJD-5280	0.41 0.91	3 1/4
180 40500	725 163000	3200	88.867 3.4987	132.575 5.2195	1.57 0.062	7.938 0.3125	TRJ-5684	0.43 0.94	TRJD-5284	0.43 0.96	3 1/2

(1) r_a max is equal to minimum washer chamfer r_s min.

NOTES

COMBINED NEEDLE ROLLER BEARINGS

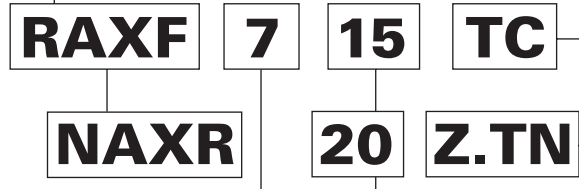
Overview: Combined bearings incorporate a radial needle roller bearing and a thrust ball or roller bearing into a convenient unitized package.

- **Catalogue range:** 5.000 mm – 70.000 mm (0.1966 in – 2.7559 in) bore.
- **Markets:** Industrial applications, machine tools, and automotive transmissions.
- **Features:** Available with ball, needle roller or cylindrical roller thrust component, machined and drawn outer rings are available, some sizes available with integral dust caps.
- **Benefits:** An effective alternative to separate radial and thrust bearings.



Combined Needle Roller Bearings – Metric Nominal Dimensions

Prefix
RAX radial needle roller and thrust needle (or cylindrical) roller bearing without inner ring or thrust washer
RAXF closed-end drawn cup design radial needle roller and needle thrust roller bearing without inner ring or thrust washer
RAXZ unitized machined outer ring thrust cylindrical roller and radial needle roller bearing
NAXR machined outer ring thrust cylindrical roller and radial needle roller bearing without inner ring
NAXK machined outer ring thrust ball and radial needle roller bearing without inner ring



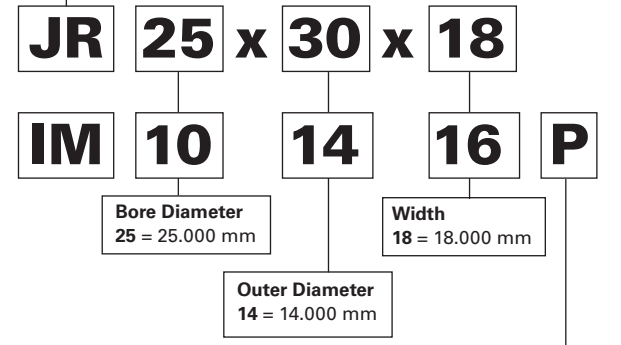
Suffix
TN molded polymer retainer
Z thrust washer retaining dust cap
TB radial play under rollers set to lower half of F6 tolerance
TC radial play under rollers set to upper half of F6 tolerance

Bore Diameter
 20 = 20.000 mm

Series (RAX)
700 drawn cup design radial needle roller and needle thrust roller bearing without inner ring or thrust washer
400 machined ring radial needle roller and thrust needle roller bearing without inner ring or thrust washer
500 machined ring radial needle roller and thrust cylindrical roller bearing

Inner Rings for Combined Needle Roller Bearings – Metric Nominal Dimensions

Prefix
JR inner ring for use with NAXR series bearings
IM inner ring for use RAX series bearings



Bore Diameter
 25 = 25.000 mm

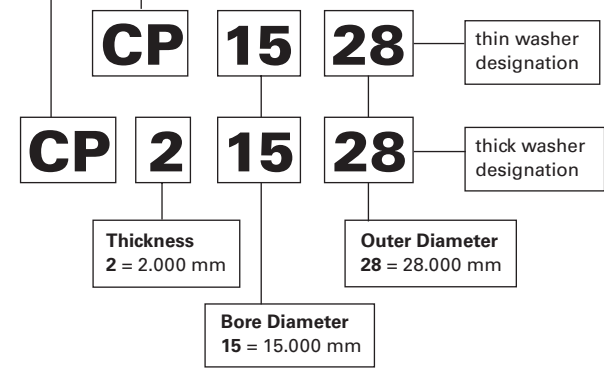
Width
 18 = 18.000 mm

Outer Diameter
 14 = 14.000 mm

Suffix (IM Series)
P ISO 492 toleranced inner ring

Thrust Washers for Combined Needle Roller Bearings - Metric Nominal Dimensions

Prefix
CP thrust washer for metric needle roller bearings



thin washer designation

thick washer designation

Thickness
 2 = 2.000 mm

Outer Diameter
 28 = 28.000 mm

Bore Diameter
 15 = 15.000 mm

Combined Needle Roller Bearings

Page

Introduction B-7-4

Ball Thrust Series – Metric Series B-7-6

Cylindrical Roller Thrust Series – Metric Series B-7-10

Needle Roller and Cylindrical Roller Thrust Series – Metric Series B-7-14

Drawn Cup, Needle Roller Thrust Series Open and Closed Bearings – Metric Series B-7-18



COMBINED BEARINGS

METRIC SERIES

Combined bearings consist of a radial bearing (needle roller bearing) and a thrust bearing (ball, roller or needle bearing). The thrust roller bearing is usually a cylindrical roller thrust bearing.

Combined bearings make an effective alternative in place of two separate bearings—in terms of cost, handling and packaging. Combined bearings can be used with or without matching inner rings and thrust washers—though these are listed opposite the bearing part numbers, where possible, on the following pages of tables for convenience.

REFERENCE STANDARDS ARE:

- **DIN 5429, Part 1** – needle roller – thrust cylindrical roller bearings, series NAXR, NAXR.Z.
- **DIN 5429, Part 1** – needle roller – thrust ball bearings, series NAXK, NAXK.Z.
- **ISO 1206** – needle roller bearings – light and medium series – dimensions and tolerances.

Needle roller-ball thrust bearing

Needle roller-needle roller thrust bearings

Needle roller-cylindrical roller thrust bearings

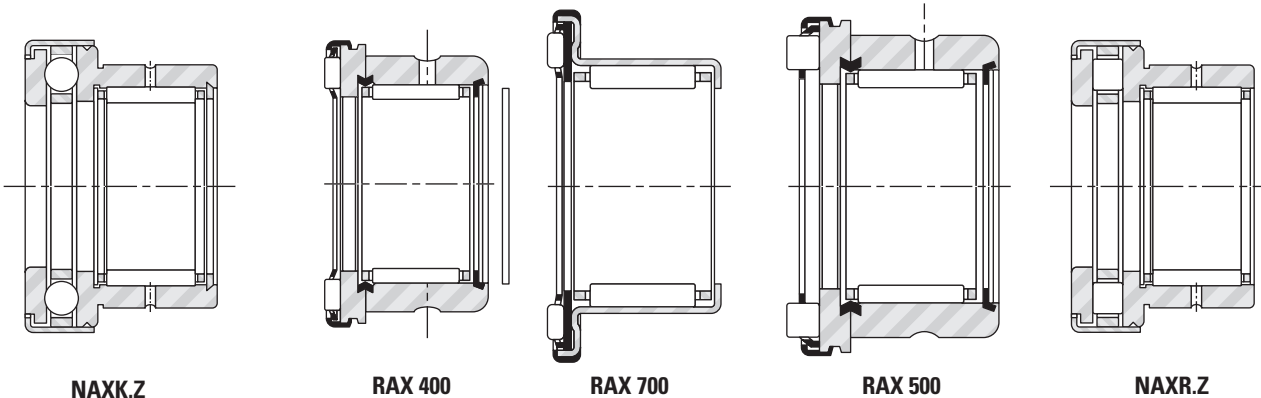


Fig. B7-1. Types of metric series combined bearings

Suffixes

TN	molded cage of reinforced engineered polymer
Z	retained with a dust cap
Z.TN	retained with a dust cap, molded cage of reinforced engineered polymer
TB	radial play under rollers set to lower half of F6 tolerance limits
TC	radial play under rollers set to upper half of F6 tolerance limits

CONSTRUCTION

Needle roller-cylindrical roller thrust bearings of series NAXR and RAXZ 500 are available with dust caps. They have the highest axial load-carrying capability of all combined bearings. The NAXR and NAXR.Z Series have the same dimensions as needle roller-ball thrust bearings (series NAXK and NAXK.Z).

Combined bearings of series RAX 700 use a thin, one-piece outer ring design, similar in construction to metric drawn cups. The RAX 700 Series is available with an open or closed (RAXF) design, as are standard drawn cups. These bearings use needle rollers for both their radial and thrust complements.

The RAX 400 Series uses needle rollers for both their radial and thrust complements, as with the RAX 700 Series, but are constructed from two separate machined rings, joined with a strong metal insert. The RAX 500 Series, fabricated like the 400 Series, uses heavier cylindrical rollers for their thrust complement.

Both series are available with matching thrust washers and inner rings. These series should be considered for applications requiring higher load capacity and running accuracy.

Each of the previous two bearing types may be best used without inner rings because the radial internal clearances are smaller if the needle roller and cage assemblies operate directly on a hardened and ground shaft. Tolerance class F6 is the normal specification for the needle roller complement bore diameters of the unmounted bearings.

RAX 400 and 500 Series (without inner rings) can be supplied with a smaller radial clearance, if desired. Refer to the suffix options TB and TC, as listed in the chart above.

Quality requirements for shafts, when used as a bearing raceway, are given in the engineering section of this catalog. When it becomes impractical to meet the shaft raceway design requirements, standard inner rings may be used with these bearings.

DIMENSIONAL ACCURACY

TOLERANCES

Metric series combined bearings (except Series RAX 700) are manufactured to the normal tolerances which apply to the metric series radial bearings and standard thrust bearings, as shown in the engineering section. The only exceptions are the diameter tolerances of the shaft-piloted washer and the bearing width tolerances. The shaft-piloted washer bore tolerance is E7 for the NAXK, NAXR, NAXK.Z and NAXR.Z Series bearings. The thickness tolerance of the combined bearings thrust component (C₁) can be found in Table B7-2. The matching thrust washer thickness tolerance may be found in the metric unitized thrust bearing section of this catalog.

Because of the nature of the RAX 700 Series design, these bearings must be inspected with suitable plug ("go" and "no go") and ring gage. The plug and ring gage sizes are listed in the inspection columns of the RAX700 Series product table.

BEARING MOUNTING

MOUNTING DIMENSIONS

Simple, through-bored housings are adequate for combined bearings. The mounting tolerances for the mechanical-ring combined bearings are provided in Table B7-1.

The shaft-piloted washers of combined bearings must be supported, at least over half of their width. Other quality requirements for shafts and housings are given in the engineering section. Requirements for fillets, recesses and shoulder heights are the same as for needle roller bearings, as shown in the Mounting Dimensions paragraph on pages B-4-9 and B-4-10.

When mounting these bearings in their housings with a tight fit, relatively high press-in forces will be required which may brinell the raceways of the thrust bearing arrangements. Particular care should be exercised when installing needle roller-cylindrical roller thrust bearings with dust caps – and where the roller assembly of the thrust bearings cannot be removed. In order to avoid brinelling of the thrust bearing raceways, the bearings should be installed with uniform, continuous pressure against the installation tool, avoiding sudden impact forces. At times it may even be desirable to heat the housing before bearing mounting.

Table B7-1. Mounting tolerances

Rotation conditions	ISO tolerance zone for housing	d		With inner ring	Without inner ring
		>	≤		
		Nominal shaft diameter		ISO tolerance zone for shaft	
Load stationary relative to housing	K6 (M6) ⁽¹⁾	mm in	mm in	k6	h6
		10.000 0.3937	40.000 1.5748		
Load rotates relative to housing	M6 (N6) ⁽¹⁾	All diameters		g6	f6
		40.000 1.5748	70.000 2.7559		
RAX 700 RAXF 700	H6 (H7)	All diameters		k5	h5 (h6)

⁽¹⁾ Tighter fit for more secure arrangement.

Table B7-2. Thrust component thickness (C₁) tolerances

Bearing series	Tolerance	
	Max.	Min.
NAXK, NAXK.Z	mm in	mm in
NAXR, NAXR.Z	+0.000 +0.000	-0.200 -0.0078
RAX 400, RAX 500	+0.050 +0.0020	-0.060 -0.0024
RAX 700, RAXF 700	+0.100 +0.0039	-0.100 -0.0039
RAXZ	+0.100 +0.0039	-0.110 -0.0043

LUBRICATION

When the applied axial loads are relatively high and the application allows the use of oil as the desired method of lubrication, bearing types NAXR and NAXK should be given consideration. Combined bearings with a dust cap may use oil lubrication, although their design makes them better suited for use with grease lubrication.

Combined bearings are typically shipped protected with a corrosion-preventive compound that is not a lubricant. The bearings may be used in oil- or grease-lubricated applications, without removal of the corrosion-preventive compound. However, it may be advisable to remove the corrosion-preventive compound before packing the bearings (with a suitable grease) to obtain optimum grease performance and to minimize the possibility of confusing grease bearings with bearings containing corrosion preventive.

LOAD RATINGS

Minimum axial load for combined bearings excluding RAX700:

$$P_{a\min} = C_{0a} / 2200 \quad (\text{kN})$$

Where:

$$C_{0a} = \text{static load rating} \quad (\text{kN})$$

DYNAMIC EQUIVALENT LOAD

Combined bearings can accommodate radial and axial loads.

Radial needle roller complement

$$P = F_r \quad (\text{kN})$$

Cylindrical or needle roller thrust complement

$$P_a = F_a \quad (\text{kN})$$

STATIC EQUIVALENT LOAD

For all combined bearings series:

Radial needle roller complement

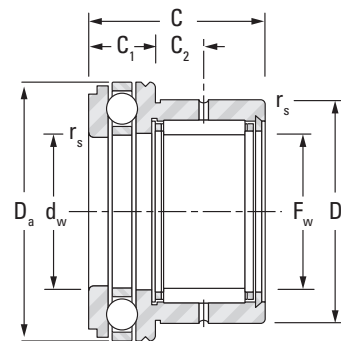
$$P_0 = F_r \quad (\text{kN})$$

Cylindrical or needle roller thrust complement

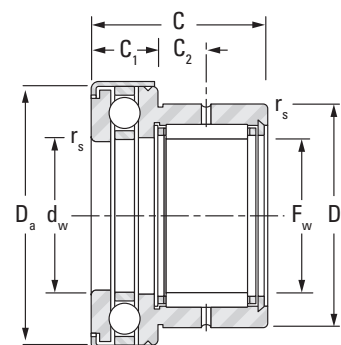
$$P_{0a} = F_a \quad (\text{kN})$$



BALL THRUST SERIES METRIC SERIES



NAXK



NAXK.Z

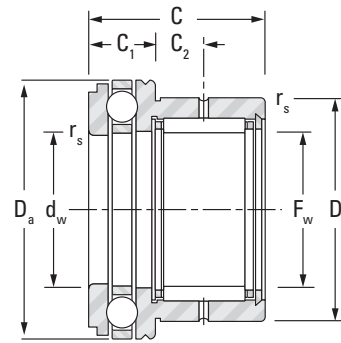
Table with 9 columns: Shaft Diameter, F_w, D, C, d_w, D_a, C_1, C_2, r_s min. Rows list various bearing sizes from 10 to 45 mm shaft diameter.

Table with columns: Bearing Designation, Speed Rating Oil, Load Ratings (Radial, Thrust), Wt., Matching Inner ring Designation, Shaft Diameter. Rows list combined bearing models like NAXK10, NAXK10Z, etc.

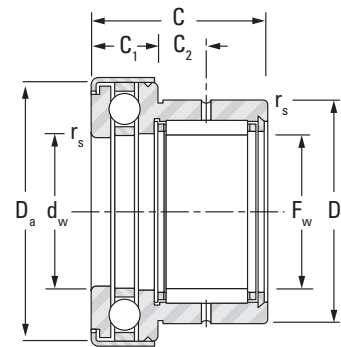
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BALL THRUST SERIES
METRIC SERIES



NAXK



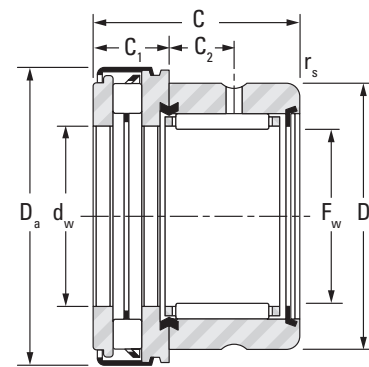
NAXK.Z

Shaft Diameter	F _w	D	C	d _w	D _a	C ₁	C ₂	r _s min
				E7				
mm in	mm in	mm in	mm in	mm in	mm in	mm in	mm in	mm in
50 1.969	50 1.969	62 2.441	35 1.378	50 1.969	70 2.756	14 0.551	10 0.394	0.6 0.024
	50 1.969	62 2.441	35 1.378	50 1.969	71.5 2.815	14 0.551	10 0.394	0.6 0.024
60 2.362	60 2.362	72 2.835	40 1.575	60 2.362	85 3.346	17 0.669	12 0.472	1 0.039
70 2.756	70 2.756	85 3.346	40 1.575	70 2.756	95 3.740	18 0.709	11 0.433	1 0.039

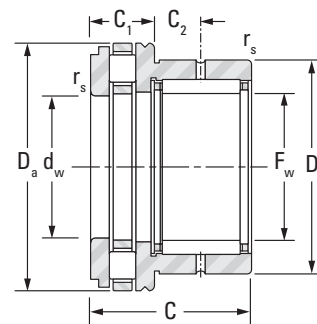
Bearing Designation	Speed Rating Oil	Load Ratings				Wt.	Matching Inner ring Designation	Shaft Diameter
		Radial		Thrust				
		Dynamic	Static	Dynamic	Static			
		C	C ₀	C	C ₀			
	min ⁻¹	kN lbf		kN lbf		kg	mm in	
NAXK50	4300	30.2 6790	68.5 15400	29.9 6720	75.5 16970	0.316	JR45x50x25	50 1.969
NAXK50Z	4300	30.2 6790	68.5 15400	29.9 6720	75.5 16970	0.332	JR45x50x25	
NAXK60	3600	31.9 7170	78.1 17560	43 9670	113 25400	0.48	JR50x60x25	60 2.362
NAXK70	3400	43.6 9800	87.9 19760	41.6 9350	110 24730	0.659	JR60x70x25	70 2.756



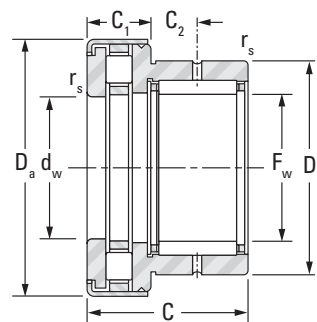
CYLINDRICAL ROLLER THRUST SERIES METRIC SERIES



RAXZ 500



NAXR



NAXR.Z

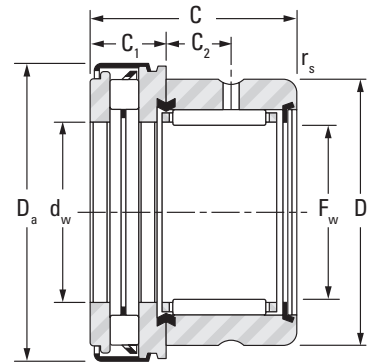
Table with 9 columns: Shaft Diameter, Fw, D, C, dw, Da, C1, C2, rs min. Rows list various bearing models with their dimensions in mm and inches.

Table with columns: Bearing Designation, Speed Rating, Load Ratings (Radial/Thrust), Wt., Matching Inner Ring Designation, Shaft Diameter. Rows list various combined bearing models with their ratings and dimensions.

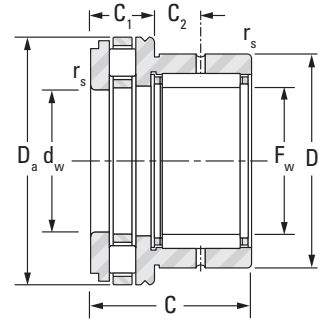
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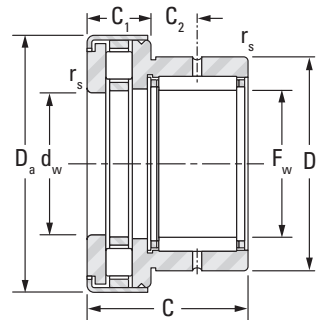
CYLINDRICAL ROLLER THRUST SERIES
METRIC SERIES



RAXZ 500



NAXR



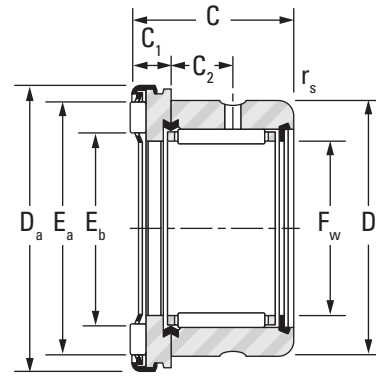
NAXR.Z

Shaft Diameter	F _w	D	C	d _w	D _a	C ₁	C ₂	r _{s min}
				E7				
mm in	mm in	mm in	mm in	mm in	mm in	mm in	mm in	mm in
40 1.575	40 1.575	52 2.047	32 1.260	40 1.575	60 2.362	13 0.512	10.0 0.394	0.6 0.024
	40 1.575	52 2.047	32 1.260	40 1.575	61 2.402	13 0.512	10.0 0.394	0.6 0.024
	40 1.575	52 2.047	31 1.220	40 1.575	61 2.402	13 0.512	9 0.354	0.85 0.033
45 1.772	45 1.772	58 2.283	32 1.260	45 1.772	65 2.559	14 0.551	9.0 0.354	0.6 0.024
	45 1.772	58 2.283	32 1.260	45 1.772	66 2.598	14 0.551	9.0 0.354	0.6 0.024
	45 1.772	58 2.283	31 1.220	45 1.772	66 2.598	13 0.512	9 0.354	0.85 0.033
50 1.969	50 1.969	62 2.441	35 1.378	50 1.969	70 2.756	14 0.551	10.0 0.394	0.6 0.024
	50 1.969	62 2.441	35 1.378	50 1.969	71 2.795	14 0.551	10.0 0.394	0.6 0.024
	50 1.969	62 2.441	34 1.339	50 1.969	71 2.795	13 0.512	11 0.433	1.3 0.051
60 2.362	60 2.362	72 2.835	36 1.417	60 2.362	86 3.386	15 0.591	11 0.433	1.3 0.051
70 2.756	70 2.756	85 3.346	36 1.417	70 2.756	96 3.780	15 0.591	11 0.433	1.3 0.051

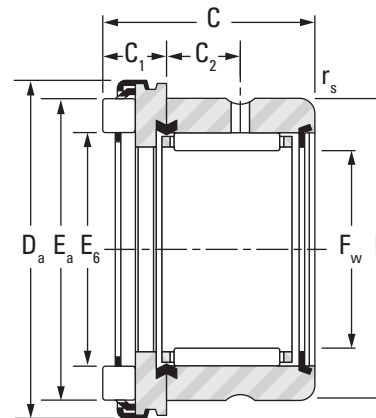
Bearing Designation			Speed Rating	Load Ratings				Wt.	Matching Inner Ring Designation	Shaft Diameter
				Radial		Thrust				
RAXZ	NAXR	NAXR.Z		Dynamic	Static	Dynamic	Static			
			C	C ₀	C	C ₀				
			min ⁻¹	kN lbf		kN lbf		kg lbs	mm in	
	NAXR40		5300	23.8 5350	47.0 10600	44.5 10000	126.0 28300	0.288 0.635	JR35x40x20	40 1.575
		NAXR40.Z	5300	23.8 5350	47.0 10600	44.5 10000	126.0 28300	0.299 0.659	JR35x40x20	
RAXZ 540			5000	23.8 5350	47.0 10600	46.0 10300	129.0 29000	0.174 0.384	IM 35 40 20 P	
	NAXR45TN		4800	24.9 5600	51.8 11600	47.0 10600	140.0 31500	0.360 0.794	JR40x45x20	45 1.772
		NAXR45Z.TN	4800	24.9 5600	51.8 11600	47.0 10600	140.0 31500	0.370 0.816	JR40x45x20	
RAXZ 545			4500	24.9 5600	51.8 11600	49.0 11000	143.0 32100	0.206 0.454	IM 40 45 20 P	
	NAXR50		4300	30.2 6790	68.5 15400	49.7 11200	155.0 34800	0.432 0.952	JR45x50x25	50 1.969
		NAXR50.Z	4300	30.2 6790	68.5 15400	49.7 11200	155.0 34800	0.452 0.996	JR45x50x25	
RAXZ 550			4000	30.2 6790	68.5 15400	51.0 11500	157.0 35300	0.232 0.511	IM 45 50 25 P	
RAXZ 560			3500	31.9 7170	78.1 17600	71.0 16000	255.0 57300	0.327 0.721	IM 55 60 25 P	60 2.362
RAXZ 570			3000	36.1 8120	84.7 19000	77.0 17300	295.0 66300	0.435 0.959	IM 60 70 25 P	70 2.756



