Koyo®

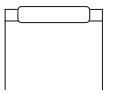
• General Bearings •

NEEDLE ROLLER BEARINGS

JTEKT

JTEKT CORPORATION

CAT. NO. B2003E



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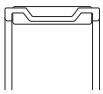

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V
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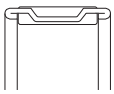

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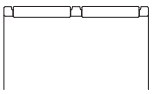

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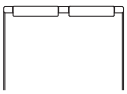

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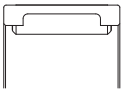

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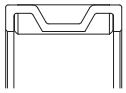

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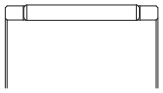
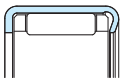
VS...P



RE
R...P
UR...P



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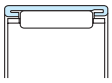

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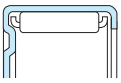
BHTM
BT
BHT

BKM



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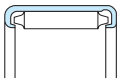
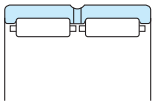
MHKM
MK
MHK



BM
BHM
B
BH

RNA49
RNA59

NQ
NQS



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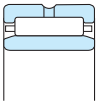

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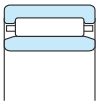

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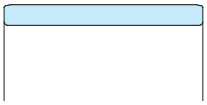

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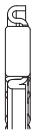
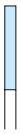


TV

TP



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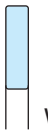

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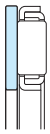

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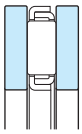

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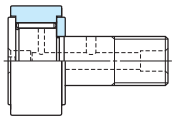

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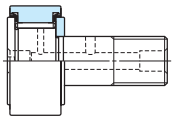
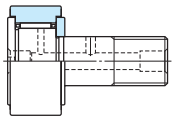
CM...RM
CR...M



CM...UUM
CM...UURM
CR...UUM



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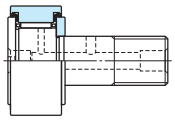

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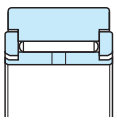
KM...UURM



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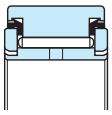
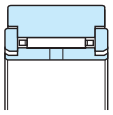


CYM...UUM
CYM...UURM



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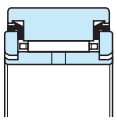
CXM...RM



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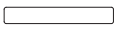
CXM...UURM



LF

Koyo®

NEEDLE ROLLER BEARINGS

CAT. NO. B2003E

Value & Technology

Publication of
New Koyo Needle Roller Bearing Catalog

We are pleased to offer our new Koyo Needle Roller Bearing catalog to you.

Needle roller bearings are being used in a wide range of machinery, such as automobiles, motor cycles, electric machines, aerospace equipment, machine tools, office and hydraulic equipment, and other general industrial machinery. In every field, new products are developed for saving of energy and conservation of environment, and needle roller bearings play a part in it.

This thoroughly-revised catalogue includes the latest bearing types, models, and technical information.

We trust this catalog will help you to select and use needle roller bearings appropriately.
We are grateful for your patronage and look forward to continuing to serve you in the future.

★The contents of this catalog are subject to change without prior notice. Every possible effort has been made to ensure that the data herein is correct; however, JTEKT cannot assume responsibility for any errors or omissions.

Contents

Technical section

Specification tables

11 Specification tables of needle roller bearings

Other products · Example of use · Supplementary tables

12 Other products

13 Example of use

14 Supplementary tables

1 Characteristics and types of needle roller bearings

1.1 Characteristics of needle roller bearings

1 Large Load Rating

As compared with general ball and roller bearings, the Koyo needle roller bearings can ensure a large load rating in a small space, and can be used without inner rings or needle roller and cage assemblies so that the whole of the machine can be reduced in size and weight, thus making the design around the bearing more compact.

2 Small Cross-sectional Height

Due to its small cross-sectional height, the bearing can fit in nearly the same space as the conventional plain bearing. In addition, handling and maintenance are very easy.

3 Withstanding High-Speed Operation

Compared with general ball and roller bearings, this bearing is smaller in pitch circle diameter. As a result, a temperature rise has little influence on the load and rotating speed, making it advantageous in high-speed operation.

4 Many Rollers

The load is uniformly applied to the rollers, thus ensuring a greater loading capacity. In addition, use of many rollers with small diameters makes the bearing advantageous in oscillating rotation.

1.2 Characteristics of varied needle roller bearing types

- **Needle roller and cage radial assembly**

  It comprises needle rollers and cage, and the shaft and housing of appropriate tolerance and hardness are used as bearing ring.

- **Needle roller and cage radial assembly for connecting rod**

  This highly strong needle roller and cage assembly is used for engine connecting rods in motor cycles and outboard motor.

- **Drawn cup needle roller bearing**

  This bearing, comprising outer ring made of high-quality cold rolled steel strips and needle rollers, is press-fitted into the housing. It comes in two types of full complement type and cage included type. Each of them comes in two outer ring types, open ends type and closed end type.

- **Machined ring needle roller bearing**

  This bearing comprises outer ring made of good-quality high carbon chromium bearing steel, and needle roller and cage incorporated in it. It comes in two types, no inner ring type and inner ring included type.

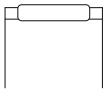
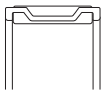
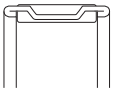
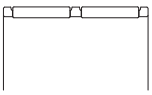
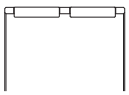
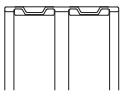
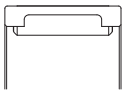
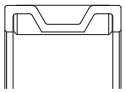
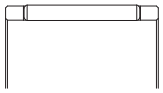
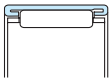
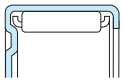
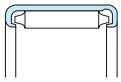
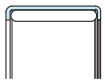
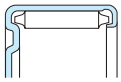
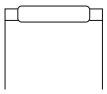
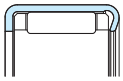
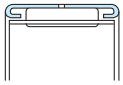
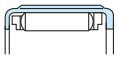
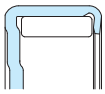
- **Needle roller thrust bearing**

  This bearing, being able to carry axial load, comprises needle roller and cage thrust assembly, and a thrust race, can be matched with a pressed thin race or machined thick race. It comes in two types of separable type in which thrust race and needle roller and cage thrust assembly are to be combined at use and non-separable type in which they are assembled.

- **Track roller**

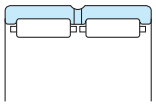
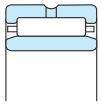
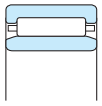
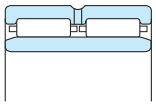
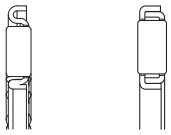
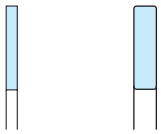
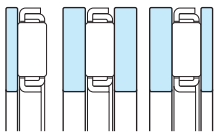
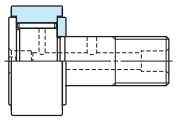
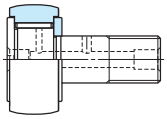
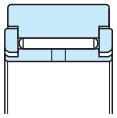
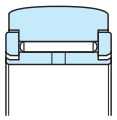
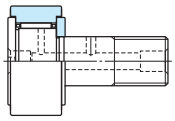
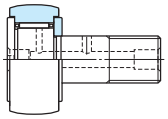
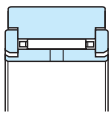
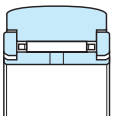
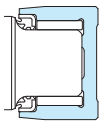
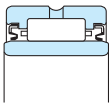
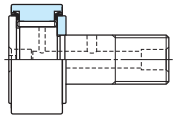
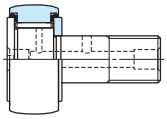
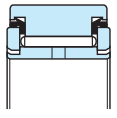
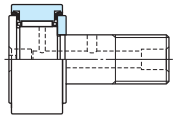
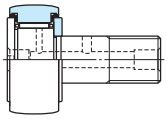
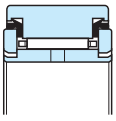
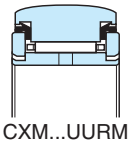
  This bearing, incorporating needle rollers in thick outer ring, comes in two types of stud type and yoke type. For each of them, full complement type, cage or seal included type, and many other types are available depending on applications.

1.3 Types of needle roller bearing

	Needle roller and cage assemblies		Drawn cup needle roller bearings		
	For general use	For use with connecting rods	With cage	Full complement type	
Basic type	 RS, R, RP  RV, V, VS  VP, VPS  WR, WRS  WRP  WV	● For use at large end (for crank pin)  BE  VE, VS...P ● For use at small end (for piston pin)  RE R...P UR...P	● Open ends type  BTM, BHTM BT, BHT ● Closed end type  MKM, MHKM MK, MHK	● Open ends type  BM, BHM B, BH  YM Y ● Closed end type  MM M, MH	
Other-types	■ With synthetic resin  RFN ■ With double split cage RU, VU, VPU RFNU (with synthetic resin)		■ With synthetic resin  BFNM ■ Sealed type  BKM...U ■ With lubrication hole  BTM...OH	■ Miniature one-way clutch*  1WC, EWC ■ For universal joint*  YM	
Characteristics: Load Capacity (Radial)	Large	Large	Medium	Large	
Characteristics: Load Capacity (Axial)	–	–	–	–	
Characteristics: Limiting speeds	High	High	High	Medium	
Characteristics: Cylindricity 1)	Medium	Medium	Medium	Low	
Characteristics: Cross-sectional height	Low	Low	Low	Low	
Reference pages of	P44 – 59	P62 – 67	P76 – 115		

[Remark] Contact JTEKT if you need bearings with *-marks.

[Note] 1) For needle roller thrust bearings, it means squareness.

	Machined ring needle roller bearings		Needle roller thrust bearings	Track rollers	
	Without inner ring	With inner ring		Full complement type	With cage
	 RNA49 RNA59  NQ NQS  RNA69	 NA49 NA59  NQI NQIS  NA69	● Needle roller and cage assembly  TV TP ● Race  W WS ● Combination type (separable type)  TPW...F TPWS...FF TPWWS...FF	● Stud type (cam followers)  CM...M CR...M  CM...RM ● Yoke type (roller followers)  CYM...M  CYM...RM	● Stud type (cam followers)  KM...M  KM...RM ● Yoke type (roller followers)  CXM...M  CXM...RM
	■ With locating snap ring (outer ring) ■ With pin hole (outer ring) ■ Double split type for crank shaft ■ For universal joint*  KC ■ With dimple for universal joint*	■ With locating snap ring (outer ring) ■ With pin hole (outer ring) ■ Sealed type  NA49...UU ■ Heavy duty series* (Bearings conforming to (ISO 6979))	■ Non-separable  TVK...  TPK...	■ Sealed type  CM...UUM CR...UUM  CM...UURM  CYM...UUM  CYM...UURM	■ Sealed type  KM...UUM  KM...UURM  CXM...UUM  CXM...UURM
	Large	Large	–	Large	Medium
	–	–	Large	–	–
	High	High	High	Low	High
	Medium	Medium	Low	Low	Medium
	Medium	Medium	Low	Medium	Medium
	P122 – 137		P148 – 157	P162 – 169, P172 – 175	

2 Outline of bearing selection

Currently, as design of needle roller bearings has become diversified, their application range is being increasingly extended. In order to select the most suitable bearings for an application, it is necessary to conduct a comprehensive study on both bearings and the equipment in which the bearings will be installed, including operating conditions, the performance required of the bearings, specifications of the other components to be installed along with the bearings, marketability, and cost performance, etc.

In selecting needle roller bearings, since the bearing installation space is usually determined beforehand, the bearing type and dimensions are chosen based upon the machine operating conditions, according to the bearing installation space.

Internal specifications including bearing tolerance, internal clearance, and lubricant are also selected, depending on the application.

For reference, general selection procedure and operating conditions are described in **Table 2.1**. There is no need to follow a specific order, since the goal is to select the right bearing to achieve optimum performance.

Table 2.1 Bearing selection procedures

	Operating conditions to be considered	Reference page No.
(1) Bearing type	• Installation space • Load magnitude, types and direction of application • Rotational speed • Running accuracy • Inclination of inner ring and outer ring (Misalignment) • Mounting ease	P8
↓		
(2) Bearing dimension	• Specifications for installation • Recommended service life • Dynamic equivalent load • Static equivalent load • Rotational speed • Bearing boundary dimensions	 P13 P14 P14 Refer to "Specification tables of needle roller bearings"
↓	• Basic dynamic load rating • Basic static load rating	P11 P13
(3) Fit and internal clearance	• Load magnitude, types • Operational temperature distribution • Materials, size and tolerances of shaft and housing • Fit • Difference in temperature of inner and outer rings • Rotational speed • Bearing tolerances	 P17 P18 P19 Refer to "Specification tables of needle roller bearings"
↓	• Clearance	P20
(4) Lubrication, lubricant, sealing device	• Operating temperature • Rotational speed • Lubrication • Lubricant • Sealing device • Limiting speed • Replenishment/replacement of grease	 P24 P21 P25 P16 P23
↓		
(5) Mounting and dismounting	• Mounting and dismounting • Mounting dimensions	P29, 31 P17
↓		

Final determination of bearing and associated aspect

3 Bearing service life and load rating

3.1 Bearing service 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.

3.2 Calculation of service life

Basic dynamic load rating, C

The basic dynamic load rating is either pure radial (for radial bearings) or central axial load (for thrust bearings) of constant magnitude in a constant direction, under which the basic rating life of 1 million revolutions can be obtained, when the inner ring rotates while the outer ring is stationary, or vice versa. The basic dynamic load rating, which represents the capacity of a bearing under rolling fatigue, is specified as the **basic dynamic radial load rating** (C_r) for radial bearings, and **basic dynamic axial load rating** (C_a) for thrust bearings. These load ratings are listed in the specification table.

These values are prescribed by ISO 281/1990, and are subject to change by conformance to the latest ISO standards.

3.3 Basic rating life

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

$$L_{10} = \left(\frac{C}{P}\right)^{10/3} \quad \cdots\cdots (3.1)$$

where :

L_{10}	: basic rating life	10^6 revolutions
C	: basic dynamic load rating	N
P	: dynamic equivalent load	N

It is convenient to express the basic rating life in terms of time, using equation, when a bearing is used for operation at a constant speed.

In this case, it can be obtained by the following equation.

$$L_{10h} = \left(\frac{C}{P}\right)^{10/3} \frac{10^6}{60n} \quad \cdots\cdots (3.2)$$

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, **Equation (3.3)** can be used to calculate the basic dynamic load rating C; the bearing size most suitable for a specified purpose can then be selected, referring to the bearing specification table.

$$C = P\left(L_{10h} \times \frac{60n}{10^6}\right)^{3/10} \quad \cdots\cdots (3.3)$$

3.4 Corrected rating life

Generally, basic rating life of bearing (L_{10}) is regarded as a standard when its reliability is 90 %, and it can be expressed using **Equation (3.1)**. A certain application requires 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 reliability coefficient (a_1), bearing characteristic coefficient (a_2), and operating condition coefficient (a_3). The corrected life, corrected rating life (L_{na}), can be expressed using equation below.

$$L_{na} = a_1 \cdot a_2 \cdot a_3 \cdot L_{10} \quad \cdots\cdots (3.4)$$

where :

L_{na}	: corrected rating life	10^6 revolutions
	estimated reliability (100–n) % : the probability of failure occurrence is expressed by n, taking bearing characteristics and operating conditions into consideration.	
L_{10}	: basic rating life (estimated reliability 90 %)	10^6 revolutions
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 3.1 describes reliability coefficient, a_1, which is necessary to obtain the corrected rating life of reliability greater than 90 %.

Table 3.1 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 bearing characteristic in relation to bearing life may differ according to bearing materials (steel types and their quality), and may be altered by production process, design, etc. In such cases, the bearing life calculation can be corrected using the bearing characteristic coefficient a_2.

JTEKT has employed vacuum-degassed bearing steel as JTEKT standard bearing material. It has a significant effect on bearing life extension which was verified through studies at JTEKT research & development center.

The basic dynamic load rating of bearings made of vacuum-degassed bearing steel is specified in the bearing specification table, taking the bearing characteristic coefficient as $a_2 = 1$.

For bearings made of special materials to extend fatigue life, the bearing characteristic coefficient is treated as $a_2 > 1$.

(3) Operating condition coefficient (a_3)

When bearings are used under operating conditions which directly affect their service life, including improper lubrication, the service life calculation can be corrected by using a_3. It is difficult to indicate a_3 generally in the case of special operating conditions that may influence the distribution of load in bearings, and it must be considered individually. When the bearing is adequately lubricated (or the rolling surfaces are separated by an oil film) a_3 is 1.

In the following cases, the operating condition coefficient is treated as $a_3 < 1$:

- Operation using lubricant of low kinematic viscosity
  - Ball bearing·····13 mm^2/s or less
  - Roller bearing·····20 mm^2/s or less
- Operation at very slow rotational speed
  - Product of rolling element pitch diameter and rotational speed is 10 000 or less.
- Contamination of lubricant is expected

When, on the other hand, an exceptionally good lubrication is utilized, a_3 may be greater than 1. If lubricating condition is improper and the calculation is performed with $a_3 < 1$, the bearing characteristic coefficient a_2 is usually less than 1.

3.5 Correction of basic dynamic load rating

The rating life of a bearing is affected to an appreciable extent by the operating temperature and the bearing hardness. Therefore, when the bearing is used in an extreme temperature or when the bearing hardness must be lower than standard, it is necessary to correct the dynamic load rating.

(1) Bearing temperature and basic dynamic load rating

In high temperature operation, bearing material hardness deteriorates, as material compositions are altered. As a result, the basic dynamic load rating is diminished. Once altered, material composition is not recovered, even if operating temperatures return to normal.

Therefore, for bearings used in high temperature operation, the basic dynamic load rating should be corrected by multiplying the basic dynamic load rating values specified in the bearing specification table by the temperature coefficient values in **Table 3.2**.

Table 3.2 Temperature coefficient values

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

(2) Hardness and dynamic load rating

When the needle roller bearing is used without an inner ring, or as a cage and needle roller assembly only, it is necessary to take into account the hardness of the raceway surface, since the shaft and/or housing is used as the raceway on which rolling elements run. Therefore, when the hardness of these surfaces is lower than the standard, 60 HRC, the load rating should be corrected by using hardness coefficient given in **Fig. 3.1**.

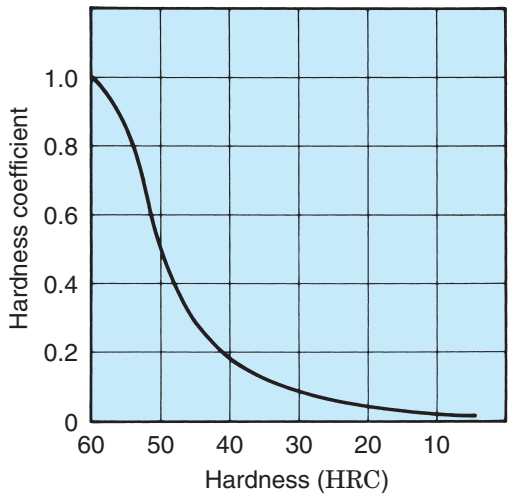


Fig. 3.1 Hardness Coefficient

3.6 Basic static load rating

Excessive static load or impact load even at very low rotation causes partial permanent deformation of the rolling element and raceway contacting surfaces. This permanent deformation increases with the load; if it exceeds a certain limit, smooth rotation will be hindered.

The basic static load rating of needle roller bearing is the static load which responds to the calculated contact stress is 4 000 MPa at the contact center between the raceway and rolling elements which receive the maximum load.

The total extent of contact stress-caused permanent deformation on surfaces of rolling elements and raceway will be approximately 0.000 1 times greater than the rolling element diameter.

The basic static load rating for radial bearings is specified as the basic static radial load rating, and for thrust bearings, as the basic static axial load rating. These load ratings are listed in the bearing specification table, using C_{0r} and C_{0a} respectively.

These values are prescribed by ISO 78/1987 and are subject to change by conformance to the latest ISO standards.

When the bearings is static or rotating at very slow speed under excessive static load or impact load, the permissible load should be determined not by fatigue life but by the permanent deformation. The permissible static load can be obtained from the static load rating and safety coefficients for operation conditions shown in **Table 3.3**.

$$C_0 = f_s \cdot P_0 \quad \cdots\cdots (3.5)$$

where :

C_0 : basic static load rating N

P_0 : static equivalent load N

f_s : safety coefficient for basic static load rating (see **Table 3.3**)

Table 3.3 Values of safety coefficient f_s

Operating condition	Load	f_s
With bearing rotation	Normal load When impact load is applied	≧ 1.5 ≧ 3.0
Without bearing rotation (occasional oscillation)	Normal load When impact load is applied When uneven distribution load is applied	≧ 1.0 ≧ 2.0

3.7 Applications and recommended bearing service life

Since longer service life does not always contribute to economical operation, the most suitable service life for each application and operating conditions should be determined.

For reference, **Table 3.4** describes recommended service life in accordance with the application, as empirically determined.

Table 3.4 Recommended bearing service life (by use)

Operating condition	Application	Recommended service life (h)
Short or intermittent operation	Household electric appliance, electric tools, agricultural equipment, heavy cargo hoisting equipment	4 000 – 8 000
Not extended duration, but stable operation required	Household air conditioner motors, construction equipment, conveyers, elevators	8 000 – 12 000
Intermittent but extended operation	Rolling mill roll necks, small motors, cranes	8 000 – 12 000
	Motors used in factories, general gears	12 000 – 20 000
	Machine tools, shaker screens, crushers	20 000 – 30 000
	Compressors, pumps, gears for essential use	40 000 – 60 000
Daily operation more than 8 hr. or continuous extended operation	Escalators	12 000 – 20 000
	Centrifugal separators, air conditioners, air blowers, woodworking equipment, passenger coach axle journals	20 000 – 30 000
	Large motors, mine hoists, locomotive axle journals, railway rolling stock traction motors	40 000 – 60 000
	Paper manufacturing equipment	100 000 – 200 000
24 hr. operation (no failure allowed)	Water supply facilities, power stations, mine water discharge facilities	100 000 – 200 000

4 Bearing load

4.1 Dynamic equivalent load

Bearings are used under various operating conditions; however, in most cases, bearings receive radial and axial load combined, while the load magnitude fluctuates during operation. Therefore, it is impossible to directly compare the actual load and basic dynamic load rating. The two are compared by replacing the loads applied to the shaft center with one of a constant magnitude and in a specific direction, that yields the same bearing service life as under actual load and rotational speed. This theoretical load is referred to as the dynamic equivalent load (P).