NEEDLE ROLLER AND CYLINDRICAL ROLLER THRUST SERIES
METRIC SERIES



RAX 400



RAX 500

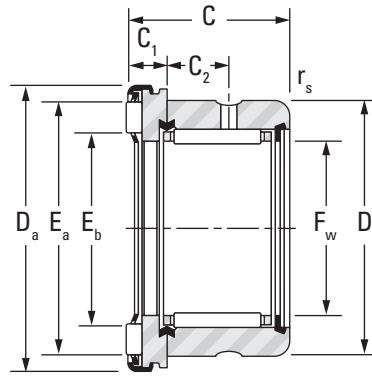
Shaft Diameter	F _w	C	D	D _a	E _b	E _a	C ₁	C ₂	r _{s min}								
										mm	in	mm	in	mm	in	mm	in
10 0.3937	10 0.3937	19 0.748	19 0.7480	22 0.8661	12 0.47	18.6 0.73	5 0.197	6 0.236	0.35 0.014								
	10 0.3937	19.5 0.768	19 0.7480	22 0.8661	12.2 0.48	18.5 0.73	5.5 0.217	6 0.236	0.35 0.014								
12 0.4724	12 0.4724	19 0.748	21 0.8268	26 1.0236	15 0.59	22.6 0.89	5 0.197	6 0.236	0.35 0.014								
	15 0.5906	19 0.748	24 0.9449	28 1.1024	17 0.67	24.6 0.97	5 0.197	6 0.236	0.35 0.014								
	15 0.5906	20 0.787	24 0.9449	28 1.1024	16.8 0.66	24.9 0.98	6 0.236	6 0.236	0.35 0.014								
17 0.6693	17 0.6693	21 0.827	26 1.0236	30 1.1811	19 0.75	26.6 1.05	5 0.197	8 0.315	0.65 0.026								
	17 0.6693	22 0.866	26 1.0236	30 1.1811	18.8 0.74	26.9 1.06	6 0.236	8 0.315	0.65 0.026								
20 0.7874	20 0.7874	24 0.945	30 1.1811	35 1.3780	22 0.87	31.6 1.24	6 0.236	9 0.354	0.85 0.033								
	20 0.7874	26 1.024	30 1.1811	35 1.3780	22 0.87	31.6 1.24	8 0.315	9 0.354	0.85 0.033								
25 0.9843	25 0.9843	24 0.945	37 1.4567	42 1.6535	27.7 1.09	37.4 1.47	6 0.236	9 0.354	0.85 0.033								
	25 0.9843	26 1.024	37 1.4567	42 1.6535	27.7 1.09	37.4 1.47	8 0.315	9 0.354	0.85 0.033								
30 1.1811	30 1.1811	24 0.945	42 1.6535	47 1.8504	32.7 1.29	42.4 1.67	6 0.236	9 0.354	0.85 0.033								
	30 1.1811	26 1.024	42 1.6535	47 1.8504	32.7 1.29	42.3 1.67	8 0.315	9 0.354	0.85 0.033								
35 1.3780	35 1.3780	24 0.945	47 1.8504	53 2.0866	37.2 1.46	49 1.93	6 0.236	9 0.354	0.85 0.033								
	35 1.3780	27 1.063	47 1.8504	53.4 2.1024	37.8 1.49	47.8 1.88	9 0.354	9 0.354	0.85 0.033								
40 1.5748	40 1.5748	24 0.945	52 2.0472	60 2.3622	43 1.69	54.9 2.16	6 0.236	9 0.354	0.85 0.033								
45 1.7717	45 1.7717	24 0.945	58 2.2835	65 2.5591	48 1.89	59.9 2.36	6 0.236	9 0.354	0.85 0.033								
	45 1.7717	28 1.102	58 2.2835	65.4 2.5748	47.8 1.88	59.8 2.35	10 0.394	9 0.354	0.85 0.033								

Bearing Designation		Speed Rating	Load Ratings				Wt.	Matching Inner Ring	Thin Plate	Thick Plate	Shaft Diameter
			Radial		Thrust						
			Dynamic	Static	Dynamic	Static					
400 Series	500 Series	min ⁻¹	C	C ₀	C	C ₀	kg lbs			mm in	
			kN lbf		kN lbf						
RAX 410		15500	5.90 1330	7.16 1610	5.00 1120	10.9 2450	0.025 0.055		CP 10 22	CP 2 10 22	10 0.3937
	RAX 510	15500	5.90 1330	7.16 1610	8.20 1840	17.9 4020	0.026 0.057		CP 10 22	CP 2 10 22	
RAX 412		13000	6.78 1520	9.03 2030	7.10 1600	18.5 4160	0.032 0.071	IM 9 12 16 P	CP 12 26	CP 2 12 26	12 0.4724
RAX 415		11500	9.66 2170	12.6 2830	7.60 1710	20.8 4680	0.034 0.075	IM 12 15 16 P	CP 15 28	CP 2 15 28	15 0.5906
	RAX 515	11500	9.66 2170	12.6 2830	14.0 3150	34.0 7640	0.036 0.079	IM 12 15 16 P	CP 15 28	CP 2 15 28	
RAX 417		10500	11.8 2650	16.3 3660	8.10 1820	23.0 5170	0.041 0.090	IM 14 17 17 P	CP 17 30	CP 2 17 30	17 0.6693
	RAX 517	10500	11.8 2650	16.3 3660	15.0 3370	39.0 8770	0.044 0.097	IM 14 17 17 P	CP 17 30	CP 2 17 30	
RAX 420		9000	14.8 3330	23.7 5330	11.8 2650	39.0 8770	0.066 0.146	IM 15 20 20 P	CP 20 35	CP 3 20 35	20 0.7874
	RAX 520	9000	14.8 3330	23.7 5330	22.0 4950	54.0 12100	0.070 0.154	IM 15 20 20 P	CP 20 35	CP 3 20 35	
RAX 425		7500	15.1 3390	26.2 5890	13.3 2990	49.0 11000	0.099 0.218	IM 20 25 20 P	CP 25 42	CP 3 25 42	25 0.9843
	RAX 525	7500	15.1 3390	26.2 5890	25.5 5730	70.0 15700	0.105 0.231	IM 20 25 20 P	CP 25 42	CP 3 25 42	
RAX 430		6500	20.2 4540	34.6 7780	14.5 3260	57.0 12800	0.111 0.245	IM 25 30 20 P	CP 30 47	CP 3 30 47	30 1.1811
	RAX 530	6500	20.2 4540	34.6 7780	26.5 5960	77.0 17300	0.118 0.260	IM 25 30 20 P	CP 30 47	CP 3 30 47	
RAX 435		5500	22.1 4970	40.8 9170	18.9 4250	84.0 18900	0.130 0.287	IM 30 35 20 P	CP 35 52	CP 3 35 52	35 1.3780
	RAX 535	5500	22.1 4970	40.8 9170	33.8 7600	94.0 21100	0.146 0.322	IM 30 35 20 P	CP 35 52	CP 3 35 52	
RAX 440		5000	23.8 5350	47.0 10600	20.4 4590	96.0 21600	0.150 0.331	IM 35 40 20 P	CP 40 60	CP 3 40 60	40 1.5748
RAX 445		4500	24.9 5600	51.8 11600	21.8 4900	109.0 24500	0.179 0.395	IM 40 45 20 P	CP 45 65	CP 3 45 65	45 1.7717
	RAX 545	4500	24.9 5600	51.8 11600	49.0 11000	143.0 32100	0.206 0.454	IM 40 45 20 P	CP 45 65	CP 3 45 65	

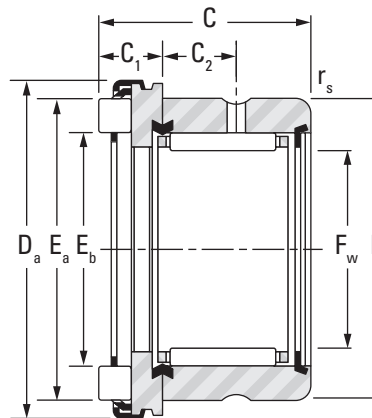
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NEEDLE ROLLER AND CYLINDRICAL ROLLER THRUST SERIES
METRIC SERIES



RAX 400



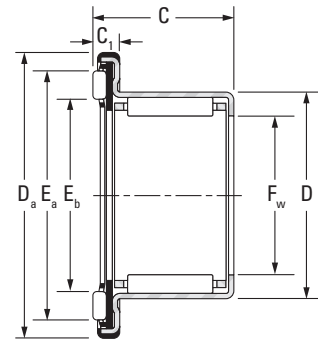
RAX 500

Shaft Diameter	F _w	C	D	D _a	E _b	E _a	C ₁	C ₂	r _{s min}
50 1.9685	50 1.9685	27 1.063	62 2.4409	70 2.7559	53.3 2.10	65.7 2.59	6 0.236	11 0.433	1.3 0.051
	50 1.9685	31 1.220	62 2.4409	70.4 2.7717	52.8 2.08	64.8 2.55	10 0.394	11 0.433	1.3 0.051
60 2.3622	60 2.3622	28 1.102	72 2.8346	85 3.3465	63.5 2.50	79.2 3.12	7 0.276	11 0.433	1.3 0.051
	60 2.3622	32 1.260	72 2.8346	85.4 3.3622	63.5 2.50	79.5 3.13	11 0.433	11 0.433	1.3 0.051
70 2.7559	70 2.7559	28 1.102	85 3.3465	95 3.7402	73.5 2.89	89.2 3.51	7 0.276	11 0.433	1.3 0.051
	70 2.7559	32 1.260	85 3.3465	95.4 3.7559	73.5 2.89	89.5 3.52	11 0.433	11 0.433	1.3 0.051

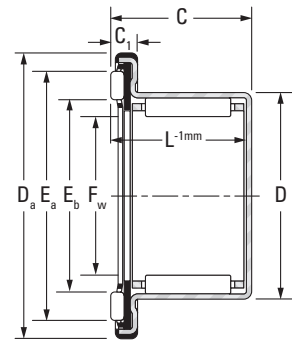
Bearing Designation		Speed Rating	Load Ratings				Wt.	Matching Inner Ring	Thin Plate	Thick Plate	Shaft Diameter
			Radial		Thrust						
400 Series	500 Series	min ⁻¹	Dynamic	Static	Dynamic	Static	kg lbs				mm in
			C	C ₀	C	C ₀					
RAX 450		4000	30.2 6790	68.5 15400	22.5 5060	118.0 26500	0.205 0.452	IM 45 50 25 P	CP 50 70	CP 3 50 70	50 1.9685
	RAX 550	4000	30.2 6790	68.5 15400	51.0 11500	157.0 35300	0.232 0.511	IM 45 50 25 P	CP 50 70	CP 3 50 70	
RAX 460		3500	31.9 7170	78.1 17600	31.5 7080	193.0 43400	0.282 0.622	IM 55 60 25 P	CP 60 85	CP 4 60 85	60 2.3622
	RAX 560	3500	31.9 7170	78.1 17600	71.0 16000	255.0 57300	0.327 0.721	IM 55 60 25 P	CP 60 85	CP 4 60 85	
RAX 470		3000	36.1 8120	84.7 19000	34.5 7760	223.0 50100	0.386 0.851	IM 60 70 25 P	CP 1,5 70 95	CP 4 70 95	70 2.7559
	RAX 570	3000	36.1 8120	84.7 19000	77.0 17300	295.0 66300	0.435 0.959	IM 60 70 25 P	CP 1,5 70 95	CP 4 70 95	



DRAWN CUP, NEEDLE ROLLER THRUST SERIES OPEN AND CLOSED BEARINGS
METRIC SERIES



RAX 700



RAXF 700

Shaft Diameter	F _w	D	C	D _a	E _b	E _a	C ₁	Bearing Designation	
								Open-Ends	Closed-End
mm in	mm in	mm in	mm in	mm in	mm in	mm in	mm in		
5 0.1969	5 0.1969	9 0.3543	11 0.433	15.5 0.6102	7.2 0.28	11.2 0.44	3.3 0.130	RAX 705	
12 0.4724	12 0.4724	18 0.7087	14.2 0.559	27.5 1.0827	15 0.59	22.6 0.89	4.2 0.165	RAX 712	RAXF 712
14 0.5512	14 0.5512	20 0.7874	14.2 0.559	29.5 1.1614	17 0.67	24.6 0.97	4.2 0.165	RAX 714	RAXF 714
15 0.5906	15 0.5906	21 0.8268	14.2 0.559	31.5 1.2402	19 0.75	26.6 1.05	4.2 0.165	RAX 715	RAXF 715
18 0.7087	18 0.7087	24 0.9449	18.2 0.717	33.5 1.3189	21 0.83	28.6 1.13	4.2 0.165	RAX 718	RAXF 718
20 0.7874	20 0.7874	26 1.0236	18.2 0.717	36.5 1.4370	22 0.87	31.6 1.24	4.2 0.165	RAX 720	RAXF 720
25 0.9843	25 0.9843	33 1.2992	22.2 0.874	45.5 1.7913	30 1.18	39.6 1.56	4.2 0.165	RAX 725	RAXF 725
30 1.1811	30 1.1811	38 1.4961	22.2 0.874	50.5 1.9882	35 1.38	44.7 1.76	4.2 0.165	RAX 730	RAXF 730
35 1.3780	35 1.3780	43 1.6929	22.2 0.874	56.5 2.2244	39 1.54	50.9 2.00	4.2 0.165	RAX 735	
40 1.5748	40 1.5748	48 1.8898	22.2 0.874	61.5 2.4213	43 1.69	54.9 2.16	4.2 0.165	RAX 7309	RAXF 7309
45 1.7717	45 1.7717	52 2.0472	22.2 0.874	66.5 2.6181	48 1.89	59.9 2.36	4.2 0.165	RAX 745	

L ⁻¹	Speed Rating	Load Ratings				Wt.	Inspection			Matching Inner Ring	Thin Plate	Thick Plate	Shaft Diameter
		Radial		Thrust			Ring Gage	Go Plug	No Go Plug				
		Dynamic	Static	Dynamic	Static								
mm in	min ⁻¹	C	C ₀	C	C ₀	mm in	mm in	mm in				mm in	
-	25000	2.15 480	1.95 440	3.15 710	6.35 1430	0.005 0.010	9.000 0.3543	5.009 0.1972	5.036 0.1983				
13.2 0.520	13000	6.30 1420	7.20 1620	6.90 1550	17.7 3980	0.017 0.036	18.000 0.7087	12.009 0.4728	12.035 0.4738	IM 8 12 12,4	CP 12 26	CP 2 12 26	12 0.4724
13.2 0.520	11500	6.90 1550	8.50 1910	7.40 1660	20.0 4500	0.018 0.040	20.000 0.7874	14.009 0.5515	14.035 0.5526	IM 10 14 12,4	CP 14 26	CP 2 14 26	14 0.5512
13.2 0.520	10500	7.40 1660	9.30 2090	7.80 1750	22.0 4950	0.020 0.044	21.000 0.8268	15.009 0.5909	15.035 0.5919	IM 12 15 12,4	CP 15 28	CP 2 15 28	15 0.5906
17.2 0.677	10000	11.5 2590	17.7 3980	8.00 1800	23.0 5170	0.027 0.060	24.000 0.9449	18.009 0.7090	18.035 0.7100	IM 13 18 16,4	CP 18 30	CP 2 18 30	18 0.7087
17.2 0.677	9000	12.2 2740	19.5 4380	11.8 2650	39.0 8770	0.031 0.068	26.000 1.0236	20.009 0.7878	20.035 0.7888	IM 15 20 16,4	CP 20 35	CP 3 20 35	20 0.7874
21.2 0.835	7200	20.5 4610	32.0 7190	13.7 3080	52.0 11700	0.055 0.121	33.000 1.2992	20.015 0.7880	25.041 0.9859	IM 20 25 20,4	CP 25 42	CP 3 25 42	25 0.9843
21.2 0.835	6300	22.3 5010	37.5 8430	14.9 3350	60.0 13500	0.063 0.139	38.000 1.4961	30.015 1.1817	30.041 1.1827	IM 25 30 20,4	CP 30 47	CP 3 30 47	30 1.1811
21.2 0.835	5500	24.5 5510	45.0 10120	19.4 4360	88.0 19800	0.075 0.165	43.000 1.6929	35.015 1.3785	35.041 1.3796	IM 30 35 20,4	CP 35 52	CP 3 35 52	35 1.3780
21.2 0.835	5000	26.2 5890	51.0 11470	20.4 4590	96.0 21600	0.086 0.190	48.000 1.8898	40.015 1.5754	40.041 1.5764	IM 35 40 20,4	CP 40 60	CP 3 40 60	40 1.5748
21.2 0.835	4500	24.8 5580	55.0 12360	21.8 4900	109 24500	0.088 0.194	52.000 2.0472	45.015 1.7722	45.041 1.7733	IM 40 45 20,4	CP 45 65	CP 3 45 65	45 1.7717



NEEDLE ROLLERS, ACCESSORIES NEEDLE/CYLINDRICAL ROLLERS

Overview: Loose needle and cylindrical rollers are mainly used as bearing rolling elements to reduce friction and torque in rotating and pivoting applications. However, these precision rollers have many other uses, such as shafts or locating pins.

- **Catalogue range:** Diameters from 1 mm (0.0394 in) to 15 mm (0.5906 in).
Lengths from 2.5 mm (0.0984 in) to 69 mm (2.7165 in).
- **Markets:** Vehicle and industrial transmissions, universal joints, and two-cycle engines.
- **Features:** Cylindrical and needle sizes are available. Needle rollers are available with flat and rounded-ends; metric series needle rollers available in Grade 2, 3 or 5.
- **Benefits:** Provide the maximum load-carrying capacity, within the smallest envelope, at a low cost.

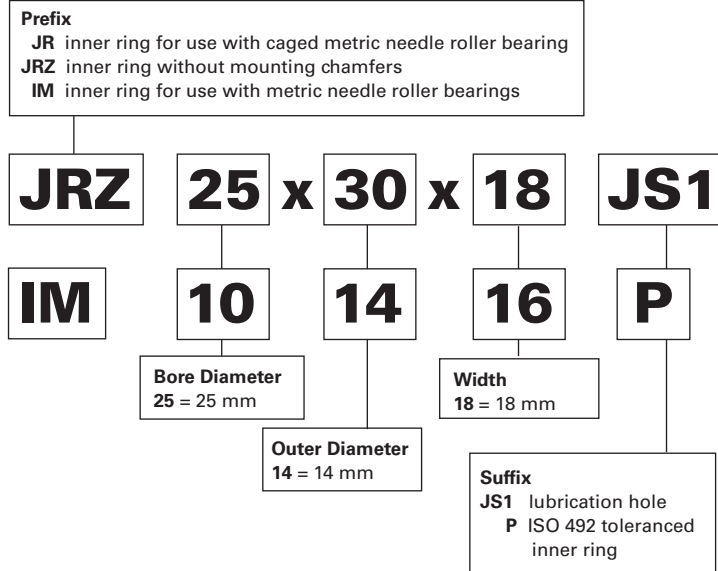
METRIC INNER RINGS

Overview: Inner rings are made from bearing-quality steel, and their O.D. and bore are precision-ground. They function as the inner raceway for a needle roller bearing by providing a surface that meets all shaft raceway design requirements (hardness, surface finish, roundness, etc.).

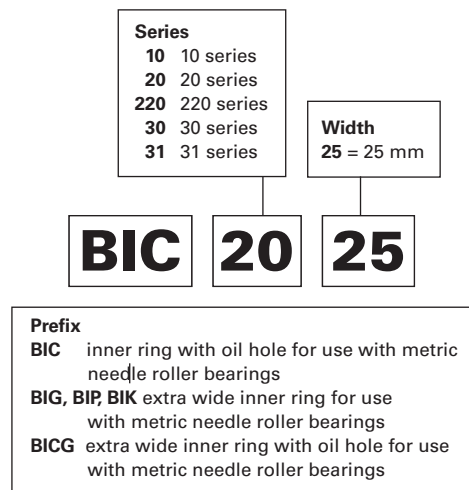
- **Catalogue range:** 5 mm (0.1969 in) bore to 180 mm (7.0866 in) outer diameter.
- **Markets:** Automotive, truck, power transmissions, and industrial applications.
- **Features:** Available with and without chamfers, some are available with a profiled outer diameter.
- **Benefits:** When it is not practical to manufacture the shaft to raceway quality, an inner ring allows a customer to obtain acceptable bearing performance.



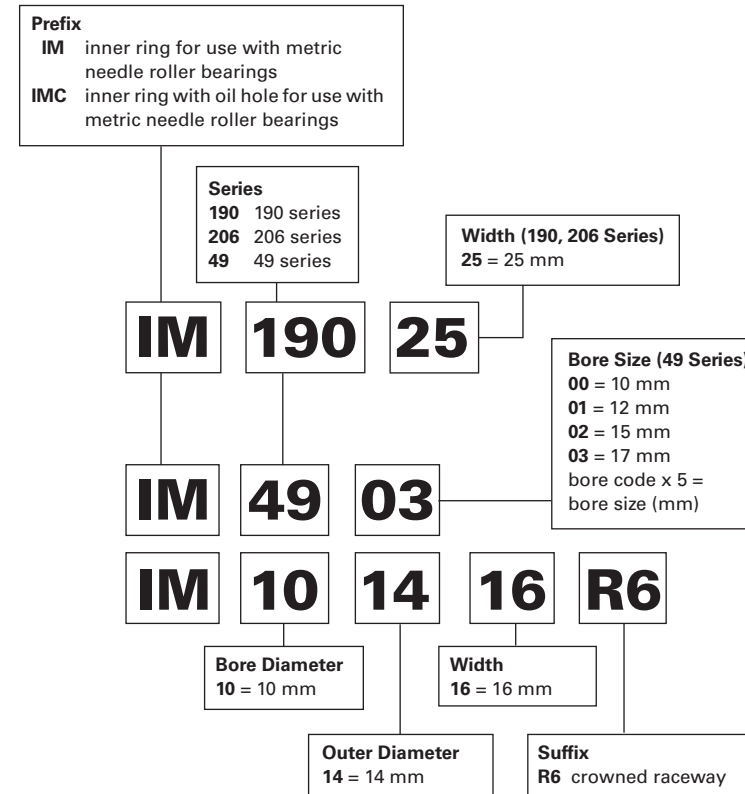
Standard Inner Rings for Needle Roller Bearings – Metric Nominal Dimensions



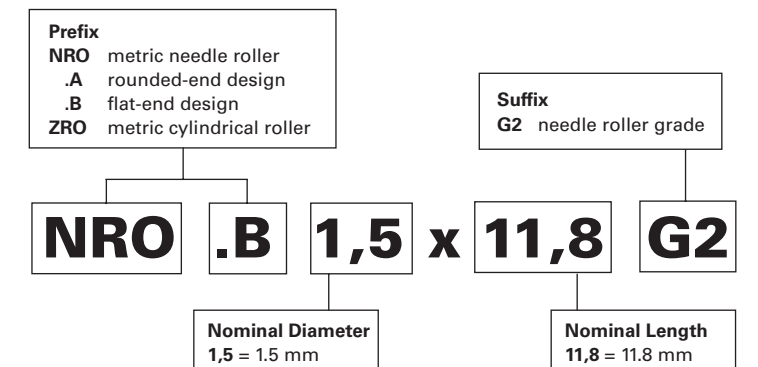
Extra Wide Inner Rings for Needle Roller Bearings – Metric Nominal Dimensions



Inner Rings for Full Complement Needle Roller Bearings – Metric Nominal Dimensions



Loose Rollers – Metric Nominal Dimensions





Needle Rollers, Accessories



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NEEDLE ROLLERS – METRIC SERIES

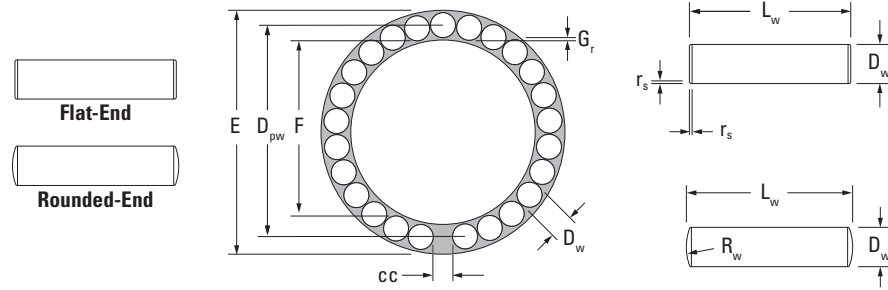


Fig. B8-1. Metric Series needle rollers

Needle rollers are made from rolling bearing-quality steel, hardened to 60-64 HRC or equivalent. Nominal metric needle rollers in various grades are standardized at national and international levels. The grades determine the dimensional and form tolerances of the needle rollers. Metric series needle rollers may differ by their end form: type A has rounded-end and type B has flat-ends. JTEKT prefers to supply needle roller in the most economical flat-end, or type B design, in G2 grade. Metric series needle rollers of type A also may be made available on request and in other G3 or G5 grades.

METRIC SERIES NEEDLE ROLLER DIMENSIONS

Nominally metric needle rollers, conforming to the International Standard ISO 3096, are shown in Table B8-2 on page B-8-8. The symbols used in Table B8-2 on page B-8-8, as well as in subsequent tables and figures, are summarized in Table B8-5 on page B-8-10. Needle rollers with flat-ends, which are the preferred design, are shown in Table B8-2 on page B-8-8. Chamfer dimension limits are also shown, the use of which results in the maximum possible effective contact length between roller and raceway. Yet, the relief at the needle roller ends help to reduce stress concentration – resulting in more uniform stress distribution, optimum load ratings, and longer life.

Every needle roller gage is separately packed, and packages are marked accordingly.

REFERENCE STANDARDS ARE:

- ISO 3096 – rolling bearings – needle rollers – dimensions and tolerances.
- DIN 5402 – rolling bearing components – needle rollers.

EXAMPLE OF METRIC SERIES NEEDLE ROLLER DESIGNATION AND PACKAGE MARKING:

NRO.B1,5x13,8G2
M2M4

- NRO – Needle roller
- .B – Flat-end needle rollers
- 1,5 – Nominal diameter $D_w = 1.500$ mm
- 13,8 – Nominal length $L_w = 13.800$ mm
- G2 – Needle roller grade
- M2M4 – Deviation of needle roller gage -2.000/-4.000 μm

The actual finished diameter is between 1.498 and 1.496 mm.

In the marking of the needle roller gage, P identifies zero (0) or plus (+), and M identifies minus (-). If a shipment of needle rollers of the same size comprises several boxes, each box contains needle rollers of the same grade. The gage may vary from box to box. Each individual box, however, contains needle rollers of the particular gage identified on the box.

METRIC SERIES NEEDLE ROLLER TOLERANCES

Table B8-1. Variation of Gage Lot Diameter, Preferred Gages and Circularity Deviation (values in μm)

Grade	Variation of Gage Lot Diameter V_{Dwl} Max.	Gages High/Low Deviation of Mean Diameter D_{wmp}										Circularity Deviation Max.
		Max.	0	-1	-2	-3	-4	-5	-6	-7	-8	
2	2	Min. -2	0	-1	-2	-3	-4	-5	-6	-7	-8	1
3	3	Max. 0	-3	-1.5	-4	-5	-6	-7.5	-8	-9	-10	1.5
5	5	Max. 0	-5	-3	-4	-5	-6	-7.5	-8	-9	-10	2.5

Note 1 - Tolerance values apply only at the middle of the needle roller length.

Note 2 - Needle rollers of any nominal dimensions and any of the quoted grades will be supplied sub-divided into the gages listed in Table B8-1 at our option, if nothing to the contrary is agreed upon at the time of ordering.



Table B8-2. Dimensions of metric series needle rollers

Table with 10 columns: Dw, Lw, Needle Roller Designation, Wt. 1000 pcs Approx., rs min, Chamfer Dimension Limits (Rad., Axial). Rows list various needle roller types like NRO.B1.5x5,8G2 to NRO.B6x17,8G2 with their dimensions and weights.

END FORM TOLERANCES

Table B8-3 specifies the applicable end configuration for rounded end and flat end needle rollers of all grades.

Table B8-3. End configuration limits for metric needle rollers

Table with 5 main columns: Rounded End Needle Rollers End Radius (Min., Max.), Nominal Diameter of Needle Roller (>, <=), Flat End Needle Rollers Chamfer Dimension Limits (Radial, Axial).

(1) The chamfer of a needle roller shall clear a fillet radius equal to rs min, which should also be considered for designs using rounded end needle rollers.

NEEDLE ROLLER LENGTH TOLERANCE

Tolerances on the length Lw for needle rollers of all grades: h13, see Table B8-4.

Table B8-4. Tolerances for needle roller length, nominal metric needle rollers

Table with 4 columns: Nominal Length, Lw mm (>, <=), Tolerance Limits mm (ISO h13) (Max., Min.).

DESIGN CALCULATIONS FOR NEEDLE ROLLER BEARING COMPLEMENTS

In the majority of full complement needle roller applications, needle roller complements of less than 35 needle rollers per row and a ratio of length to diameter between 4:1 and 8:1, is advantageous.

In general, needle roller complements for rotating motion should employ a smaller number of large diameter needle rollers, while needle roller complements subjected to oscillating motion (especially under high loads) should employ a large number of smaller diameter needle rollers.

Oscillating applications with small angular travel encourage the development of fretting corrosion. The best performance under these conditions has been achieved by using the largest practical number of small diameter needle rollers.

CALCULATION OF RACEWAY DIAMETERS

The calculation of inner and outer raceway diameters may be carried out using either the formula given in Table B8-5 on page B-8-10 or the raceway calculation form in Table B8-6 on page B-8-10.

Table B8-8 on page B-8-11 lists the suggested values for minimum radial internal clearance (Gr min) and the minimum circumferential clearance divided by pi (cc min/pi), to be used for calculating needle roller complements for normal rotating applications – where the speeds, loads and shaft deflections are moderate.

Applications with poor lubrication, unusual motion, large misalignment, raceway distortions, load reversals, high speeds, etc., cannot be characterized as normal rotating applications. These miscellaneous applications require adjustment of the minimum clearances, listed in Table B8-8 on page B-8-11.



Table B8-5. Design factors for needle rollers

Z	Number of needle rollers per bearing path
K	Chordal factor, $K = 1/\sin(180^\circ/Z)$
cc	Total circumferential clearance. See Tables B8-8 and B8-9 on page B-8-11 for cc_{min}/π values.
G_r	Radial internal clearance. See Tables B8-8 and B8-9 on page B-8-11 for $G_{r min}$ values
D_{pw}	Pitch diameter: $D_{pw} = KD_w \max + (cc_{min}/\pi) = E_{min} - D_w \max$ $= F_{max} + G_{r min} + D_w \max$
E	Outer raceway bore diameter: $E_{min} = D_{pw} + D_w \max = (K + 1)D_w \max + (cc_{min}/\pi)$ $= F_{max} + G_{r min} + 2D_w \max$
F	Inner raceway diameter: $F_{max} = D_{pw} - D_w \max - G_{r min}$ $= (K-1)D_w \max + (cc_{min}/\pi) - G_{r min}$ $= E_{min} - 2D_w \max - G_{r min}$
D_w	Nominal needle roller diameter
D_{we}	Needle roller diameter applicable in the calculation of load ratings: $D_{we} = D_{pw} - F_{max} - G_{r min} = \frac{D_{pw} - cc_{min}/\pi}{K}$ $= \frac{F_{max} + G_{r min} - (cc_{min}/\pi)}{(K-1)}$ $= E_{min} - D_{pw} = \frac{E_{min} - cc_{min}/\pi}{(K+1)}$
L_w	Overall needle roller length
R_w	End radius, rounded-end needle roller
r_s	Corner rounding, flat-end needle roller
L_{we}	Needle roller length applicable in the calculation of load ratings, for rounded-end needle rollers: $L_{we} = L_w \max - (L_w \max - \sqrt{L_w \max^2 - D_{we}^2})$ For flat-end needle rollers: $L_{we} = L_w \max - (2r_s \min)$

Note: If length of contact of the needle roller with the raceway is reduced because of undercuts, chamfers, etc. — L_{we} must be reduced correspondingly

RACEWAY DIAMETER TOLERANCES

Tables B8-10 and B8-11 on page B-8-11 lists the recommended tolerances that should be applied to the dimensions for the maximum inner raceway and minimum outer raceway diameter after they have been calculated using the information given in Table B8-5 or Table B8-6.

Table B8-6. Raceway calculation form

Step	Source	Design factor	mm (in)
1	Given	D_w , needle roller diameter	3.000 max. (0.1181 max.)
2	Table B8-7	K, for 30 needle rollers	9.56677 (9.56677)
3	(1)×(2)	KD_w	28.700 (1.1299)
4	Table B8-8 on page B-8-11	$cc_{min}/\pi = 0.127$	0.127 min. (0.005 min.)
5	(3) + (4)	D_{pw} pitch diameter	28.827 (1.1349)
6	Given	D_w , needle roller diameter	3.000 max. (0.1181 max.)
7	(5) - (6)		25.827 (1.0168)
8	Table B8-8 on page B-8-11	G_r , radial clearance	0.013 min. (0.0005 min.)
9	(7) - (8)	F, inner raceway diameter	25.814 max. (1.0163 max.) 25.805 min. ⁽¹⁾ (1.0159 min.)
10	(5) + (6)	E, outer raceway diameter	31.827 min. (1.2530 min.) 31.843 max. ⁽¹⁾ (1.2536 max.)

⁽¹⁾ Tolerance from Tables B8-10 and B8-11 on page B-8-11.

Table B8-7. K values

K values		K values		K values		K values		K values		K values	
Z	K	Z	K	Z	K	Z	K	Z	K	Z	K
6	2.00000	16	5.12583	26	8.29623	36	11.47371	46	14.65364	56	17.86471
7	2.30476	17	5.44219	27	8.61379	37	11.79163	47	14.97171	57	18.15285
8	2.61313	18	5.75877	28	8.93140	38	12.10957	48	15.28979	58	18.47100
9	2.92380	19	6.07553	29	9.24907	39	12.42752	49	15.60788	59	18.78916
10	3.23607	20	6.39245	30	9.56677	40	12.74549	50	15.92597	60	19.10732
11	3.54947	21	6.70951	31	9.88452	41	13.06348	51	16.24408		
12	3.86370	22	7.02667	32	10.20230	42	13.38149	52	16.56219		
13	4.17858	23	7.34394	33	10.52011	43	13.69951	53	16.88031		
14	4.49396	24	7.66130	34	10.83795	44	14.01754	54	17.19843		
15	4.80973	25	7.97873	35	11.15582	45	14.33559	55	17.51657		

CLEARANCES IN NEEDLE ROLLER COMPLEMENTS

Needle rollers, supplied in bulk, are generally used for full complement assemblies. Successful operation of a full complement of needle rollers not only requires careful selection of radial internal clearance, but more importantly, depends on proper circumferential clearance – or the total clearance between needle rollers.

Needle roller guidance, in a full complement assembly, depends largely on contact between needle rollers. Too little circumferential clearance causes overheating. Too much circumferential clearance in a heavily loaded full complement of needle rollers causes loss of needle roller guidance and results in needle roller skew and resultant end thrusting.

Control of radial clearance and circumferential clearance is influenced by the needle roller diameter tolerance, as well as the tolerances of the inner and outer raceway diameters.

Table B8-8. Minimum clearances, normal rotating applications

F Nominal Inner Raceway Diameter mm in		cc_{min}/π	$G_{r min}$
>	≤	mm in	mm in
>	≤		
-	3 0.1181	0.025 0.0010	0.006 0.0002
3 0.1181	6 0.2362	0.102 0.0040	0.008 0.0003
6 0.2362	10 0.3937	0.127 0.0050	0.009 0.0004
10 0.3937	18 0.7087	0.127 0.0050	0.011 0.0004
18 0.7087	30 1.1811	0.127 0.0050	0.013 0.0005
30 1.1811	50 1.9685	0.127 0.0050	0.016 0.0006
50 1.9685	80 3.1496	0.127 0.0050	0.019 0.0007
80 3.1496	120 4.7244	0.127 0.0050	0.022 0.0009

Table B8-9. Minimum clearances, miscellaneous applications

Application	cc_{min}/π	$G_{r min}$
universal joint	1/3 • normal	1/2 • normal
transmission pilot	normal	3 • normal
constant mesh gear	0.2 • roller dia.	normal
transmission planet	normal	normal
crank pin for two cycle engine	5 • normal	7 • normal

END CLEARANCE

The total needle roller end clearance, or endplay, normally should be 0.20 mm (0.008 in) minimum per path of needle rollers.

Table B8-10. Recommended inner raceway diameter tolerances

F Nominal Inner Raceway Diameter mm in		Tolerance Limits (ISO h5) mm in	
>	≤	Max.	Min.
3 0.1181	6 0.2362	0 0	-0.005 -0.0002
6 0.2362	10 0.3937	0 0	-0.006 -0.0002
10 0.3937	18 0.7087	0 0	-0.008 -0.0003
18 0.7087	30 1.1811	0 0	-0.009 -0.0004
30 1.1811	50 1.9685	0 0	-0.011 -0.0004
50 1.9685	80 3.1496	0 0	-0.013 -0.0005
80 3.1496	120 4.7244	0 0	-0.015 -0.0006

Table B8-11. Recommended outer raceway bore diameter tolerances

E Nominal Outer Raceway Bore Diameter mm in		Tolerance Limits (ISO H6) mm in	
>	≤	Max.	Min.
3 0.1181	6 0.2362	0.008 0.0003	0 0
6 0.2362	10 0.3937	0.009 0.0004	0 0
10 0.3937	18 0.7087	0.011 0.0004	0 0
18 0.7087	30 1.1811	0.013 0.0005	0 0
30 1.1811	50 1.9685	0.016 0.0006	0 0
50 1.9685	80 3.1496	0.019 0.0007	0 0
80 3.1496	120 4.7244	0.022 0.0009	0 0



LOAD RATING AND LIFE CALCULATIONS FOR FULL COMPLEMENTS OF NEEDLE ROLLERS

Before selecting the quantity and size of needle rollers to be used in a needle roller complement, it is usually necessary to calculate the load rating required using the applied load, speed and desired life. For a review of bearing size selection, see the engineering section of this catalog.

Because it is not practical to tabulate the dynamic and static load ratings for the great number of needle roller complements that can be assembled by using different quantities, diameters and lengths of rollers, formulae are provided for the necessary calculations. See Tables B8-3 and B8-4 on page B-8-9 and Table B8-5 on page B-8-10 for calculation of L_{we}.

For convenience, values of f_c and values of Z^{3/4} have been combined into single factors (f_c Z^{3/4}). These factors, for a wide range of roller complements, are tabulated in Table B8-12.

Table B8-12. Values of f_c Z^{3/4} for metric units

Table with 4 columns: Z, f_c Z^3/4 kN - units (mm, in), Z, f_c Z^3/4 kN - units (mm, in). Rows 6-33.

BASIC DYNAMIC LOAD RATINGS

The basic dynamic load rating C, for any roller bearing, can be calculated from the formula:

C = f_c (i L_w e cos alpha)^7/9 Z^3/4 D_w e^29/27

Where:

f_c = a factor which depends on the geometry of the bearing components, the accuracy to which the various components are made, and the material. Maximum values are listed in such standards as ISO 281 and USA ANSI-ABMA Standard 11.

i = number of rows of rollers in any one bearing.

alpha = nominal angle of contact. Since alpha = 0 for a radial roller bearing, cos alpha = 1.

Other symbols are explained in Table B8-5 on page B-8-10.

For single-path radial roller bearings, where i = 1 and cos alpha = 1, the basic dynamic load rating formula can be written as:

C = f_c Z^3/4 L_w e^7/9 D_w e^29/27

Example:

Calculate the basic dynamic load rating for a full complement of 28 flat-end rollers, 3.000 mm (0.1181 in) diameter and 17.800 mm (0.7008 in) length.

C = f_c Z^3/4 L_w e^7/9 D_w e^29/27
f_c Z^3/4 from Table B8-12 on page B-8-12 = 1.145

D_w e^29/27 = 3^29/27 = 3.254

L_w e = 17.8 - 0.4 = 17.4 mm (see Table B8-5 on page B-8-10)

L_w e^7/9 = 17.4^7/9 = 9.223

C = 1.145 x 9.223 x 3.254 = 34.4 kN

When a couple load (overturning moment) is imposed on a single row of needle rollers, the resulting uneven distribution of load can seriously affect bearing life. In such cases, two rows of needle rollers are generally suggested.

Your representative should be consulted before a final selection of a needle roller complement is made.

BASIC STATIC LOAD RATING

The basic static load rating (C_0) for any roller bearing, including needle roller bearings, can be calculated from the following formula included in ISO 76, USA ANSI-ABMA Standard 11, and other Standards:

C_0 = f_0 (1 - D_w e cos alpha / D_p w) i Z L_w e D_w e cos alpha

Where:

f_0 = 0.044 when kilo-newton and millimeter units are used.

D_p w = pitch diameter of the needle roller complement (mm).

i = number of rows of rollers in any one bearing.

alpha = nominal angle of contact. Since alpha = 0 for radial roller bearing, cos alpha = 1.

The other symbols are described in Table B8-5 on page B-8-10.



NEEDLE ROLLERS – INCH SERIES

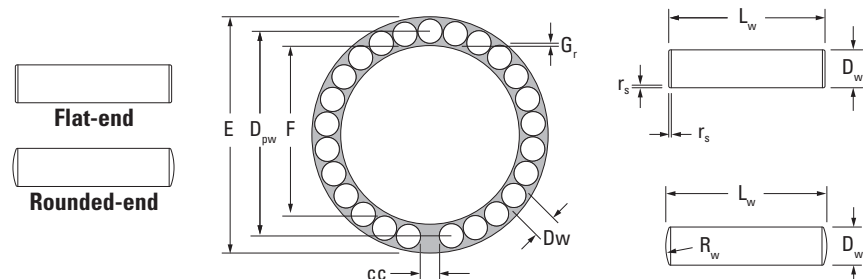


Fig. B8-2. Inch series needle rollers

INTRODUCTION

Before selecting a specific needle roller complement, the engineering section should be reviewed for detailed information concerning:

- Bearing type selection.
- Bearing life and reliability.
- Definition of load ratings.
- Life and load relationships.
- Effect of raceway hardness.
- Example of life calculation.
- Lubrication.
- Shaft design.
- Housing design.

In addition to these general considerations, material which follows should also be reviewed when selecting a needle roller complement.

Standard inch series needle rollers are furnished in two styles – rounded-end or the most economical design: flat-end. Materials, dimensions and tolerances for standard needle rollers are specified in this section.

When required, needle rollers having spherical ends, conical ends, trunnion ends or crank pin ends, as well as other end designs, can be furnished. Your representative should be consulted before final needle roller selection is made.

INCH SERIES – NEEDLE ROLLER DIMENSIONS

Needle rollers are made from rolling-bearing-quality steel hardened to 60-64 HRC or equivalent. Nominally inch needle rollers are given in Table B8-13. Your representative should be consulted for availability. The symbols used in Tables B8-13, as well as in subsequent tables and figures, are summarized in Table B8-14 on page B-8-16.

Needle rollers with rounded-ends permit the use of a more generous fillet between the raceway and the locating shoulder than is possible with flat-end rollers. Also, due to the length of the rounded-end, the possibility of the roller's cylindrical surface operating over the edge of the raceway is less – reducing the chance of occurrence of harmful stress concentrations. On the other hand, where design considerations permit their use, flat-end rollers achieve the maximum possible effective contact length between roller and raceway along with maximum load ratings and longer life.

Table B8-13. Preferred needle roller sizes

D _w Nominal dia.	L _w Nominal length																							
	3.048	4.064	4.826	5.588	6.350	7.112	7.874	9.652	11.176	12.700	14.224	15.748	19.050	22.352	25.400	28.448	31.750	35.052	38.100	44.450	50.800	57.150	63.500	
mm in	0.12	0.16	0.19	0.22	0.25	0.28	0.31	0.38	0.44	0.5	0.56	0.62	0.75	0.88	1	1.12	1.25	1.38	1.5	1.75	2	2.25	2.5	
1.588 0.0625					•	•	•	•	•	•	•	•	•											
1.984 0.0781								•	•	•	•	•	•											
2.383 0.0938								•	•	•	•	•	•	•	•									
3.175 0.1250										•	•	•	•	•	•	•	•	•	•					
3.967 0.1562												•	•	•	•	•	•	•	•	•				
4.763 0.1875													•	•	•	•	•	•	•	•	•			
5.558 0.2188														•	•	•	•	•	•	•	•	•	•	•
6.350 0.2500															•	•	•	•	•	•	•	•	•	•

* Indicates preferred needle roller sizes. Consult with your representative.

CLEARANCES IN NEEDLE ROLLER COMPLEMENTS

Needle rollers, supplied in bulk, are generally used to assemble full complement bearings. Successful operation of a full complement of rollers not only requires careful selection of radial clearance, but more importantly, depends on proper circumferential clearance – or the total clearance between rollers.

Circumferential guidance in a full complement of needle rollers depends largely on roller-to-roller contact. Too little circumferential clearance causes overheating. Too much circumferential clearance, in a heavily loaded full complement of needle rollers, causes loss of roller guidance and results in roller skew and heavy end thrust.

Control of radial clearance and circumferential clearance is influenced by the roller diameter tolerance, as well as the tolerances of the inner and outer raceway diameters.

END CLEARANCE

The total needle roller end clearance, or endplay, normally should be 0.2 mm (0.008 in) minimum per path of needle rollers.

NOMINAL-INCH NEEDLE ROLLER TOLERANCES

Unless otherwise specified, inch needle rollers are normally manufactured with a tolerance of +0.000 mm -0.005 mm (+0.0000 in -0.0002 in). This tolerance has proven acceptable and ensures satisfactory control of circumferential clearance. The needle roller length tolerance may vary with the end configuration. The normal roller length tolerance for rounded-end rollers is +0.000 mm -0.508 mm (+0.0000 in -0.0200 in).

JTEKT also manufactures needle rollers with 0.0025 mm (0.0001 in) diameter tolerance. These offer enhanced load-carrying capability and improved control of circumferential clearance. For needle rollers of greater precision, please consult with your representative.

Nominal dimensions for typical inch series needle rollers are shown in Table B8-13 on page B-8-14. JTEKT can supply rollers with smaller and larger length-to-diameter ratios for special applications. Rollers with dimensions other than those shown in Table B8-13 on page B-8-14 can be obtained, provided the quantities permit economical production. For example, although the largest needle rollers shown in Table B8-13 on page B-8-14 are 6.35 mm (0.2500 in) [the usual limits for needle rollers], JTEKT can produce quantities of rollers as large as 15.900 mm (0.6250 in) diameter.

Your representative should be contacted with the following information about the required needle rollers:

- Nominal metric or inch.
- Diameter and tolerance (e.g., 3.175 mm, + 0.000 mm, -0.005 mm [0.1250 in, + 0.0000 in, -0.0002 in]).
- Length and tolerance (e.g., 14.224 mm, + 0.000 mm, -0.508 mm [0.5600 in, + 0.0000 in, -0.0200 in]).
- End form (e.g., rounded-end or flat-end).
- Material (e.g., high-carbon chrome steel).

- Special features required (e.g., controlled stress).
- Quantity required.

DESIGN CALCULATIONS FOR NEEDLE ROLLER BEARING COMPLEMENTS

In the majority of full complement needle roller applications, roller complements of less than 35 needle rollers per row and a ratio of roller length to roller diameter between 4:1 and 8:1 is advantageous. Other combinations of quantity and length-to-diameter ratios of needle rollers have been used successfully. Specific design requirements usually dictate the appropriate selection.

In general, roller complements for rotating motion should employ a smaller number of larger-diameter needle rollers, while roller complements subjected to oscillating motion (especially under high loads) should employ a larger number of smaller-diameter needle rollers.

Oscillating applications with small angular travel encourage the development of fretting corrosion. The best performance under these conditions has been achieved by using the largest practical number of small-diameter needle rollers.

CALCULATION OF RACEWAY DIAMETERS

It may be convenient to use the Bearing Calculation Form in Table B8-15 on page B-8-16 to calculate the maximum inner raceway and the minimum outer raceway diameters of a bearing. The formula given in Table B8-14 on page B-8-16 can also be used. To assist the designer in making these calculations, the values of K, required for calculation of needle roller complements of 6 through 60 needle rollers, are listed in Table B8-18 on page B-8-17. Values of K for other numbers of needle rollers will be furnished on request or can be calculated from the formula given in Table B8-14 on page B-8-16.

Table B8-16 on page B-8-16 lists the suggested values for minimum radial clearance and (G_{r min}) minimum circumferential clearance divided by π (cc_{min}/π), to be used for calculating needle roller complements for normal rotating applications where the speeds, loads and shaft deflections are moderate.

Applications with poor lubrication, unusual motion, large misalignment, raceway distortions, load reversals, high speeds, etc., can not be characterized as normal rotating applications. These miscellaneous applications require adjustment of the minimum clearances listed in Table B8-16 on page B-8-16. The factors in Tables B8-17 on page B-8-16 may be used for general guidance in the adjustment of the minimal clearances. For any of the listed miscellaneous applications or any application where abnormal factors such as those listed above exist – and particularly when the inner raceway diameter will exceed 50.800 mm (2.0000 in) – your representative should be consulted for design assistance.



Table B8-14. Design factors for needle rollers

Z	Number of needle rollers per bearing path
K	Chordal factor, $K = 1/\sin(180^\circ/Z)$
cc	Total circumferential clearance. See Tables B8-16 and B8-17 for cc_{min}/π values.
G_r	Radial internal clearance. See Tables B8-16 and B8-17 for $G_{r\ min}$ values
D_{pw}	Pitch diameter: $D_{pw} = KD_{w\ max} + (cc_{min}/\pi) = E_{min} - D_{w\ max}$ $= F_{max} + G_{r\ min} + D_{w\ max}$
E	Outer raceway bore diameter: $E_{min} = D_{pw} + D_{w\ max} = (K + 1)D_{w\ max} + (cc_{min}/\pi)$ $= F_{max} + G_{r\ min} + 2D_{w\ max}$
F	Inner raceway diameter: $F_{max} = D_{pw} - D_{w\ max} - G_{r\ min}$ $= (K-1)D_{w\ max} + (cc_{min}/\pi) - G_{r\ min}$ $= E_{min} - 2D_{w\ max} - G_{r\ min}$
D_w	Nominal needle roller diameter
D_{we}	Needle roller diameter applicable in the calculation of load ratings: $D_{we} = D_{pw} - F_{max} - G_{r\ min} = \frac{D_{pw} - cc_{min}/\pi}{K}$ $= \frac{F_{max} + G_{r\ min} - (cc_{min}/\pi)}{(K-1)}$ $= E_{min} - D_{pw} = \frac{E_{min} - cc_{min}/\pi}{(K+1)}$
L_w	Overall needle roller length
R_w	End radius, rounded-end needle roller
r_s	Corner rounding, flat-end needle roller
L_{we}	Needle roller length applicable in the calculation of load ratings, for rounded-end needle rollers: $L_{we} = L_{w\ max} - (0.4D_{we})$ For flat-end needle rollers: $L_{we} = L_{w\ max} - (2r_s\ min)$

Note: If length of contact of the needle roller with the raceway is reduced because of undercuts, chamfers, etc. – L_{we} must be reduced correspondingly.