In the case of needle roller bearings, the radial bearing is subjected to radial load only, and the thrust bearing, to axial load only. The equivalent load can be obtained from the following equation.

(Radial bearings) $P = F_r$ ..... (4.1)

(Thrust bearings) $P = F_a$ ..... (4.2)

where :

P	: dynamic equivalent load	N
F_r	: radial load	N
F_a	: axial load	N

4.2 Static equivalent load

The static equivalent load is a theoretical load calculated such that, during rotation at very low speed or when bearings are stationary, the same contact stress as that imposed under actual loading condition is generated at the contact center between raceway and rolling element to which the maximum stress is applied.

For radial bearings, radial load passing through the bearing center is used for the calculation; for thrust bearings, axial load in a direction along the center shaft is used.

The static equivalent load of a needle roller bearing can be calculated using the following equations :

(Radial bearings) $P_0 = F_r$ ..... (4.3)

(Thrust bearings) $P_0 = F_a$ ..... (4.4)

where :

P_0	: static equivalent load	N

4.3 Load Applied to the Bearing

Generally, loads affecting bearings includes force exerted by the weight of the object the bearings support, transmission force of devices such as gears and belts, loads generated in equipment during operation etc.

Seldom can these kinds of load be determined by simple calculation, because the load is not always constant.

In many cases, the load fluctuates, and it is difficult to determine the frequency and magnitude of the fluctuation.

Therefore, loads are normally obtained by multiplying theoretical values with various coefficients obtained empirically.

(1) Coefficient for belt transmission

In the case of a belt transmission, firstly the force acting on the pulley should be obtained by the following equation.

● Torque affecting pulley (M)

$$M = 19.1 \times 10^6 \, W / n \quad (\mathrm{mN \cdot m}) \quad \cdots\cdots (4.5)$$

● Effective belt transmission force (K_b)

$$K_b = M / D_p \quad (\mathrm{N}) \quad \cdots\cdots (4.6)$$

where :

W	: transmission force	kW
D_p	: pitch circle diameter of pulley	mm
n	: rotational speed	$\mathrm{min^{-1}}$

In addition to the transmission force thus obtained, the belt tension must be taken into account to obtain the load which acts on the pulley shaft. This can be done by simply multiplying the driving force by a belt coefficient given in **Table 4.1** according to the type of the belt and the belting arrangement.

$$F_b = f_b \cdot K_b \quad \cdots\cdots (4.7)$$

where :

F_b	: load affecting pulley shaft	N
f_b	: belt coefficient (see **Table 4.1**)	

Table 4.1 Values of belt coefficient f_b

Belt type	f_b
V-belt	2.0 – 2.5
Flat belt (with tension pulley)	2.5 – 3.0
Flat belt	4.0 – 5.0

[Note] Use larger f_b values for shorter shaft distance and slower speed.

(2) Gear coefficient

In the case of gear transmission, loads transmitted by gearing are theoretically classified into three types : tangential load (K_t), radial load (K_r) and axial load (K_a).

These loads can be calculated by finding the transmission force and gear type. To spur gears, radial load is applied, while radial load and axial load are applied to bevel gears, worm gears, and helical gears. To take a spur gear as the simplest example, load acting on it can be determined by the equation below.

● Torque affecting gears (M)

$$M = 19.1 \times 10^6 \, W / n \quad (\mathrm{mN \cdot m}) \quad \cdots\cdots (4.8)$$

● Gear tangential load (K_t)

$$K_t = 2M / D_p \quad (\mathrm{N}) \quad \cdots\cdots (4.9)$$

● Gear radial load (K_r)

$$K_r = K_t \cdot \tan \alpha \quad (\mathrm{N}) \quad \cdots\cdots (4.10)$$

● Combined force on bearing (K_g)

$$K_g = \sqrt{K_t^2 + K_r^2} = K_t \cdot \sec \alpha \quad (\mathrm{N}) \quad \cdots\cdots (4.11)$$

where :

W	: transmitting force	kW
D_p	: gear pitch circle diameter	mm
n	: rotational speed	$\mathrm{min^{-1}}$
α	: gear pressure angle	

Thus, actual load affecting gear shaft can be determined by multiplying the combined force by gear coefficient depending on the gear accuracy and good or poor finishing quality as shown the equation below.

$$P_g = f_g \cdot K_g \quad \cdots\cdots (4.12)$$

where :

P_g	: load affecting gear	N
K_g	: theoretical load affecting gear	N
f_g	: gear coefficient (see **Table 4.2**)	

Table 4.2 Values of gear coefficient f_g

Gear type	f_g
Precision gears (both pitch error and tooth shape error less than 0.02 mm)	1.0 – 1.1
Normal gears (both pitch error and tooth shape error from 0.02 mm to 0.10 mm)	1.1 – 1.3

(3) Load coefficient

Generally, every machine is subject to vibration or impact during operation to a greater or lesser. Therefore, since actual load affecting bearing is greater than the calculated load, proper load coefficient must be multiplied.

$$F = f_w \cdot F_c \quad \cdots\cdots (4.13)$$

where :

F	: measured load	N
F_c	: calculated load	N
f_w	: load coefficient Generally, values of load coefficient f_w shown in the table below are used.	

Table 4.3 Values of load coefficient f_w

Machine operating condition	f_w
Operation of rotary machine without impact (Motor, turbo blower, rotary furnace)	1.0 – 1.2
Operation of machine having reciprocating sections (Internal-combustion engine, crank shaft of sorter) Operation of machine with impact and vibration (Cultivator, wheel and axle)	1.2 – 2.0
Operation of machine with severe impact (Rolling mills, crusher, shaker screens)	2.0 – 3.0

4.4 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.

When the load and speed fluctuate between different levels as shown in **Fig. 4.1** the mean dynamic equivalent load can be obtained according to following equation :

$$P_m = \sqrt[10/3]{\frac{P_1^{10/3} n_1 t_1 + P_2^{10/3} n_2 t_2 + \cdots\cdots + P_n^{10/3} n_n t_n}{n_1 t_1 + n_2 t_2 + \cdots\cdots + n_n t_n}} \quad \cdots\cdots (4.14)$$

where :

P_m	: mean dynamic equivalent load	N
P_1	: dynamic equivalent load applied for t_1 hours at rotational speed n_1	N
⋮	⋮	⋮
P_n	: dynamic equivalent load applied for t_n hours at rotational speed n_n	N

Also, mean rotational speed n_m can be calculated using the following equation :

$$n_m = \frac{n_1 t_1 + n_2 t_2 + \cdots\cdots + n_n t_n}{t_1 + t_2 + \cdots\cdots\cdots t_n} \quad \cdots\cdots (4.15)$$

When the load varies in a stageless fluctuation as shown in **Fig. 4.2**, the following equation is useful to approximate the mean dynamic equivalent load.

$$P_m = \frac{P_{min} + 2P_{max}}{3} \quad \cdots\cdots (4.16)$$

where :

P_{min} : minimum dynamic equivalent load N

P_{max} : maximum dynamic equivalent load N

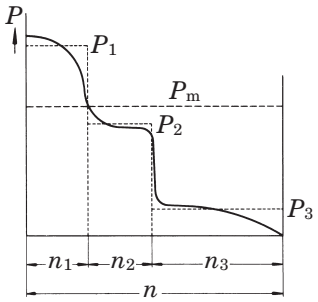


Fig. 4.1

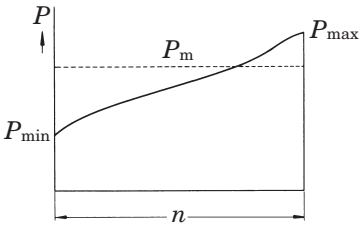


Fig. 4.2

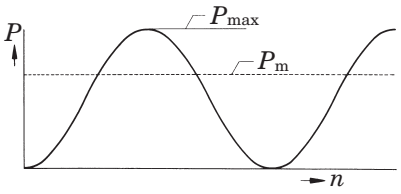


Fig. 4.3

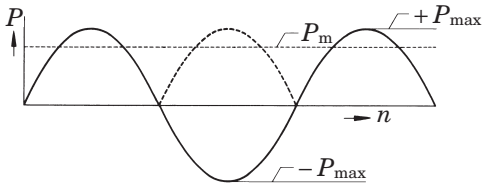


Fig. 4.4

When the load fluctuates between 0 and P_{max} in the form of a sine curve as in **Fig. 4.3**, an approximation of mean dynamic equivalent load can be calculated by the following equation :

$$P_m \fallingdotseq 0.68\, P_{max} \quad \cdots\cdots (4.17)$$

When the load fluctuates between 0 and P_{max} in the upper half of a sine curve as in **Fig. 4.4** an approximation of mean dynamic equivalent load can be calculated by the following equation :

$$P_m \fallingdotseq 0.75\, P_{max} \quad \cdots\cdots (4.18)$$

4.5 Limiting speed

The rotational speed of a bearing is normally affected by friction heat generated in the bearing. If the heat exceeds a certain amount, seizure or other failures occur, thus causing rotation to be discontinued.

The limiting speed is the highest speed at which a bearing can continuously operate without generating such critical heat.

The limiting speed differs depending on various factors including bearing type, dimensions and their accuracy, lubrication, lubricant type and amount, shapes of cages and materials and load conditions, etc.

The limiting speed determined under grease lubrication and oil lubrication (oil bath) for each bearing type are listed in the bearing specification table.

These speeds are applied when bearings of standard design are rotated under normal load conditions (approximately, $C/P \geqq 13$).

When the load condition is $C/P < 13$, i.e. the dynamic equivalent load P exceeds approximately 8 % of basic dynamic load rating C, the limiting speed should be corrected by using **Equation (4-19)** :

$$n_a = f_1 \cdot n \quad \cdots\cdots (4.19)$$

where :

n_a : corrected limiting speed min^{-1}

f_1 : correction coefficient determined from the load magnitude (**Fig 4.5**)

n : limiting speed under normal load condition (values in the Specification tables of needle roller bearings)

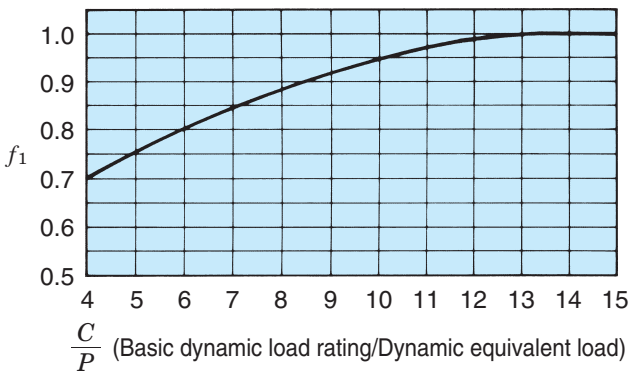


Fig. 4.5

5 Shaft and housing

5.1 Accuracy and roughness

The needle roller bearing is designed to be thin, particularly in the inner and outer rings. In the case of the bearing without inner or outer rings, the shaft or housing are used as raceway surfaces, therefore material heat treatment and machining accuracy are important coefficients in the design of the shaft and housing.

The accuracy and roughness required for them to act as raceway and fitting surfaces are shown in **Table 5.1**.

Table 5.1 Accuracy and roughness of shafts and housings (Drawn cup needle roller bearings, Needle roller and cage assembies, Machined ring needle roller bearings)

Item	Shaft		Housing bore	
	Raceway surface	Fitting surface	Raceway surface	Fitting surface
Roundness	Best if less than one half or one third of the shaft diameter tolerance		Best if less than one half or one third of the bore diameter tolerance	
Cylindricity	5 μm or less per 25 mm, or one half or less of the shaft diameter tolerance		5 μm or less per 25 mm, or one half or less of the bore diameter tolerance	
Roughness (Ra)	0.4 a or less	0.8 a or less	0.6 a or less	1.6 a or less
Hardness	58 HRC or harder [1] (60 to 64 HRC are best.)	—	58 HRC or harder [1] (60 to 64 HRC are best.)	—
Shaft Slope	Max. 13 μm per 25 mm length			

[Note] 1) Case hardened steel which is carburized or induction-hardened should not only meet the surface hardness requirement specified above but also have a case depth of 52.3 HRC (550 HV) to a depth in the range (0.08 to 0.1) × D_w mm. (D_w : roller diameter)
In general, 30 thru 45 HRC is best for the center hardness.

5.2 Material

The material for the shaft and housing to be used as the raceway surface must have sufficient rigidity and hardness, excellent wear and impact load resistance, dimensional stability, and long rolling fatigue life.

The materials generally used for the shaft or housing to be used as the raceway surface are as shown in **Table 5.2**. It is also required that the hardened case after heat treatment be of a fine and uniform martensite structure.

5.3 Mounting Dimensions

In the case of machined ring needle roller bearings, the fillet radius (R) of the housing must be smaller than the minimum value of the bearing chamfer (r) (the same holds true for the shaft filled seating a bearing with inner ring). For details of the mounting dimensions, refer to the opening paragraph for each type.

Table 5.2 Materials for shaft or housing used as raceway surface

Type of Steel	Symbol	JIS
High carbon chromium bearing steel	SUJ2	G4805
Chromium molybdenum steel (carborized)	SCM415, SCM420	G4053
Nickel chromium molybdenum steel (carborized)	SNCM415, SNCM420	
Chromium steel (carborized)	SCr415, SCr420	
Nickel chromium steel (carborized)	SNC415, SNC815	
Carbon steel	S50C, S55C	G4051

6 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.

6.1 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 6.1 tabulates the relationship between these characteristics and fit.

Table 6.1 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 :

[in the case of $F_r \leqq 0.25\, C_0$]

$$\Delta_{dF} = 0.08 \sqrt{\frac{d}{B}} \cdot F_r \times 10^{-3} \quad \cdots\cdots (6.1)$$

[in the case of $F_r \leqq 0.25\, C_0$]

$$\Delta_{dF} = 0.02 \frac{F_r}{B} \times 10^{-3} \quad \cdots\cdots (6.2)$$

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

For inner ring rotating bearings, the fit should be tight enough to prevent the inner ring from coming loose under load. Consequently, when the radial load, exceeds the C_0 value by more than 25 %, greater interference is needed. Much greater interference is needed, when impact loads are expected. In either case, the effective interference should be less than 0.001 times the shaft diameter.

(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 :

In the case of a ground shaft

$$\Delta_{deff} \fallingdotseq \frac{d}{d+2} \Delta_d \quad \cdots\cdots (6.3)$$

In the case of a turned shaft

$$\Delta_{deff} \fallingdotseq \frac{d}{d+3} \Delta_d \quad \cdots\cdots (6.4)$$

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, 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.

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 outer ring and housing. Therefore, when clearance is provided to accommodate shaft thermal expansion, care should be taken.

If the assumed temperature difference between the bearing inside and surrounding housing is Δ_t, the temperature difference at the fitting surfaces of the inner ring and shaft will be approximately (0.10 to 0.15) $\times \Delta_t$.

The reduction of interference (Δ_{dt}) due to temperature difference is then expressed as follows :

$$\Delta_{dt} = (0.10 \sim 0.15)\,\Delta_t \cdot \alpha \cdot d \fallingdotseq 0.001\,5\,\Delta_t \cdot d \times 10^{-3} \quad \cdots\cdots (6.5)$$

where :

Δ_{dt}	: reduction of interference due to temperature difference	mm
Δ_t	: temperature difference between the inside of the bearing and the surrounding housing	°C
α	: linear expansion coefficient of bearing steel ($\fallingdotseq 12.5 \times 10^{-6}$)	1/°C
d	: nominal bore diameter of bearing	mm

(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 6.2**.

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 6.2**, should be less than 120 MPa.

Table 6.2 cannot be used for the drawn cup needle roller bearings.

6.2 Recommended Fits

For recommended fits for needle roller bearings, refer to the paragraph mentioned before the specification table classified by types.

Table 6.2 Maximum fitting-generated stress in bearings

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

where :

σ	: maximum stress	MPa	D_e	: raceway contact diameter of outer ring roller bearing ··· $D_e \fallingdotseq 0.25\,(3D + d)$	mm
d	: nominal bore diameter (shaft diameter)	mm	D	: nominal outside diameter (bore diameter of housing)	mm
D_i	: raceway contact diameter of inner ring roller bearing ··· $D_i \fallingdotseq 0.25\,(D + 3d)$	mm	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.

7 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 7.1**.

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 71.

The radial internal clearances of machined ring needle roller bearings before mounting are shown in **Table 8** in page 121.

Table 7.1 Operating clearance

Operating clearance (S)	$S = S_o - (S_f + S_{t1} + S_{t2}) + S_w$*	* S_w (increase of clearance due to load) is generally small, and thus may be ignored, although there is a equation for determining the value.
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 solid shaft)** $S_{fi} = \Delta_{deff} \frac{d}{D_i}$	**(In the case of $D_h \neq \infty$)** $S_{fo} = \Delta_{Deff} \frac{D_e}{D} \cdot \frac{\left(1 - \frac{D^2}{{D_h}^2}\right)}{\left(1 - \frac{{D_e}^2}{{D_h}^2}\right)}$ **(In the case of $D_h = \infty$)** $S_{fo} = \Delta_{Deff} \frac{D_e}{D}$
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 : $S_{t1} = \alpha (D_i \cdot t_i - D_e \cdot t_e)$	where : $D_e = D_i + 2D_w$ Consequently, $S_{t1} + S_{t2}$ will be determined by the following equation : $S_{t1} + S_{t2} = \alpha \cdot D_i \cdot t_1 + 2\alpha \cdot D_w \cdot t_2$ Temperature differential between the inner and outer rings, t_1, can be expressed as follows : $t_1 = t_i - t_e$ Temperature differential between the rolling element and outer ring, t_2, can be expressed as follows : $t_2 = t_w - t_e$
Decrease of clearance due to temperature rise of rolling element (S_{t2})	$S_{t2} = 2\alpha \cdot D_w \cdot t_w$	

In **Table 7.1**,

S : operating clearance	mm	Δ_{Deff} : effective interference of outer ring	mm
S_o : 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 roller bearing ··· $D_e \fallingdotseq 0.25\ (3D + d)$	mm
S_{fi} : expansion of inner ring raceway contact diameter	mm	D : nominal outside diameter	mm
S_{fo} : contraction of outer ring raceway contact diameter	mm	α : linear expansion coefficient of bearing steel (12.5×10^{-6})	1/ºC
S_{t1} : decrease of clearance due to temperature differentials between inner and outer rings	mm	D_w : average diameter of rolling elements roller bearing ··· $D_w \fallingdotseq 0.25\ (D - d)$	mm
S_{t2} : decrease of clearance due to temperature rise of the rolling elements	mm	t_i : temperature rise of the inner ring	ºC
S_w : increase of clearance due to load	mm	t_e : temperature rise of the outer ring	ºC
Δ_{deff} : effective interference of inner ring	mm	t_w : temperature rise of rolling elements	ºC
d : nominal bore diameter (shaft diameter)	mm		
d_0 : bore diameter of hollow shaft	mm		
D_i : inner ring raceway contact diameter roller bearing ··· $D_i \fallingdotseq 0.25\ (D + 3d)$	mm		

■ 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.

8 Lubrication and sealing devices

8.1 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.

8.2 Lubricant

Bearing lubrication is classified broadly into two categories : grease lubrication and oil lubrication. **Table 8.1** makes a general comparison between the two.

Table 8.1 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

8.3 Grease lubrication

Generally, the bearing grease should be highly stable without containing impurities, free acid of free alkali.

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 8.2**.

Table 8.2 Characteristics of respective greases

	Lithium grease			Calcium grease (cup grease)	Sodium grease (fiber grease)	Complex base grease		Non-soap base grease		
Thickener	Lithium soap			Calcium soap	Sodium soap	Lithium complex soap	Calcium complex soap	Bentone	Urea compounds	Fluorine compounds
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 (℃)	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 (℃)	−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. Suitable for bearings for measuring instruments and extra-small ball bearings for small electric motors.	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. Used in bearings for rolling mills.	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 ℃.

(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 ºC by deadweight in 5 seconds. The softer the grease, the higher the figure.

Table 8.3 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 8.3 Grease consistency and service conditions

ASTM (JIS) penetration index (25 ºC, 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.

8.4 Replenishment/replacement of grease

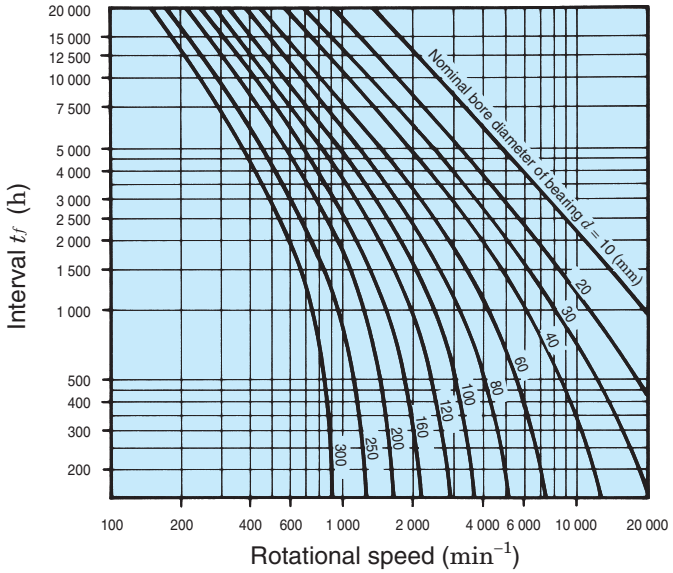
The method of replenishing/replacing grease depends largely on the lubrication method. Whichever method may be utilized, care should be taken to use clean grease and to keep dirt or other foreign matter out of the housing.

In addition, it is desirable to refill with grease of the same brand as that filled at the start.

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. 8.1**. It is recommended you use this diagram as a guide for replenishment and replacement of grease.



■ Temperature correction

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

$t_f' = t_f \cdot a$

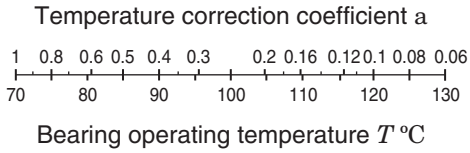


Fig. 8.1 Grease feeding interval

8.5 Oil lubrication

For bearing lubrication, oils with high mechanical and chemical stability are preferred. Therefore, high quality mineral oils are generally used. They are least likely to form heterogeneous mixtures or gummy compounds, or to be oxidized.

It is also important that the oil should be free from dirt or foreign material. In selecting lubricating oil, it is essential to select an oil with proper viscosity. Generally the oil should have a viscosity of 12 to 15 mm^2/s at the operating temperature of the bearing.

When the bearing is to be used in a wide range of temperatures, the oil should have a high viscosity index. For heavy or impact load, use oils with high film strength. For high speed applications, lower viscosity oils are desirable.

To aid you in the selection of lubricating oil, the relationship between viscosity and operating temperature is shown in **Fig. 8.2**.

Examples of lubricating oil selection for various operating conditions are shown in **Table 8.4**.

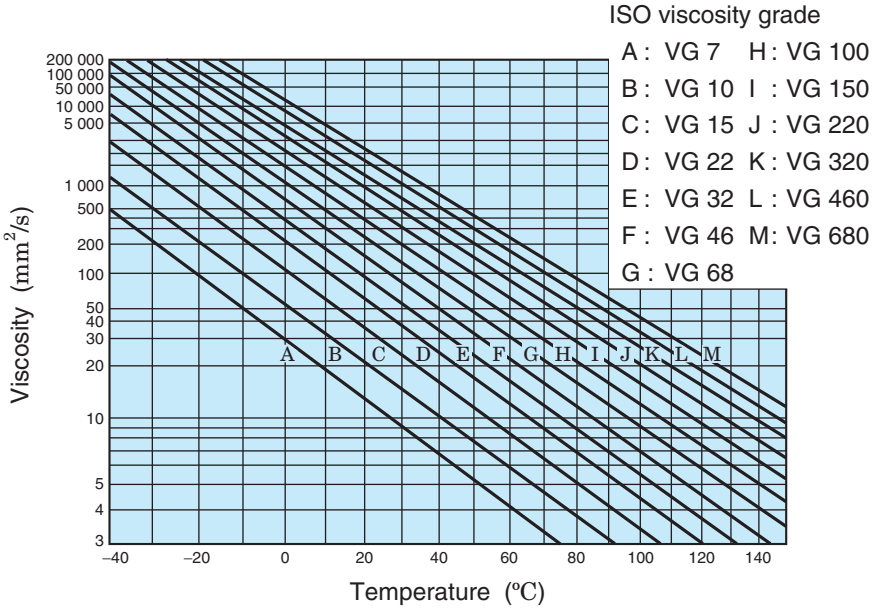


Fig. 8.2 Relationship between lubricating oil viscosity and temperature (viscosity index : 100)

Table 8.4 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 ℃	All rotation speeds	ISO VG 15, 22, 46 (Refrigerating machine oil)	—
0 to 60 ℃	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 ℃	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 ℃	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. $d_m n = \dfrac{D+d}{2} \times n$ ··· {D : nominal outside diameter (mm), d : nominal bore diameter (mm), n : rotational speed (min^{-1})}

2. Refer to refrigerating machine oil (JIS K 2211), turbine oil (JIS K 2213), gear oil (JIS K 2219), machine oil (JIS K 2238) and bearing oil (JIS K 2239).
3. Please contact with JTEKT if the bearing operating temperature is under –30 ℃ or over 150 ℃.

8.6 Oil lubrication method

Oil lubrication is usable even at high speed rotation and somewhat high temperature, and is effective in reducing bearing vibration and noise.

Thus oil lubrication is used in many cases where grease lubrication does not work.

The lubrication methods often used for needle roller bearings are shown in **Table 8.5**. Also available are oil jet lubrication and oil mist lubrication methods. However, because of a limitation on rotating speed for needle roller bearings, these are not usually employed.

Table 8.5 Oil lubrication methods

Method	Description	Remarks
Oil bath	This is the most popular method. The oil level is adjusted to the center of the lowest roller of the bearing. The oil level may vary depending on the operating speeds. A somewhat lower level is recommended for higher speeds. In the case of low speeds, there may not be a problem of over lubrication.	Used for low to medium rotating speeds.
Oil splash	Gears or simple flinger are attached to the shaft to feed the oil by splashing. When used on a gear device, it is advisable to use a shielded bearing or baffle to prevent the intrusion of metal particles from the gear, or contaminants, into the bearing.	Used for the gear box of machine tools and automotive transmissions, etc.
Oil drip	Oil is dripped by means of a visible oiler. The rate of oil supply is adjusted by a nob on top of the oiler. The oil which passed through the bearing should be drained before forming an excessive oil sump in the housing.	Used for relatively high speeds.
Forced oil circulation	The lubricating oil is circulated. An oil inlet is provided on one side of the housing, and an oil outlet on the other. The outlet should have a larger diameter than the inlet so as to prevent accumulation of excessive oil in the housing. In addition, the inlet is located in the lower half of housing so that the oil will not leak through the shaft. When the operating temperature is high, in addition to increasing the rate of oil flow, it is recommended to provide a cooling device somewhere : in the system for more efficient heat removal and extending lubricant life.	Widely used for bearings operated at high temperatures.

8.7 Sealing devices

Sealing devices not only prevent foreign matter (dirt, water, metal powder) from entering, but prevent lubricant inside from leaking. If the sealing device fails to function satisfactorily, foreign matter or leakage will cause bearing damage as a result of malfunction or seizure.

Therefore, it is necessary to design or choose the most suitable sealing devices as well as to choose the proper lubricating measures according to operating conditions.

Sealing devices may be divided into non-contact and contact types according to their structure.

They should satisfy the following conditions :

- Free from excessive friction (heat generation)
- Easy maintenance
  (especially ease of mounting and dismounting)
- As low cost as possible

(1) Non-contact type sealing devices

A non-contact type sealing device, which includes oil groove, flinger (slinger), and labyrinth, eliminates friction because it does not have a contact point with the shaft.

These devices utilize narrow clearance and centrifugal force and are especially suitable for operation at high rotation speed and high temperature.

Table 8.6 (1) Non-contact type sealing devices

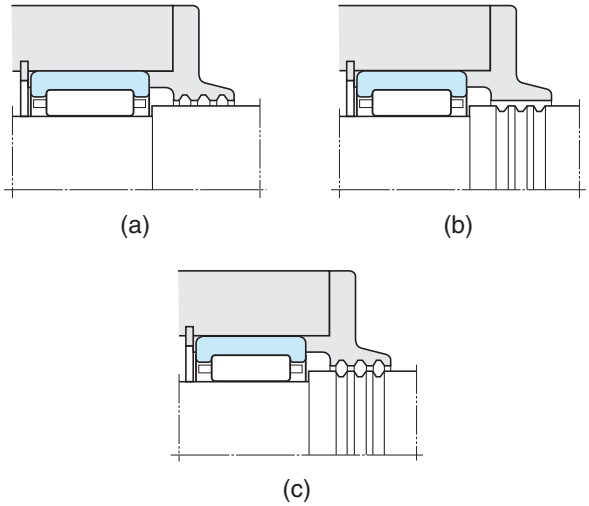
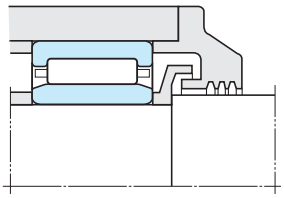
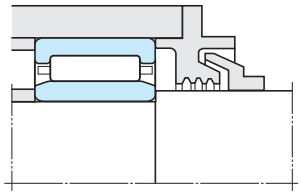
(1) Oil groove

■ This kind of seal having more than three grooves at the narrow clearance between the shaft and housing cover, is usually accompanied by other sealing devices except when it is used with grease lubrication at low rotation speed. ■ Preventing entrance of contaminants can be improved by filling the groove with calcium grease (cup grease) having a consistency of 150 to 200. ■ The clearance between the shaft and housing cover should be as narrow as possible. Recommended clearances are as follows. · Shaft diameter of less than 50 mm ····· 0.25 – 0.4 mm · Shaft diameter of over 50 mm ····· 0.5 – 1 mm ■ Recommended dimensions for the oil groove are as follows. · Width ····· 2 – 5 mm · Depth ····· 4 – 5 mm

Table 8.6 (2) Non-contact type sealing devices

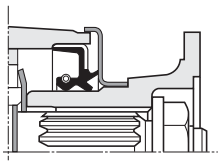
(2) Flinger (slinger)



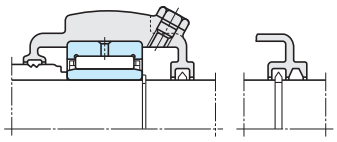
(d) Flinger attached inside



(e) Flinger attached outside



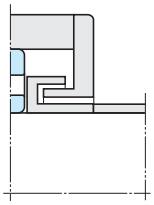
(f) Cover type flinger



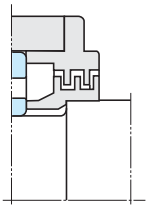
(g) Oil thrower

- A flinger utilizes centrifugal force to splash away the oil and dirt. It produces an air stream which prevents oil leakage and dirt by a pumping action. In many cases, this device is used together with other sealing devices.
- A flinger installed inside the housing (**Fig. d**) provides an inward pumping action, preventing lubricant leakage; and, when installed outside (**Fig. e**), the outward pumping action prevents infiltration of contaminants.
- A cover type flinger (**Fig. f**) splashes away dirt and dust by centrifugal force.
- The oil thrower, shown in (**Fig. g**), is a kind of flinger. An annular ridge on the shaft or a ring fitted onto the shaft utilizes centrifugal force to prevent the lubricant from flowing out.

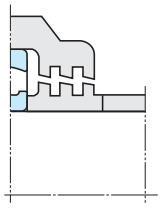
(3) Labyrinth



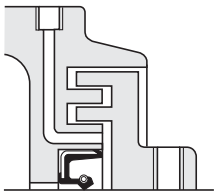
(h) Axial labyrinth



(i) Radial labyrinth



(j) Aligning labyrinth



(k) Axial labyrinth with greasing feature

- A labyrinth provides clearance in the shape of engagements between the shaft and housing.
  It is the most suitable for prevention of lubricant leakage at high rotation speed.
- Though an axial labyrinth, shown in (**Fig. h**), is popular because of its ease of mounting, the sealing effect is better in a radial labyrinth, shown in (**Fig. i**).
- An aligning labyrinth (**Fig. j**) is used with self-aligning type bearings.
- In the cases of (**Fig. i**) and (**Fig. j**), the housing or the housing cover should be split.
- Recommended labyrinth clearances are given in the following table.

Shaft diameter	Radial clearance	Axial clearance
50 mm or less	0.25 – 0.4 mm	1 – 2 mm
Over 50 mm	0.5 – 1 mm	3 – 5 mm

- To improve sealing effect, fill the labyrinth clearance with grease, shown in (**Fig. k**).

(2) Contact type sealing devices

This type provides a sealing effect by means of the contact of its end with the shaft and are manufactured from synthetic rubber, synthetic resin, or felt.

The synthetic rubber oil seal is most popular.

1) Oil seals

Many types and sizes of oil seals, as a finished part, have been standardized.

JTEKT produces various oil seals.

The names and functions of each oil seal part are shown in **Fig. 8.3** and **Table 8.7**. **Table 8.8** provides a representative example.

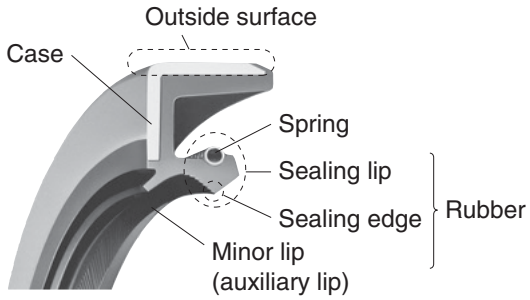


Fig. 8.3 Names of oil seal parts

Table 8.7 Complete list of oil seal part functions

Names	Functions
Sealing edge	Prevents fluid leakage by making contact with rotating shaft. (The contact surface of the sealing edge with the shaft should always filled with lubricant, so as to maintain an oil film therein.)
Sealing lip and spring	Provides proper pressure on the sealing edge to maintain stable contact. Spring provides proper pressure on the lip and maintains such pressure for a long time.
Outside surface	Fixes the oil seal to the housing and prevents fluid leakage through the fitting surface. (Comes encased in metal cased type or rubber covered type.)
Case	Strengthens seal.
Minor lip (auxiliary lip)	Prevents entry of contaminants. (In many cases, the space between the sealing lip and minor lip is filled with grease.)

Table 8.8 Typical oil seal types

With case		With inner case	Without case
Without spring	With spring		With spring
 HM (JIS GM) MH (JIS G)	 HMS (JIS SM) MHS (JIS S) CRS	 HMSH (JIS SA)	 MS
 HMA MHA	 HMSA (JIS DM) MHSA (JIS D) CRSA	 HMSAH (JIS DA)	—
● The oil seals shown in the lower row contain the minor lip (auxiliary lip). ● Special types of seals such as the mud resistance seal, pressure resistance seal and outer seal for rotating housings can be provided to serve under various operating conditions.			● By providing a slit on the oil seals, it is possible to attach them from other points than the shaft ends.

Oil seals without minor lips are mounted in different directions according to their operating conditions (shown in **Fig. 8.4**).

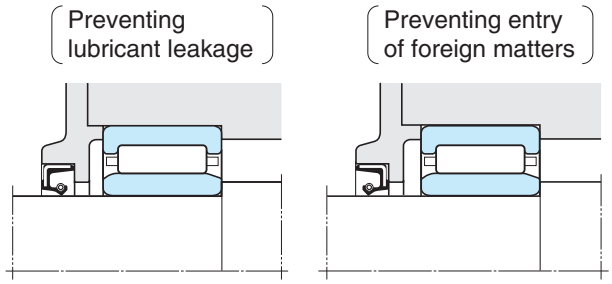


Fig. 8.4 Direction of sealing lips and their purpose

When the seal is used in a dirty operating environment, or penetration of water is expected, it is advisable to have two oil seals combined or to have the space between the two sealing lips be filled with grease. (shown in **Fig. 8.5**)

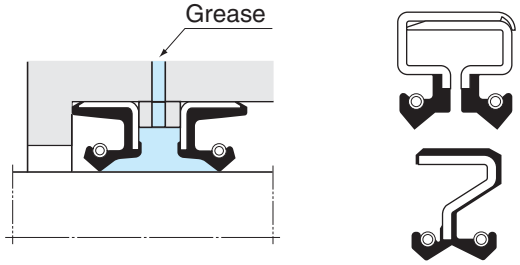


Fig. 8.5 Seals used in a dirty operating environment

Respective seal materials possess different properties. Accordingly, as shown in **Table 8.9**, allowable lip speed and operating temperature differ depending on the materials. Therefore, by selecting proper materials, oil seals can be used for sealing not only lubricants but also chemicals including alcohol, acids, alkali, etc.

Table 8.9 Allowable lip speed and operating temperature range of oil seals

Seal material	Allowable lip speed (m/s)	Operating temperature range (°C)
NBR	15	–40 to +120
Acrylic rubber	25	–30 to +150
Silicone rubber	32	–50 to +170
Fluoro rubber	32	–20 to +180

To ensure the maximum sealing effect of the oil seal, the shaft materials, surface roughness and hardness should be carefully chosen.

Table 8.10 shows the recommended shaft conditions.

Table 8.10 Recommended shaft conditions

Material	Machine structure steel, low alloy steel and stainless steel
Surface hardness	For low speed : harder than 30 HRC For high speed : harder than 50 HRC
Surface roughness (Ra)	0.2 – 0.6 a A surface which is excessively rough may cause oil leakage or abrasion; whereas an excessively fine surface may cause sealing lip seizure, preventing the oil film from forming. Surface must also be free of spiral grinding marks.

2) Felt seals and others

Although felt seals have been used conventionally, it is recommended to replace them with rubber oil seals because the use of felt seals are limited to the following conditions.

- Light dust protection
- Allowable lip speed : not higher than 5 m/s

Contact type sealing devices include mechanical seals, O-rings and packings other than those described herein.

JTEKT manufactures various oil seals ranging from those illustrated in **Table 8.8** to special seals for automobiles, large seals for rolling mills, mud resistance seals, pressure resistance seals, outer seals for rotating housings and O-rings.

For details, refer to JTEKT separate catalog "Oil seals & O-rings" (CAT. NO. R2001E).

9 Handling of bearings

9.1 General instructions

Since rolling bearings are more precisely made than other machine parts, careful handling is absolutely necessary.

- Keep bearings and the operating environment clean. Dirt, even if it is invisible, can affect the bearing. The utmost care should be used not to let any dirt into the bearing.
- Handle carefully. Bearings are precision ground and heat-treated to have wear-resisting hardness. Therefore, they can be cracked or brinelled if they are subjected to impacts or excessive forces due to rough handling, improper mounting or dismounting practice.
- Do not expose the bearing to high temperatures. Standard bearings can be tempered if they are heated to a temperature over 120 ℃, and reduction of hardness due to such tempering may shorten the bearing life.
- Handle using the proper tools. Do not use substitute jigs.
- Bearings should be handled by experienced or well trained operators.
- Keep bearings well protected from rust.
- Set bearing operation standards and follow them.
  - · Storage of bearings
  - · Cleaning of bearings and their adjoining parts
  - · Inspection of dimensions of adjoining parts and finish conditions
  - · Mounting
  - · Inspection after mounting
  - · Dismounting
  - · Maintenance and inspection (periodical inspection)
  - · Replenishment of lubricants

9.2 Bearing mounting

When mounting a bearing, never hammer the outer ring to mount the inner ring or vice versa. Otherwise, the raceway may be brinelled, causing failure on the bearing earlier than usual.

Mounting procedures depend on the type and fitting conditions of bearings. A general mounting method is described here. (For the drawn cup needle roller bearings, see page 71.)

1) Press fit

A mounting fixture is put in contact with the bearing ring (inner or outer ring) and the bearing is installed by used of a press. This is the most widely employed method. (**Fig. 9.1**)

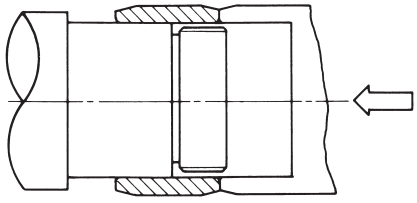


Fig. 9.1

2) Shrink fit

The inner ring is heated and expanded in oil to fit the inner ring onto the shaft.

In this case, it is important that oil temperature should not be higher than 100 ℃, because bearings heated at higher than 120 ℃ lose hardness. The heating temperature and expansion of inner ring are shown in **Fig. 9.2**.

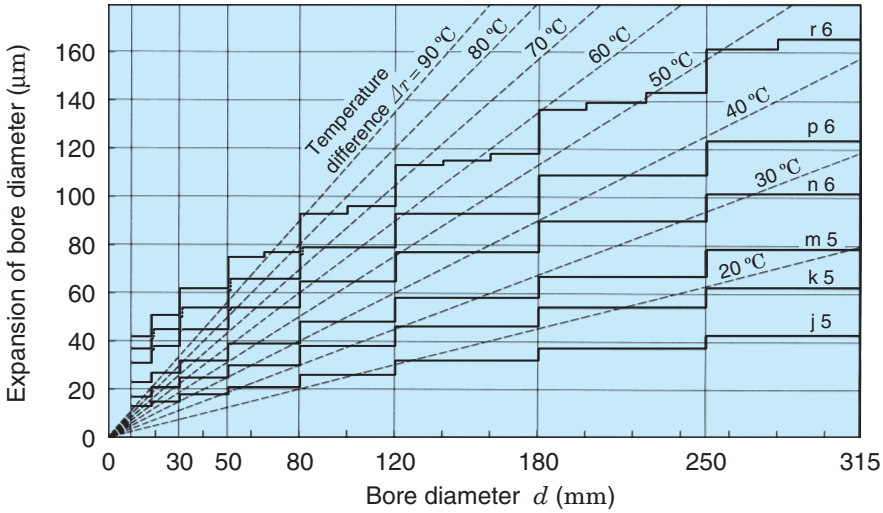


Fig. 9.2 Temperature difference and expansion of inner rings

[Note] Solid lines show the maximum interference value between bearings (class 0) and shafts (r 6, p 6, n 6, m 5, k 5, j 5) at normal temperature.
Therefore, the heating temperature should be selected to gain a larger "expansion of the bore diameter" than the maximum interference values.

9.3 Force is necessary to press fit and remove bearings

The force necessary to press fit the bearing onto the shaft or housing and remove it from them, differs depending on the finish of shafts and housings and how much interference the bearings allow.

Generally, the value can be obtained by using the equations shown in **Table 9.1**.

Table 9.1 Force necessary for press fit and removal

Shaft and inner ring	Housing bore and outer ring
(Hollow shafts)	**($D_h \neq \infty$)**
$K_a = 9.8\, f_k \cdot \Delta_{deff} \cdot B \cdot \dfrac{\left(1-\dfrac{d^2}{D_i{}^2}\right)\left(1-\dfrac{d_0{}^2}{d^2}\right)}{\left(1-\dfrac{d_0{}^2}{D_i{}^2}\right)} \cdot 10^3$	$K_a = 9.8\, f_k \cdot \Delta_{Deff} \cdot B \cdot \dfrac{\left(1-\dfrac{D_e{}^2}{D^2}\right)\left(1-\dfrac{D^2}{D_h{}^2}\right)}{\left(1-\dfrac{D_e{}^2}{D_h{}^2}\right)} \cdot 10^3$
(Solid shafts)	**($D_h = \infty$)**
$K_a = 9.8\, f_k \cdot \Delta_{deff} \cdot B \cdot \left(1-\dfrac{d^2}{D_i{}^2}\right) \cdot 10^3$	$K_a = 9.8\, f_k \cdot \Delta_{Deff} \cdot B \cdot \left(1-\dfrac{D_e{}^2}{D^2}\right) \cdot 10^3$

where :

K_a : force necessary for press fit or removal N

f_k : resistance coefficient (Coefficient taking into consideration friction between shafts and inner rings
··· Press fit : $f_k = 4$, Removing : $f_k = 6$)

B : nominal inner ring width	mm		
Δ_{deff} : effective interference of inner ring	mm	Δ_{Deff} : effective interference of outer ring	mm
d : nominal inner ring bore diameter (shaft dia.)	mm	D : nominal outside diameter (housing bore diameter)	mm
D_i : raceway contact diameter of inner ring	mm	D_e : raceway contact diameter of outer ring	mm
d_o : hollow shaft bore diameter	mm	D_h : outside diameter of housing	mm

9.4 Test run

A trial operation is conducted to insure that the bearings are properly mounted.