RACEWAY DIAMETER TOLERANCE LIMITS

Tables B8-19 and B8-20 on page B-8-17 lists the recommended tolerances that should be applied to the dimensions for the maximum inner raceway and the minimum outer raceway diameter after they have been calculated using the Bearing Calculation Form, Table B8-15.

Table B8-15. Bearing calculation form

Step	Source	Design factor	mm (in)	
1	Given	D_w , roller diameter	3.175 (0.1250) max.	Min.
2	Table B8-18	K, for 30 rollers	9.56677 (9.56677)	
3	(1)×(2)	KD_w	30.374 (1.1958)	
4	Table B8-16	$cc_{min}/\pi = 0.005$ in	0.127 (0.005) min.	Max.
5	(3) + (4)	D_{pw} , pitch diameter	30.501 (1.2008)	
6	Given	D_w , roller diameter	3.175 (0.1250) max.	Min.
7	(5) - (6)		27.326 (1.0758)	
8	Table B8-16	G_r , radial clearance	0.013 (0.0005) min.	Max.
9	(7) - (8)	F, inner raceway diameter	27.349 (1.0753) max.	27.340 (1.0749) min. ⁽¹⁾
10	(5) + (6)	E, outer raceway diameter	33.676 (1.3258) min.	33.692 (1.3264) max. ⁽¹⁾

⁽¹⁾ From Tables B8-20 and B8-21 on page B-8-17.

Table B8-16. Minimum clearances, normal rotating applications

F Nominal Inner Raceway Diameter mm in		cc_{min}/π	$G_{r\ min}$
>	≤	mm in	mm in
-	3	0.025	0.006
-	0.1181	0.0010	0.0002
3	6	0.102	0.008
0.1181	0.2362	0.0040	0.0003
6	10	0.127	0.009
0.2362	0.3937	0.0050	0.0004
10	18	0.127	0.011
0.3937	0.7087	0.0050	0.0004
18	30	0.127	0.013
0.7087	1.1811	0.0050	0.0005
30	50	0.127	0.016
1.1811	1.9685	0.0050	0.0006
50	80	0.127	0.019
1.9685	3.1496	0.0050	0.0007
80	120	0.127	0.022
3.1496	4.7244	0.0050	0.0009

Table B8-17. Minimum clearances, miscellaneous applications

Application	cc_{min}/π	$G_{r\ min}$
universal joint	1/3 • normal	1/2 • normal
transmission pilot	normal	3 • normal
constant mesh gear	0.2 • roller dia.	normal
transmission planet	normal	normal
crank pin for two cycle engine	5 • normal	7 • normal

Table B8-18. K values

Z	K	Z	K	Z	K	Z	K
6	2.00000	21	6.70951	36	11.47371	51	16.24408
7	2.30476	22	7.02667	37	11.79163	52	16.56219
8	2.61313	23	7.34394	38	12.10957	53	16.88031
9	2.92380	24	7.66130	39	12.42752	54	17.19843
10	3.23607	25	7.97873	40	12.74549	55	17.51657
11	3.54947	26	8.29623	41	13.06348	56	17.83471
12	3.86370	27	8.61379	42	13.38149	57	18.15285
13	4.17858	28	8.93140	43	13.69951	58	18.47100
14	4.49396	29	9.24907	44	14.01754	59	18.78916
15	4.80973	30	9.56677	45	14.33559	60	19.10732
16	5.12583	31	9.88452	46	14.65364		
17	5.44219	32	10.20230	47	14.97171		
18	5.75877	33	10.52011	48	15.28979		
19	6.07553	34	10.83795	49	15.60788		
20	6.39245	35	11.15582	50	15.92597		

Table B8-19. Recommended inner raceway diameter tolerances

F Nominal Inner Raceway Diameter mm in		Tolerance Limits (ISO h5) mm in	
>	≤	Max.	Min.
3	6	0	-0.005
0.1181	0.2362	0	-0.0002
6	10	0	-0.006
0.2362	0.3937	0	-0.0002
10	18	0	-0.008
0.3937	0.7087	0	-0.0003
18	30	0	-0.009
0.7087	1.1811	0	-0.0004
30	50	0	-0.011
1.1811	1.9685	0	-0.0004
50	80	0	-0.013
1.9685	3.1496	0	-0.0005
80	120	0	-0.015
3.1496	4.7244	0	-0.0006

Table B8-20. Recommended outer raceway bore diameter tolerances

E Nominal Outer Raceway Bore Diameter mm in		Tolerance Limits (ISO H6) mm in	
>	≤	Max.	Min.
3	6	0.008	0
0.1181	0.2362	0.0003	0
6	10	0.009	0
0.2362	0.3937	0.0004	0
10	18	0.011	0
0.3937	0.7087	0.0004	0
18	30	0.013	0
0.7087	1.1811	0.0005	0
30	50	0.016	0
1.1811	1.9685	0.0006	0
50	80	0.019	0
1.9685	3.1496	0.0007	0
80	120	0.022	0
3.1496	4.7244	0.0009	0

KEYSTONED ROLLER ASSEMBLIES

Retention of the rollers in the outer raceway by keystoneing can be helpful in assembly operations. The following formula may be used to check the bearing design to be sure that a given number of rollers, Z, will keystone.

$$YD_{w\ min} > E_{max} = \text{keystone condition}$$

That is, the product of the keystone constant Y, given below, and the minimum roller diameter $D_{w\ min}$, must be greater than the maximum outer race bore, E_{max} .

Roller complements with 14 or more rollers usually will not keystone unless steps are taken to reduce the circumferential clearance. It is suggested that your representative be consulted when designing a keystoneed roller complement with 14 or more rollers.

Table B8-21. Keystone constant

Z	Y	Z	Y
8	3.67633	14	5.51128
9	3.97094	15	5.82467
10	4.27277	16	6.13885
11	4.57895	17	6.45365
12	4.88797	18	6.76893
13	5.19892	19	7.08461



LOAD RATING AND LIFE CALCULATIONS FOR FULL COMPLEMENTS OF NEEDLE ROLLERS

Before selecting the quantity and size of needle rollers to be used in a needle roller complement, it is usually necessary to calculate the load rating required using the applied load, speed and desired life.

Since it is not practical to tabulate the dynamic and static load ratings for the great number of needle roller complements that can be assembled by using different quantities, diameters and lengths of rollers, formulae are provided for the necessary calculations.

For convenience, values of f_c and values of $Z^{3/4}$ have been combined into single factors ($f_c Z^{3/4}$). These factors for a wide range of needle roller complements are contained in Table B8-22.

Table B8-22. Values of $f_c Z^{3/4}$ for inch units

Z	$f_c Z^{3/4}$ lbf - units in	Z	$f_c Z^{3/4}$ lbf - units in
6	24000	36	119600
7	30200	37	121500
8	35900	38	123400
9	41200	39	125200
10	46100	40	127100
11	50700	41	128900
12	55100	42	130600
13	59100	43	132400
14	63000	44	134100
15	66600	45	135800
16	70100	46	137500
17	73400	47	139200
18	76600	48	140800
19	79700	49	142400
20	82600	50	144000
21	85400	51	145600
22	88100	52	147200
23	90800	53	148800
24	93300	54	150300
25	95800	55	151800
26	98200	56	153300
27	100600	57	154800
28	102900	58	156300
29	105100	59	157800
30	107300	60	159200
31	109500		
32	111600		
33	113600		
34	115600		
35	117600		

BASIC DYNAMIC LOAD RATINGS

The basic dynamic load rating, C, for any roller bearing can be calculated from the formula:

$$C = f_c (i L_w \cos \alpha)^{7/9} Z^{3/4} D_w^{29/27}$$

Where:

- f_c = a factor which depends on the geometry of the bearing components, the accuracy to which the various components are made, and the material. Maximum values are listed in such standards as ISO 281 and USA ANSI-ABMA Standard 11.
- i = number of rows of needle rollers in any one bearing.
- α = nominal angle of contact. Since $\alpha = 0$ for a radial needle roller bearing, $\cos \alpha = 1$.

Other symbols are explained in Table B8-14 on page B-8-16.

For single-path radial needle roller bearings, where $i = 1$ and $\cos \alpha = 1$, the basic dynamic load rating formula can be written as:

$$C_r = f_c Z^{3/4} L_{we}^{7/9} D_w^{29/27}$$

Example:

Calculate the basic dynamic load rating in lbf for a full complement of 28 rounded-end rollers, 0.1250 inch diameter and 0.750 inch length.

$$C = f_c Z^{3/4} L_{we}^{7/9} D_w^{29/27}$$

$$f_c Z^{3/4} \text{ from Table B8-22} = 102900$$

Where:

$$D_w^{29/27} = 0.1250^{29/27} = 0.1072$$

$$L_{we} = 0.750 - (0.4) 0.1250 = 0.700 \text{ (see Table B8-14 on page B-8-16)}$$

$$L_{we}^{7/9} = 0.700^{7/9} = 0.758$$

$$C = 102900 \times 0.1072 \times 0.758 = 8360 \text{ lbf}$$

When a couple load (overturning moment) is imposed on a single row of needle rollers, the resulting uneven distribution of load can seriously affect bearing life. In such cases, two rows of needle rollers are generally suggested.

Your representative should be consulted before a final selection of a needle roller complement is made.

BASIC STATIC LOAD RATING

The basic static load rating (C_0) for any roller bearing, including needle roller bearings, can be calculated from the following formula included in ISO 76, USA ANSI-ABMA Standard 11 and other Standards:

$$C_0 = f_0 \left(1 - \frac{D_{we} \cos \alpha}{D_{pw}} \right) i Z L_{we} D_{we} \cos \alpha$$

Where:

- f_0 = 6430 when pound-force and inch units are used
- D_{pw} = pitch diameter of the needle roller complement (inch).
- i = number of rows of rollers in any one bearing.
- α = nominal angle of contact. Since $\alpha = 0$ for radial roller bearing, $\cos \alpha = 1$.

The other symbols are described in Table B8-14 on page B-8-16.

CYLINDRICAL ROLLERS – METRIC SERIES

JTEKT cylindrical rollers are made from bearing-quality steel and hardened to 58-65 HRC or equivalent. Nominal metric cylindrical rollers are sorted into gages based on the mean deviation from nominal diameter and nominal length. The relieved ends of the cylindrical rollers, when used in bearing complements, help to reduce stress concentration at the ends of rollers, both under misalignment or ideal alignment. This results in a more uniform stress distribution along the roller-raceway contact length and optimum bearing performance.

METRIC SERIES CYLINDRICAL ROLLER DIMENSIONS

Nominally metric cylindrical rollers conforming to DIN 5402 sheet 1 are shown in Table B8-23. Chamfer dimension limits of these cylindrical rollers with flat-ends are also shown in Table B8-23. The use of these chamfer limits results in the maximum possible effective contact length between roller and raceway, along with the already mentioned relieved ends, producing the maximum possible load ratings and longer life.

Each cylindrical roller gage is packed separately, and the mean deviations of diameter and length gages are shown on the package (below the roller designation).

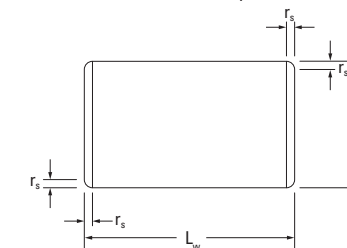


Fig. B8-3. Metric series cylindrical rollers

Table B8-23. Dimensions of metric series cylindrical rollers

D _w	L _w	r _s min	r _s max	Cylindrical roller designation	Wt. 100 pieces approx.	D _w	L _w	r _s min	r _s max	Cylindrical roller designation	Wt. 100 pieces approx.
Nominal diameter	Nominal length					Nominal diameter	Nominal length				
mm in	mm in	mm in	mm in		kg lbs	mm in	mm in	mm in	mm in		kg lbs
3 0.1181	5 0.1969	0.2 0.0079	0.4 0.0158	ZR0.3x5	0.027 0.060	7.5 0.2953	9 0.3543	0.2 0.0079	0.6 0.0236	ZR0.7,5x9	0.312 0.688
3.5 0.1378	5 0.1969	0.2 0.0079	0.4 0.0158	ZR0.3,5x5	0.037 0.082	7.5 0.2953	11 0.4331	0.2 0.0079	0.6 0.0236	ZR0.7,5x11	0.374 0.825
4 0.1575	4 0.1575	0.2 0.0079	0.4 0.0158	ZR0.4x4	0.039 0.086	8 0.3150	8 0.3150	0.2 0.0079	0.6 0.0236	ZR0.8x8	0.308 0.679
4 0.1575	6 0.2362	0.2 0.0079	0.4 0.0158	ZR0.4x6	0.058 0.128	8 0.3150	12 0.4724	0.2 0.0079	0.6 0.0236	ZR0.8x12	0.465 1.025
4 0.1575	8 0.3150	0.2 0.0079	0.4 0.0158	ZR0.4x8	0.078 0.172	9 0.3543	10 0.3937	0.3 0.0118	0.7 0.0276	ZR0.9x10	0.5 1.102
5 0.1969	5 0.1969	0.2 0.0079	0.6 0.236	ZR0.5x5	0.075 0.165	9 0.3543	14 0.5512	0.3 0.0118	0.7 0.0276	ZR0.9x14	0.68 1.499
5 0.1969	8 0.3150	0.2 0.0079	0.6 0.0236	ZR0.5x8	0.121 0.267	10 0.3937	10 0.3937	0.3 0.0118	0.7 0.0276	ZR0.10x10	0.6 1.323
5.5 0.2165	8 0.3150	0.2 0.0079	0.6 0.0236	ZR0.5,5x8	0.146 0.322	10 0.3937	11 0.4331	0.3 0.0118	0.7 0.0276	ZR0.10x11	0.68 1.499
6 0.2362	6 0.2362	0.2 0.0079	0.6 0.0236	ZR0.6x6	0.13 0.287	10 0.3937	14 0.5512	0.3 0.0118	0.7 0.0276	ZR0.10x14	0.85 1.874
6 0.2362	12 0.4724	0.2 0.0079	0.6 0.0236	ZR0.6x12	0.261 0.575	11 0.4331	15 0.5906	0.3 0.0118	0.7 0.0276	ZR0.11x15	1.1 2.425
6.5 0.2559	9 0.3543	0.2 0.0079	0.6 0.0236	ZR0.6,5x9	0.23 0.507	12 0.4724	14 0.5512	0.3 0.0118	0.7 0.0276	ZR0.12x14	1.23 2.712
7 0.2756	7 0.2756	0.2 0.0079	0.6 0.0236	ZR0.7x7	0.206 0.454	13 0.5118	20 0.7874	0.4 0.0158	0.8 0.0315	ZR0.13x20	2.04 4.497
7 0.2756	10 0.3937	0.2 0.0079	0.6 0.0236	ZR0.7x10	0.296 0.653	14 0.5512	14 0.5512	0.4 0.0158	0.8 0.0315	ZR0.14x14	1.66 3.660
7 0.2756	14 0.5512	0.2 0.0079	0.6 0.0236	ZR0.7x14	0.417 0.919	14 0.5512	20 0.7874	0.4 0.0158	0.8 0.0315	ZR0.14x20	2.38 5.247
7.5 0.2953	7.5 0.2953	0.2 0.0079	0.6 0.0236	ZR0.7,5x7.5	0.254 0.560						

Note: Mass in accordance with DIN 5402.



EXAMPLE OF METRIC SERIES CYLINDRICAL ROLLER DESIGNATION AND PACKAGE MARKING:

ZR0.6 x 8

P0/M6

Nominal diameter: $D_w = 6.000$ mm

Nominal length: $L_w = 8.000$ mm

Mean deviation of the diameter +0.0010 mm (see Table B8-24)

Mean deviation of the length -0.006 mm (see Table B8-25)

The actual finished diameter is between 5.999 and 6.001 mm

The actual finished length is between 7.991 and 7.997 mm

In the marking of the cylindrical roller gage, P identifies zero (0) or plus (+), M identifies minus (-). If a shipment of cylindrical rollers of the same size comprises several boxes, each box contains cylindrical rollers of the identical gage, although the gage may vary from box to box.

Table B8-24. Diameter and form accuracy of metric series cylindrical rollers

Nominal Diameter D_w		Total Diameter Deviation		Variation of Gage	Mean Deviation of Gage DIN/ISO 1101													Circularity Deviation		
>	≤	Max.	Min.															Max.		
mm	mm	μm	μm	μm	μm													μm		
—	20	+7	-9	2	+6	+5	+4	+3	+2	+1	0	-1	-2	-3	-4	-5	-6	-7	-8	0.8

Table B8-25. Length gages of metric series cylindrical rollers

Nominal Diameter L_w		Total Length Deviation		Variation of Gage	Mean Deviation of Gage				Axial Runout DIN/ISO 1101
>	≤	Max.	Min.						
mm	mm	μm	μm	μm	μm				μm
—	48	+9	-15	6	+6	0	-6	-12	6

INNER RINGS – METRIC SERIES

When it is impractical to meet the shaft raceway design requirements (hardness, surface finish, case depth, etc.) outlined in the engineering section of this catalog, standard inner rings may be used.

Inner rings are made of rolling bearing steel and after hardening, their bores, raceways and end surfaces are ground. Metric series inner rings may be used to provide inner raceway surfaces for metric series radial needle roller and cage assemblies, metric series needle roller bearings and metric series drawn cup needle roller bearings. The extended inner rings are suitable for use with bearings containing lip contact seals and for applications in which axial movement may be present.

CONSTRUCTION

Metric series inner rings are available with combinations of three primary design features. The inner rings may be purchased: without chamfers at the end of the raceway surface to allow for maximum possible raceway contact area, with lubrication holes to allow for increased lubrication to the bearing area, or with a profiled outer diameter for use in applications having a greater degree of misalignment. Table B8-26 outlines the features offered in the different series.

Table B8-26. Outline of features

Series	Lube Hole	Chamfers	Raceway Profile
JR		X	
JR.JS1	X	X	
JRZ.JS1	X		
IM		X	
IM...P		X	
IMC	X	X	
IM...R6		X	X

The lubrication holes are located nominally at the center of the inner ring width. The nominal diameters for the lubrication holes for inner rings listed in this section are shown in Table B8-27.

Table B8-27. Nominal diameters for the lubrication holes for inner ring

Series Designation	Inner Ring Bore Diameter		Nominal Lubrication Hole Diameter
	>	≤	mm
JR.JS1		20	2.0
	20	40	2.5
	40	80	3.0
JRZ.JS1	80		3.5
IMC	All catalogue parts		2.2

The BIC and BICG Series inner rings have chamfers and oil holes and are designed to be used with the full complement, metric, needle roller bearings of Series RNA1000, RNA2000 and RNA3000. These inner rings are intended for RNA bearings of the same number; for example a BIC2020 would be used with a RNA2020.

DIMENSIONAL ACCURACY

The tolerances of size, form, and runout for metric series inner rings meet the requirements of ISO normal tolerance class for radial bearings (see the engineering section of this catalog). Most

metric series inner rings are produced with outer diameter raceway tolerance in accordance with h5 which, in most cases, is suitable for combining the metric series needle roller bearings to give the normal clearance class and for use with metric caged drawn cup bearings. An exception is the inner rings for metric, full complement drawn cup needle roller bearings; these inner rings are produced with outside diameter raceway tolerance in accordance with g5. Other raceway tolerances may also be found on inner rings for combining with needle roller bearings to give one of the clearance classes, or other specially requested radial internal clearance requirement.

Table B8-28 lists the dimensional accuracy of the IM series inner rings.

Table B8-28. Dimensional accuracy of IM series inner ring

Part Designation	OD Tolerance	Other Feature Tolerances
IM & IMC with P suffix	h5	ISO 492 Normal Tolerance Class
IM & IMC without P suffix	g5	Consult engineering
Series 49 (e.g. IM4901, IM4902)	Consult engineering	ISO 492 Normal Tolerance Class
Series IM 19000 & IM 20600	+0.000 / -0.005 mm	Consult engineering

MOUNTING OF INNER RINGS

Inner rings may be mounted on the shaft with either a loose transition fit or an interference fit. These fits, used in conjunction with the proper fit of the bearing outer ring, will provide the correct operating clearances for most applications.

Regardless of the fit of the inner ring on the shaft, the inner ring should be axially located by shaft shoulders or other positive means. The shaft shoulder diameter adjacent to the inner ring must not exceed the inner ring outer diameter (per suggestions on page B-4-9 of the metric series needle roller bearing section).

When metric series inner rings are to be used with the metric series needle roller bearings, appropriate shaft tolerances should be selected from Table B4-4 on page B-4-9 in the heavy-duty needle roller bearing section. When metric series inner rings are to be used with drawn- cup bearings, the suggested shaft tolerances are given in the "inner rings" discussion on page B-2-8 of the metric series drawn cup needle roller bearings section of this catalog.

INCH SERIES INNER RINGS

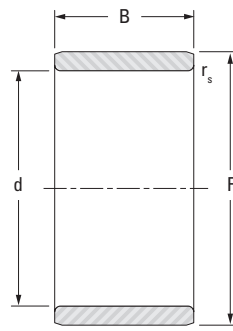
Inch series inner rings for use with inch series drawn cup bearings are tabulated on page B-2-74 of this catalog. See page B-4-54 for inch series inner rings for use with inch series heavy-duty needle roller bearings.

END WASHERS – METRIC SERIES

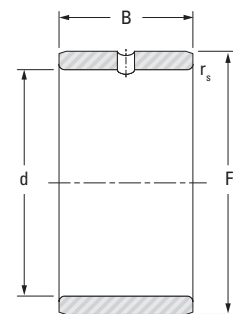
When the metric series radial needle roller and cage assembly used in series NAO and RNAO needle roller bearings without flanges cannot be axially located by suitable shoulders or side faces, end washers of series SNSH may be used. These end washers, which are made of spring steel, are designed to be guided in the housing bore. They are tabulated on page B-8-39.



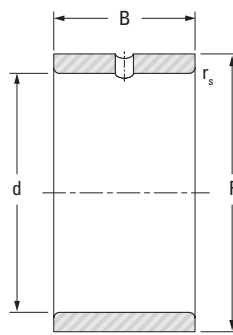
INNER RINGS
METRIC SERIES



JR, IM..P



JR.JS1

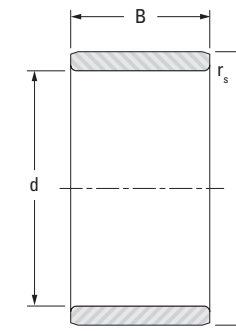


JRZ.JS1

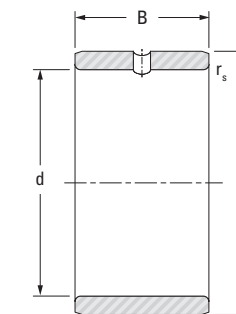
Shaft Dia.	d	F ⁽¹⁾	B	r _s min	Inner Ring Designation	Wt.
mm in	mm in	mm in	mm in	mm in		kg lbs
5 0.1969	5 0.1969	8 0.3150	8 0.3150	0.3 0.01	JR5x8x8JS1	0.002 0.004
	5 0.1969	8 0.3150	12 0.4724	0.3 0.01	JR5x8x12	0.003 0.007
	5 0.1969	8 0.3150	16 0.630	0.3 0.01	JR5x8x16	0.004 0.009
6 0.2362	6 0.2362	9 0.3543	8 0.315	0.3 0.01	JR6x9x8JS1	0.002 0.004
	6 0.2362	9 0.3543	12 0.4724	0.3 0.01	JR6x9x12	0.003 0.007
	6 0.2362	9 0.3543	16 0.630	0.3 0.01	JR6x9x16	0.004 0.009
	6 0.2362	10 0.3937	10 0.394	0.3 0.01	JR6x10x10	0.004 0.009
	6 0.2362	10 0.3937	10 0.394	0.3 0.01	JR6x10x10JS1	0.004 0.009
	6 0.2362	10 0.3937	12 0.4724	0.3 0.01	JRZ6x10x12JS1	0.005 0.011
7 0.2756	7 0.2756	10 0.3937	10.5 0.413	0.3 0.01	JR7x10x10,5	0.003 0.007
	7 0.2756	10 0.3937	12 0.4724	0.3 0.01	JR7x10x12	0.004 0.009
	7 0.2756	10 0.3937	16 0.630	0.3 0.01	JR7x10x16	0.005 0.011
8 0.3150	8 0.3150	12 0.4724	10 0.394	0.3 0.01	JR8x12x10	0.005 0.011
	8 0.3150	12 0.4724	10 0.394	0.3 0.01	JR8x12x10JS1	0.005 0.011
	8 0.3150	12 0.4724	10.5 0.413	0.3 0.01	JR8x12x10,5	0.005 0.011
	8 0.3150	12 0.4724	12 0.472	0.3 0.01	JRZ8x12x12JS1	0.006 0.013
	8 0.3150	12 0.4724	12.5 0.492	0.3 0.01	JR8x12x12,5	0.006 0.013
	8 0.3150	12 0.4724	16 0.630	0.3 0.01	IM 8 12 16 P	0.007 0.016
9 0.3543	9 0.3543	12 0.4724	12 0.4724	0.3 0.01	JR9x12x12	0.005 0.011
	9 0.3543	12 0.4724	16 0.630	0.3 0.01	JR9x12x16	0.006 0.013
10 0.3937	10 0.3937	13 0.5118	12.5 0.492	0.3 0.01	JR10x13x12,5	0.005 0.011
	10 0.3937	14 0.5512	11 0.433	0.3 0.01	JR10x14x11JS1	0.007 0.015
	10 0.3937	14 0.5512	12 0.4724	0.3 0.01	JR10x14x12	0.007 0.015
	10 0.3937	14 0.5512	12 0.4724	0.3 0.01	JR10x14x12JS1	0.007 0.015

⁽¹⁾ Inner rings for metric full complement needle roller bearings are produced with outside diameter tolerance g5.

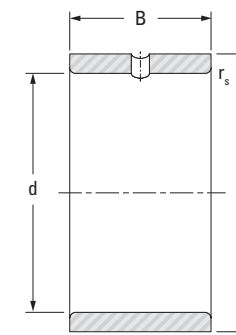
INNER RINGS
METRIC SERIES



JR, IM..P



JR.JS1



JRZ.JS1

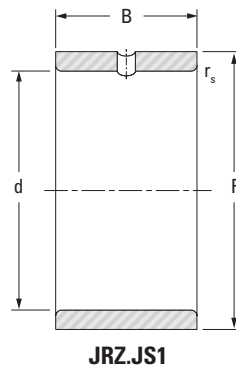
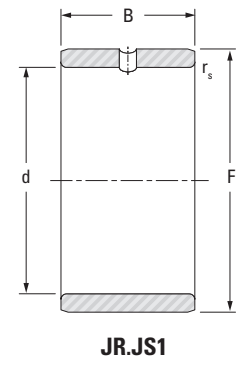
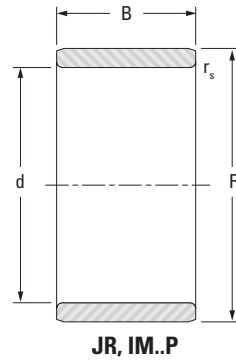
Shaft Dia.	d	F ⁽¹⁾	B	r _s min	Inner Ring Designation	Wt.
mm in	mm in	mm in	mm in	mm in		kg lbs
10 0.3937	10 0.3937	14 0.5512	13 0.512	0.3 0.01	JR10x14x13	0.007 0.015
	10 0.3937	14 0.5512	14 0.551	0.3 0.01	JRZ10x14x14JS1	0.008 0.018
	10 0.3937	14 0.5512	16 0.630	0.3 0.01	JR10x14x16	0.009 0.020
	10 0.3937	14 0.5512	20 0.787	0.3 0.01	JR10x14x20	0.012 0.026
12 0.4724	12 0.4724	15 0.5906	12.5 0.492	0.3 0.01	JR12x15x12,5	0.006 0.013
	12 0.4724	15 0.5906	16 0.630	0.3 0.01	JR12x15x16	0.008 0.018
	12 0.4724	15 0.5906	16.5 0.650	0.3 0.01	JR12x15x16,5	0.008 0.018
	12 0.4724	15 0.5906	18.5 0.728	0.3 0.01	JR12x15x18,5	0.009 0.020
	12 0.4724	15 0.5906	22.4 0.882	0.2 0.01	IM 12 15 22,4 P	0.011 0.024
	12 0.4724	15 0.5906	22.5 0.886	0.3 0.01	JR12x15x22,5	0.011 0.024
	12 0.4724	16 0.6299	12 0.472	0.3 0.01	JR12x16x12	0.008 0.018
	12 0.4724	16 0.6299	12 0.472	0.3 0.01	JR12x16x12JS1	0.008 0.018
	12 0.4724	16 0.6299	13 0.512	0.3 0.01	JR12x16x13	0.008 0.018
	12 0.4724	16 0.6299	14 0.551	0.3 0.01	JRZ12x16x14JS1	0.010 0.022
	12 0.4724	16 0.6299	16 0.630	0.3 0.01	JR12x16x16	0.011 0.024
	12 0.4724	16 0.6299	20 0.787	0.3 0.01	JR12x16x20	0.014 0.031
	12 0.4724	16 0.6299	22 0.866	0.3 0.01	JR12x16x22	0.015 0.033
13 0.5118	13 0.5118	18 0.7087	16 0.630	0.35 0.014	IM 13 18 16 P	0.015 0.033
14 0.5512	14 0.5512	17 0.6693	17 0.669	0.3 0.01	JR14x17x17	0.009 0.020
15 0.5906	15 0.5906	18 0.7087	16.5 0.650	0.3 0.01	JR15x18x16,5	0.010 0.022
	15 0.5906	19 0.7480	16 0.630	0.3 0.01	JR15x19x16	0.013 0.029
	15 0.5906	19 0.7480	20 0.787	0.3 0.01	JR15x19x20	0.017 0.037
	15 0.5906	20 0.7874	12 0.472	0.3 0.01	JR15x20x12	0.012 0.026
	15 0.5906	20 0.7874	12 0.472	0.3 0.01	JR15x20x12JS1	0.012 0.026

⁽¹⁾ Inner rings for metric full complement needle roller bearings are produced with outside diameter tolerance g5.

Continued on next page.



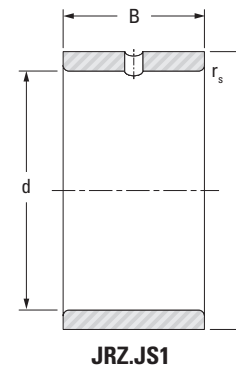
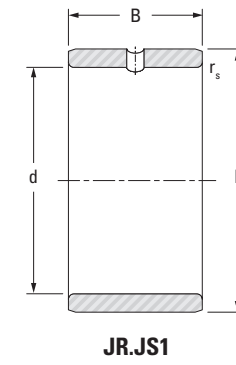
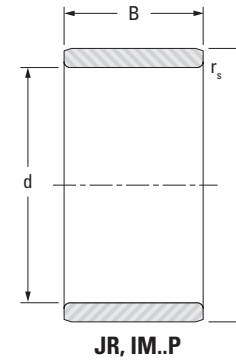
INNER RINGS
METRIC SERIES



Shaft Dia.	d	F ⁽¹⁾	B	r _s min	Inner Ring Designation	Wt.
mm in	mm in	mm in	mm in	mm in		kg lbs
15 0.5906	15 0.5906	20 0.7874	13 0.512	0.3 0.01	JR15x20x13	0.014 0.031
	15 0.5906	20 0.7874	14 0.551	0.3 0.01	JRZ15x20x14JS1	0.015 0.033
	15 0.5906	20 0.7874	16 0.630	0.3 0.01	JR15x20x16	0.017 0.037
	15 0.5906	20 0.7874	20 0.787	0.35 0.014	IM 15 20 20 P	0.021 0.045
	15 0.5906	20 0.7874	23 0.906	0.3 0.01	JR15x20x23	0.025 0.055
	15 0.5906	20 0.7874	26 1.024	0.3 0.01	JR15x20x26	0.028 0.062
17 0.6693	17 0.6693	20 0.7874	16.5 0.650	0.3 0.01	JR17x20x16,5	0.011 0.024
	17 0.6693	20 0.7874	20 0.787	0.3 0.01	JR17x20x20	0.014 0.031
	17 0.6693	20 0.7874	20.5 0.807	0.3 0.01	JR17x20x20,5	0.014 0.031
	17 0.6693	20 0.7874	30.5 1.201	0.3 0.01	JR17x20x30,5	0.021 0.046
	17 0.6693	21 0.8268	16 0.630	0.3 0.01	JR17x21x16	0.015 0.033
	17 0.6693	21 0.8268	20 0.787	0.3 0.01	JR17x21x20	0.019 0.042
	17 0.6693	22 0.8661	13 0.512	0.3 0.01	JR17x22x13	0.015 0.033
	17 0.6693	22 0.8661	13 0.512	0.35 0.014	IM 4903	0.015 0.033
	17 0.6693	22 0.8661	16 0.630	0.3 0.01	JR17x22x16	0.019 0.042
	17 0.6693	22 0.8661	16 0.630	0.3 0.01	JR17x22x16JS1	0.019 0.042
	17 0.6693	22 0.8661	16 0.630	0.3 0.01	JRZ17x22x16JS1	0.019 0.042
	17 0.6693	22 0.8661	20 0.787	0.35 0.014	IM 17 22 20 P	0.023 0.051
	17 0.6693	22 0.8661	23 0.906	0.3 0.01	JR17x22x23	0.028 0.062
	17 0.6693	22 0.8661	26 1.024	0.3 0.01	JR17x22x26	0.031 0.068
	17 0.6693	22 0.8661	32 1.260	0.3 0.01	JR17x22x32	0.038 0.084
20 0.7874	20 0.7874	24 0.9449	16 0.630	0.3 0.01	JR20x24x16	0.018 0.040
	20 0.7874	24 0.9449	20 0.787	0.3 0.01	JR20x24x20	0.022 0.049
	20 0.7874	25 0.9843	16 0.630	0.3 0.01	JR20x25x16	0.022 0.049

⁽¹⁾ Call for O.D. tolerance

INNER RINGS
METRIC SERIES



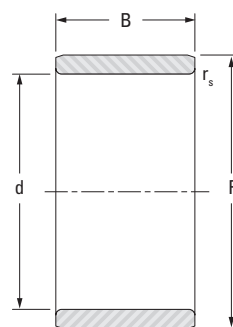
Shaft Dia.	d	F ⁽¹⁾	B	r _s min	Inner Ring Designation	Wt.
mm in	mm in	mm in	mm in	mm in		kg lbs
20 0.7874	20 0.7874	25 0.9843	16 0.630	0.3 0.01	JR20x25x16JS1	0.022 0.049
	20 0.7874	25 0.9843	17 0.669	0.3 0.01	JR20x25x17	0.023 0.051
	20 0.7874	25 0.9843	18 0.709	0.3 0.01	JRZ20x25x18JS1	0.025 0.055
	20 0.7874	25 0.9843	20 0.787	0.3 0.01	JR20x25x20	0.028 0.062
	20 0.7874	25 0.9843	20.5 0.807	0.3 0.01	JR20x25x20,5	0.029 0.064
	20 0.7874	25 0.9843	26 1.024	0.3 0.01	JR20x25x26	0.036 0.079
	20 0.7874	25 0.9843	26.5 1.043	0.3 0.01	JR20x25x26,5	0.037 0.082
	20 0.7874	25 0.9843	30 1.181	0.3 0.01	JR20x25x30	0.042 0.093
	20 0.7874	25 0.9843	32 1.260	0.3 0.01	JR20x25x32	0.044 0.097
	20 0.7874	25 0.9843	38.5 1.516	0.3 0.01	JR20x25x38,5	0.054 0.119
22 0.8661	22 0.8661	26 1.0236	16 0.630	0.3 0.01	JR22x26x16	0.019 0.042
	22 0.8661	26 1.0236	20 0.787	0.3 0.01	JR22x26x20	0.023 0.051
	22 0.8661	28 1.1024	17 0.669	0.3 0.01	JR22x28x17	0.030 0.066
	22 0.8661	28 1.1024	20.5 0.807	0.3 0.01	JR22x28x20,5	0.038 0.084
	22 0.8661	28 1.1024	30 1.181	0.3 0.01	JR22x28x30	0.056 0.123
23 0.9055	23 0.9055	28 1.1024	20 0.787	0.35 0.014	IM 23 28 20 P	0.030 0.066
25 0.9843	25 0.9843	29 1.1417	20 0.787	0.3 0.01	JR25x29x20	0.027 0.060
	25 0.9843	29 1.1417	30 1.181	0.3 0.01	JR25x29x30	0.040 0.088
	25 0.9843	30 1.1811	16 0.630	0.3 0.01	JR25x30x16	0.027 0.060
	25 0.9843	30 1.1811	16 0.630	0.3 0.01	JR25x30x16JS1	0.027 0.060
	25 0.9843	30 1.1811	17 0.669	0.3 0.01	JR25x30x17	0.028 0.062
	25 0.9843	30 1.1811	18 0.709	0.3 0.01	JRZ25x30x18JS1	0.031 0.068
	25 0.9843	30 1.1811	20 0.787	0.3 0.01	JR25x30x20	0.034 0.075
	25 0.9843	30 1.1811	20.5 0.807	0.3 0.01	JR25x30x20,5	0.035 0.077

⁽¹⁾ Call for O.D. tolerance

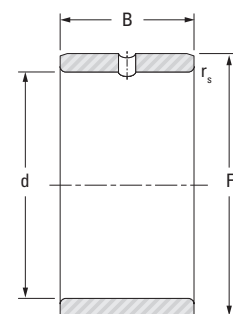
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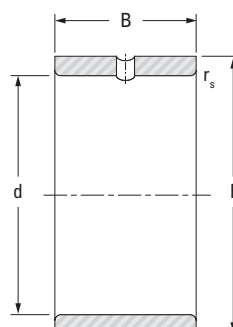
INNER RINGS
METRIC SERIES



JR, IM..P



JR.JS1

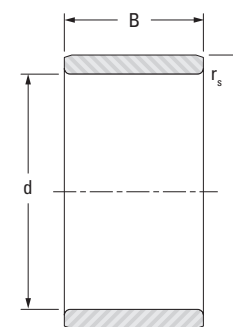


JRZ.JS1

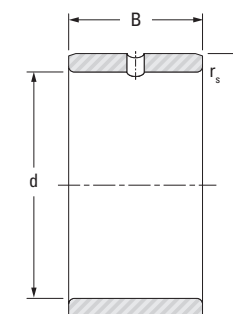
Shaft Dia.	d	F ⁽¹⁾	B	r _s min	Inner Ring Designation	Wt.
mm in	mm in	mm in	mm in	mm in		kg lbs
25 0.9843	25 0.9843	30 1.1811	26 1.024	0.3 0.01	JR25x30x26	0.044 0.097
	25 0.9843	30 1.1811	26.5 1.043	0.3 0.01	JR25x30x26,5	0.045 0.099
	25 0.9843	30 1.1811	30 1.181	0.3 0.01	JR25x30x30	0.051 0.112
	25 0.9843	30 1.1811	32 1.260	0.3 0.01	JR25x30x32	0.054 0.119
	25 0.9843	30 1.1811	38.5 1.516	0.3 0.01	JR25x30x38,5	0.066 0.146
28 1.1024	28 1.1024	32 1.2598	17 0.669	0.3 0.01	JR28x32x17	0.028 0.062
	28 1.1024	32 1.2598	20 0.787	0.3 0.01	JR28x32x20	0.030 0.066
	28 1.1024	32 1.2598	30 1.181	0.3 0.01	JR28x32x30	0.044 0.097
30 1.1811	30 1.1811	35 1.3780	16 0.630	0.3 0.01	JR30x35x16	0.031 0.068
	30 1.1811	35 1.3780	17 0.669	0.3 0.01	JR30x35x17	0.033 0.073
	30 1.1811	35 1.3780	17 0.669	0.35 0.014	IM 4906	0.033 0.073
	30 1.1811	35 1.3780	18 0.709	0.3 0.01	JRZ30x35x18JS1	0.036 0.079
	30 1.1811	35 1.3780	20 0.787	0.3 0.01	JR30x35x20	0.039 0.086
	30 1.1811	35 1.3780	20 0.787	0.3 0.01	JRZ30x35x20JS1	0.039 0.086
	30 1.1811	35 1.3780	20.5 0.807	0.3 0.01	JR30x35x20,5	0.040 0.088
	30 1.1811	35 1.3780	26 1.024	0.3 0.01	JR30x35x26	0.054 0.119
	30 1.1811	35 1.3780	30 1.181	0.3 0.01	JR30x35x30	0.057 0.126
	30 1.1811	35 1.3780	32 1.260	0.3 0.01	JR30x35x32	0.062 0.137
	30 1.1811	38 1.4961	20 0.787	0.6 0.02	JR30x38x20JS1	0.067 0.148
32 1.2598	32 1.2598	37 1.4567	20 0.787	0.3 0.01	JR32x37x20	0.043 0.095
	32 1.2598	37 1.4567	30 1.181	0.3 0.01	JR32x37x30	0.064 0.141
	32 1.2598	40 1.5748	20 0.787	0.6 0.02	JR32x40x20	0.069 0.152
	32 1.2598	40 1.5748	36 1.417	0.6 0.02	JR32x40x36	0.128 0.282
35 1.3780	35 1.3780	40 1.5748	17 0.669	0.3 0.01	JR35x40x17	0.040 0.088

⁽¹⁾ Call for O.D. tolerance

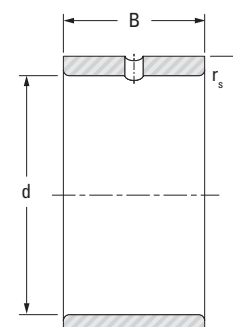
INNER RINGS
METRIC SERIES



JR, IM..P



JR.JS1



JRZ.JS1

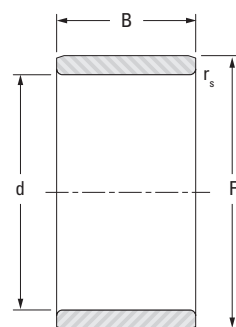
Shaft Dia.	d	F ⁽¹⁾	B	r _s min	Inner Ring Designation	Wt.
mm in	mm in	mm in	mm in	mm in		kg lbs
35 1.3780	35 1.3780	40 1.5748	20 0.787	0.3 0.01	JR35x40x20	0.046 0.101
	35 1.3780	40 1.5748	20.5 0.807	0.3 0.01	JR35x40x20,5	0.049 0.108
	35 1.3780	40 1.5748	22 0.866	0.3 0.01	JR35x40x22	0.052 0.115
	35 1.3780	40 1.5748	30 1.181	0.3 0.01	JR35x40x30	0.071 0.157
	35 1.3780	40 1.5748	34 1.339	0.3 0.01	JR35x40x34	0.080 0.176
	35 1.3780	40 1.5748	40 1.575	0.3 0.01	JR35x40x40	0.094 0.207
	35 1.3780	42 1.6535	20 0.787	0.6 0.02	JR35x42x20	0.065 0.143
	35 1.3780	42 1.6535	20 0.787	0.6 0.02	JR35x42x20JS1	0.065 0.143
	35 1.3780	42 1.6535	23 0.906	0.6 0.02	JRZ35x42x23JS1	0.074 0.163
	35 1.3780	42 1.6535	36 1.417	0.6 0.02	JR35x42x36	0.122 0.269
	35 1.3780	44 1.7323	22 0.866	0.6 0.02	JR35x44x22	0.097 0.214
37 1.4567	37 1.4567	42 1.6535	20 0.787	0.35 0.014	IM 37 42 20 P	0.046 0.101
38 1.4961	38 1.4961	43 1.6929	20 0.787	0.3 0.01	JR38x43x20	0.050 0.110
	38 1.4961	43 1.6929	30 1.181	0.3 0.01	JR38x43x30	0.075 0.165
40 1.5748	40 1.5748	45 1.7717	17 0.669	0.3 0.01	JR40x45x17	0.044 0.097
	40 1.5748	45 1.7717	20 0.787	0.3 0.01	JR40x45x20	0.052 0.115
	40 1.5748	45 1.7717	20.5 0.807	0.3 0.01	JR40x45x20,5	0.054 0.119
	40 1.5748	45 1.7717	25 0.984	0.35 0.014	IM 40 45 25 P	0.062 0.137
	40 1.5748	45 1.7717	30 1.181	0.3 0.01	JR40x45x30	0.078 0.172
	40 1.5748	45 1.7717	34 1.339	0.3 0.01	JR40x45x34	0.089 0.196
	40 1.5748	45 1.7717	40 1.575	0.3 0.01	JR40x45x40	0.115 0.254
	40 1.5748	48 1.8898	22 0.866	0.6 0.02	JR40x48x22	0.094 0.207
	40 1.5748	48 1.8898	23 0.906	0.6 0.02	JRZ40x48x23JS1	0.100 0.220
	40 1.5748	48 1.8898	40 1.575	0.6 0.02	JR40x48x40	0.173 0.381

⁽¹⁾ Call for O.D. tolerance

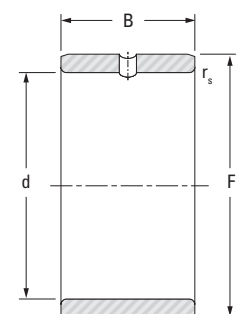
Continued on next page.



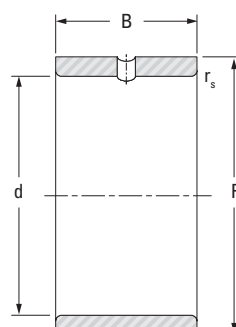
INNER RINGS
METRIC SERIES



JR, IM..P



JR.JS1

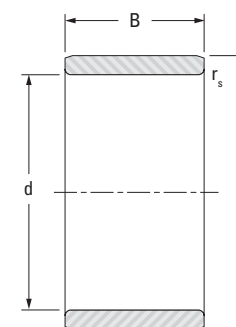


JRZ.JS1

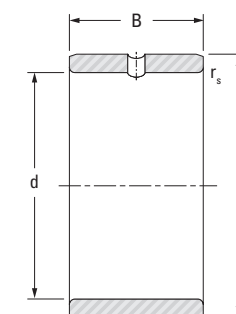
Shaft Dia.	d	F ⁽¹⁾	B	r _s min	Inner Ring Designation	Wt.
mm in	mm in	mm in	mm in	mm in		kg lbs
40 1.5748	40 1.5748	50 1.9685	20 0.787	1 0.04	JR40x50x20	0.110 0.243
42 1.6535	42 1.6535	47 1.8504	20 0.787	0.3 0.01	JR42x47x20	0.055 0.121
	42 1.6535	47 1.8504	30 1.181	0.3 0.01	JR42x47x30	0.083 0.183
45 1.7717	45 1.7717	50 1.9685	20 0.787	0.3 0.01	JR45x50x20	0.058 0.128
	45 1.7717	50 1.9685	25 0.984	0.6 0.02	JR45x50x25	0.073 0.161
	45 1.7717	50 1.9685	25.5 1.004	0.3 0.01	JR45x50x25,5	0.075 0.165
	45 1.7717	50 1.9685	35 1.378	0.6 0.02	JR45x50x35	0.103 0.227
	45 1.7717	50 1.9685	40 1.575	0.3 0.01	JR45x50x40	0.117 0.258
	45 1.7717	52 2.0472	22 0.866	0.6 0.02	JR45x52x22	0.090 0.198
	45 1.7717	52 2.0472	22 0.866	0.85 0.033	IM 4909	0.087 0.192
	45 1.7717	52 2.0472	23 0.906	0.6 0.02	JR45x52x23	0.096 0.212
	45 1.7717	52 2.0472	23 0.906	0.6 0.02	JRZ45x52x23JS1	0.096 0.212
	45 1.7717	52 2.0472	40 1.575	0.6 0.02	JR45x52x40	0.167 0.368
	45 1.7717	55 2.1654	20 0.787	1 0.04	JR45x55x20	0.133 0.293
	45 1.7717	55 2.1654	20 0.787	1 0.04	JR45x55x20JS1	0.133 0.293
	45 1.7717	55 2.1654	22 0.866	1 0.04	JR45x55x22	0.135 0.298
	45 1.7717	55 2.1654	40 1.575	1 0.04	JR45x55x40	0.247 0.545
50 1.9685	50 1.9685	55 2.1654	20 0.787	0.3 0.01	JR50x55x20	0.065 0.143
	50 1.9685	55 2.1654	25 0.984	0.6 0.02	JR50x55x25	0.081 0.179
	50 1.9685	55 2.1654	35 1.378	0.65 0.026	IM 50 55 35 P	0.107 0.236
	50 1.9685	55 2.1654	35 1.378	0.6 0.02	JR50x55x35	0.113 0.249
	50 1.9685	55 2.1654	40 1.575	0.3 0.01	JR50x55x40	0.130 0.287
	50 1.9685	58 2.2835	22 0.866	0.6 0.02	JR50x58x22	0.117 0.258
	50 1.9685	58 2.2835	23 0.906	0.6 0.02	JRZ50x58x23JS1	0.122 0.269