In the case of compact machines, rotation may be checked by manual operation at first, followed by power operation. Large equipment may be driven from the beginning using a power source.

Idle running is performed by turning off the power source immediately after turning it on. It must be confirmed that bearings rotate smoothly without any abnormal vibration and noise, then power operation should be restarted under no load and at low speed, then the speed is gradually increased until the designed speed is reached. If any of the abnormalities are found, operation must be stopped, and inspection for defects immediately conducted.

The bearings should be dismounted, washed, checked, and remounted if necessary.

General notes are as shown below.

- The bearing unit can smoothly rotate or sealing device is not too tight.
- The slinger or labyrinth does not interfere with other parts.
- If you have rugged feels with hands, dusts or foreign matters are caught in, or the raceway surface (rolling contact surface) have flaws.
- If the running torque is uneven, improper mounting may occur.
- In power rotation test, judge with sound and temperature increase.
  The use of an industrial stethoscope or a listening rods will facilitate the noise check.
  Clear metallic noise indicates the bearing being poorly lubricated. Irregular noise peaks often indicate the existence of foreign matter in the bearing.
  If the bearing temperature is found too high, it may be inadequately lubricated or improperly mounted.

9.5 Bearing dismounting

After dismounting bearings, handling of the bearings and the various methods available for this should be considered.

If the bearing is to be disposed of, any simple method such as torch cutting can be employed. If the bearing is to be reused or checked for the causes of its failure, the same amount of care as in mounting should be taken in dismounting so as not to damage the bearing and other parts.

Since bearings with interference fits are easily damaged during dismounting, measures to prevent damage during dismounting must be incorporated into the design.

An example of dismounting methods intended for reuse or for failure analysis is described here.

It is useful for discovering the causes of failures when the conditions of bearings, including mounting direction and location, are recorded prior to dismounting.

The bearing can be removed most easily by the use of a puller (**Fig. 9.3**) or a press (**Fig. 9.4**).

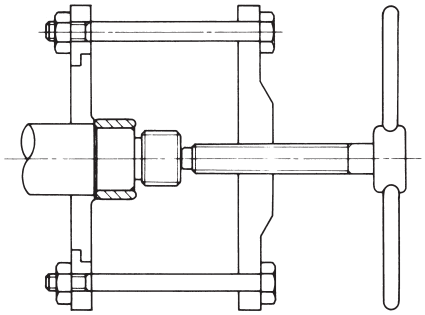


Fig. 9.3 Special tools

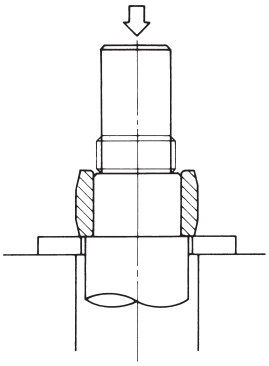
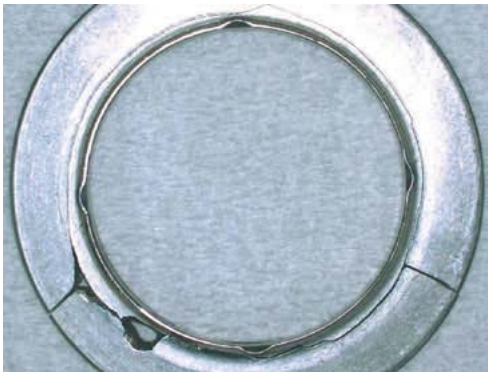


Fig. 9.4 Dismounting of inner ring by use of a press

9.6 Cleaning

To clean needle roller bearings, neutral water-free light oil or kerosene is used to clean bearings, a warm alkali solution can also be used if necessary. A dirty bearing should be cleaned using two cleaning processes, such as rough cleaning and finish cleaning. In the rough cleaning, the bearing is moved forcefully in the washing oil. Do not rotate the bearing from the beginning because foreign matter will abrade the raceway while rotating. Filtering is important so that the washing oil will remain clean at all times. Apply anti-corrosion oil or rust preventive grease on bearings immediately after cleaning.

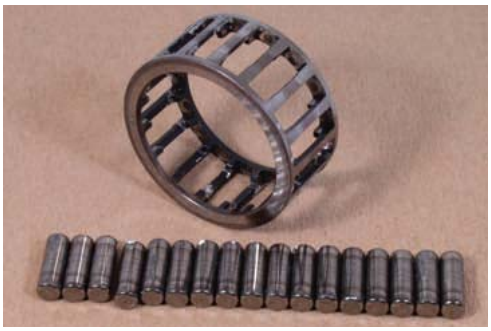
10 Examples of bearing failures

Failures	Characteristics	
(1) Flaking	  	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 such a case. [Reference] 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. [Reference] Peeling (shown in middle figure) Peeling is a phenomenon that extra surface area (0.02 mm or less) of rolling surfaces is fatigued and peeled due to concentrated stress acting on microscopic peaks of surface roughness.
(2) Cracking Chipping	 	Cracking is mainly triggered by defected areas due to wear of other materials, 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.

	Damages	Causes	Countermeasures
	Flaking occurring at an incipient stage	· Too small internal clearance · Improper or insufficient lubricant · Too much load · Rust	· Provide proper internal clearance. · Select proper lubricating method or lubricant.
	Symmetrical flaking along circumference of raceway	· Inaccurate housing roundness	· 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	· Improper mounting · Shaft deflection · Inaccuracy of the shaft and housing	· Correct centering. · Correct squareness of shaft or housing shoulder.
	Flaking on the raceway surface at the same interval as rolling element spacing	· Heavy impact load during mounting · A flaw caused during mounting · Rust generated while out of operation	· Improve mounting procedure. · Provide rust prevention treatment before long cessation of operation.
	Cracking in outer ring, inner ring or race	· Excessive interference · Excessive fillet on shaft or housing · Heavy impact load · Advanced flaking or seizure · Impact on race during mounting	· 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	· Heavy impact load · Advanced flaking	· Improve mounting and handling procedures. · Re-examine load conditions.

Failures	Characteristics	
(3) Brinelling Nicks	· 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	 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. Wear is not directly related to material fatigue. Wear caused by foreign matter and corrosion can affect not only sliding surfaces but rolling surfaces.	
(5) Fretting	  Fretting occurs to bearings which are subject to vibration while in stationary condition or which are exposed to minute vibration. It is characterized by rust-colored wear particles. Since fretting on the raceways often appears similar to brinelling, it is sometimes called “falsebrinelling”.	
(6) Creeping	Creeping is a phenomenon in which bearing rings move relative to the shaft or housing during operation.	

	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 matters · 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.

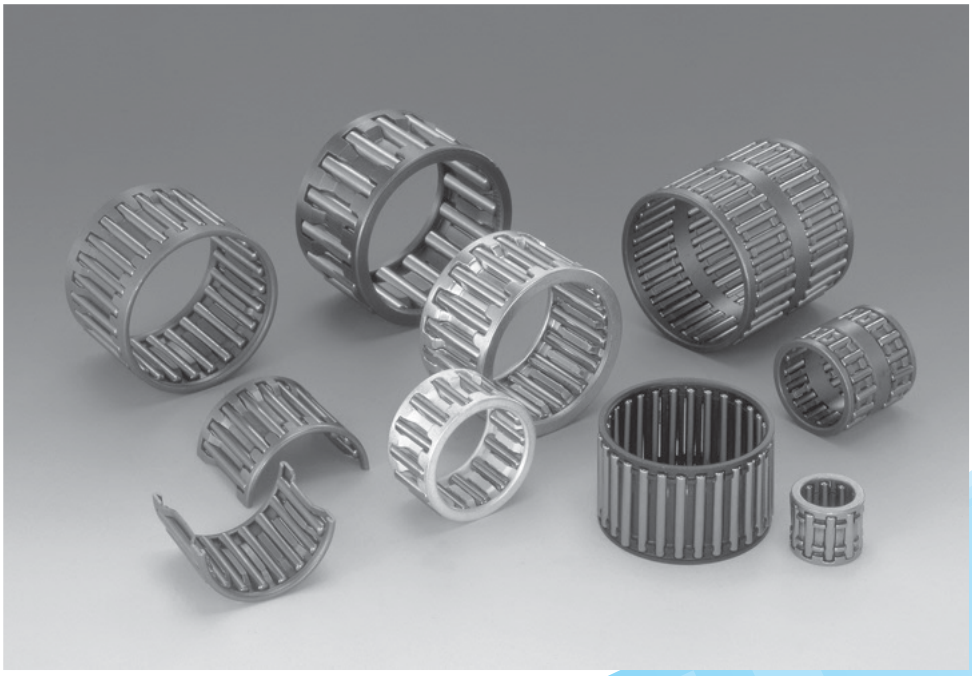
Failures	Characteristics	
(7) Damage to Cages	 	Since cages are made of low hardness materials, external pressure and contact with other parts can easily produce flaws and distortion. In some cases, these are aggravated and become chipping and cracks. Large chipping and cracks are often accompanied by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

	Damages	Causes	Countermeasures
	Flaws, distortion, chipping, cracking and excessive wear in cages.	· Extraordinary vibration, impact, moment · Improper or insufficient lubricant · Dents made during mounting	· Re-examine load conditions. · Select proper lubricating method or lubricant. · Re-examine cage types. · Improve mounting.
	Discoloration, distortion, and melting together due to heating in bearings	· Too small internal clearance · Improper or insufficient lubricant · Excessive load · Aggravated by other bearing flaws	· Provide proper internal clearance. · Select proper lubricating method or lubricant. · Re-examine bearing type. · Earlier discovery of bearing flaws

Specification tables of needle roller bearings

Koyo®

Needle roller and cage assemblies



NEEDLE ROLLER BEARINGS

Needle roller and cage assemblies

The Koyo needle roller and cage assemblies have a cage which is specially designed to retain and to guide rollers accurately.

After heat treatment, the roller, made of high carbon chromium bearing steel, is ground and crowned.

■ Inner and outer rings are not needed.

When the shaft and housing are highly accurate and hard enough to serve as the bearing raceway, inner and outer rings are not required so that the structure around the bearing can be simplified.

1 Bearing number

(Ex. 1)

R 8 / 13

- 13 — Cage width (13 mm)
- 8 — Roller set bore diameter (8 mm)
- R — Bearing type code (refer to **Table 2**)

(Ex. 2)

25 R 30 12

- 12 — Cage width (12 mm)
- 30 — Roller set outside diameter (30 mm)
- R — Bearing type code (refer to **Table 2**)
- 25 — Roller set bore diameter (25 mm)

(Ex. 3)

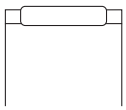
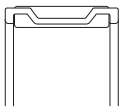
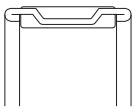
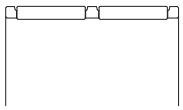
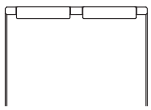
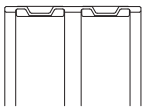
R FN U 16 / 17

- 17 — Cage width (17 mm)
- 16 — Roller set bore diameter (16 mm)
- FN — Special cage code (refer to **Table 1**)
- R — Bearing type code (refer to **Table 2**)

Table 1 Special cage code

Code	Description
F, FN	With polyamide cage
U	With double split cage

Table 2 Type code of needle roller and cage assemblies

Type	Single-row			Double-row		
						
Type code	RS, R, RP	RV, V, VS	VP, VPS	WR, WRS	WRP	WV

[Note] 1) Concerning the needle roller and cage assembly used for connecting rods, refer to page 60.

2 Tolerances

The tolerances of needle roller used for the Koyo needle roller and cage assembly are as specified in JIS B 1506. (refer to page 177)

Table 3 shows the tolerances of cage width (B_c) to the standard item (conform to JIS B 1536-3).

Table 3 Tolerance of cage width B_c

Bearing type	Cage width deviation Δ_{Bcs}	
	upper	lower
RS, R, RP (Welded type), RV, V, VS, WR, WRS, WRP, WV	−0.2	−0.55
VP, VPS, RP	*−0.2*	*−0.7*

[Remark] Values in Italics are prescribed in JTEKT standards.

3 Shaft and housing

The needle roller and cage assmbly generally uses the shaft and housing as the raceway ring; and therefore they are required to satisfy the specifications shown in **Table 4**.

In addition, the dimensional tolerance of the guide width (b) of Koyo needle roller and cage assembly is recommended to $b = B_c{}^{+0.2}_{0}$ in relation to cage width (B_c). (refer to **Fig. 1**)

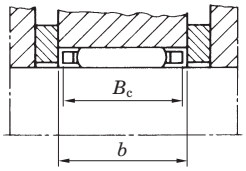


Fig. 1

Table 4 Specifications of shafts and housings

	Shaft (Raceway surface)	Housing bore (Raceway surface)
Roundness	Best if less than one half or one third of the shaft diameter (housing bore diameter) tolerance	
Cylindricity	5 μm or less per 25 mm, or one half or less of the shaft diameter (housing bore diameter) tolerance	
Roughness (Ra)	0.4 a or less	0.6 a or less
Hardness[1)]	58 HRC or harder (60 to 64 HRC are best.)	
Shaft Slope	13 μm or less per 25 mm	

[Note] 1) Case hardened steel which is carburized or induction-hardened should not only meet the surface hardness requirement specified above but also have a case depth of 52.3 HRC (550 HV) to a depth in the range (0.08 to 0.1) × D_w mm. (D_w : roller diameter) In general, 30 thru 45 HRC is best for the center hardness.

4 Fits

The recommended fits of the Koyo needle roller and cage assmbly are shown in **Table 5**.

Table 5 Recommended fit

Conditions	Tolerance class		
	Shaft		Housing bore
	$F_w \leqq 50$ mm	$F_w > 50$ mm	
High accuracy, impact load, oscillating motion	js5	h5	G6
General	h5	g5	
High temperature, large shaft deflection, large misalignment	f6		

5 Inspection

Radial needle roller and cage assemblies should be inspected in accordance with the procedures specified in JIS B 1515-2. **Table 6** shows the inspecting gauge specifications specified in JIS B 1536-3.

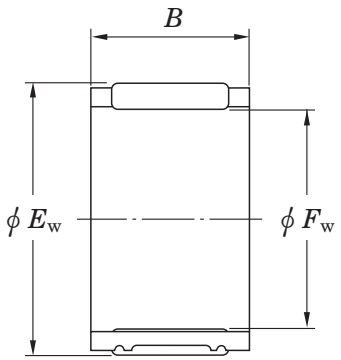
Table 6 Inspecting gauge specifications

Unit : mm

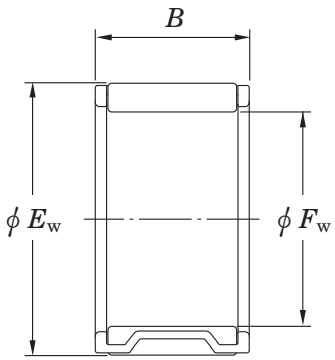
E_w		Inspecting gauge specifications	
over	up to	Plug gauge specifications for roller set bore diameter	Ring gauge specifications for roller set outside diameter
—	**6**	Same as F_w	$E_w + 0.004$
6	**10**		$E_w + 0.005$
10	**18**		$E_w + 0.006$
18	**30**		$E_w + 0.007$
30	**50**		$E_w + 0.009$
50	**80**		$E_w + 0.010$
80	**120**		$E_w + 0.012$

[Note] 1) In the ring gauge specifications for roller set outside diameter, values added to E_w are the same as the lower tolerances of G6 tolerance class of JIS B 0401-2.

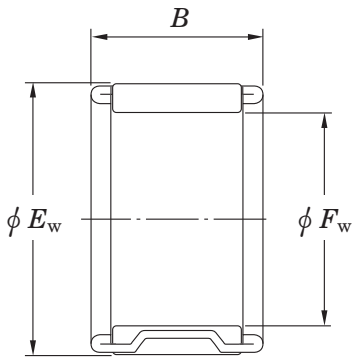
Single-row
F_w 9 ~ (15) mm



RS, R, RP



RV, V, VS



VP, VPS

Boundary dimensions (mm)			Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No.	Specification (Cage)	(Refer.) Mass (g)
F_w	E_w	B	C_r	C_{0r}	Oil lub.			
9	12	10	3.8	4.0	43 000	**RS091210**	—	2.9
	14	18	9.1	9.0	41 000	**RF091418**	Polyamide	5.3
10	13	13	5.8	7.0	41 000	**R10/13**	—	4.0
	13	20	5.0	5.8	41 000	**RF101320**	Polyamide	2.4
	14	8	4.5	4.3	40 000	**RS10/8-1**	—	3.5
	14	10	5.1	5.0	40 000	**RS10/10**	—	4.3
	14	13	7.0	7.4	40 000	**RS10/13**	—	5.5
	15	18	10.5	10.9	37 000	**RP101518**	Welded	7.8
12	15	13	6.3	8.2	36 000	**R12/13**	—	4.7
	16	20	9.5	11.5	35 000	**12R1620A**	—	10
	17	11.5	8.2	8.3	34 000	**RV121712A-2**	—	6.6
13	17	10	5.9	6.4	33 000	**RS131710-2**	—	5.5
	17	12	7.3	8.4	33 000	**RS131712**	—	6.5
	18	15	10.2	11.2	32 000	**13R1815**	—	10
14	18	10	5.8	6.5	31 000	**RS141810Q2**	—	6.0
	18	15	9.6	12.3	31 000	**RS141815**	—	8.5
	18	17	10.1	13.2	31 000	**R14/17A**	—	10
	19	9	7.0	7.1	30 000	**RV141909P1**	—	5.7
	19	18	12.3	14.6	30 000	**RS141918**	—	13
15	19	7.8	4.7	5.0	29 000	**RS151908A**	—	5.0
	19	10	6.3	7.2	29 000	**R15/10-1**	—	6.1
	19	13	8.7	10.9	29 000	**R15/13**	—	7.9
	19	17	10.5	14.0	29 000	**R15/17**	—	10
	19	20	12.6	17.7	29 000	**R15/20**	—	12
	20	13	10.4	11.9	29 000	**VS15/13**	—	8.6
	20	18	13.8	17.2	29 000	**RS15/18A**	—	14
	20	20	16.2	21.2	29 000	**VS15/20**	—	12

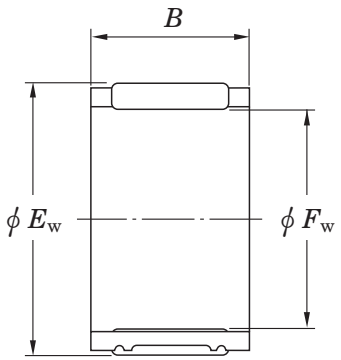
[Note] 1) For further information, consult with JTEKT.
[Remark] Limiting speed of grease lubrication should be kept to under 60 % of that for oil lubrication.