⁽¹⁾ Call for O.D. tolerance

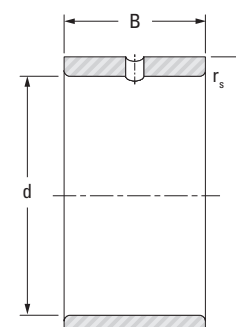
INNER RINGS
METRIC SERIES



JR, IM..P



JR.JS1



JRZ.JS1

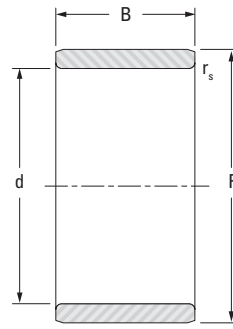
Shaft Dia.	d	F ⁽¹⁾	B	r _s min	Inner Ring Designation	Wt.
mm in	mm in	mm in	mm in	mm in		kg lbs
50 1.9685	50 1.9685	58 2.2835	40 1.575	0.6 0.02	JR50x58x40	0.213 0.470
	50 1.9685	60 2.3622	20 0.787	1 0.04	JR50x60x20	0.155 0.342
	50 1.9685	60 2.3622	20 0.787	1 0.04	JR50x60x20JS1	0.155 0.342
	50 1.9685	60 2.3622	25 0.984	1 0.04	JR50x60x25	0.170 0.375
	50 1.9685	60 2.3622	40 1.575	1 0.04	JR50x60x40	0.310 0.683
55 2.1654	55 2.1654	60 2.3622	25 0.984	0.6 0.02	JR55x60x25	0.088 0.194
	55 2.1654	60 2.3622	35 1.378	0.65 0.026	IM 55 60 35 P	0.118 0.260
	55 2.1654	60 2.3622	35 1.378	0.6 0.02	JR55x60x35	0.124 0.273
	55 2.1654	63 2.4803	25 0.984	1 0.04	JR55x63x25	0.141 0.311
	55 2.1654	63 2.4803	45 1.772	1 0.04	JR55x63x45	0.286 0.631
	55 2.1654	65 2.5591	30 1.181	1 0.04	JR55x65x30	0.222 0.489
	55 2.1654	65 2.5591	60 2.362	1 0.04	JR55x65x60	0.444 0.979
58 2.2835	58 2.2835	65 2.5591	25 0.984	0.85 0.033	IM 58 65 25 P	0.125 0.276
60 2.3622	60 2.3622	68 2.6772	25 0.984	0.6 0.02	JR60x68x25	0.153 0.337
	60 2.3622	68 2.6772	35 1.378	0.6 0.02	JR60x68x35	0.220 0.485
	60 2.3622	68 2.6772	45 1.772	1 0.04	JR60x68x45	0.284 0.626
	60 2.3622	70 2.7559	25 0.984	1 0.04	JR60x70x25	0.200 0.441
	60 2.3622	70 2.7559	30 1.181	1 0.04	JR60x70x30	0.240 0.529
	60 2.3622	70 2.7559	35 1.378	0.85 0.033	IM 60 70 35 P	0.280 0.616
	60 2.3622	70 2.7559	60 2.362	1 0.04	JR60x70x60	0.480 1.058
65 2.5591	65 2.5591	72 2.8346	25 0.984	1 0.04	JR65x72x25	0.143 0.315
	65 2.5591	72 2.8346	45 1.772	1 0.04	JR65x72x45	0.266 0.586
65 2.5591	65 2.5591	73 2.8740	25 0.984	0.6 0.02	JR65x73x25	0.170 0.375
	65 2.5591	73 2.8740	35 1.378	0.6 0.02	JR65x73x35	0.240 0.529

⁽¹⁾ Call for O.D. tolerance

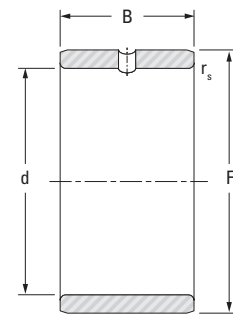
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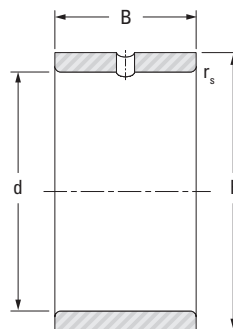
INNER RINGS
METRIC SERIES



JR, IM..P



JR.JS1

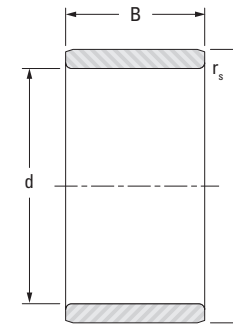


JRZ.JS1

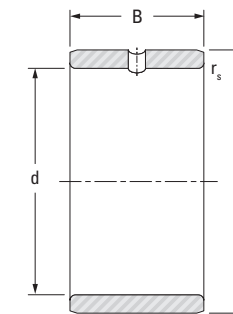
Shaft Dia.	d	F ⁽¹⁾	B	r _s min	Inner Ring Designation	Wt.
mm in	mm in	mm in	mm in	mm in		kg lbs
65 2.5591	65 2.5591	75 2.9528	28 1.102	1 0.04	JR65x75x28	0.240 0.529
	65 2.5591	75 2.9528	30 1.181	1 0.04	JR65x75x30	0.260 0.573
	65 2.5591	75 2.9528	60 2.362	1 0.04	JR65x75x60	0.520 1.146
70 2.7559	70 2.7559	80 3.1496	25 0.984	1 0.04	JR70x80x25	0.230 0.507
	70 2.7559	80 3.1496	30 1.181	1 0.04	JR70x80x30	0.270 0.595
	70 2.7559	80 3.1496	35 1.378	1 0.04	JR70x80x35	0.320 0.705
	70 2.7559	80 3.1496	54 2.126	1 0.04	JR70x80x54	0.500 1.102
	70 2.7559	80 3.1496	60 2.362	1 0.04	JR70x80x60	0.556 1.226
75 2.9528	75 2.9528	85 3.3465	25 0.984	1 0.04	JR75x85x25	0.240 0.529
	75 2.9528	85 3.3465	30 1.181	1 0.04	JR75x85x30	0.289 0.637
	75 2.9528	85 3.3465	35 1.378	1 0.04	JR75x85x35	0.338 0.745
	75 2.9528	85 3.3465	54 2.126	1 0.04	JR75x85x54	0.530 1.168
80 3.1496	80 3.1496	90 3.5433	25 0.984	1 0.04	JR80x90x25	0.260 0.573
	80 3.1496	90 3.5433	30 1.181	1 0.04	JR80x90x30	0.306 0.675
	80 3.1496	90 3.5433	35 1.378	1 0.04	JR80x90x35	0.355 0.783
	80 3.1496	90 3.5433	54 2.126	1 0.04	JR80x90x54	0.565 1.246
85 3.3465	85 3.3465	95 3.7402	26 1.024	1 0.04	JR85x95x26	0.290 0.639
	85 3.3465	95 3.7402	30 1.181	1 0.04	JR85x95x30	0.334 0.736
	85 3.3465	95 3.7402	36 1.417	1 0.04	JR85x95x36	0.397 0.875
	85 3.3465	100 3.9370	35 1.378	1.1 0.04	JR85x100x35	0.595 1.312
	85 3.3465	100 3.9370	63 2.480	1.1 0.04	JR85x100x63	1.080 2.381
90 3.5433	90 3.5433	100 3.9370	26 1.024	1 0.04	JR90x100x26	0.300 0.661
	90 3.5433	100 3.9370	30 1.181	1 0.04	JR90x100x30	0.350 0.772
	90 3.5433	100 3.9370	36 1.417	1 0.04	JR90x100x36	0.422 0.930

⁽¹⁾ Call for O.D. tolerance

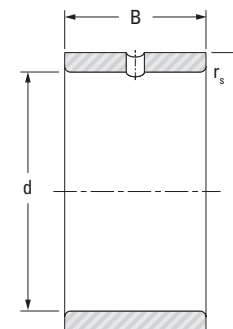
INNER RINGS
METRIC SERIES



JR, IM..P



JR.JS1



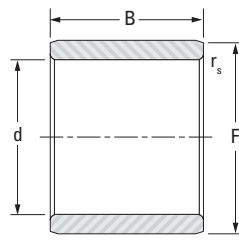
JRZ.JS1

Shaft Dia.	d	F ⁽¹⁾	B	r _s min	Inner Ring Designation	Wt.
mm in	mm in	mm in	mm in	mm in		kg lbs
90 3.5433	90 3.5433	105 4.1339	32 1.260	1.1 0.04	JR90x105x32	0.580 1.279
	90 3.5433	105 4.1339	35 1.378	1.1 0.04	JR90x105x35	0.624 1.376
	90 3.5433	105 4.1339	63 2.480	1.1 0.04	JR90x105x63	1.140 2.513
95 3.7402	95 3.7402	105 4.1339	26 1.024	1 0.04	JR95x105x26	0.310 0.683
	95 3.7402	105 4.1339	36 1.417	1 0.04	JR95x105x36	0.430 0.948
	95 3.7402	110 4.3307	35 1.378	1.1 0.04	JR95x110x35	0.653 1.440
	95 3.7402	110 4.3307	63 2.480	1.1 0.04	JR95x110x63	1.200 2.646
100 3.9370	100 3.9370	110 4.3307	30 1.181	1.1 0.04	JR100x110x30	0.384 0.847
	100 3.9370	110 4.3307	40 1.575	1.1 0.04	JR100x110x40	0.510 1.124
	100 3.9370	115 4.5276	40 1.575	1.1 0.04	JR100x115x40	0.790 1.742
110 4.3307	110 4.3307	120 4.7244	30 1.181	1 0.04	JR110x120x30	0.425 0.937
	110 4.3307	125 4.9213	40 1.575	1.1 0.04	JR110x125x40	0.870 1.918
120 4.7244	120 4.7244	130 5.1181	30 1.181	1 0.04	JR120x130x30	0.460 1.014
	120 4.7244	135 5.3150	45 1.772	1.1 0.04	JR120x135x45	1.060 2.337
130 5.1181	130 5.1181	145 5.7087	35 1.378	1.1 0.04	JR130x145x35	0.890 1.962
	130 5.1181	150 5.9055	50 1.969	1.5 0.06	JR130x150x50	1.730 3.814
140 5.5118	140 5.5118	155 6.1024	35 1.378	1.1 0.04	JR140x155x35	0.955 2.105
	140 5.5118	160 6.2992	50 1.969	1.5 0.06	JR140x160x50	1.860 4.101
150 5.9055	150 5.9055	165 6.4961	40 1.575	1.1 0.04	JR150x165x40	1.170 2.579
160 6.2992	160 6.2992	175 6.8898	40 1.575	1.1 0.04	JR160x175x40	1.240 2.734
170 6.6929	170 6.6929	185 7.2835	45 1.772	1.1 0.04	JR170x185x45	1.480 3.263
180 7.0866	180 7.0866	195 7.6772	45 1.772	1.1 0.04	JR180x195x45	1.560 3.439

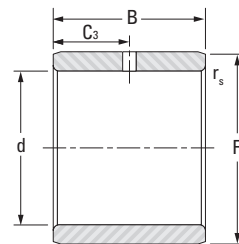
⁽¹⁾ Call for O.D. tolerance



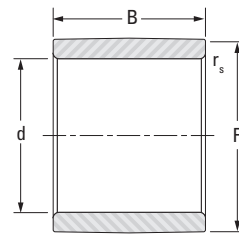
INNER RINGS FOR FULL COMPLEMENT DRAWN CUP NEEDLE ROLLER BEARINGS
METRIC SERIES



IM



IMC

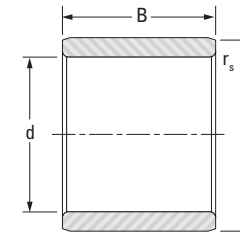


IM...R6

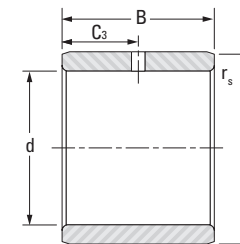
Shaft Dia. mm in	d mm in	F ⁽¹⁾ mm in	B mm in	Hole Location C ₃ mm in	r _s min mm in	Inner Ring Designation	Wt. kg lbs
8 0.3150	8 0.3150	12 0.4724	12.4 0.488		0.3 0.01	IM 8 12 12,4	0.006 0.013
9 0.3543	9 0.3543	13 0.5118	12.4 0.488		0.3 0.01	IM 9 13 12,4	0.006 0.013
	9 0.3543	13 0.5118	12.4 0.488		0.3 0.01	IM 9 13 12,4 R6	0.006 0.013
10 0.3937	10 0.3937	14 0.5512	12.4 0.488		0.3 0.01	IM 10 14 12,4	0.007 0.015
	10 0.3937	14 0.5512	16.4 0.646		0.3 0.01	IM 10 14 16,4	0.009 0.020
11 0.4331	11 0.4331	15 0.5906	12.4 0.488		0.3 0.01	IM 11 15 12,4	0.008 0.018
12 0.4724	12 0.4724	15 0.5906	12.4 0.488		0.2 0.01	IM 12 15 12,4	0.006 0.013
	12 0.4724	16 0.6299	12.4 0.488		0.2 0.01	IM 12 16 12,4	0.008 0.018
	12 0.4724	16 0.6299	12.4 0.488		0.3 0.01	IM 12 16 12,4 R6	0.008 0.018
	12 0.4724	16 0.6299	12.4 0.488	6.2 0.24	0.3 0.01	IMC 12 16 12,4	0.008 0.018
13 0.5118	13 0.5118	17 0.6693	12.4 0.488		0.3 0.01	IM 13 17 12,4	0.009 0.020
	13 0.5118	18 0.7087	12.4 0.488		0.35 0.014	IM 13 18 12,4	0.011 0.025
	13 0.5118	18 0.7087	12.4 0.488		0.35 0.014	IM 13 18 12,4 R6	0.011 0.025
	13 0.5118	18 0.7087	16.4 0.646		0.35 0.014	IM 13 18 16,4	0.015 0.033
15 0.5906	15 0.5906	20 0.7874	12.4 0.488		0.35 0.014	IM 15 20 12,4	0.013 0.028
	15 0.5906	20 0.7874	16.4 0.646		0.35 0.014	IM 15 20 16,4	0.017 0.037
	17 0.6693	22 0.8661	16.4 0.646		0.35 0.014	IM 17 22 16,4	0.019 0.041
	17 0.6693	22 0.8661	16.4 0.646		0.35 0.014	IM 17 22 16,4 R6	0.019 0.041
17 0.6693	17 0.6693	22 0.8661	16.4 0.646	8.2 0.32	0.35 0.014	IMC 17 22 16,4	0.019 0.041
20 0.7874	20 0.7874	25 0.9843	16.4 0.646		0.35 0.014	IM 20 25 16,4	0.022 0.047
	20 0.7874	25 0.9843	16.4 0.646		0.35 0.014	IM 20 25 16,4 R6	0.022 0.047
	20 0.7874	25 0.9843	16.4 0.646	8.2 0.32	0.35 0.014	IMC 20 25 16,4	0.022 0.047
	20 0.7874	25 0.9843	20.4 0.803		0.35 0.014	IM 20 25 20,4	0.027 0.060

⁽¹⁾ Call for O.D. tolerance

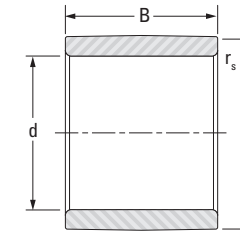
INNER RINGS FOR FULL COMPLEMENT DRAWN CUP NEEDLE ROLLER BEARINGS
METRIC SERIES



IM



IMC



IM...R6

Shaft Dia. mm in	d mm in	F ⁽¹⁾ mm in	B mm in	Hole Location C ₃ mm in	r _s min mm in	Inner Ring Designation	Wt. kg lbs
20 0.7874	20 0.7874	25 0.9843	20.4 0.803	10.2 0.40	0.35 0.014	IMC 20 25 20,4	0.027 0.060
	20 0.7874	25 0.9843	25.0 0.984		0.35 0.014	IM 20 25 25	0.033 0.073
23 0.9055	23 0.9055	28 1.1024	20.4 0.803		0.35 0.014	IM 23 28 20,4	0.031 0.067
25 0.9843	25 0.9843	30 1.1811	16.4 0.646		0.35 0.014	IM 25 30 16,4	0.027 0.060
	25 0.9843	30 1.1811	16.4 0.646		0.35 0.014	IM 25 30 16,4 R6	0.027 0.060
	25 0.9843	30 1.1811	16.4 0.646	8.2 0.32	0.35 0.014	IMC 25 30 16,4	0.027 0.058
	25 0.9843	30 1.1811	20.4 0.803		0.35 0.014	IM 25 30 20,4	0.033 0.073
	25 0.9843	30 1.1811	20.4 0.803	10.2 0.40	0.35 0.014	IMC 25 30 20,4	0.033 0.073
	25 0.9843	30 1.1811	25 0.984		0.35 0.014	IM 25 30 25	0.040 0.088
30 1.1811	30 1.1811	35 1.3780	16.4 0.646		0.35 0.014	IM 30 35 16,4	0.031 0.068
	30 1.1811	35 1.3780	16.4 0.646		0.35 0.014	IM 30 35 16,4 R6	0.031 0.068
	30 1.1811	35 1.3780	16.4 0.646	8.2 0.32	0.35 0.014	IMC 30 35 16,4	0.031 0.068
	30 1.1811	35 1.3780	20.4 0.803		0.35 0.014	IM 30 35 20,4	0.039 0.086
	30 1.1811	35 1.3780	20.4 0.803		0.35 0.014	IM 30 35 20,4 R6	0.039 0.086
	30 1.1811	35 1.3780	20.4 0.803	10.2 0.40	0.35 0.014	IMC 30 35 20,4	0.039 0.086
	30 1.1811	35 1.3780	25.0 0.984		0.35 0.014	IM 30 35 25	0.048 0.106
35 1.3780	35 1.3780	40 1.5748	16.4 0.646		0.35 0.014	IM 35 40 16,4	0.036 0.079
	35 1.3780	40 1.5748	16.4 0.646		0.35 0.014	IM 35 40 16,4 R6	0.036 0.079
	35 1.3780	40 1.5748	20.4 0.803		0.35 0.014	IM 35 40 20,4	0.045 0.099
	35 1.3780	40 1.5748	20.4 0.803		0.35 0.014	IM 35 40 20,4 R6	0.045 0.099
	35 1.3780	40 1.5748	20.4 0.803	10.2 0.40	0.35 0.014	IMC 35 40 20,4	0.045 0.099
	35 1.3780	40 1.5748	25 0.984		0.35 0.014	IM 35 40 25	0.055 0.121
40 1.5748	40 1.5748	44 1.7323	16.4 0.646		0.3 0.01	IM 40 44 16,4	0.032 0.071

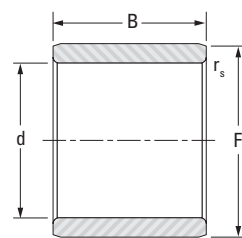
⁽¹⁾ Call for O.D. tolerance

Continued on next page.

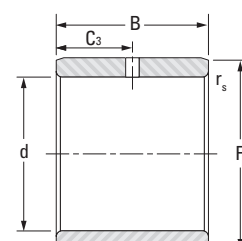


INNER RINGS FOR FULL COMPLEMENT DRAWN CUP NEEDLE ROLLER BEARINGS

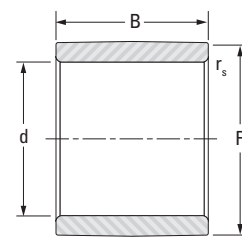
METRIC SERIES



IM



IMC



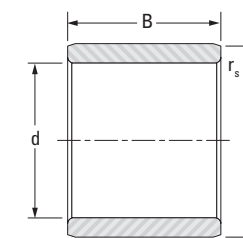
IM...R6

Shaft Dia.	d	F ⁽¹⁾	B	Hole Location C ₃	r _s min	Inner Ring Designation	Wt.
mm in	mm in	mm in	mm in	mm in	mm in		kg lbs
40 1.5748	40 1.5748	44 1.7323	16.4 0.646		0.3 0.01	IM 40 44 16,4 R6	0.032 0.071
	40 1.5748	44 1.7323	16.4 0.646	8.2 0.32	0.3 0.01	IMC 40 44 16,4	0.032 0.071
	40 1.5748	45 1.7717	20.4 0.803		0.35 0.014	IM 40 45 20,4	0.051 0.112
	40 1.5748	44 1.7323	20.4 0.803	10.2 0.40	0.35 0.014	IMC 40 45 20,4	0.051 0.112
45 1.7717	45 1.7717	50 1.9685	20.4 0.803		0.65 0.026	IM 45 50 20,4	0.056 0.123
	45 1.7717	50 1.9685	20.4 0.803		0.65 0.026	IM 45 50 20,4 R6	0.056 0.123
	45 1.7717	50 1.9685	25 0.984		0.65 0.026	IM 45 50 25	0.069 0.152
	45 1.7717	60 2.3622	25 0.984		0.65 0.026	IM 45 50 25 R6	0.069 0.152
50 1.9685	50 1.9685	55 2.1654	20.4 0.803		0.65 0.026	IM 50 55 20,4 R6	0.062 0.137
	50 1.9685	55 2.1654	20.4 0.803		0.65 0.026	IM 50 55 20,4	0.062 0.137

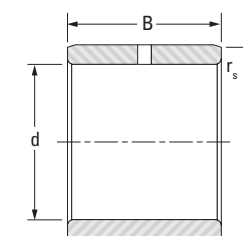
⁽¹⁾ Call for O.D. tolerance

INNER RINGS FOR MACHINE-TOOL QUALITY PRECISION-COMBINED BEARINGS

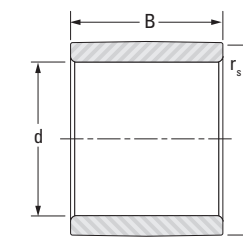
METRIC SERIES



IM



IMC



IM...R6

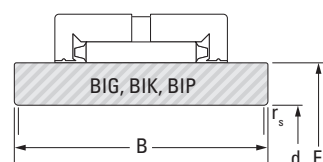
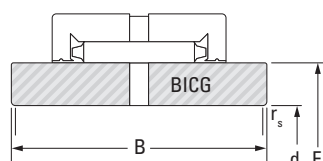
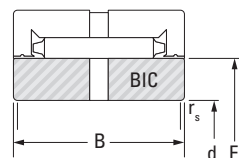
Shaft Dia.	d	F ⁽¹⁾	B	r _s min	Inner Ring Designation	Wt.
mm in	mm in	mm in	mm in	mm in		kg lbs
17 0.6693	17 0.6693	20 0.7874	27.5 1.083	0.2 0.01	IM 19017	0.019 0.042
	17 0.6693	20 0.7874	32 1.240	0.2 0.01	IM 20617	0.021 0.046
	17 0.6693	22 0.8665	13 0.512	0.35 0.014	IM 4903	0.015 0.033
20 0.7874	20 0.7874	25 0.9843	27.5 1.083	0.35 0.014	IM 19020	0.038 0.084
	20 0.7874	25 0.9843	32 1.240	0.35 0.014	IM 20620	0.044 0.097
25 0.9843	25 0.9843	30 1.1811	27.5 1.083	0.35 0.014	IM 19025	0.042 0.093
	25 0.9843	30 1.1811	32 1.240	0.35 0.014	IM 20625	0.052 0.115
30 1.1811	30 1.1811	35 1.3780	17 0.669	0.35 0.014	IM 4906	0.033 0.072
	30 1.1811	35 1.3780	27.5 1.083	0.35 0.014	IM 19030	0.053 0.117
	30 1.1811	35 1.3780	32 1.240	0.35 0.014	IM 20630	0.061 0.134
35 1.3780	35 1.3780	40 1.5748	27.5 1.083	0.35 0.014	IM 19035	0.063 0.139
	35 1.3780	40 1.5748	32 1.240	0.35 0.014	IM 20635	0.072 0.159
40 1.5748	40 1.5748	45 1.7717	27.5 1.083	0.35 0.014	IM 19040	0.069 0.152
	40 1.5748	45 1.7717	32 1.240	0.35 0.014	IM 20640	0.080 0.176
45 1.7717	45 1.7717	50 1.9685	30.5 1.201	0.65 0.026	IM 19045	0.085 0.187
	45 1.7717	50 1.9685	35 1.358	0.65 0.026	IM 20645	0.096 0.212
	45 1.7717	52 2.0476	22 0.866	0.85 0.033	IM 4909	0.087 0.192

⁽¹⁾ Call for O.D. tolerance



INNER RINGS WITH OIL HOLES/EXTRA WIDE, RNA BEARINGS

METRIC SERIES

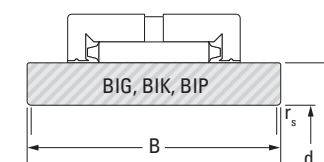
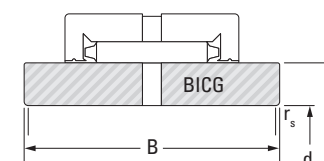
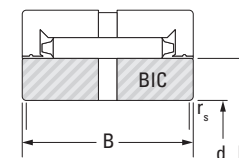