F_w (15) ~ (20) mm

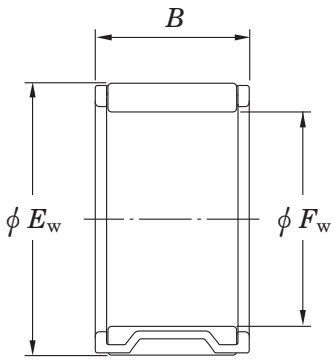
ϕE_w : Roller set outside diameter
ϕF_w : Roller set bore diameter

Boundary dimensions (mm)			Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No.	Specification (Cage)	(Refer.) Mass (g)
F_w	E_w	B	C_r	C_{0r}	Oil lub.			
15	21	9	7.4	6.9	28 000	**RV152109-4**	—	7.8
	21	17	13.4	14.8	28 000	**RS152117**	—	16
16	20	13	9.4	12.5	28 000	**R16/13**	Width tolerance special [1)]	8.5
	21	26	19.9	28.0	27 000	**16VP2126**	Width tolerance special [1)]	16
	22	12	9.6	9.6	26 000	**16VS2212-2**	—	11
	22	24	20.4	25.6	26 000	**RS16/24**	Width tolerance special [1)]	23
	22	28.4	21.7	27.9	26 000	**VPS16/28A**	—	24
17	20	6	3.1	3.6	27 000	**RF172006**	With single split polyamide	1.3
	20	8	3.8	4.7	27 000	**RF172008A-2**	With single split polyamide	1.7
	21	10	6.8	8.3	26 000	**R17/10**	—	6.8
	21	13	9.4	12.6	26 000	**R17/13**	—	8.8
	21	15	10.7	15.0	26 000	**R17/15**	—	10
	21	17	11.3	16.1	26 000	**RS172117**	—	11
	22	20	15.2	20.2	26 000	**17R2220**	—	17
	23	13	11.4	12.4	25 000	**RS17/13**	—	14
18	22	13	9.5	13.1	25 000	**R18/13**	—	9.2
	22	16	11.1	16.0	25 000	**R18/16-8**	—	11
	22	17	11.9	17.4	25 000	**R18/17**	—	12
	24	17	15.1	17.9	24 000	**RS182417**	Width tolerance special [1)]	19
	25	17	17.8	20.1	23 000	**RP182517**	Welded	19
	26	21.9	19.1	20.3	23 000	**RF182622A-1**	Polyamide	19
	26	21.9	22.7	25.5	23 000	**RV182622A-2**	—	31
19	24	22	16.6	23.3	23 000	**RS192422**	—	21
20	24	10	7.2	9.4	23 000	**R20/10**	—	7.9
	24	13	9.8	14.0	23 000	**R20/13P**	—	10
	25	25	18.8	27.9	22 000	**RF202525**	Polyamide	14

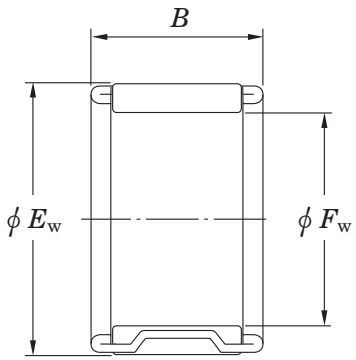
Single-row
F_w (20) ~ (22) mm



RS, R, RP



RV, V, VS



VP, VPS

Boundary dimensions (mm)			Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No.	Specification (Cage)	(Refer.) Mass (g)
F_w	E_w	B	C_r	C_{0r}	Oil lub.			
20	26	11.6	10.7	11.9	22 000	**20VS2612**	Width tolerance special [1]	12
	26	12	12.8	15.1	22 000	**RV202612-4**	—	14
	26	14	14.1	17.0	22 000	**VS20/14A**	—	15
	26	17	15.8	19.6	22 000	**RS20/17**	—	21
	26	18.8	17.4	22.3	22 000	**RP202619A**	—	17
	26	20	18.9	24.7	22 000	**VP20/20-1**	Width tolerance special [1]	19
	26	30	26.8	38.9	22 000	**RS202630**	Welded	39
	27	15	16.2	18.3	21 000	**20V2715**	—	19
	27	29	25.4	32.6	21 000	**20V2729**	—	37
	28	20	24.1	28.2	21 000	**RP202820**	—	28
	28	25	28.8	35.4	21 000	**20V2825B**	—	37
	30	15	18.2	17.1	20 000	**RV203015**	—	30
21	29	22.5	23.7	27.6	20 000	**RF212923A**	Polyamide	24
22	26	12	9.6	14.1	21 000	**RS222612**	—	10
	26	13	10.4	15.6	21 000	**R22/13-1**	—	11
	26	17	13.0	20.7	21 000	**R22/17**	—	14
	27	20	17.0	25.2	20 000	**RS222720**	—	21
	28	11	9.5	10.5	20 000	**RS222811**	—	15
	28	14	13.2	15.9	20 000	**22VS2814E**	—	16
	28	17	16.1	20.7	20 000	**RS22/17**	—	22
	28	22.5	21.3	29.6	20 000	**RP222823A**	Welded, Width tolerance special [1]	25
	28	23	24.2	35.1	20 000	**VS22/23B**	Width tolerance special [1]	25
	29	17	17.0	20.0	20 000	**RV222917**	—	23
	30	15	16.7	17.9	19 000	**RV223015**	—	25
	30	18	21.8	25.2	19 000	**RV223018**	—	30
	30	20	24.1	28.8	19 000	**RV223020-1**	—	31
	32	15	21.1	21.3	19 000	**RV223215**	—	32
	32	16	21.1	21.3	19 000	**RV223216**	—	35

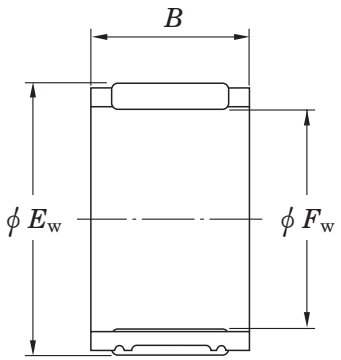
[Note] 1) For further information, consult with JTEKT.
[Remark] Limiting speed of grease lubrication should be kept to under 60 % of that for oil lubrication.

F_w (22) ~ (25) mm

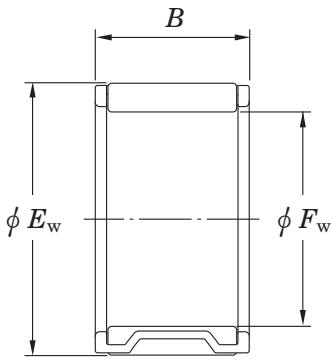
ϕE_w : Roller set outside diameter
ϕF_w : Roller set bore diameter

Boundary dimensions (mm)			Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No.	Specification (Cage)	(Refer.) Mass (g)
F_w	E_w	B	C_r	C_{0r}	Oil lub.			
22	32	30	40.4	48.9	19 000	**RV223230**	—	62
23	29	30	26.0	39.0	19 000	**23V2930**	Width tolerance special [1]	35
	30	15	17.4	21.0	19 000	**RV233015**	—	21
	33	20	27.0	29.4	18 000	**23V3320-1**	Width tolerance special [1]	44
24	28	13	11.1	17.4	19 000	**RS242813**	—	12
	28	17	13.7	22.8	19 000	**R24/17A**	—	16
	28	23	18.2	32.9	19 000	**RS242823**	—	21
	32	15	20.0	23.2	18 000	**RV243215-4**	—	27
25	29	9.9	7.1	9.8	19 000	**R25/10A**	Width tolerance special [1]	10
	29	13	11.5	18.4	19 000	**R25/13-1**	—	13
	30	9.9	9.3	12.0	18 000	**25R3010A**	Width tolerance special [1]	13
	30	12	10.5	14.1	18 000	**25R3012**	—	15
	30	17	15.7	23.6	18 000	**25V3017**	—	18
	30	20	19.0	30.1	18 000	**25R3020-1**	—	24
	30	20	16.6	25.3	18 000	**25VPU3020B**	Double split	16
	31	17.5	17.4	23.8	18 000	**VPS25/18**	—	18
	31	18	17.4	23.8	18 000	**RS25/18**	—	27
	31	20	21.0	30.5	18 000	**VS25/20**	Width tolerance special [1]	26
	31	24	24.9	37.8	18 000	**25R3124**	—	35
	32	16	18.9	23.8	18 000	**25V3216**	—	25
	32	24	26.4	36.7	18 000	**RS253224**	—	43
	32	32	37.8	58.4	18 000	**RPU253232F-1**	Double split	51
	32	32	39.6	62.0	18 000	**RV253232**	—	49
	33	20	24.1	29.8	17 000	**RV253320**	—	35
	33	23.8	30.2	40.0	17 000	**25R3324B-1**	Width tolerance special [1]	48
	33	30	38.6	54.8	17 000	**RF253330**	Polyamide	41
	35	25	32.5	38.0	17 000	**25R3525**	—	65
	35	30	39.6	49.0	17 000	**25V3530A**	—	69

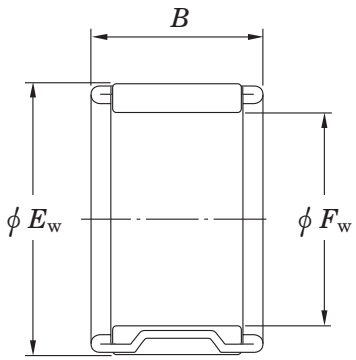
Single-row
F_w (25) ~ (30) mm



RS, R, RP



RV, V, VS



VP, VPS

Boundary dimensions (mm)			Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No.	Specification (Cage)	(Refer.) Mass (g)
F_w	E_w	B	C_r	C_{0r}	Oil lub.			
25	37	24	34.1	36.2	16 000	**25V3724**	—	69
	37	25	38.3	42.2	16 000	**25V3725A**	—	77
	37	33	47.5	55.7	16 000	**RV253733**	—	96
26	30	20	16.9	30.6	18 000	**RS263020**	—	20
	30	21.9	16.9	30.4	18 000	**RS263022A**	—	22
	31	16	15.7	23.8	18 000	**RS263116**	—	20
	31	19	18.5	29.5	18 000	**RS263119**	—	24
	33	34	30.4	44.0	17 000	**RPU263334F**	Double split	42
	34	17	23.9	30.0	17 000	**RV263417**	—	32
27	32	27	26.2	46.6	17 000	**RFN27/27**	Polyamide, Width tolerance special [1]	20
	33	28.6	30.0	49.2	17 000	**VPSU27/29AF**	Double split	33
28	32	26	17.1	31.5	17 000	**28R3226**	—	27
	32	29	17.1	31.5	17 000	**28R3229**	—	32
	33	17	17.9	29.0	16 000	**28R3317**	—	22
	33	23	22.8	39.6	16 000	**R28/23A**	—	31
	33	27	25.0	44.5	16 000	**R28/27**	—	36
	36	20	23.2	29.3	16 000	**28R3620**	—	45
	38	24	31.2	37.1	15 000	**RS283824**	—	70
	40	28	49.1	59.5	15 000	**RV284028**	—	90
	41	25	40.2	43.6	14 000	**RV284125**	—	86
	42	50.5	88.9	116.5	14 000	**RF284251A**	Polyamide	182
29	34	22	17.3	27.6	16 000	**R29/22A**	—	30
	34	24.4	19.7	32.8	16 000	**RFU293424A**	With double split polyamide	17
	34	27	25.7	46.7	16 000	**29R3427A-1**	—	37
	43	43	73.7	92.2	14 000	**RV294343**	—	177
30	34	14	7.7	11.4	16 000	**30R3414A**	—	16
	34	14	7.7	11.5	16 000	**RFN303414**	Polyamide	6.1

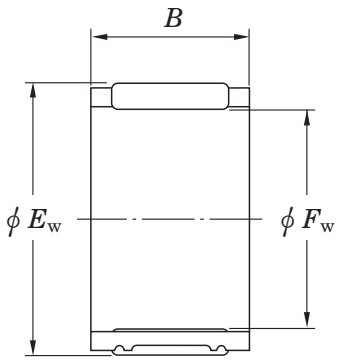
[Note] 1) For further information, consult with JTEKT.
[Remark] Limiting speed of grease lubrication should be kept to under 60 % of that for oil lubrication.

F_w (30) ~ (32) mm

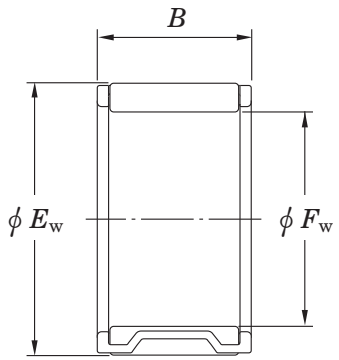
ϕE_w : Roller set outside diameter
ϕF_w : Roller set bore diameter

Boundary dimensions (mm)			Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No.	Specification (Cage)	(Refer.) Mass (g)
F_w	E_w	B	C_r	C_{0r}	Oil lub.			
30	34	29	18.1	34.8	16 000	**30R3429**	—	34
	34	29	20.4	40.8	16 000	**RSU303429**	Double split	33
	35	17	17.7	29.2	15 000	**R30/17-1**	—	24
	35	21.1	22.2	39.0	15 000	**RS303521A**	—	30
	35	24	24.9	45.1	15 000	**RS303524**	—	34
	37	16	21.8	30.3	15 000	**RV303716**	—	29
	37	20	25.2	36.6	15 000	**RS30/20A**	—	41
	37	26	34.7	55.3	15 000	**RV303726**	—	47
	38	22.1	27.7	37.5	15 000	**RP303822A**	Welded	45
	38	28.3	33.5	47.8	15 000	**RPU303828AF**	Double split	47
	39	27	34.2	45.6	14 000	**RP303927**	—	51
	39	30	38.3	52.8	14 000	**30VP3930A**	Width tolerance special [1)]	58
	39	32	42.6	60.5	14 000	**RP303932**	Welded, Width tolerance special [1)]	63
	40	15.5	26.7	31.1	14 000	**RV304016A-4**	—	46
	40	20	32.0	39.1	14 000	**30V4020**	—	55
	42	15	27.0	28.0	14 000	**RF304215**	Polyamide	36
	42	25	44.0	52.3	14 000	**RV304225**	—	84
	42	32	52.7	66.0	14 000	**30V4232**	Width tolerance special [1)]	108
	45	30	54.4	60.2	13 000	**30V4530**	—	135
31	36	20.3	19.9	34.2	15 000	**RFU313620A-1**	With double split polyamide	17
32	36	15	10.8	18.3	15 000	**32R3615A**	—	19
	37	17	19.0	32.6	14 000	**R32/17-1**	—	26
	37	20	22.3	39.9	14 000	**R32/20**	—	30
	37	23.8	22.6	40.5	14 000	**RF323724A-1**	With single split polyamide	20
	37	26	26.2	49.0	14 000	**RF323726**	Polyamide, Width tolerance special [1)]	24
	37	29.5	31.1	61.2	14 000	**VP32/30A**	—	32
	38	20	24.9	40.6	14 000	**32VP3820A**	Welded	27
	38	26	27.3	45.6	14 000	**RP323826**	Width tolerance special [1)]	34

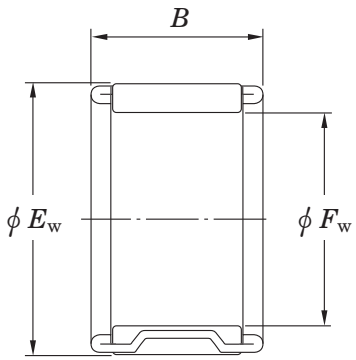
Single-row
F_w (32) ~ (35) mm



RS, R, RP



RV, V, VS



VP, VPS

Boundary dimensions (mm)			Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No.	Specification (Cage)	(Refer.) Mass (g)
F_w	E_w	B	C_r	C_{0r}	Oil lub.			
32	38	27	29.6	50.7	14 000	**32VP3827**	Width tolerance special [1)]	38
	39	16	21.2	29.8	14 000	**RS323916**	—	35
	42	16	27.5	32.9	14 000	**RV324216**	—	49
	42	20.5	33.5	42.2	14 000	**RV324221-1**	—	64
	45	28	47.9	56.5	13 000	**32V4528**	—	112
	46	18	37.0	38.8	13 000	**RF324618**	Polyamide	57
	46	18	30.3	29.8	13 000	**RV324618-1**	—	71
33	37	22	18.5	37.2	14 000	**RSU333722F**	Double split	27
34	39	20.3	19.6	34.4	14 000	**RFU343920A**	With double split polyamide	18
	42	38	49.2	81.9	13 000	**34R4238**	Width tolerance special [1)]	98
	44	40	64.1	99.1	13 000	**34VP4440-1**	—	101
35	39	25	22.0	47.4	14 000	**RF353925**	With single split polyamide	24
	40	13	14.2	23.0	13 000	**RS354013**	—	22
	40	17	18.4	32.0	13 000	**RS354017**	—	29
	40	22	23.6	44.4	13 000	**RS354022**	—	37
	40	24	25.9	49.9	13 000	**RS354024**	—	39
	40	24.8	23.7	44.4	13 000	**RSU354025AF**	Double split	39
	40	25	27.0	52.7	13 000	**RS354025-1**	—	41
	40	26	28.7	56.9	13 000	**RS354026**	—	41
	40	28	28.7	56.9	13 000	**RF354028**	Polyamide	27
	40	29	30.6	61.7	13 000	**RP354029-1**	Width tolerance special [1)]	33
	40	30	30.6	61.7	13 000	**VP35/30**	—	34
	40	31	30.6	61.6	13 000	**RP354031**	Welded, Width tolerance special [1)]	37
	40	33	31.1	63.2	13 000	**RP354033-1**	—	39
	40	35	31.8	64.9	13 000	**RF354035**	Polyamide	32
	41	35	40.4	78.0	13 000	**35VP4135A**	—	51
	41	40	42.4	82.6	13 000	**35VP4140A**	—	59

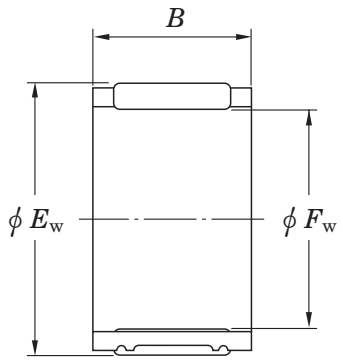
[Note] 1) For further information, consult with JTEKT.
[Remark] Limiting speed of grease lubrication should be kept to under 60 % of that for oil lubrication.

F_w (35) ~ (38) mm

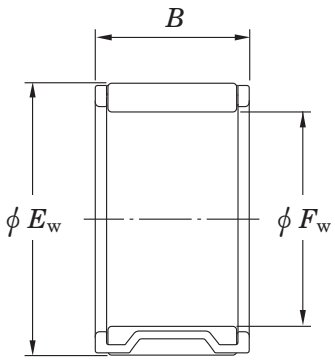
ϕE_w : Roller set outside diameter
ϕF_w : Roller set bore diameter

Boundary dimensions (mm)			Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No.	Specification (Cage)	(Refer.) Mass (g)
F_w	E_w	B	C_r	C_{0r}	Oil lub.			
35	42	20	27.2	42.0	13 000	**VS35/20**	—	42
	42	30	39.9	68.8	13 000	**VS35/30**	Width tolerance special [1)]	59
	48	17.5	37.8	42.7	12 000	**RV354818A-4**	—	81
	49	25	53.4	63.4	12 000	**RV354925-1**	—	120
36	40	10	9.6	16.5	13 000	**36R4010**	—	14
	41	20	21.7	40.3	13 000	**RS364120**	—	34
	41	25	29.9	60.6	13 000	**36RFN4125A**	Polyamide	27
	41	30.5	33.1	69.2	13 000	**R36/31**	—	51
	42	17	20.5	32.8	13 000	**RS364217-K**	—	35
	42	19	23.2	38.6	13 000	**RS364219-K**	—	39
	42	21	25.9	44.4	13 000	**RS364221-K**	—	44
	42	25	33.1	60.9	13 000	**RF364225-1**	Polyamide	34
	48	25	54.0	71.7	12 000	**RF364825-1**	Polyamide	80
	52	30	73.9	89.9	11 000	**RF365230**	Polyamide	139
37	42	11.6	11.3	17.5	13 000	**RS374212A**	—	23
	42	12.8	14.0	23.2	13 000	**VP37/13A**	Width tolerance special [1)]	14
	42	17.3	21.3	39.7	13 000	**VP37/17**	Width tolerance special [1)]	21
	42	22	24.0	46.3	13 000	**37R4222**	—	38
	42	23	23.8	45.5	13 000	**RF374223-1**	With single split polyamide	22
	42	27	30.8	63.6	13 000	**RS374227**	—	46
	42	27	30.0	61.5	13 000	**RSU374227**	Double split	45
	42	29	31.9	66.5	13 000	**VP37/29**	—	35
	42	31	33.9	72.1	13 000	**RS374231**	Welded	52
	42	32	31.2	64.3	13 000	**VP37/32**	—	37
	43	32	39.1	75.8	13 000	**37R4332**	—	66
	43	36.8	40.0	77.9	13 000	**RPU374337F**	Double split	60
38	42	10	8.9	15.2	13 000	**RF384210**	Polyamide	6.6

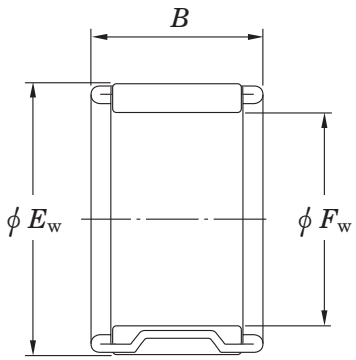
Single-row
F_w (38) ~ (42) mm



RS, R, RP



RV, V, VS



VP, VPS

Boundary dimensions (mm)			Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No.	Specification (Cage)	(Refer.) Mass (g)
F_w	E_w	B	C_r	C_{0r}	Oil lub.			
38	44	23.4	25.1	43.1	12 000	**RF384423A**	Polyamide	26
	44	24.5	27.5	48.4	12 000	**RSU384425AF**	Double split	51
	44	26	28.7	51.1	12 000	**RF384426**	Polyamide	29
	44	33	37.9	73.4	12 000	**RP384433**	—	64
	44	36.2	39.9	78.1	12 000	**RP384436A**	—	57
	44	39.8	43.7	88.1	12 000	**RP384440A**	—	65
	52	39	74.8	99.2	11 000	**RP385239**	—	155
39	46	32.8	42.4	76.9	12 000	**39R4633**	—	82
	55	20.5	55.0	62.6	11 000	**RF395521A**	Polyamide	98
	59	23	63.8	66.3	10 000	**RV395923-1**	—	196
40	45	13	17.1	30.8	12 000	**RV404513**	—	22
	45	17	19.9	37.4	12 000	**R40/17-1**	—	32
	45	21.2	23.6	46.6	12 000	**RS404521A**	—	40
	45	27	29.9	63.0	12 000	**RS404527**	—	49
	45	30	30.5	64.4	12 000	**R40/30**	—	55
	45	32	14.3	23.3	12 000	**R40/32A**	—	53
	46	14.5	21.2	35.5	12 000	**RP404615A**	Welded	31
	46	29	36.4	70.6	12 000	**RS404629**	—	65
	47	20	27.6	44.8	11 000	**RS40/20**	—	54
	47	28.5	38.0	67.6	11 000	**RS40/29A**	—	77
	48	34	50.4	88.3	11 000	**40V4834**	—	87
	55	27.5	68.0	85.6	11 000	**RF405528A-1**	Polyamide	124
	56	20	50.8	56.7	10 000	**RV405620-4**	—	122
	57	31.5	83.4	103	10 000	**RF405732A**	Polyamide	168
	60	31.5	94.1	110	10 000	**RF406032A**	Polyamide	214
41	46	24	11.0	16.8	11 000	**41R4624A**	—	44
42	47	10	13.9	23.8	11 000	**RS424710-1**	Welded	21

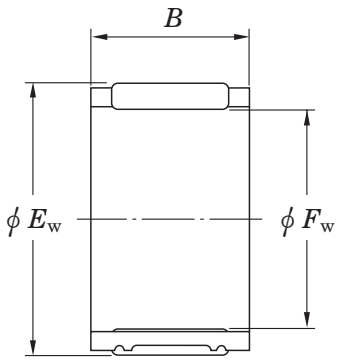
[Note] 1) For further information, consult with JTEKT.
[Remark] Limiting speed of grease lubrication should be kept to under 60 % of that for oil lubrication.

F_w (42) ~ (45) mm

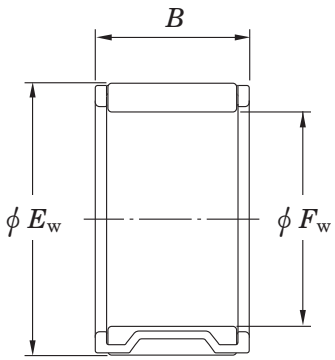
ϕE_w : Roller set outside diameter
ϕF_w : Roller set bore diameter

Boundary dimensions (mm)			Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No.	Specification (Cage)	(Refer.) Mass (g)
F_w	E_w	B	C_r	C_{0r}	Oil lub.			
42	47	25	29.5	63.1	11 000	**RS424725**	—	52
	47	27	32.3	70.8	11 000	**RS424727**	—	51
	47	30	31.9	69.8	11 000	**RSU424730**	Double split	58
	47	30	36.3	82.4	11 000	**VP42/30**	—	44
	49	22	29.3	49.0	11 000	**RF424922**	Polyamide	35
43	48	18	21.9	43.2	11 000	**RS434818**	—	36
	48	18.5	22.1	43.7	11 000	**RS434819A-2**	—	38
	48	21.2	25.0	51.5	11 000	**RS434821A**	—	46
	48	23.3	29.4	63.2	11 000	**RS434823A**	—	46
	48	24.4	28.2	59.9	11 000	**RS434824A**	—	49
	48	30	34.1	76.5	11 000	**RS434830**	Welded	58
	49	31	40.1	82.5	11 000	**43VP4931E**	—	55
	52	39.9	65.2	116	11 000	**43VP5240**	—	114
44	50	27.5	36.0	72.2	11 000	**44RFN5028**	Polyamide	39
	50	39	46.4	100	11 000	**RP445039**	—	71
45	50	13	16.0	29.4	11 000	**R45/13**	—	28
	50	17	22.7	46.1	11 000	**RS455017**	—	35
	50	19	24.1	49.7	11 000	**R45/19**	—	39
	50	20.2	24.1	49.6	11 000	**RS455020A**	—	46
	50	24	29.3	63.9	11 000	**RS455024**	—	50
	50	26	31.8	70.9	11 000	**R45/26**	—	54
	50	33	37.3	87.0	11 000	**RS455033-1**	—	69
	51	28.6	34.1	67.7	10 000	**45RFN5129**	Polyamide	40
	51	28.9	37.5	76.9	10 000	**RP455129A**	Welded	65
	51	28.9	37.5	76.9	10 000	**RPU455129AF**	Double split	67
	52	22	35.4	63.9	10 000	**RS455222**	—	66
	53	25	41.4	71.1	10 000	**RV455325P**	—	73

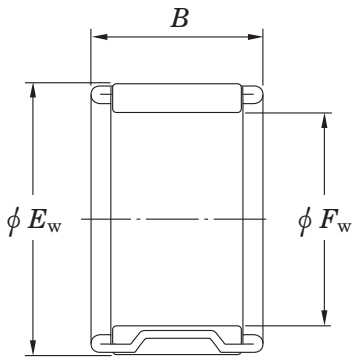
Single-row
F_w (45) ~ (50) mm



RS, R, RP



RV, V, VS



VP, VPS

Boundary dimensions (mm)			Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No.	Specification (Cage)	(Refer.) Mass (g)
F_w	E_w	B	C_r	C_{0r}	Oil lub.			
45	53	26	41.4	71.1	10 000	**45V5326P**	—	77
	53	28	42.3	73.2	10 000	**45VP5328**	Width tolerance special [1]	66
	64	23	64.0	70.4	9 200	**RV456423-7**	—	191
46	52	20	25.9	48.2	10 000	**46VP5220**	—	34
	52	37	45.8	100	10 000	**46VP5237B**	—	67
47	52	30	36.4	85.4	10 000	**R47/30H**	—	62
	52	30	35.1	81.7	10 000	**RSU475230F-1**	Double split	62
	53	28.8	35.3	72.3	10 000	**RP475329A**	—	55
	53	30	42.6	92.1	10 000	**RP475330-1**	Welded	74
	53	36	47.0	104	10 000	**RP475336**	—	68
48	53	13	16.1	30.1	9 900	**RS485313**	—	30
	53	28	34.1	79.2	9 900	**48R5328**	—	60
	54	20	29.3	57.3	9 800	**48R5420-1**	—	54
	54	27	38.1	80.4	9 800	**48R5427**	—	72
	54	28	37.8	79.3	9 800	**RS485428**	Welded	72
	54	29	39.5	84.3	9 800	**48R5429**	—	78
	54	30.2	43.8	96.2	9 800	**RP485430A-1**	Welded	72
	54	39	47.9	108	9 800	**48R5439**	—	106
	55	21	32.4	58.1	9 700	**RP485521**	Welded	60
49	56	44.6	61.2	133	9 500	**RP495645A**	Welded	120
	56	44.6	61.2	133	9 500	**RS495645A**	—	146
50	55	17.5	22.3	46.5	9 500	**RS505518A**	Welded	39
	55	20	25.1	54.3	9 500	**RS505520-1**	—	47
	55	27	11.5	18.9	9 500	**R50/27A**	—	56
	56	13	16.7	28.2	9 400	**RF505613**	Polyamide	18
	56	28	39.5	85.5	9 400	**RP505628**	Welded	69
	56	30	41.0	89.6	9 400	**RF505630**	Polyamide	50

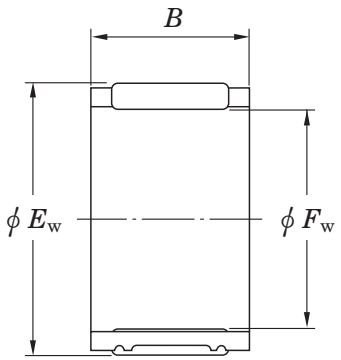
[Note] 1) For further information, consult with JTEKT.
[Remark] Limiting speed of grease lubrication should be kept to under 60 % of that for oil lubrication.

F_w (50) ~ 58 mm

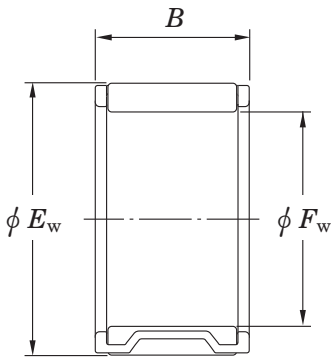
ϕE_w : Roller set outside diameter
ϕF_w : Roller set bore diameter

Boundary dimensions (mm)			Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No.	Specification (Cage)	(Refer.) Mass (g)
F_w	E_w	B	C_r	C_{0r}	Oil lub.			
50	57	33.5	47.8	97.1	9 300	**RP505734A**	—	79
	57	38.9	58.3	126	9 300	**RS505739A**	—	133
	57	40.8	60.9	133	9 300	**RS505741A**	—	127
	58	25	38.5	66.9	9 300	**RF505825**	Polyamide	53
	70	36	114	147	8 300	**RF507036**	Polyamide	277
51	56	28	34.8	83.0	9 300	**VP51/28**	—	45
52	72	32	108	138	8 100	**RF527232**	Polyamide	259
53	58	25	32.2	76.0	9 000	**RF535825**	Polyamide	35
54	60	31.1	45.3	104	8 800	**RP546031A**	Welded	83
	60	36	45.5	105	8 800	**RP546036**	Welded, Width tolerance special [1)]	82
	61	34.7	60.2	135	8 700	**RPU546135AF**	Double split	116
	61	41.3	63.3	143	8 700	**RS546141A**	—	145
55	59	13	10.8	21.9	8 800	**55RFN5913A**	Polyamide	11
	60	20	26.7	60.6	8 700	**R55/20**	—	52
	60	28	35.8	88.4	8 700	**RS556028**	—	69
56	60	20	24.0	62.4	8 600	**RF566020**	Polyamide	23
	61	11	13.6	25.6	8 500	**RF566111**	Polyamide	14
	61	30	39.7	102	8 500	**RS566130**	Welded	75
	61	33.5	42.5	111	8 500	**R56/34**	—	85
58	65	26	42.1	87.1	8 100	**58R6526**	Width tolerance special [1)]	99
	65	36.6	55.7	125	8 100	**58RFN6537A**	Polyamide	80
	65	36.6	56.4	127	8 100	**RS586537A-2**	—	145
	65	37.5	57.7	131	8 100	**RP586538A**	Welded, Width tolerance special [1)]	108
	80	72	233	359	7 200	**RV588072**	—	889

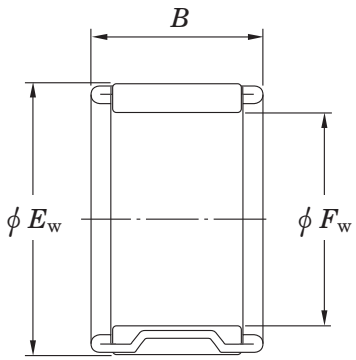
Single-row
F_w 60 ~ 78 mm



RS, R, RP



RV, V, VS



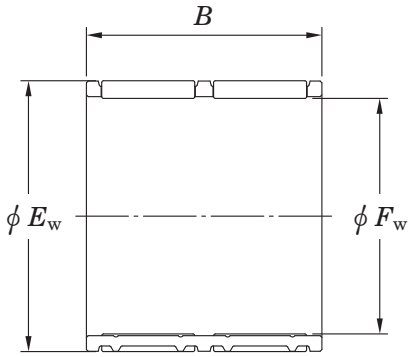
VP, VPS

Boundary dimensions (mm)			Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No.	Specification (Cage)	(Refer.) Mass (g)
F_w	E_w	B	C_r	C_{0r}	Oil lub.			
60	65	30	40.0	105	8 000	**R60/30**	—	81
	66	19	31.5	67.8	7 900	**RS606619**	—	63
	67	23	40.1	82.8	7 900	**60V6723**	—	77
	82	30	118	152	7 000	**RF608230**	Polyamide	316
63	68	30	40.9	110	7 600	**R63/30**	—	83
64	70	24.5	39.4	92.4	7 500	**64R7025A**	—	86
	70	35	55.7	144	7 500	**64R7035**	—	122
65	70	20	12.1	22.3	7 400	**R65/20A**	—	57
	70	24	12.5	22.9	7 400	**R65/24A**	—	67
70	76	20	34.7	80.8	6 800	**70R7620**	—	77
	76	32	55.1	147	6 800	**RP707632**	Welded	116
	78	30	59.4	132	6 800	**70R7830**	—	154
71	79	30.15	61.3	138	6 700	**71V7930B**	—	135
	79	39.5	75.3	179	6 700	**RS717940AZ**	—	203
72	79	21	39.6	86.6	6 600	**72V7921**	—	84
73	79	20	36.3	86.8	6 600	**R73/20**	—	84
78	85	33.75	62.3	159	6 100	**78R8534A**	—	168

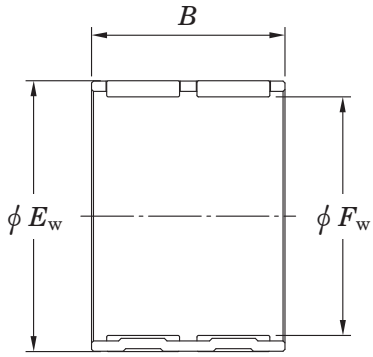
[Note] 1) For further information, consult with JTEKT.
[Remark] Limiting speed of grease lubrication should be kept to under 60 % of that for oil lubrication.

ϕE_{w} : Roller set outside diameter
ϕF_{w} : Roller set bore diameter

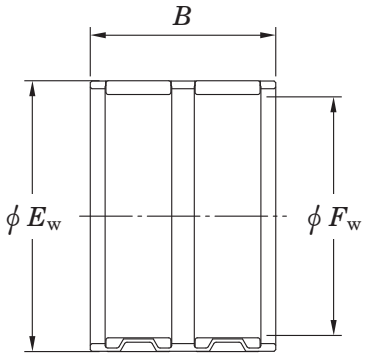
Double-row
F_w 20 ~ 39 mm



WR, WRS



WRP



WV

Boundary dimensions (mm)			Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No.	Specification (Cage)	(Refer.) Mass (g)
F_w	E_w	B	C_r	C_{0r}	Oil lub.			
20	25	26	15.7	22.0	22 000	**20WR2526**	—	27
	25	40	26.8	43.9	22 000	**20WR2540**	—	39
22	26	26	17.5	30.3	21 000	**WRS222626**	—	22
24	28	34	21.7	40.9	19 000	**WR24/34**	—	31
	29	45.5	34.7	64.6	19 000	**WRS242946A**	—	52
25	29	22	16.0	28.2	19 000	**WR25/22**	—	22
	29	23.8	17.9	32.5	19 000	**WRS252924A**	—	23
	29	26	19.4	36.0	19 000	**WR25/26**	—	25
	30	26	21.9	36.2	18 000	**25WR3026**	—	32
26	31	24	20.6	33.9	18 000	**26WR3124-2**	—	30
27	31	23.8	18.7	35.4	17 000	**WRS273124A**	—	25
	32	23.8	21.0	35.1	17 000	**WRS273224A**	—	31
30	34	29	14.4	25.5	16 000	**30WR3429A**	—	32
	37	32	32.4	50.4	15 000	**WRS30/32B**	—	66
32	37	28	24.4	44.8	14 000	**WR32/28**	—	43
	37	35	33.2	66.5	14 000	**WRS323735**	—	53
37	42	35	35.1	75.2	13 000	**WRSU374235**	Double split	59
38	44	40	43.7	88.1	12 000	**WRPU384440F**	Double split	75
	44	51	48.9	102	12 000	**38WR4451**	—	110
39	44	43	40.7	93.0	12 000	**WRS394443**	Welded	75
	44	43.8	39.0	88.0	12 000	**39WR4444**	—	80
	46	44.3	54.7	107	12 000	**WRP394644A**	Welded	97
	46	44.5	54.2	106	12 000	**WRS394645A**	—	109

[Remark] Limiting speed of grease lubrication should be kept to under 60 % of that for oil lubrication.

F_w 45 ~ 75 mm

ϕE_w : Roller set outside diameter
ϕF_w : Roller set bore diameter

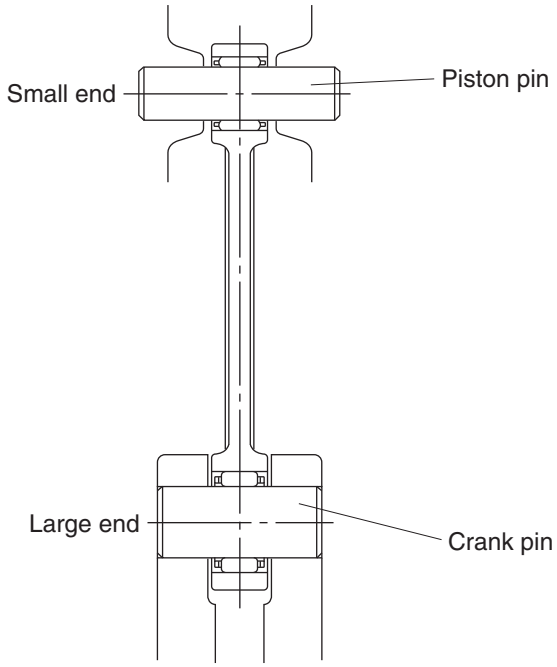
Boundary dimensions (mm)			Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No.	Specification (Cage)	(Refer.) Mass (g)
F_w	E_w	B	C_r	C_{0r}	Oil lub.			
45	50	40.6	42.0	101	11 000	**WRSU455041A**	Double split	84
	51	40	47.4	104	10 000	**WRP455140**	Welded	97
47	52	33	37.8	89.9	10 000	**WRS475233A-1**	Welded	69
	54	38.6	48.5	96.9	9 900	**WRP475439A**	Welded	107
50	55	45	53.5	144	9 500	**WR50/45**	—	102
	56	40	51.0	119	9 400	**50WR5640**	—	110
	58	54	72.8	151	9 300	**WRSU505854**	Double split	200
51	56	50.8	55.5	151	9 300	**51WR5651A**	—	118
58	65	42.6	59.2	135	8 100	**WRP586543A**	Welded	144
60	66	36	50.4	124	7 900	**WRP606636**	Welded	120
68	73	31.6	44.9	127	7 100	**WRS687332A**	Welded	90
70	80	55	103	225	6 700	**70WR8055**	—	351
71	79	46	80.1	194	6 700	**WRS717946Z**	—	243
75	81	45	71.5	210	6 400	**WR75/45**	—	183

Needle roller and cage assemblies for use with connecting rods

The Koyo needle roller and cage assembly for use with connecting rod ensures excellent rigidity and a large load rating.

This assembly is also outstanding in wear resistance, light-weight, and is designed to assure a long life. It is widely employed for mini-vehicles, 2-wheel vehicles, snow-mobiles, engines for general use, out board motor, spray units for farming, and high-speed compressors.

The Koyo needle roller and cage assembly for use with connecting rods is available in two types : for a crank pin side (BE, VE and VS...P) and piston pin side (RE, R...P and UR...P).



■ Needle roller and cage assemblies for large ends (BE, VE and VS...P)

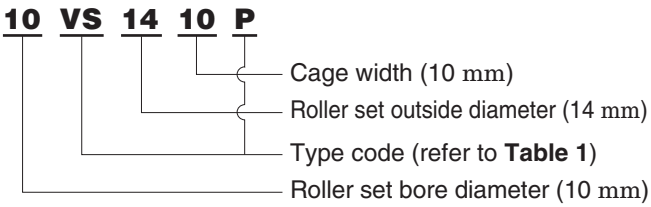
The cage is guided by connecting rod bore and is made of special steel. A double split type cage is also manufactured according to the structure of the crank shaft.

■ Needle roller and cage assemblies for small ends (RE, R...P and UR...P)

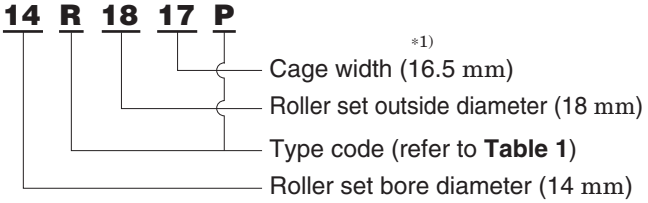
The cage is guided by the piston pin and incorporates maximum length rollers.

1 Bearing number

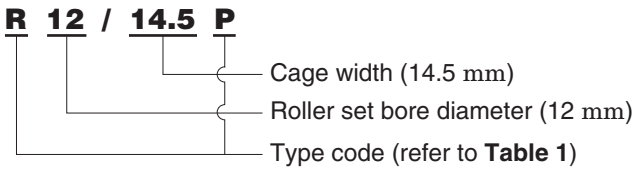
(Ex. 1)



(Ex. 2)

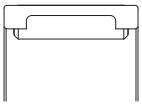
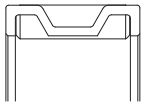


(Ex. 3)



∗1) The figure in the bearing number indicating cage width show the value rounded at a decimal of the actual cage width.

Table 1 Type code of needle roller and cage assemblies for use with connecting rods

Type	For use at large end		For use at small end
			
Type code	BE	VE VS...P	RE R...P UR...P

2 Rods and pins

To get maximum performance out of Koyo needle roller and cage assemblies for use with connecting rods, connecting rod bores serving as the raceway surface of the bearing, as well as the crank pin and piston pin should always be within the limits given in **Table 2**.

Table 2 Specifications of rods and pins

Item			Connecting Rod Bores	Crank and Piston Pin's Outside Diameters
Roughness (Ra)			0.2 a or less	0.1 a or less
Hardness			60 to 64 HRC	
Case Depth (mm) **(Up to 550** HV**)**			0.6 to 1.2 (Set according to the pin diameter and load condition)	
Roundness (μm)	**Diameter** (mm)	**Over 9 up to 18**	3 or less	2 or less
		Over 18 up to 30	4 or less	3 or less
		Over 30 up to 40	5 or less	4 or less
Cylindricity (μm)	**Diameter** (mm)	**Over 9 up to 18**	2 or less	1 or less
		Over 18 up to 30	3 or less	2 or less
		Over 30 up to 40	4 or less	3 or less
Parallelism[1)]		**Medium-Low Speed**	0.04 mm or less per 100 mm	
		High speed	0.02 mm or less per 100 mm	

[Note] 1) Parallelism between large and small ends

3 Radial clearance

For the selection of clearance for the Koyo needle roller and cage assemblies for use with connecting rods, the engine type and operating conditions must be taken into account. The recommended clearances are shown in **Table 3**.

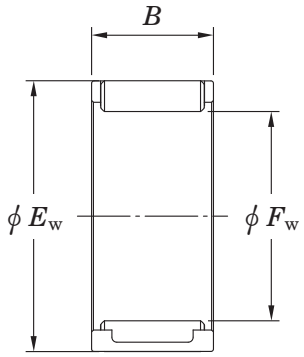
The recommended clearance can be obtained by selecting the proper connecting rod bore, pin and needle roller.