Shaft Dia.	d	F ⁽¹⁾	B	r _s min	Inner Ring Designation	Wt.
mm in	mm in	mm in	mm in	mm in		kg lbs
12 0.4724	12 0.4724	17.6 0.6929	15 0.591	0.35 0.014	BIC 1012	0.016 0.035
	12 0.4724	17.6 0.6929	20 0.787	0.35 0.014	BIP 1012	0.020 0.044
15 0.5906	15 0.5906	20.8 0.8189	15 0.591	0.65 0.026	BIC 1015	0.018 0.040
	15 0.5906	22.1 0.8701	22 0.866	0.65 0.026	BIC 2015	0.035 0.077
17 0.6693	17 0.6693	23.9 0.9409	15 0.591	0.65 0.026	BIC 1017	0.026 0.057
	20 0.7874	28.7 1.1299	18 0.709	0.65 0.026	BIC 1020	0.046 0.101
	20 0.7874	28.7 1.1299	22 0.866	0.65 0.026	BIC 2020	0.056 0.123
	20 0.7874	28.7 1.1299	22 0.866	0.65 0.026	BIP 1020	0.056 0.123
25 0.9843	25 0.9843	33.5 1.3189	18 0.709	0.65 0.026	BIC 1025	0.054 0.119
	25 0.9843	33.5 1.3189	22 0.866	0.65 0.026	BIC 2025	0.065 0.143
	25 0.9843	33.5 1.3189	30 1.181	0.65 0.026	BIC 22025	0.500 1.102
	25 0.9843	33.5 1.3189	32 1.260	0.65 0.026	BIG 2025	0.095 0.209
	25 0.9843	33.5 1.3189	42 1.654	0.65 0.026	BIK 2025	0.125 0.276
30 1.1811	30 1.1811	38.2 1.5039	18 0.709	0.65 0.026	BIC 1030	0.060 0.132
	30 1.1811	38.2 1.5039	22 0.866	0.65 0.026	BIC 2030	0.074 0.163
	30 1.1811	44.0 1.7323	30 1.181	0.65 0.026	BIC 3030	0.188 0.414
	30 1.1811	38.2 1.5039	32 1.260	0.65 0.026	BIG 2030	0.108 0.238
	30 1.1811	44.0 1.7323	40 1.575	0.65 0.026	BIG 3030	0.247 0.545
35 1.3780	35 1.3780	44.0 1.7323	18 0.709	0.65 0.026	BIC 1035	0.077 0.170
	35 1.3780	44.0 1.7323	22 0.866	0.65 0.026	BIC 2035	0.093 0.205
	35 1.3780	44.0 1.7323	32 1.260	0.65 0.026	BIG 2035	0.135 0.298
40 1.5748	40 1.5748	49.7 1.9567	18 0.709	0.85 0.033	BIC 1040	0.094 0.207
	40 1.5748	49.7 1.9567	22 0.866	0.85 0.033	BIC 2040	0.115 0.254
	40 1.5748	55.4 2.1811	36 1.417	0.85 0.033	BIC 3040	0.321 0.708

⁽¹⁾ Call for O.D. tolerance

INNER RINGS WITH OIL HOLES/EXTRA WIDE, RNA BEARINGS

METRIC SERIES



Shaft Dia.	d	F ⁽¹⁾	B	r _s min	Inner Ring Designation	Wt.
mm in	mm in	mm in	mm in	mm in		kg lbs
	40 1.5748	49.7 1.9567	32 1.260	0.85 0.033	BIG 2040	0.170 0.375
	40 1.5748	49.7 1.9567	22 0.866	0.85 0.033	BIP 1040	0.115 0.254
45 1.7717	45 1.7717	55.4 2.1811	18 0.709	0.85 0.033	BIC 1045	0.113 0.249
	45 1.7717	55.4 2.1811	22 0.866	0.85 0.033	BIC 2045	0.139 0.306
	45 1.7717	62.1 2.4449	38 1.496	0.85 0.033	BIC 3045	0.422 0.930
	45 1.7717	55.4 2.1811	32 1.260	0.85 0.033	BIG 2045	0.210 0.463
50 1.9685	50 1.9685	62.1 2.4449	20 0.787	0.85 0.033	BIC 1050	0.163 0.359
	50 1.9685	62.1 2.4449	24 0.945	0.85 0.033	BIC 11050	0.196 0.432
	50 1.9685	62.1 2.4449	28 1.102	0.85 0.033	BIC 2050	0.228 0.503
	50 1.9685	68.8 2.7087	38 1.496	0.85 0.033	BIC 3050	0.515 1.135
	50 1.9685	62.1 2.4449	38 1.496	0.85 0.033	BIG 2050	0.312 0.688
	50 1.9685	62.1 2.4449	28 1.102	0.85 0.033	BIP 1050	0.228 0.503
55 2.1654	55 2.1654	68.8 2.7087	20 0.787	0.85 0.033	BIC 1055	0.205 0.452
	55 2.1654	72.6 2.8583	38 1.496	0.85 0.033	BIC 3055	0.525 1.157
	55 2.1654	72.6 2.8583	48 1.890	0.85 0.033	BICG 3055	0.660 1.455
	55 2.1654	68.8 2.7087	38 1.496	0.85 0.033	BIG 2055	0.390 0.860
	55 2.1654	68.8 2.7087	28 1.102	0.85 0.033	BIP 1055	0.288 0.635
60 2.3622	60 2.3622	72.6 2.8583	28 1.102	0.85 0.033	BIC 2060	0.282 0.622
	60 2.3622	78.3 3.0827	38 1.496	0.85 0.033	BIC 3060	0.583 1.285
	60 2.3622	72.6 2.8583	38 1.496	0.85 0.033	BICG 2060	0.385 0.849
	60 2.3622	72.6 2.8583	38 1.496	0.85 0.033	BIG 2060	0.385 0.849
65 2.5591	65 2.5591	83.1 3.2717	38 1.496	0.85 0.033	BIC 3065	0.623 1.373
	65 2.5591	78.3 3.0827	38 1.496	0.85 0.033	BIG 2065	0.437 0.963
70 2.7559	70 2.7559	88.0 3.4646	38 1.496	0.85 0.033	BIC 3070	0.662 1.459

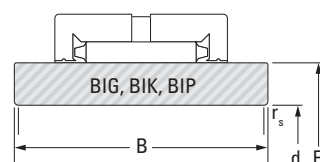
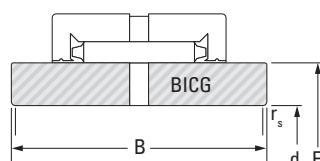
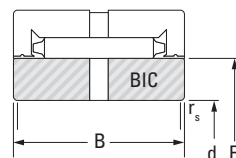
⁽¹⁾ Call for O.D. tolerance

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INNER RINGS WITH OIL HOLES/EXTRA WIDE, RNA BEARINGS

METRIC SERIES

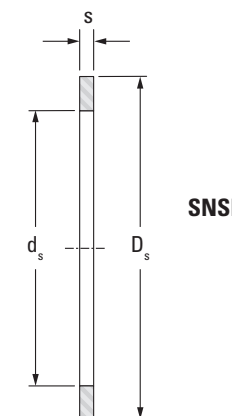


Shaft Dia.	d	F ⁽¹⁾	B	r _s min	Inner Ring Designation	Wt.
mm in	mm in	mm in	mm in	mm in		kg lbs
70 2.7559	70 2.7559	88.0 3.4646	48 1.890	0.85 0.033	BIG 3070	0.820 1.808
	70 2.7559	88.0 3.4646	58 2.283	0.85 0.033	BIK 3070	1.010 2.227
75 2.9528	75 2.9528	88.0 3.4646	32 1.260	0.85 0.033	BIC 2075	0.410 0.904
	75 2.9528	88.0 3.4646	42 1.654	0.85 0.033	BIG 2075	0.538 1.186
	75 2.9528	96.0 3.7795	58 2.283	0.85 0.033	BIK 3075	1.260 2.778
80 3.1496	80 3.1496	96.0 3.7795	24 0.945	0.85 0.033	BIC 1080	0.410 0.904
	80 3.1496	96.0 3.7795	32 1.260	0.85 0.033	BIC 2080	0.545 1.202
	80 3.1496	99.5 3.9173	38 1.496	0.85 0.033	BIC 3080	0.805 1.775
	80 3.1496	96.0 3.7795	42 1.654	0.85 0.033	BIG 2080	0.714 1.574
90 3.5433	90 3.5433	104.7 4.1220	32 1.260	1.35 0.053	BIC 2090	0.531 1.171
	90 3.5433	109.1 4.2953	43 1.693	1.35 0.053	BIC 3090	0.990 2.183
	90 3.5433	109.1 4.2953	53 2.087	1.35 0.053	BIG 3090	1.220 2.690
	90 3.5433	109.1 4.2953	63 2.480	1.35 0.053	BIK 3090	1.480 3.263
95 3.7402	95 3.7402	109.1 4.2953	32 1.260	1.35 0.053	BIC 2095	0.548 1.208
	95 3.7402	114.7 4.5157	43 1.693	1.35 0.053	BIC 3095	1.075 2.370
	95 3.7402	114.7 4.5157	63 2.480	1.35 0.053	BIK 3095	1.585 3.494
100 3.9370	100 3.9370	119.2 4.6929	43 1.693	1.35 0.053	BIC 3100	1.090 2.403
	100 3.9370	114.7 4.5157	42 1.654	1.35 0.053	BIG 2100	0.800 1.764
105 4.1339	105 4.1339	119.2 4.6929	32 1.260	1.35 0.053	BIC 2105	0.615 1.356
	105 4.1339	124.7 4.9094	55 2.165	1.35 0.053	BIG 3105	1.505 3.318
110 4.3307	110 4.3307	124.7 4.9094	34 1.339	1.35 0.053	BIC 2110	0.705 1.554
	110 4.3307	124.7 4.9094	44 1.732	1.35 0.053	BIG 2110	0.920 2.028
125 4.9213	125 4.9213	142.5 5.6102	44 1.732	1.35 0.053	BICG 2125	1.340 2.954
	125 4.9213	142.5 5.6102	44 1.732	1.35 0.053	BIG 2125	1.325 2.921
130 5.1181	130 5.1181	158.0 6.2205	52 2.047	1.35 0.053	BIC 3130	2.530 5.578

⁽¹⁾ Call for O.D. tolerance

END WASHERS

METRIC SERIES



d _s	D _s	S	End Washer Designation	Wt.
mm in	mm in	mm in		kg lbs
8.0 0.315	18 0.709	2.0 0.079	SNSH8X18X2	0.003 0.007
8.5 0.335	15 0.591	0.5 0.020	SNSH8,5X15X0,5	0.0005 0.001
10.5 0.413	17 0.669	0.5 0.020	SNSH10,5X17X0,5	0.0006 0.001
10.5 0.413	20 0.787	0.5 0.020	SNSH10,5X20X0,5	0.0009 0.002
12.5 0.492	19 0.748	0.5 0.020	SNSH12,5X19X0,5	0.0006 0.001
12.5 0.492	22 0.866	0.5 0.020	SNSH12,5X22X0,5	0.0010 0.002
14.5 0.571	22 0.866	0.5 0.020	SNSH14,5X22X0,5	0.0008 0.002
14.5 0.571	26 1.024	0.5 0.020	SNSH14,5X26X0,5	0.0014 0.003
15.5 0.610	23 0.906	0.5 0.020	SNSH15,5X23X0,5	0.0009 0.002
16.5 0.650	24 0.945	0.5 0.020	SNSH16,5X24X0,5	0.0009 0.002
16.5 0.650	28 1.102	0.5 0.020	SNSH16,5X28X0,5	0.0016 0.004
17.5 0.689	25 0.984	0.5 0.020	SNSH17,5X25X0,5	0.001 0.002
18.5 0.728	26 1.024	0.5 0.020	SNSH18,5X26X0,5	0.001 0.002
18.5 0.728	30 1.181	0.5 0.020	SNSH18,5X30X0,5	0.002 0.004
20.5 0.807	28 1.102	0.5 0.020	SNSH20,5X28X0,5	0.001 0.002
20.5 0.807	32 1.260	0.5 0.020	SNSH20,5X32X0,5	0.002 0.004

d _s	D _s	S	End Washer Designation	Wt.
mm in	mm in	mm in		kg lbs
22.5 0.886	30 1.181	0.5 0.020	SNSH22,5X30X0,5	0.001 0.003
22.5 0.886	35 1.378	0.5 0.020	SNSH22,5X35X0,5	0.002 0.005
25.5 1.004	35 1.378	0.5 0.020	SNSH25,5X35X0,5	0.002 0.004
25.5 1.004	37 1.457	0.5 0.020	SNSH25,5X37X0,5	0.002 0.005
28.5 1.122	40 1.575	0.5 0.020	SNSH28,5X40X0,5	0.002 0.005
30.5 1.201	40 1.575	0.5 0.020	SNSH30,5X40X0,5	0.002 0.005
35.5 1.398	47 1.850	0.5 0.020	SNSH35,5X47X0,5	0.003 0.006
40.5 1.594	50 1.969	0.5 0.020	SNSH40,5X50X0,5	0.003 0.006
41.0 1.614	55 2.165	1.0 0.039	SNSH41X55X1	0.008 0.018
45.5 1.791	55 2.165	0.5 0.020	SNSH45,5X55X0,5	0.003 0.007
46.0 1.811	62 2.441	1.0 0.039	SNSH46X62X1	0.011 0.024
51.0 2.008	65 2.559	1.0 0.039	SNSH51X65X1	0.010 0.022
56.0 2.205	72 2.835	1.0 0.039	SNSH56X72X1	0.013 0.029
61.0 2.402	78 3.071	1.0 0.039	SNSH61X78X1	0.015 0.033
66.0 2.598	85 3.346	1.0 0.039	SNSH66X85X1	0.018 0.040



NOTES



SUPPLEMENTARY TABLES

C

C

C SUPPLEMENTARY TABLES

<i>Supplementary table 1 SI units and conversion factors</i>	C-2
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<i>Supplementary table 5 Viscosity conversion</i>	C-9
<i>Index</i>	C-10

Supplementary table 1 (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)]	1 Å = 10 ⁻¹⁰ m = 0.1 nm = 100 pm 1 μ = 1 μm 1 in = 25.4 mm 1 ft = 12 in = 0.304 8 m 1 yd = 3 ft = 0.914 4 m 1 mile = 5 280 ft = 1 609.344 m	1 m = 10 ¹⁰ Å 1 m = 39.37 in 1 m = 3.280 8 ft 1 m = 1.093 6 yd 1 km = 0.621 4 mile
Area	m ²	a [are(s)] ha [hectare(s)] acre [acre(s)]	1 a = 100 m ² 1 ha = 10 ⁴ m ² 1 acre = 4 840 yd ² = 4 046.86 m ²	1 km ² = 247.1 acre
Volume	m ³	ℓ, L [liter(s)] * cc [cubic centimeters] gal (US) [gallon(s)] fl oz (US) [fluid ounce(s)] barrel (US) [barrels (US)]	1 ℓ = 1 dm ³ = 10 ⁻³ m ³ 1 cc = 1 cm ³ = 10 ⁻⁶ m ³ 1 gal (US) = 231 in ³ = 3.785 41 dm ³ 1 fl oz (US) = 29.573 5 cm ³ 1 barrel (US) = 158.987 dm ³	1 m ³ = 10 ³ ℓ 1 m ³ = 10 ⁶ cc 1 m ³ = 264.17 gal 1 m ³ = 33 814 fl oz 1 m 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 *	1 kn = 1 852 m / h	1 km / h = 0.539 96 kn
Acceleration	m / s ²	G	1 G = 9.806 65 m / s ²	1 m / s ² = 0.101 97 G
Frequency	Hz [hertz]	c / s [cycle(s) / second]	1 c / s = 1 s ⁻¹ = 1 Hz	
Rotational frequency	s ⁻¹	rpm [revolutions per minute] * min ⁻¹ r / min	1 rpm = 1 / 60 s ⁻¹	1 s ⁻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)]	1 t = 10 ³ kg 1 lb = 0.453 592 37 kg 1 gr = 64.798 91 mg 1 oz = 1 / 16 lb = 28.349 5 g 1 ton (UK) = 1 016.05 kg 1 ton (US) = 907.185 kg 1 car = 200 mg	1 kg = 2.204 6 lb 1 g = 15.432 4 gr 1 kg = 35.274 0 oz 1 t = 0.984 2 ton (UK) 1 t = 1.102 3 ton (US) 1 g = 5 car

[Note] 1) * : Unit can be used as an SI unit.
No asterisk : Unit cannot be used.

Supplementary table 1 (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]	1 dyn = 10 ⁻⁵ N 1 kgf = 9.806 65 N 1 gf = 9.806 65 × 10 ⁻³ N 1 tf = 9.806 65 × 10 ³ N 1 lbf = 4.448 22 N	1 N = 10 ⁵ dyn 1 N = 0.101 97 kgf 1 N = 0.224 809 lbf
Moment of force	N·m [newton meter(s)]	gf·cm kgf·cm kgf·m tf·m lbf·ft	1 gf·cm = 9.806 65 × 10 ⁻⁵ N·m 1 kgf·cm = 9.806 65 × 10 ⁻² N·m 1 kgf·m = 9.806 65 N·m 1 tf·m = 9.806 65 × 10 ³ N·m 1 lbf·ft = 1.355 82 N·m	1 N·m = 0.101 97 kgf·m 1 N·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]	1 gf / cm ² = 9.806 65 × 10 Pa 1 kgf / mm ² = 9.806 65 × 10 ⁶ Pa 1 kgf / m ² = 9.806 65 Pa 1 lbf / in ² = 6 894.76 Pa 1 bar = 10 ⁵ Pa 1 at = 1 kgf / cm ² = 9.806 65 × 10 ⁴ Pa 1 mH ₂ O = 9.806 65 × 10 ³ Pa 1 atm = 101 325 Pa 1 mHg = $\frac{101\,325}{0.76}$ Pa 1 Torr = 1 mmHg = 133.322 Pa	1 MPa = 0.101 97 kgf / mm ² 1 Pa = 0.101 97 kgf / m ² 1 Pa = 0.145 × 10 ⁻³ lbf / in ² 1 Pa = 10 ⁻² mbar 1 Pa = 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 1 kgf·s / m ² = 9.806 65 Pa·s	1 Pa·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 1 (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)		

[Note] 1) * : Unit can be used as an SI unit.
No asterisk : Unit cannot be used.

Supplementary table 1 (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)] $\left\{ \begin{array}{l} 1 \text{ T} = 1 \text{ N} / (\text{A} \cdot \text{m}) \\ = 1 \text{ Wb} / \text{m}^2 \\ = 1 \text{ V} \cdot \text{s} / \text{m}^2 \end{array} \right\}$	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	$\left\{ \begin{array}{l} \text{W} \\ 1 \text{ W} = 1 \text{ J} / \text{s} \\ = 1 \text{ A} \cdot \text{V} \end{array} \right\}$			



Supplementary table 2 Steel hardness numbers⁽¹⁾

Rockwell C-Scale Hardness Number	Diamond Pyramid Hardness Number Vickers	Brinell Hardness Number 10 mm Ball 3000 kg Load			Rockwell Hardness Number			Rockwell Superficial Hardness Number Superficial Brale Penetrator			Shore Scleroscope Hardness Number	Tensile Strength (approx.) MPa	Tensile Strength (approx.) 1000 psi	Rockwell C-Scale Hardness Number
		Standard Ball	Hultgren Ball	Tungsten Carbide Ball	A-Scale 60 kg Load Brale Penetrator	B-Scale 15 kg Load 1/16 in (1.59 mm) Dia.	D-Scale 100 kg Brale Penetrator	15-N Scale 15 kg Load	30-N Scale 30 kg Load	45-N Scale 45 kg Load				
68	940	—	—	—	85.6	—	76.9	93.2	84.4	75.4	97	—	—	68
67	900	—	—	—	85	—	76.1	92.9	83.6	74.2	95	—	—	67
66	865	—	—	—	84.5	—	75.4	92.5	82.8	73.3	92	—	—	66
65	832	—	—	739	83.9	—	74.5	92.2	81.9	72	91	—	—	65
64	800	—	—	722	83.4	—	73.8	91.8	81.1	71	88	—	—	64
63	772	—	—	705	82.8	—	73	91.4	80.1	69.9	87	—	—	63
62	746	—	—	688	82.3	—	72.2	91.1	79.3	68.8	85	—	—	62
61	720	—	—	670	81.8	—	71.5	90.7	78.4	67.7	83	—	—	61
60	697	—	613	654	81.2	—	70.7	90.2	77.5	66.6	81	—	—	60
59	674	—	599	634	80.7	—	69.9	89.8	76.6	65.5	80	2250	326	59
58	653	—	587	615	80.1	—	69.2	89.3	75.7	64.3	78	2170	315	58
57	633	—	575	595	79.6	—	68.5	88.9	74.8	63.2	76	2100	305	57
56	613	—	561	577	79	—	67.7	88.3	73.9	62	75	2030	295	56
55	595	—	546	560	78.5	—	66.9	87.9	73	60.9	74	1980	287	55
54	577	—	534	543	78	—	66.1	87.4	72	59.8	72	1920	278	54
53	560	—	519	525	77.4	—	65.4	86.9	71.2	58.6	71	1850	269	53
52	544	500	508	512	76.8	—	64.6	86.4	70.2	57.4	69	1810	262	52
51	528	487	494	496	76.3	—	63.8	85.9	69.4	56.1	68	1740	253	51
50	513	475	481	481	75.9	—	63.1	85.5	68.5	55	67	1690	245	50
49	498	464	469	469	75.2	—	62.1	85	67.6	53.8	66	1650	239	49
48	484	451	455	455	74.7	—	61.4	84.5	66.7	52.5	64	1600	232	48
47	471	442	443	443	74.1	—	60.8	83.9	65.8	51.4	63	1550	225	47
45	446	421	421	421	73.1	—	59.2	83	64	49	60	1460	212	45
44	434	409	409	409	72.5	—	58.5	82.5	63.1	47.8	58	1420	206	44
43	423	400	400	400	72	—	57.7	82	62.2	46.7	57	1390	201	43
42	412	390	390	390	71.5	—	56.9	81.5	61.3	45.5	56	1350	196	42
41	402	381	381	381	70.9	—	56.2	80.9	60.4	44.3	55	1320	191	41
40	392	371	371	371	70.4	—	55.4	80.4	59.5	43.1	54	1280	186	40
39	382	362	362	362	69.9	—	54.6	79.9	58.6	41.9	52	1250	181	39
38	372	353	353	353	69.4	—	53.8	79.4	57.7	40.8	51	1210	176	38
37	363	344	344	344	68.9	—	53.1	78.8	56.8	39.6	50	1190	172	37
36	354	336	336	336	68.4	(109)	52.3	78.3	55.9	38.4	49	1160	168	36
35	345	327	327	327	67.9	(108.5)	51.5	77.7	55	37.2	48	1120	163	35
34	336	319	319	319	67.4	(108)	50.8	77.2	54.2	36.1	47	1100	159	34
33	327	311	311	311	66.8	(107.5)	50	76.6	53.3	34.9	46	1060	154	33
32	318	301	301	301	66.3	(107)	49.2	76.1	52.1	33.7	44	1030	150	32
31	310	294	294	294	65.8	(106)	48.4	75.6	51.3	32.5	43	1010	146	31
30	302	286	286	286	65.3	(105.5)	47.7	75	50.4	31.3	42	980	142	30
29	294	279	279	279	64.7	(104.5)	47	74.5	49.5	30.1	41	950	138	29
28	286	271	271	271	64.3	(104)	46.1	73.9	48.6	28.9	41	920	134	28
27	279	264	264	264	63.8	(103)	45.2	73.3	47.7	27.8	40	900	131	27
26	272	258	258	258	63.3	(102.5)	44.6	72.8	46.8	26.7	38	880	127	26
25	266	253	253	253	62.8	(101.5)	43.8	72.2	45.9	25.5	38	850	124	25
24	260	247	247	247	62.4	(101)	43.1	71.6	45	24.3	37	830	121	24
23	254	243	243	243	62	100	42.1	71	44	23.1	36	810	118	23
22	248	237	237	237	61.5	99	41.6	70.5	43.2	22	35	790	115	22
21	243	231	231	231	61	98.5	40.9	69.9	42.3	20.7	35	780	113	21
20	238	226	226	226	60.5	97.8	40.1	69.4	41.5	19.6	34	760	110	20