Table 3 Recommended radial clearances

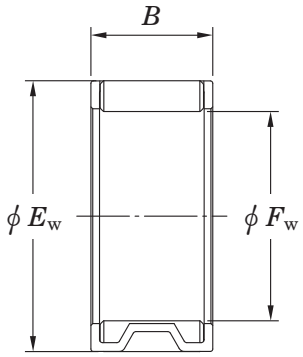
Unit : μm

Diameter (mm)		Large End		Small End	
over	up to	min.	max.	min.	max.
—	**10**	9	25	3	14
10	**18**	9	25	3	14
18	**30**	10	25	5	17
30	**40**	18	33	—	—

For large ends
F_w 10 ~ (25) mm



BE



VE, VS...P

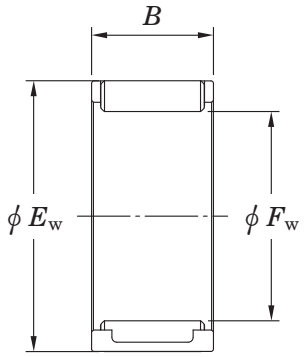
Boundary dimensions (mm)			Basic load ratings (kN)		Bearing No.	Specification (Cage)	(Refer.) Mass (g)
F_w	E_w	B	C_r	C_{0r}			
10	14	9.8	5.02	4.84	**VE101410AB1**	—	3.6
12	17	10	6.85	6.61	**VE121710B1**	Silver plating	5.6
13	18	9.8	6.85	6.70	**VE131810AB1**	—	5.9
14	19	9.8	6.81	6.78	**VE141910AB1**	Copper plating	6.2
	19	11.8	7.91	8.21	**VE141912AB1**	—	7.5
15	21	10	7.75	7.26	**15VS2110P-1**	—	8.6
16	22	13.2	10.6	11.0	**VE162213ASB1**	Silver plating	12
17	23	14	11.3	12.1	**17VS2314AP**	—	13
	24	14	12.9	13.2	**17VS2414AP**	—	16
18	27	26.8	29.0	32.6	**VE182727AB1**	Copper plating	42
20	26	14	13.3	15.7	**20VS2614CP-1**	—	15
	26	16	13.7	16.3	**20VS2616P**	—	17
	27	13.8	13.7	14.8	**VE202714AB1**	Silver plating	17
	28	15.8	18.3	19.7	**VE202816AB1**	Copper plating	25
22	28	13.7	14.8	18.6	**BE222814ASB1**	Silver plating	17
	28	14	13.2	15.9	**22VS2814FP**	—	16
	28	15.7	17.8	23.7	**BE222816ASB1**	Silver plating	20
	29	14	15.3	17.5	**22VS2914AP**	—	19
	29	15.8	18.9	23.1	**BE222916ASB1**	Silver plating	25
	29	17	16.8	19.7	**22VS2917BP**	—	22
24	30	19.7	20.0	28.2	**VE243020AB1**	Silver plating	24
	31	16.8	21.0	27.1	**BE243117ASY1B1**	Silver plating, Both sides roller separatable	27
	31	17	18.5	23.0	**24VS3117BP-2**	—	25
25	31	19.8	19.0	26.5	**VE253120AB1-1**	Silver plating	24

F_w (25) ~ 33 mm

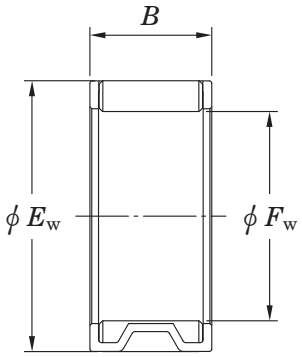
ϕE_w : Roller set outside diameter
ϕF_w : Roller set bore diameter

Boundary dimensions (mm)			Basic load ratings (kN)		Bearing No.	Specification (Cage)	(Refer.) Mass (g)
F_w	E_w	B	C_r	C_{0r}			
25	32	15.8	20.5	26.6	**BE253216ASY1B2**	Silver plating, Both sides roller separatable	26
	32	16.5	20.5	26.6	**BE253217ASY1B2**	Silver plating, Both sides roller separatable	28
	32	19.7	24.0	32.6	**VE253220AB1**	Copper plating	32
	34	17.7	25.8	30.1	**25VS3418P**	—	37
26	31	13.8	13.5	19.7	**VE263114AB1**	Copper plating	15
	31	15.8	15.6	23.7	**VE263116ASB1-1**	Silver plating	17
	32	13.9	15.8	21.3	**VE263214BB1**	Silver plating	19
	32	19.8	22.5	33.7	**BE263220ASB1**	Silver plating	30
	33	21.8	24.6	33.8	**BE263322ASYB1**	Silver plating, One side roller separatable	38
	35	20	28.7	35.0	**26VS3520AP-1**	—	45
27	34	17.8	20.6	20.8	**BE273418ASB1**	Silver plating	32
	34	18.8	27.5	39.8	**BE273419ASYB1-1**	Silver plating, One side roller separatable	36
28	33	13.8	14.3	21.8	**VE283314AB1**	Silver plating	17
	35	13.8	17.2	21.9	**VE283514AB1**	Copper plating	24
	36	13.8	19.6	23.7	**VE283614AB1**	Copper plating	28
	36	15.8	22.1	27.6	**VE283616AB1**	Copper plating	32
	38	15.8	26.2	29.7	**BE283816ASYB1**	Copper plating, One side roller separatable	50
	38	16.8	27.2	31.1	**28VS3817AP**	—	41
30	37	16	20.6	28.3	**30VS3716AP-1**	—	30
	38	15.8	22.9	29.6	**30VS3816P-1**	—	34
	39	19.8	32.4	42.7	**BE303920ASB1**	Silver plating	54
	39	21.8	31.4	40.8	**VE303922AB1-1**	Silver plating	50
	40	19.8	31.2	37.9	**BE304020ASYB2**	Silver plating, One side roller separatable	60
32	41	17.8	24.2	29.7	**VE324118AB2**	Silver plating	46
	41	21.7	34.0	46.1	**VE324122ASB1**	Silver plating	52
33	41	19.8	30.9	44.6	**VE334120AB3**	Silver plating	46
	43	21	35.1	45.3	**33VS4321P**	—	65

For large ends
F_w 34 ~ 41 mm



BE

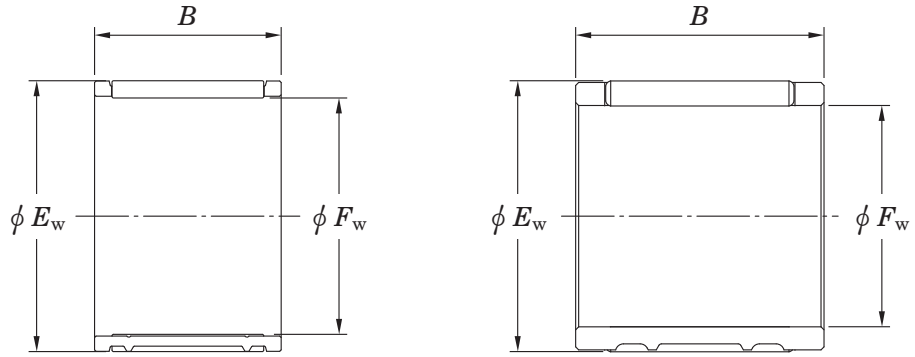


VE, VS...P

Boundary dimensions (mm)			Basic load ratings (kN)		Bearing No.	Specification (Cage)	(Refer.) Mass (g)
F_w	E_w	B	C_r	C_{0r}			
34	42	19.8	32.5	48.3	**BE344220ASB1**	Silver plating	52
	44	19.8	38.5	51.2	**BE344420ASY1B1**	Silver plating, Both sides roller separatable	64
35	42	19.8	27.0	41.7	**VE354220AB1**	Silver plating	43
	43	20	31.5	46.8	**35VS4320BP**	—	51
38	48	22.8	48.7	72.3	**BE384823BSY1B1**	Silver plating, Both sides roller separatable	87
	50	22.8	51.3	68.2	**BE385023ASY1B1-5**	Silver plating, Both sides roller separatable	113
41	51	24.8	49.3	75.1	**BE415125ASY1B1**	Copper plating, Both sides roller separatable	104

ϕE_w : Roller set outside diameter
ϕF_w : Roller set bore diameter

For small ends
F_w 9 ~ (18) mm



R...P RE

Boundary dimensions (mm)			Basic load ratings (kN)		Bearing No.	(Refer.) Mass (g)
F_w	E_w	B	C_r	C_{0r}		
9	12	12	4.95	5.57	**9R1212P**	3.6
10	14	12.5	6.38	6.60	**RE101413BL1-1**	5.8
12	15	16.3	6.51	8.57	**RE121516BL2**	5.7
	16	11.8	6.61	7.24	**RE121612AL1**	6.4
	16	12.8	6.61	7.24	**RE121613AL1**	7.0
	16	14.8	8.35	9.78	**12R1615CP**	7.9
	16	15.4	8.35	9.78	**RE121615AL1**	8.3
	17	14.2	9.08	9.47	**RE121714BL2**	9.5
14	18	15.8	8.88	11.1	**RE141816AL1**	9.7
	18	16.5	9.40	11.9	**RE141817AL2-2**	9.8
	18	17.5	8.27	10.1	**14R1818AP-1**	11
	18	18.5	8.90	11.1	**14R1819AP**	11
	18	20	9.43	11.9	**14R1820CP**	12
	18	21.8	11.5	15.3	**14R1822P**	13
	19	18	9.96	11.0	**14R1918P-2**	14
15	19	17	10.5	14.0	**15R1917BP-2**	11
	19	17.3	9.85	12.9	**RE151917BL3**	11
	20	17.8	12.3	14.7	**RE152018BL2**	14
	20	19.8	12.2	14.5	**RE152020AL2**	17
16	20	18.8	11.0	15.1	**R16/18.8AP-2**	13
	20	19.5	9.79	13.0	**R16/19.5FP**	14
	20	22.5	9.77	13.0	**R16/22.5EP**	16
	21	17.5	12.2	14.8	**16R2118BP-2**	16
	21	19.5	12.0	14.6	**16R2120AP**	18
18	22	19.65	10.7	15.2	**RE182220AL1**	15
	22	22	12.0	17.6	**18R2222P**	17
	22	23.6	13.1	19.7	**RE182224AL2**	17

F_w (18) ~ 24 mm

ϕE_w : Roller set outside diameter
ϕF_w : Roller set bore diameter

Boundary dimensions (mm)			Basic load ratings (kN)		Bearing No.	(Refer.) Mass (g)
F_w	E_w	B	C_r	C_{0r}		
18	23	22	14.1	18.6	**18R2322P**	21
19	24	24.8	18.0	26.0	**RE192425AL1**	26
20	24	13	9.80	14.0	**R20/13P-2**	10
	25	13	11.1	14.1	**20R2513P**	13
	25	21.8	17.3	25.0	**RE202522AL2**	24
	25	23	18.8	27.8	**RE202523L2**	24
	25	25	18.8	27.8	**20R2525P-1**	27
	25	27.8	21.4	32.9	**RE202528AL1**	30
	26	24	19.3	25.4	**RE202624L1**	33
22	27	24.8	19.4	29.9	**RE222725AL1**	29
24	29	23.8	21.1	34.1	**RE242924AL1**	30

Koyo®

Drawn cup needle roller bearings

NEEDLE ROLLER BEARINGS

Drawn cup needle roller bearings

Koyo drawn cup needle roller bearings are available in two types : full complement type and caged type. The outer rings of the bearings are made of a high-quality steel strips, press-finished and case-hardened. The rollers are made of a high carbon chromium bearing steel, heat-treated and finished by grinding.

■ Simple structure of housing

The drawn cup needle roller bearings are mounted with interference fit into housings and do not require, housing shoulders, snap rings or other devices for axial location.

■ Easy to mount

The bearings can be easily mounted by press-fitting into the housings.

1 Bearing number

(Ex. 1) Metric series

BTM 17 10

- 10 — Width (10 mm)
- 17 — Roller set bore diameter (17 mm)
- BTM — Bearing type code (refer to **Table 2**)

(Ex. 2) Metric series

17 BTM 23 12 U

- U — Special code (refer to **Table 1**)
- 12 — Width (12 mm)
- 23 — Outside diameter (23 mm)
- BTM — Bearing type code (refer to **Table 2**)
- 17 — Roller set bore diameter (17 mm)

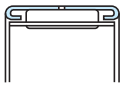
(Ex. 3) Inch series

MH 16 12 1

- 1 — Closed end type (for inch series only)
- 12 — Width ($12 \times 1/16 = 3/4$ inch)
- 16 — Roller set bore diameter ($16 \times 1/16 = 1$ inch)
- MH — Bearing type code (refer to **Table 2**)

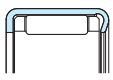
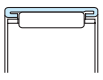
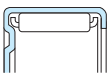
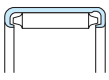
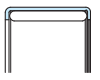
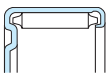
Table 1 Special code

Code	Description
U	Single side sealed
OH	With lubrication hole
J	Bearings designed according to ISO standards



(With lubrication hole)

Table 2 Type code of drawn cup needle roller bearings

Type	Caged type				Full complement type			For universal joint
	Open ends type			Closed end type	Open ends type		Closed end type	
	 (With polyamide cage)		 (Sealed)					
Metric series	BFNM	BTM BHTM	BKM	MKM MHKM	BM BHM	YM	MM	YM (Please consult with JTEKT for details.)
Inch series	—	BT BHT	—	MK MHK	B BH	Y	M MH	

2 Comparison between full complement type and caged type

It is very important to select the most suitable bearings, taking into consideration various conditions such as rotational speeds, load, setting accuracy and lubrication.

Table 3

Rotational Speed	The full complement type bearing is suited for low-speed rotation or oscillating motion, while the caged type is better for high speed application.
Load	When the bearings are the same size, the full complement type bearing has a greater load rating than the caged type. The effective bearing service life, however, should not be judged on load rating only.
Setting accuracy	The caged type bearing is advantageous when tolerance of mounting dimension and shaft deflection are relatively large.
Lubrication	The caged type bearing maintains a larger amout of lubricant than the full complement type. When frequent lubrication is needed, it is convenient to use bearings with lubrication holes.

3 Shaft and housing

The drawn cup needle roller bearings are usually mounted on shafts without inner rings. Therefore, the shafts should satisfy the specifications of **Table 4**.

In addition, the outer rings are made of thin sheet steel, so correct shapes and tolerance can be obtained by fitting the bearings into housings that satisfy the specifications in **Table 4**.

If any shaft cannot be machined with proper finishing accuracy and hardness, use the inner rings. (refer to page 139)

Table 4 Specifications of shafts and housings

	Shaft (Raceway surface)	Housing bore (Fitting surface)
Roundness	Best if less than one half or one third of the shaft diameter (housing bore diameter) tolerance.	
Cylindricity	5 μm or less per 25 mm, or one half or less of the shaft diameter (housing bore diameter) tolerance.	
Roughness (Ra)	0.4 a or less	1.6 a or less
Hardness[1)]	58 HRC or harder (60 to 64 HRC are best.)	
Others	● Shaft deflection due to external forces and shaft slope due to tolerance of mounting dimension should be 13 μm or less per 25 mm.	● The bore should be a through-hole. ● To protect the bearing edge, the bearing should be set at least 0.25 mm inside the housing surface. ● To maintain the tolerance of the bearing, the housing should have sufficient strength so that deformation due to a load is minimized. ● Split type housing should not be used. If it must be used, the bearing should be fitted into a steel sleeve beforehand.

[Note] 1) Case hardened steel which is carburized or induction-hardened should not only meet the surface hardness requirement specified above but also have a case depth of 52.3 HRC (550 HV) to a depth in the range (0.08 to 0.1) × D_w mm. (D_w : roller diameter)
In general, 30 thru 45 HRC is best for the center hardness.

4 Fits

Drawn cup needle roller bearings can perform accurately only when press fitted on housings of correct sizes.

When the material for housings is steel or cast iron having rigidity, the recommended fits are as shown in **Table 5**.

The fits may be partially changed according to the operating conditions (refer to **Table 6**).

Table 5 Recommended fit

Distinction[1]		Inner ring rotation		Outer ring rotation	
		Shaft	Housing bore	Shaft	Housing bore
Metric series		h6	N7	f6	R7
Inch series	$7.144 < D \leqq 8.731$ (9/32") (11/32")		0 -0.013 mm		P7
	$8.731 < D$ (11/32")		J7		M7

[Note] 1) D = Nominal outside diameter (mm)

Table 6 Fits altered according to the operating conditions

Distinction[1]		Housing Made of Light Alloy of Steel[2] or Cast Iron of 6 mm or less in thickness	Oscillating Shaft	With[3] Inner Ring
		Housing Bore	Shaft	Shaft
Metric series		R7 or S7	It should be 0.013 mm larger than the recommended tolerance.	j6 is recommended
Inch series	$7.144 < D \leqq 8.731$ (9/32") (11/32")	P7 or R7		
	$8.731 < D$ (11/32")	M7 or R7		

[Notes] 1) D = Nominal outside diameter (mm)
2) This tolerance varies depending on the material and the shape of the housing. The optimum value must be determined by actual mounting. For details, consult with JTEKT.
3) When specially interference fitted, consult with JTEKT.

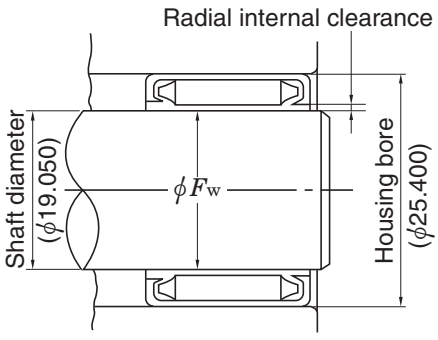
5 Internal clearance and outer ring width tolerances

The radial internal clearance with a drawn cup needle roller bearing mounted on a housing varies depending on the tolerances for the bearing, housing and shaft. For example, the relationship between the radial internal clearance and the dimensional tolerances in the case of Koyo drawn cup needle roller bearing "B1212" is shown in **Table 7**.

Generally, radial internal clearance is reduced not by decreasing the housing bore size, but by increasing the shaft diameter.

Table 7 Radial internal clearance for bearing "B1212" (Calculation example)

Unit : mm

<table>
<tr><td rowspan="2">Conditions</td><td>


Dimensional tolerances
(1) Housing bore (refer to specification table on page 103)
$\begin{cases} H_{\text{max.}} = 25.412 \\ H_{\text{min.}} = 25.391 \end{cases}$ (25.4 J7)
(2) Roller set bore diameter [When press fitted into a ring gauge of $\phi H = 25.387$ …refer to Table 10 on page 74)]
$\begin{cases} F_{\text{w max.}} = 19.088 \\ F_{\text{w min.}} = 19.063 \end{cases}$
(3) Shaft diameter (refer to specification table on page 103)
$\begin{cases} S_{\text{max.}} = 19.050 \\ S_{\text{min.}} = 19.037 \end{cases}$ (19.050 h6)
</td></tr>
<tr><td>(4) Roller set bore diameter when press fitted into this housing.
From (1) and (2), $\begin{cases} A_{\text{max.}} = (H_{\text{max.}} - H) + F_{\text{w max.}} = 19.113 \\ A_{\text{min.}} = (H_{\text{min.}} - H) + F_{\text{w min.}} = 19.067 \end{cases}$</td></tr>
<tr><td>Radial internal clearance (after mounting)</td><td>$\begin{cases} R_{\text{s max.}} = A_{\text{max.}} - S_{\text{min.}} = 0.076 \\ R_{\text{s min.}} = A_{\text{min.}} - S_{\text{max.}} = 0.017 \end{cases}$</td></tr>
</table>

Table 8 Tolerances of outer ring width

Unit : mm

Outer ring width C	Deviation of a single outer ring width Δ_{Cs}	
	upper	lower
All widths	0	–0.3

6 Mounting

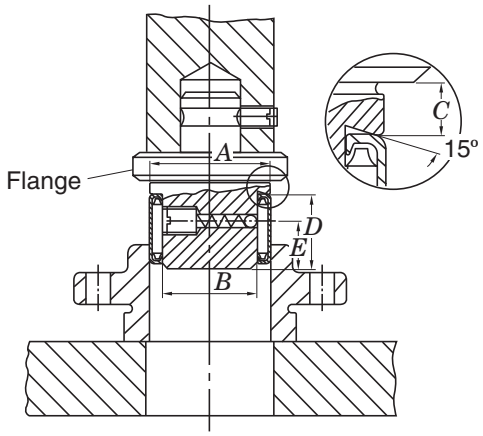
Since the drawn cup needle roller bearing must be press fitted into a housing, and an installation jig must be used.

The jig used to mount open type bearings is shown in **Fig. 1**.

An ordinary hand press is safe and convenient to use for the press fitting of bearings.

Instruction for mounting bearings

1) When mounting bearings of the below-mentioned types, the marking side should be touching the shoulder of the pressing jig.
   [BM, BHM, MM, MKM, MHKM
B, BH, M, MH, MK, MHK]
2) The bearing should not be pounded into its housing with a hammer or other impact tool, even in conjunction with the mounting jig.
3) The shoulder of the mounting jig should be given a slope of 15° so that it will not damage the edge of the bearing.
4) The mounting jig should have flange as stopper and guide for correct mounting, as shown in **Fig. 1**. (The ball and spring in the jig are intended to prevent the roller from falling during the press fitting of the bearing, and to make the job easier.)



A = Housing bore diameter – 0.05 mm
B = Shaft diameter – 0.10 mm
C = 0.20 mm (min.)
D = Bearing width ± 1.0 mm
E = Approx. 1/2 D

Fig. 1

7 Inspection

The outer rings of Koyo drawn cup needle roller bearings are manufactured by drawing the steel sheet into the correct shape; however, they may go out of round in the heat treatment.

When the bearings are pressed into true round housing of accurate sizes and wall thickness, they become round and proper size for satisfactory bearing performance. For this reason, it is meaningless to inspect unmounted drawn cup bearings by measuring O.D.

The bearings are designed to possess optimum internal clearances, and it is usually unnecessary to inspect them.

If the inspection is necessary, it is best to follow the procedure given below. (specified in JIS B 1515-2)

1) Press the bearing into a ring gauge of the correct size.
2) Check the bearing bore diameter (roller set bore diameter) by plugging with the "Go end" and "No-Go end" gauges.
   The sizes of the gauges (ring gauge and plug gauge) are shown in **Tables 9** and **10**.
   Table 11 shows the bearing ring gauge specifications and the tolerances of roller set bore diameter specified in JIS B 1536-2 (conform to ISO standards).