(1) Source ASTM

Supplementary table 4 °C / °F conversion

°C		°F	°C		°F	°C		°F	°C		°F
-73	-100	-148	-1.6	29	84.2	17.7	64	147.2	37.1	99	210.2
-62	-80	-112	-1.1	30	86.0	18.2	65	149.0	37.7	100	212
-51	-60	-76	-0.6	31	87.8	18.8	66	150.8	40.6	105	221
-40	-40	-40	0	32	89.6	19.3	67	152.6	43	110	230
-29	-20	-4	0.5	33	91.4	19.9	68	154.4	49	120	248
-23.3	-10	14	1.1	34	93.2	20.4	69	156.2	54	130	266
-17.7	0	32	1.6	35	95.0	21.0	70	158.0	60	140	284
-17.2	1	33.8	2.2	36	96.8	21.5	71	159.8	65	150	302
-16.6	2	35.6	2.7	37	98.6	22.2	72	161.6	71	160	320
-16.1	3	37.4	3.3	38	100.4	22.7	73	163.4	76	170	338
-15.5	4	39.2	3.8	39	102.2	23.3	74	165.2	83	180	356
-15.0	5	41.0	4.4	40	104.0	23.8	75	167.0	88	190	374
-14.4	6	42.8	4.9	41	105.8	24.4	76	168.8	93	200	392
-13.9	7	44.6	5.4	42	107.6	25.0	77	170.6	121	250	482
-13.3	8	46.4	6.0	43	109.4	25.5	78	172.4	149	300	572
-12.7	9	48.2	6.6	44	111.2	26.2	79	174.2	177	350	662
-12.2	10	50.0	7.1	45	113.0	26.8	80	176.0	204	400	752
-11.6	11	51.8	7.7	46	114.8	27.3	81	177.8	232	450	842
-11.1	12	53.6	8.2	47	116.6	27.7	82	179.6	260	500	932
-10.5	13	55.4	8.8	48	118.4	28.2	83	181.4	288	550	1 022
-10.0	14	57.2	9.3	49	120.2	28.8	84	183.2	315	600	1 112
-9.4	15	59.0	9.9	50	122.0	29.3	85	185.0	343	650	1 202
-8.8	16	61.8	10.4	51	123.8	29.9	86	186.8	371	700	1 292
-8.3	17	63.6	11.1	52	125.6	30.4	87	188.6	399	750	1 382
-7.7	18	65.4	11.5	53	127.4	31.0	88	190.4	426	800	1 472
-7.2	19	67.2	12.1	54	129.2	31.5	89	192.2	454	850	1 562
-6.6	20	68.0	12.6	55	131.0	32.1	90	194.0	482	900	1 652
-6.1	21	69.8	13.2	56	132.8	32.6	91	195.8	510	950	1 742
-5.5	22	71.6	13.7	57	134.6	33.3	92	197.6	538	1 000	1 832
-5.0	23	73.4	14.3	58	136.4	33.8	93	199.4	593	1 100	2 012
-4.4	24	75.2	14.8	59	138.2	34.4	94	201.2	648	1 200	2 192
-3.9	25	77.0	15.6	60	140.0	34.9	95	203.0	704	1 300	2 372
-3.3	26	78.8	16.1	61	141.8	35.5	96	204.8	760	1 400	2 552
-2.8	27	80.6	16.6	62	143.6	36.1	97	206.6	815	1 500	2 732
-2.2	28	82.4	17.1	63	145.4	36.6	98	208.4	871	1 600	2 937

[Example] The center columns of numbers is the temperature in either degrees Centigrade (°C) or Fahrenheit (°F) whichever is desired to convert into the other. If degrees Fahrenheit is given, read degrees Centigrade to the left. If degrees Centigrade is given, read degrees Fahrenheit to the right.

$$^{\circ}\text{C} = \frac{5}{9} (^{\circ}\text{F} - 32)$$

$$^{\circ}\text{F} = \frac{9}{5} ^{\circ}\text{C} + 32$$

Supplementary table 5 Viscosity conversion

Kinematic viscosity mm ² /s	Saybolt SUS (second)		Redwood R (second)		Engler E (degree)
	100 °F	210 °F	50 °C	100 °C	
2	32.6	32.8	30.8	31.2	1.14
3	36.0	36.3	33.3	33.7	1.22
4	39.1	39.4	35.9	36.5	1.31
5	42.3	42.6	38.5	39.1	1.40
6	45.5	45.8	41.1	41.7	1.48
7	48.7	49.0	43.7	44.3	1.56
8	52.0	52.4	46.3	47.0	1.65
9	55.4	55.8	49.1	50.0	1.75
10	58.8	59.2	52.1	52.9	1.84
11	62.3	62.7	55.1	56.0	1.93
12	65.9	66.4	58.2	59.1	2.02
13	69.6	70.1	61.4	62.3	2.12
14	73.4	73.9	64.7	65.6	2.22
15	77.2	77.7	68.0	69.1	2.32
16	81.1	81.7	71.5	72.6	2.43
17	85.1	85.7	75.0	76.1	2.54
18	89.2	89.8	78.6	79.7	2.64
19	93.3	94.0	82.1	83.6	2.76
20	97.5	98.2	85.8	87.4	2.87
21	102	102	89.5	91.3	2.98
22	106	107	93.3	95.1	3.10
23	110	111	97.1	98.9	3.22
24	115	115	101	103	3.34
25	119	120	105	107	3.46
26	123	124	109	111	3.58
27	128	129	112	115	3.70
28	132	133	116	119	3.82
29	137	138	120	123	3.95
30	141	142	124	127	4.07
31	145	146	128	131	4.20
32	150	150	132	135	4.32
33	154	155	136	139	4.45
34	159	160	140	143	4.57

Kinematic viscosity mm ² /s	Saybolt SUS (second)		Redwood R (second)		Engler E (degree)
	100 °F	210 °F	50 °C	100 °C	
35	163	164	144	147	4.70
36	168	170	148	151	4.83
37	172	173	153	155	4.96
38	177	178	156	159	5.08
39	181	183	160	164	5.21
40	186	187	164	168	5.34
41	190	192	168	172	5.47
42	195	196	172	176	5.59
43	199	201	176	180	5.72
44	204	205	180	185	5.85
45	208	210	184	189	5.98
46	213	215	188	193	6.11
47	218	219	193	197	6.24
48	222	224	197	202	6.37
49	227	228	201	206	6.50
50	231	233	205	210	6.63
55	254	256	225	231	7.24
60	277	279	245	252	7.90
65	300	302	266	273	8.55
70	323	326	286	294	9.21
75	346	349	306	315	9.89
80	371	373	326	336	10.5
85	394	397	347	357	11.2
90	417	420	367	378	11.8
95	440	443	387	399	12.5
100	464	467	408	420	13.2
120	556	560	490	504	15.8
140	649	653	571	588	18.4
160	742	747	653	672	21.1
180	834	840	734	757	23.7
200	927	933	816	841	26.3
250	1 159	1 167	1 020	1 051	32.9
300	1 391	1 400	1 224	1 241	39.5

[Remark] 1 mm²/s = 1 cSt (centi stokes)



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CODE	DESCRIPTION	PAGE
FPL	Needle roller bearing, track roller, yoke type, full complement, non-separable, small series, cylindrical outer ring outside diameter, inner ring, metric series	B-5-38
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GCL 10-15	Needle roller bearing, track roller, stud type, full complement, small series, unsealed, cylindrical outer ring outside diameter, metric series	B-5-22~B-5-23
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GCUR MM	Cylindrical roller bearing, track roller, stud type, full complement, crowned outer ring outside diameter, eccentric collar, metal-sealed, metric series	B-5-30~B-5-31
GCURL MM	Cylindrical roller bearing, track roller, stud type, full complement, cylindrical outer ring outside diameter, eccentric collar, metal-sealed, metric series	B-5-30~B-5-31





CODE	DESCRIPTION	PAGE	CODE	DESCRIPTION	PAGE
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HJ	Needle roller bearing with integral flanges, lubricating groove and a lubricating hole in the outer ring, without inner ring, inch series	B-4-48~B-4-51	JR. JS1	Inner ring for needle roller bearing, with lubrication hole, metric series	B-2-28~B-2-37 & B-8-22~B-8-29
HJ RS	Needle roller bearing with integral flanges, lubricating groove and a lubricating hole in the outer ring, without inner ring, with one seal, inch series	B-4-52~B-4-53	JRZ. JS1	Inner ring for needle roller bearing, with lubrication hole, without raceway chamfer, metric series	B-2-28~B-2-37 & B-8-22~B-8-28
HJ .2RS	Needle roller bearing with integral flanges, lubricating groove and a lubricating hole in the outer ring, with two seals, without inner ring, inch series	B-4-52~B-4-53	JT	Drawn cup needle roller bearing, with one seal, open ends, caged, inch series	B-2-72~B-2-73
HK	Drawn cup needle roller bearing, open ends, caged, metric series	B-2-14~B-2-19	JTT	Drawn cup needle roller bearing, with two seals, open ends, caged, inch series	B-2-72~B-2-73
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HK .2RS	Drawn cup needle roller bearing, open ends, caged, with two seals, metric series	B-2-24~B-2-25	K BE	Radial needle roller and cage assembly for crank pin applications, metric series	B-1-47~B-1-48
IM	Inner ring for full complement drawn cup needle roller bearing, no lubrication hole, metric series	B-2-43~B-2-45 & B-8-32~B-8-34	K F	Radial needle roller and cage assembly, machined cage, single-row, metric series	B-1-8~B-1-28
IM	Inner ring for machine-tool quality precision-combined bearings, metric series	B-8-35	K FH	Radial needle roller and cage assembly, machined cage, case hardened, single-row, metric series	B-1-28
IMC	Inner ring for full complement drawn cup needle roller bearing, with lubrication hole, metric series	B-2-43~B-2-45 & B-8-32~B-8-34	K FV	Radial needle roller and cage assembly, machined cage, hardened and tempered, single-row, metric series	B-1-8~B-1-28
IM..P	Inner ring for needle roller bearing, no lubrication hole, metric series	B-2-28~B-2-35 & B-8-22~B-8-29	K H	Radial needle roller and cage assembly, hardened steel cage, single-row, metric series	B-1-8~B-1-28
IM...R6	Inner ring for full complement drawn cup needle roller bearing, no lubrication hole, without raceway chamfer, metric series	B-2-43~B-2-45 & B-8-32~B-8-34	K SE	Radial needle roller and cage assembly for wrist pin applications, metric series	B-1-51~B-1-52
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IR (6 digit)	Inner ring for heavy-duty needle roller bearing, inch series	B-4-54~B-4-56	K ZW	Radial needle roller and cage assembly, double-row, metric series	B-1-11~B-1-27
IRA	Inner ring for drawn cup needle roller bearing, extra wide, inch-series	B-2-74~B-2-76	K.811, K.812	Thrust cylindrical roller and cage assembly (without washers), metric series	B-6-38~B-6-40
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JH	Drawn cup needle roller bearing, caged, open ends, heavy series, inch series	B-2-66~B-2-69	KR .2RS	Needle roller bearing, track roller, stud type, caged, sealed, crowned outer ring outer diameter, metric series	B-5-18~B-5-19

CODE	DESCRIPTION	PAGE	CODE	DESCRIPTION	PAGE
KR .DZ	Needle roller bearing, track roller, stud type, caged, cylindrical outer ring outer diameter, metric series	B-5-16~B-5-17	NA49	Heavy-duty needle roller bearing, caged, with integral flanges, lubricating groove and one lubrication hole in the outer ring, with inner ring, metric series	B-4-13~B-4-18, B-4-19
KR .DZ.2RS	Needle roller bearing, track roller, stud type, caged, sealed, cylindrical outer ring outer diameter, metric series	B-5-18~B-5-19	NA49 RS	Heavy-duty needle roller bearing, caged, with integral flanges, lubricating groove and one lubricating hole in the outer ring, with inner ring, with one seal, metric series	B-4-30
KRV	Needle roller bearing, track roller, stud type, full complement, crowned outer ring outer diameter metric series	B-5-20~B-5-21	NA49 .2RS	Heavy-duty needle roller bearing, caged, with integral flanges, lubricating groove and one lubricating hole in the outer ring, with inner ring, with two seals, metric series	B-4-30
KRV .DZ	Needle roller bearing, track roller, stud type, full complement, cylindrical outer ring outer diameter, metric series	B-5-20~B-5-21	NA69	Heavy-duty needle roller bearing, caged, with flanges (inserted or integral), lubricating groove and one Lubricating hole in the outer ring, with inner ring (sizes with 32 mm and larger bores have two needle roller and cage assemblies), metric series	B-4-13~B-4-18
LS	Thrust washer for AXK series, heavy, metric series	B-6-13~B-6-17	NAO	Heavy-duty needle roller bearing, caged, without flanges, with inner ring, metric series	B-4-32~B-4-34
M- 1	Drawn cup needle roller bearing, full complement, closed end, inch series	B-2-54~B-2-61	NATR	Needle roller bearing, track roller, yoke type, caged, crowned outer ring outer diameter, with end washers, non-separable design, with inner ring, metric serie	B-5-36
MH- 1	Drawn cup needle roller bearing, full complement, heavy series, closed end, inch series	B-2-54~B-2-61	NATR .DZ	Needle roller bearing, track roller, yoke type, caged, cylindrical outer ring outer diameter, with end washers, non-separable design, with inner ring, metric series	B-5-36
MJ- 1	Drawn cup needle roller bearing, caged, closed end, inch series	B-2-66~B-2-69	NAXK	Combined needle roller bearings, combination machined race needle roller and thrust ball bearing, caged, single directional axial load capability, without inner ring, metric series	B-7-6~B-7-9
MJH- 1	Drawn cup needle roller bearing, caged, heavy series, closed end, inch series	B-2-66~B-2-69	NAXK .Z	Combined needle roller bearings, combination machined race needle roller and thrust ball bearing, caged, single directional axial load capability, with dust cap, without inner ring, metric series	B-7-6~B-7-9
NA1000	Heavy-duty needle roller bearing, full complement, with inner ring, metric series	B-4-42~B-4-43	NAXR	Combined needle roller bearings, combination machined race needle roller and thrust cylindrical roller bearing, caged, single directional axial load capability, without inner ring, metric serie	B-7-10~B-7-13
NA2000	Heavy-duty needle roller bearing, full complement, with inner ring, metric series	B-4-42~B-4-44	NAXR .Z	Combined needle roller bearings, combination machined race needle roller and thrust cylindrical roller bearing, caged, single directional axial load capability, with dust cap, without inner ring, metric series	B-7-10~B-7-13
NA22000	Heavy-duty needle roller bearing, full complement, with inner ring, metric series	B-4-42			
NA22 .2RS	Needle roller bearing, track roller, yoke type, caged, sealed, with integral flanges, crowned outer ring outer diameter, with inner ring, metric series	B-5-35			
NA22.2RS.DZ	Needle roller bearing, track roller, yoke type, caged, sealed, with integral flanges, cylindrical outer ring outer diameter, with inner ring, metric series	B-5-35			
NA3000	Heavy-duty needle roller bearing, full complement, with inner ring, metric series	B-4-42~B-4-44			
NA48	Heavy-duty needle roller bearing, caged, with integral flanges, lubricating groove and one lubrication hole in the outer ring, with inner ring, metric series	B-4-18			



NEEDLE ROLLER BEARINGS

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NK	Heavy-duty needle roller bearing, caged, with flanges (inserted or integral), without inner ring, metric series B-4-20~B-4-26		R P	Radial needle roller and cage assembly for wrist pin applications, metric series B-1-53~B-1-54	
NKJ	Heavy-duty needle roller bearing, caged, with flanges (inserted or integral), with inner ring, metric series B-4-13~B-4-18		RAX 400	Combined needle roller bearings, combination machined race needle roller and needle roller thrust bearing, with cage, single directional axial load capability, without inner ring, metric series B-7-14~B-7-17	
NKJS	Heavy-duty needle roller bearing, with integral flanges, lubricating groove and one lubricating hole in the outer ring, with inner ring, metric series.... B-4-14~B-4-18		RAX 500	Combined needle roller bearings, combination machined race needle roller and cylindrical roller thrust bearing, with cage, single directional axial load capability, without inner ring, metric series B-7-14~B-7-17	
NKS	Heavy-duty needle roller bearing, caged, with integral flanges, lubricating groove and one lubricating hole in the outer ring, without inner ring, metric series B-4-21~B-4-25		RAX 700	Combined needle roller bearings, combination drawn cup needle roller (with open ends) and needle roller thrust bearing, caged, single directional axial load capability, without inner ring, metric series B-7-18~B-7-19	
NKTN	Heavy-duty needle roller bearing, molded cage of reinforced engineered polymer, with flanges (inserted or integral), without inner ring, metric series B-4-20		RAXF 700	Combined needle roller bearings, combination drawn cup needle roller (with closed end) and needle roller thrust bearing, caged, single directional axial load capability, without inner ring, metric series B-7-18~B-7-19	
NQ	Heavy-duty needle roller bearing, caged, with integral flanges, without inner ring, metric series B-4-27~B-4-29		RAXZ 500	Combined needle roller bearings, combination machined race needle roller and cylindrical roller thrust bearing, caged, single directional axial load capability, without inner ring, with unitized thrust washer, metric series B-7-10~B-7-13	
NQI	Heavy-duty needle roller bearing, caged, with integral flanges, with inner ring, metric series..... B-4-19		RC	Drawn cup roller clutch, single roller per integral spring, inch series..... B-3-14~B-3-15	
NRO.B	Needle roller, flat end, metric series B-8-8		RC -FS	Drawn cup roller clutch, single roller per stainless steel spring, inch series..... B-3-14~B-3-15	
NTA	Thrust needle roller and cage assembly (without washers), two-piece cage, inch series..... B-6-52~B-6-61		RCB	Drawn cup roller clutch and bearing assembly, single roller per integral spring, inch series..... B-3-16~B-3-17	
NTH	Thrust cylindrical roller and cage assembly (without washers), inch series B-6-62~B-6-63		RCB -FS	Drawn cup roller clutch and bearing assembly, single roller per stainless steel spring, inch series..... B-3-16~B-3-17	
NTHA	Cylindrical roller thrust bearing, with separable washers, one shaft-piloted washer and one housing-piloted washer, inch series..... B-6-64~B-6-65		RE	Radial needle roller and cage assembly for wrist pin applications, metric series B-1-53~B-1-54	
NUKR	Cylindrical roller bearing, track roller, stud-type, full complement, with shields, crowned outer ring outer diameter, metric series..... B-5-20~B-5-21		RF	Radial needle roller and cage assembly, molded polymer cage, metric series B-1-30~B-1-40	
NUTR	Cylindrical roller bearing, track roller, yoke-type, full complement, crowned outer ring outer diameter, with end washers, non-separable design, with inner ring, metric series B-5-37		RFN	Radial needle roller and cage assembly, molded polymer cage, metric series B-1-40	
NUTR.DZ	Cylindrical roller bearing, track roller, yoke-type, full complement, cylindrical outer ring outer diameter, with end washers, non-separable design, with inner ring, metric series B-5-37		RFU	Radial needle roller and cage assembly, half-caged, molded polymer cage, metric series B-1-32~B-1-40	
R	Radial needle roller and cage assembly, steel cage, metric series B-1-30~B-1-41				

CODE	DESCRIPTION	PAGE	CODE	DESCRIPTION	PAGE
RNA1000	Heavy-duty needle roller bearing, full complement, without inner ring, metric series	B-4-38~B-4-40	RPU	Radial needle roller and cage assembly, half-caged, steel cage, metric series	B-1-33~B-1-40
RNA11000B6, RNAB11000	Needle roller bearing, track roller, yoke type, full complement, crowned outer ring outside diameter, without inner ring, metric series	B-5-44	RS	Radial needle roller and cage assembly, steel cage, metric series	B-1-30~B-1-40
RNA2000	Heavy-duty needle roller bearing, full complement, without inner ring, metric series	B-4-38~B-4-41	RSTO	Needle roller bearing, track roller, yoke type, caged, crowned outer ring outer diameter, separable design, without inner ring, without end washers, metric series	B-5-32
RNA22 .2RS	Needle roller bearing, track roller, yoke type, caged, sealed, with integral flanges, crowned outer ring outer diameter, without inner ring, metric series ...	B-5-34	RSTO. DZ	Needle roller bearing, track roller, yoke type, caged, cylindrical outer ring outer diameter, separable design, without inner ring, without end washers, metric series	B-5-32
RNA22 .2RS.DZ	Needle roller bearing, track roller, yoke type, caged, sealed, with integral flanges, cylindrical outer ring outer diameter, without inner ring, metric series ...	B-5-34	RSU	Radial needle roller and cage assembly, half-caged, steel cage, metric series	B-1-37
RNA22000	Heavy-duty needle roller bearing, full complement, without inner ring, metric series	B-4-38~B-4-39	RV	Radial needle roller and cage assembly, steel cage, metric series	B-1-30~B-1-41
RNA3000	Heavy-duty needle roller bearing, full complement, without inner ring, metric series	B-4-39~B-4-41	RVU	Radial needle roller and cage assembly, half-caged, steel cage, metric series	B-1-35
RNA48	Heavy-duty needle roller bearing, caged, with integral flanges, lubricating groove and one lubricating hole in the outer ring, without inner ring, metric series	B-4-26	SNSH	End washers, for use with NAO and RNAO needle roller bearings, metric series	B-4-32~B-4-37 & B-8-39
RNA49	Heavy-duty needle roller bearing, caged, with integral flanges, lubricating groove and one lubricating hole in the outer ring, without inner ring, metric series	B-4-20~B-4-26, B-4-28~B-4-29	STO	Needle roller bearing, track roller, yoke type, caged, crowned outer ring outer diameter, separable design, with inner ring, metric series	B-5-33
RNA49 RS	Heavy-duty needle roller bearing, caged, with integral flanges, lubricating groove and one lubricating hole in the outer ring, without inner ring, with one seal, metric series	B-4-31	STO. DZ	Needle roller bearing, track roller, yoke type, caged, cylindrical outer ring outer diameter, separable design, with inner ring, metric series	B-5-33
RNA49 .2RS	Heavy-duty needle roller bearing, caged, with integral flanges, lubricating groove and one lubricating hole in the outer ring, without inner ring, with two seals, metric series	B-4-31	STO. ZZ	Needle roller bearing, track roller, yoke type, caged, crowned outer ring outer diameter, with end washers, separable design, with inner ring, metric series	B-5-36
RNA69	Heavy-duty needle roller bearing, caged, with flanges (inserted or integral), lubricating groove and one lubricating hole in the outer ring, without inner ring (sizes with 40 mm and larger bores have two needle roller and cage assemblies), metric series	B-4-21~B-4-26, B-4-28	STO. ZZ.DZ	Needle roller bearing, track roller, yoke type, caged, cylindrical outer ring outer diameter, with end washers, separable design, with inner ring, metric series	B-5-36
RNAL11000	Needle roller bearing, track roller, yoke type, full complement, crowned outer ring outside diameter, without inner ring, metric series	B-5-44	TP	Thrust needle roller and cage assembly (without washers), two-piece cage, metric series	B-6-18
RNAO	Heavy-duty needle roller bearing without flanges, without inner ring, metric series	B-4-35~B-4-37	TPK J	Unitized needle roller thrust bearing, non-separable design, with one O.D. lipped thrust washer, metric series	B-6-23
RP	Radial needle roller and cage assembly, steel cage, metric series	B-1-31~B-1-40	TPK JL	Unitized needle roller thrust bearing, with non-separable washers, one I.D. lipped washer and one O.D. lipped washer, metric series	B-6-21
			TPK L	Unitized needle roller thrust bearing, non-separable design, with one I.D. lipped thrust washer, metric series	B-6-25



NEEDLE ROLLER BEARINGS



CODE	DESCRIPTION	PAGE	CODE	DESCRIPTION	PAGE
TR	Thrust washer A, B, C, etc. indicates (A,B,C, etc) washer thickness, inch series.....	B-6-53~B-6-61	WRFU	Radial needle roller and cage assembly, double-row, half-caged, molded polymer cage, metric series.....	B-1-35
TRI	Thrust washer, shaft piloted, inch series.....	B-6-65	WRP	Radial needle roller and cage assembly, double-row, steel cage, metric series.....	B-1-37~B-1-40
TRID	Thrust washer, housing piloted, inch series.....	B-6-65	WRPU	Radial needle roller and cage assembly, double-row, half-caged, steel cage, metric series.....	B-1-36
TRJ	Thrust washer, shaft piloted, inch series.....	B-6-65	WRS	Radial needle roller and cage assembly, double-row, steel cage, metric series.....	B-1-33~B-1-41
TRJD	Thrust washer, housing piloted, inch series.....	B-6-65	WS.811, WS.812	Thrust washer, shaft piloted, metric series.....	B-6-13~B-6-15, B-6-39~B-6-41
TV	Thrust needle roller and cage assembly (without washers), one-piece cage, metric series.....	B-6-18	WS F	Thrust washer, heavy, metric series.....	B-6-19
TVK J	Unitized needle roller thrust bearing, non-separable design, with one O.D. lipped thrust washer, metric series.....	B-6-23	Y	Drawn cup needle roller bearing, full complement, open ends, inch series.....	B-2-62
TVK JL	Unitized needle roller thrust bearing, with non-separable washers, one I.D. lipped washer and one O.D. lipped washer, metric series.....	B-6-21	YM	Drawn cup needle roller bearing, full complement, open ends, metric series.....	B-2-41~B-2-42
TVK L	Unitized needle roller thrust bearing, non-separable design, with one I.D. lipped thrust washer, metric series.....	B-6-25	ZRO	Cylindrical roller, metric series.....	B-8-19
UR P	Radial needle roller and cage assembly for wrist pin applications, half-caged, metric series.....	B-1-53			
V	Radial needle roller and cage assembly, steel cage, metric series.....	B-1-31~B-1-41			
VE	Radial needle roller and cage assembly for crank pin applications, metric series.....	B-1-49~B-1-50			
VENN	Grease fitting for stud-type track rollers, metric series.....	B-5-14			
VEU	Radial needle roller and cage assembly for crank pin applications, half-caged, metric series.....	B-1-50			
VS	Radial needle roller and cage assembly, steel cage, metric series.....	B-1-31~B-1-36			
VS P	Radial needle roller and cage assembly for crank pin applications, metric series.....	B-1-49~B-1-50			
VU	Radial needle roller and cage assembly, half-caged, steel cage, metric series.....	B-1-33			
W F	Thrust washer, stamped, metric series.....	B-6-19			
WJ	Radial needle roller and cage assembly, single-row, heavy series, inch series.....	B-1-57~B-1-59			
WJC	Radial needle roller and cage assembly, single-row, inch series.....	B-1-57			
WR	Radial needle roller and cage assembly, double-row, steel cage, metric series.....	B-1-31~B-1-41			



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