Table 9 Inspecting gauge specifications (metric series)

Unit : mm

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

Table 10 Inspecting gauge specifications (inch series)

Unit : mm

Nominal roller set bore diameter F_w	Ring gauge	Plug gauge	
		Go end	No-Go end
4.762 (3/16)	8.730	4.783	4.808
6.350 (1/4)	11.125	6.388	6.413
7.938 (5/16)	12.713 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)	25.387	19.063	19.088
20.638 (13/16)	26.975 28.562	20.650	20.675
22.225 (7/8)	28.562 30.150	22.238	22.263
23.812 (15/16)	30.150	23.825	23.850
25.400 (1)	31.737 33.325	25.413	25.438

Nominal roller set bore diameter F_w	Ring gauge	Plug gauge	
		Go end	No-Go end
26.988 (1 1/16)	33.325	27.000	27.025
28.575 (1 1/8)	34.912 38.087	28.588	28.613
30.162 (1 3/16)	38.087	30.175	30.200
31.750 (1 1/4)	38.087 41.262	31.763	31.788
33.338 (1 5/16)	41.262	33.350	33.378
34.925 (1 3/8)	41.262 44.437	34.938	34.966
38.100 (1 1/2)	47.612	38.113	38.143
41.275 (1 5/8)	50.787	41.288	41.318
44.450 (1 3/4)	53.962	44.463	44.496
47.625 (1 7/8)	57.137	47.638	47.671
50.800 (2)	60.312	50.815	50.848
52.388 (2 1/16)	64.280	52.413	52.451
53.975 (2 1/8)	63.487	53.990	54.028
57.150 (2 1/4)	66.662	57.165	57.203
63.500 (2 1/2)	73.139	63.515	63.553
66.675 (2 5/8)	76.187	66.700	66.738
69.850 (2 3/4)	79.362	69.875	69.913
88.900 (3 1/2)	101.587	88.925	88.963

Table 11 Ring gauge specifications and roller set bore diameter tolerance (for bearings designed according to ISO standards)

Unit : mm

Nominal roller set bore diameter F_w	Nominal outside diameter D	Ring gauge	Roller set bore diameter F_w tolerance	
			lower	upper
4	8	7.984	4.010	4.028
5	9	8.984	5.010	5.028
6	10	9.984	6.010	6.028
7	11	10.980	7.013	7.031
8	12	11.980	8.013	8.031
	14	13.980		
9	13	12.980	9.013	9.031
	15	14.980		
10	14	13.980	10.013	10.031
	16	15.980		
12	16	15.980	12.016	12.034
	18	17.980		
14	20	19.976	14.016	14.034
	22	21.976		
15	21	20.976	15.016	15.034
	23	22.976		
16	22	21.976	16.016	16.034
	24	23.976		
17	23	22.976	17.016	17.034
	25	24.976		
18	24	23.976	18.016	18.034
	26	25.976		
20	26	25.976	20.020	20.041
	28	27.976		
22	28	27.976	22.020	22.041
	30	29.976		
25	32	31.972	25.020	25.041
	35	34.972		
28	35	34.972	28.020	28.041
	38	37.972		
30	37	36.972	30.020	30.041
	40	39.972		
32	39	38.972	32.025	32.050
	42	41.972		
35	42	41.972	35.025	35.050
	45	44.972		
38	45	44.972	38.025	38.050
	48	47.972		
40	47	46.972	40.025	47.050
	50	49.972		
42	49	48.972	42.025	42.050
	52	51.967		
45	52	51.967	45.025	45.050
	55	54.967		
50	58	57.967	32.025	32.050
55	63	62.967	55.030	55.060
60	68	67.967	60.030	60.060
65	73	72.967	65.030	65.060
70	78	77.967	70.030	70.060

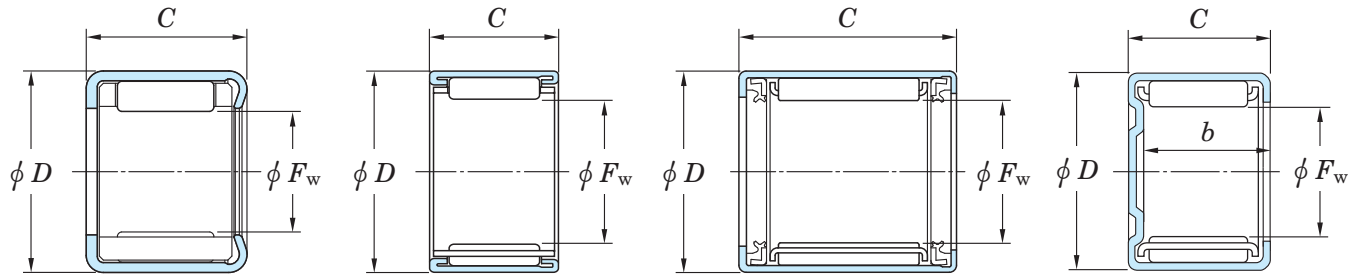
[Remark] The supplementary code "J" is added as a suffix to the bearing numbers that are designed according to ISO standards.

Metric series
F_w 4 ~ (12) mm

Caged type

With open ends

With closed end



BFNM | BTM, BHTM | BKM | MKM, MHKM

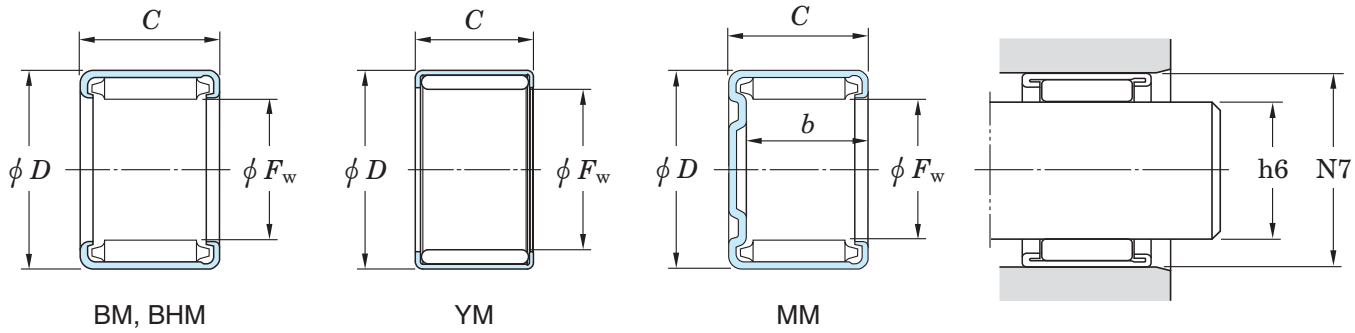
Boundary dimensions (mm)				Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No. [2]	
							Caged type	
F_w	D	C	b min.	C_r	C_{0r}	Oil lub.	With open ends	With closed end
4	8	8	—	1.60	1.25	47 000	**4BFNM88**	—
5	9	9	—	2.40	2.15	44 000	**5BFNM99**	—
6	10	9	6	2.40	2.40	42 000	**6BTM109**	—
7	11	9	—	2.55	2.70	39 000	**7BTM119**	—
8	12	10	8.4	3.25	3.85	37 000	**8BTM1210**	**8MKM1210**
	12	10	7.8	4.95	7.50	13 000	—	—
	12	10	—	5.25	8.60	13 000	—	—
	15	10	8.4	4.00	3.30	34 000	**BHTM810**	**MHKM810**
	15	15	—	7.45	6.50	34 000	**BHTM815**	—
	15	20	17.3	9.25	9.70	34 000	**BHTM820**	**MHKM820**
9	13	10	7.8	4.90	8.05	12 000	—	—
	13	10	8.4	3.35	4.10	35 000	**9BTM1310A**	**9MKM1310**
	13	12	10.4	4.20	5.50	35 000	**9BTM1312**	**9MKM1312**
	16	12	10.4	5.35	5.05	32 000	**BHTM912-1**	**MHKM912**
	16	16	13.3	7.55	7.90	32 000	**BHTM916**	**MHKM916**
10	14	10	7.8	5.70	9.35	11 000	—	—
	14	10	8.4	3.55	4.55	33 000	**10BTM1410**	**10MKM1410**
	14	12	10.4	4.40	6.00	33 000	**10BTM1412**	**10MKM1412**
	14	15	11.8	5.65	8.25	33 000	**BTM101415**	—
	17	10	8.4	4.65	4.25	30 000	**BHTM1010**	**MHKM1010**
	17	12	10.4	6.00	5.90	30 000	**BHTM1012-1**	**MHKM1012**
	17	15	—	7.85	8.45	30 000	**BHTM1015**	—
	17	20	17.3	10.7	12.5	30 000	**BHTM1020**	**MHKM1020**
12	16	10	8.4	4.00	5.60	29 000	**12BTM1610**	**12MKM1610**

[Notes] 1) The limiting speeds shown above are applicable when oil seal is used and the bearing is lubricated with grease.
2) FN in bearing number indicates a bearing comprising polyamide molded cage.
3) The recommended dimensional tolerances of shaft shown above are applicable except h6.
4) The recommended dimensional tolerances of housing bore shown above are applicable except N7.

Full complement type

With open ends

With closed end



BM, BHM YM MM

Full complement type With open ends	Full complement type With closed end	Recommended dimensions (mm) Shaft dia. (h6) min.	Shaft dia. (h6) max.	Housing bore dia. (N7) min.	Housing bore dia. (N7) max.	(Refer.) Mass (g) With open ends	(Refer.) Mass (g) With closed end
—	—	3.992	4.000	7.981	7.996	1.3	—
—	—	4.992	5.000	8.981	8.996	1.8	—
—	—	5.992	6.000	9.981	9.996	2.5	—
—	—	6.991	7.000	10.977	10.995	2.9	—
—	—	7.991	8.000	11.977	11.995	3.6	4.1
BM081210	**8MM1210**	7.991	8.000	11.977	11.995	3.7	4.2
YM081210	—	7.991	8.000	11.977	11.995	4.0	—
—	—	7.991	8.000	14.977	14.995	6.5	7.3
—	—	7.991	8.000	14.977	14.995	9.4	—
—	—	7.991	8.000	14.977	14.995	13	14
9BM1310	**9MM1310**	8.991	9.000	12.977	12.995	4.0	4.6
—	—	8.991	9.000	12.977	12.995	3.8	4.3
—	—	8.991	9.000	12.977	12.995	4.6	5.2
—	—	8.991	9.000	15.977	15.995	8.8	9.9
—	—	8.991	9.000	15.977	15.995	12	13
10BM1410	**10MM1410**	9.991	10.000	13.977	13.995	4.2	4.8
—	—	9.991	10.000	13.977	13.995	4.2	4.8
—	—	9.991	10.000	13.977	13.995	5.0	5.7
—	—	9.991	10.000	13.977	13.995	6.4	—
—	—	9.991	10.000	16.977	16.995	7.8	8.9
—	—	9.991	10.000	16.977	16.995	9.4	11
—	—	9.991	10.000	16.977	16.995	12	—
—	—	9.991	10.000	16.977	16.995	16	18
—	—	11.989	12.000	15.977	15.995	5.0	5.6

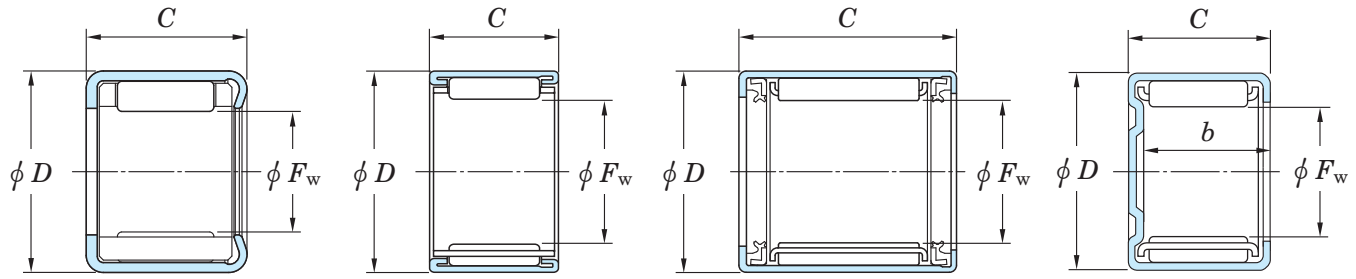
[Remark] Limiting speed of grease lubrication should be kept to under 60 % of that for oil lubrication.

Metric series
F_w (12) ~ 14.50 mm

Caged type

With open ends

With closed end



BFNM | BTM, BHTM | BKM | MKM, MHKM

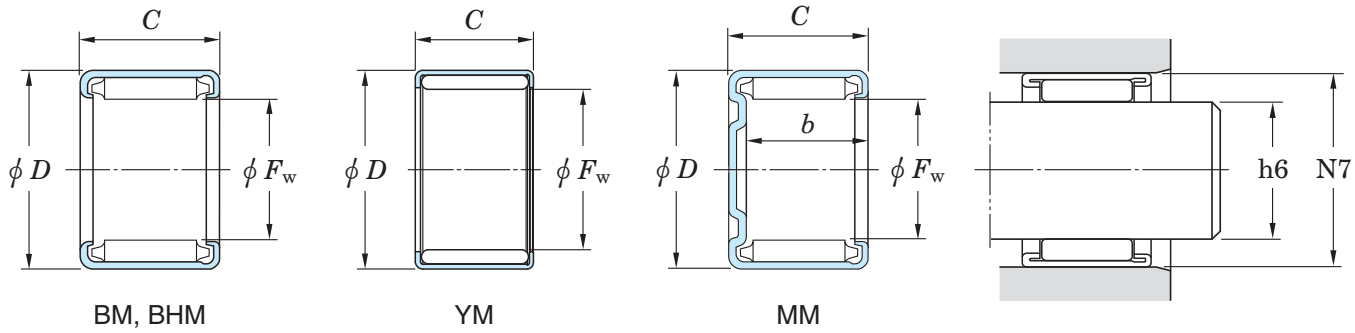
Boundary dimensions (mm)				Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No. [2]	
							Caged type	
F_w	D	C	b min.	C_r	C_{0r}	Oil lub.	With open ends	With closed end
12	18	10	8.4	4.60	4.80	27 000	**12BTM1810**	**12MKM1810**
	18	12	9.6	8.40	12.6	9 400	—	—
	18	12	9.3	5.95	6.70	27 000	**12BTM1812**	**12MKM1812**
	18	15	—	6.10	7.32	27 000	**12BTM1815A**	—
	18	16	—	5.65	6.25	16 000[1]	**12BKM1816UU**	—
	19	12	9.3	6.70	6.95	26 000	**BHTM1212-1**	**MHKM1212**
	19	15	—	8.85	9.95	26 000	**BHTM1215-1**	**MKM121915**
	19	20	17.3	12.1	14.9	26 000	**BHTM1220**	**MHKM1220**
	19	25	—	15.0	19.6	26 000	**BHTM1225**	—
13	17	15	—	5.10	7.85	27 000	**BKM131715J**	—
	19	12	—	8.55	13.4	9 100	—	—
	19	12	9.3	5.85	6.70	26 000	**13BTM1912**	**13MKM1912**
	19	14	—	7.65	9.60	26 000	**BKM131914J**	—
	20	12	—	7.50	8.40	25 000	**13BTM2012J**	—
	21	14	—	9.75	10.5	25 000	**BKM132114BJ**	—
13.50	19	12	—	6.25	7.95	25 000	**BTM141912A**	—
14	19	16	13.7	11.7	23.3	8 800	—	—
	19	16	13.3	7.85	11.7	25 000	**14BTM1916B**	**14MKM1916**
	20	12	9.6	9.15	14.6	8 600	—	—
	20	12	9.3	6.10	7.20	25 000	**14BTM2012**	**14MKM2012**
	20	16	13.7	12.7	22.4	8 600	—	—
	20	16	13.3	8.75	11.4	25 000	**14BTM2016**	**14MKM2016**
	20	25	—	12.2	15.5	14 000[1]	**14BKM2025JUU**	—
	22	16	13.3	11.1	12.6	23 000	**BHTM1416**	**MHKM1416**
	22	20	17.3	14.4	17.5	23 000	**BHTM1420**	**MHKM1420**
14.50	19.50	13.50	—	7.55	10.9	25 000	**BTM152014A**	—

[Notes] 1) The limiting speeds shown above are applicable when oil seal is used and the bearing is lubricated with grease.
2) FN in bearing number indicates a bearing comprising polyamide molded cage.
3) The recommended dimensional tolerances of shaft shown above are applicable except h6.
4) The recommended dimensional tolerances of housing bore shown above are applicable except N7.

Full complement type

With open ends

With closed end



BM, BHM YM MM

Full complement type With open ends	Full complement type With closed end	Recommended dimensions (mm) Shaft dia. (h6) min.	Shaft dia. (h6) max.	Housing bore dia. (N7) min.	Housing bore dia. (N7) max.	(Refer.) Mass (g) With open ends	(Refer.) Mass (g) With closed end
—	—	11.989	12.000	17.977	17.995	7.2	8.2
12BM1812	**12MM1812**	11.989	12.000	17.977	17.995	9.7	11
—	—	11.989	12.000	17.977	17.995	7.6	8.5
—	—	11.989	12.000	17.991 [4]	18.012 [4]	12	—
—	—	11.989	12.000	17.977	17.995	11	—
—	—	11.989	12.000	18.972	18.993	10	12
—	—	11.989	12.000	18.972	18.993	13	—
—	—	11.989	12.000	18.972	18.993	17	19
—	—	11.989	12.000	18.972	18.993	21	—
—	—	12.989	12.000	16.977	16.995	7.1	—
13BM1912	—	12.989	13.000	18.972	18.993	10	—
—	—	12.989	13.000	18.972	18.993	9.5	11
—	—	12.989	13.000	18.972	18.993	11	—
—	—	12.989	13.000	19.972	19.993	11	—
—	—	12.989	13.000	20.972	20.993	15	—
—	—	13.447 [3]	13.460 [3]	19.000 [4]	19.021 [4]	9.5	—
14BM1916	**14MM1916**	13.989	14.000	18.972	18.993	12	14
—	—	13.983 [3]	13.994 [3]	18.972	18.993	11	12
14BM2012	**14MM2012**	13.989	14.000	19.972	19.993	11	12
—	—	13.989	14.000	19.972	19.993	9.8	11
14BM2016	**14MM2016**	13.989	14.000	19.972	19.993	15	17
—	—	13.989	14.000	19.972	19.993	13	15
—	—	13.989	14.000	19.972	19.993	20	—
—	—	13.989	14.000	21.972	21.993	19	21
—	—	13.989	14.000	21.972	21.993	23	26
—	—	14.489	14.500	19.472	19.493	9.5	—

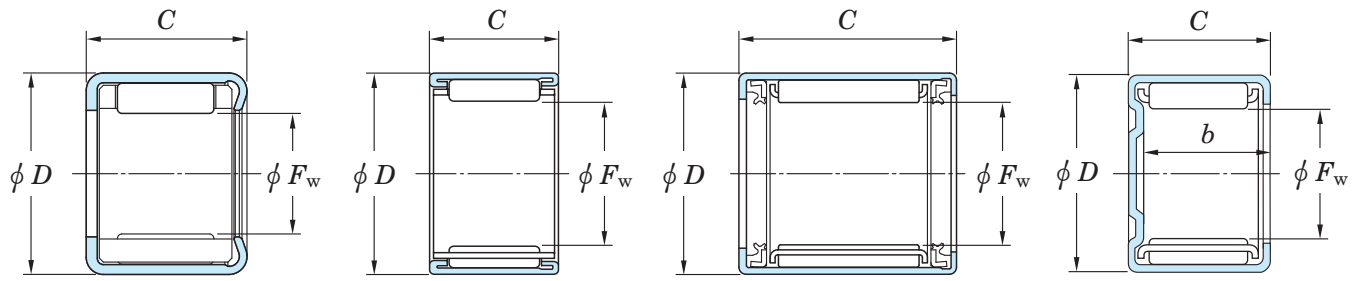
[Remark] Limiting speed of grease lubrication should be kept to under 60 % of that for oil lubrication.

Metric series
F_w 15 ~ (17) mm

Caged type

With open ends

With closed end



BFNM | BTM, BHTM | BKM | MKM, MHKM

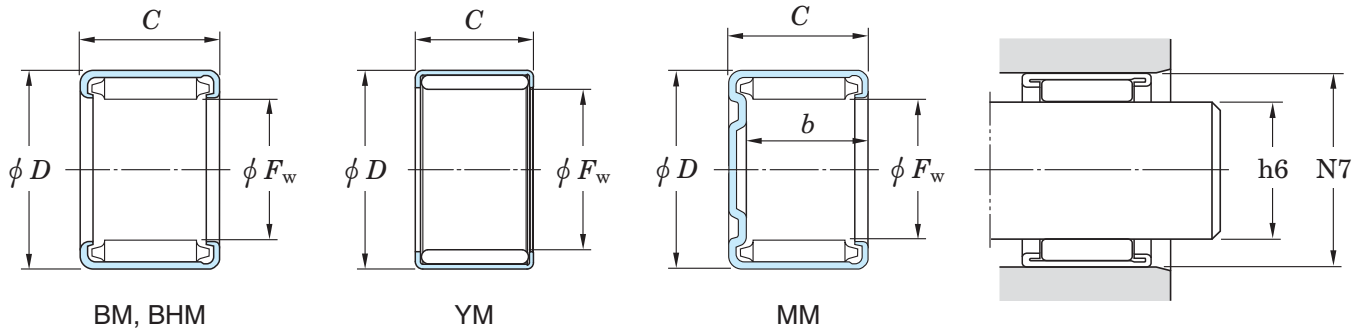
Boundary dimensions (mm)				Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No. [2]	
							Caged type	
F_w	D	C	b min.	C_r	C_{0r}	Oil lub.	With open ends	With closed end
15	20	16	—	8.15	12.6	24 000	**15BTM2016C-2**	—
	21	10	—	7.70	11.8	8 100	—	—
	21	10	—	5.25	6.25	23 000	**15BTM2110JA**	—
	21	12	9.6	9.70	15.9	8 100	—	—
	21	12	9.3	7.00	8.80	23 000	**15BTM2112-1**	**15MKM2112**
	21	16	13.7	13.4	24.2	8 100	—	—
	21	16	13.3	9.80	13.6	23 000	**15BTM2116**	**15MKM2116**
	21	22	—	13.0	19.5	23 000	**15BTM2122**	—
	22	10	8.4	6.15	6.45	23 000	**BHTM1510**	**MHKM1510**
	22	12	9.3	6.90	7.95	23 000	**BHTM1512A**	**MHKM1512**
	22	15	—	10.9	13.3	23 000	**BHTM1515-1**	—
	22	20	17.3	14.2	18.8	23 000	**BHTM1520**	**MHKM1520**
	22	25	—	17.7	25.0	23 000	**BHTM1525**	—
16	22	12	9.6	10.2	17.1	7 700	—	—
	22	12	9.3	7.60	9.80	22 000	**16BTM2212A**	**16MKM2212**
	22	16	13.7	14.1	25.9	7 700	—	—
	22	16	13.3	10.7	15.1	22 000	**16BTM2216**	**16MKM2216**
	22	22	—	16.2	22.9	22 000	**16BTM2222B**	—
	24	12	—	8.00	8.45	21 000	**BHTM1612**	—
	24	16	13.3	12.2	14.9	21 000	**BHTM1616A**	**MHKM1616**
	24.15	14	12.6	8.45	9.05	12 000 [1]	—	**MKM162414U**
17	21.50	15	10.6	6.15	9.60	22 000	**17BTM2215**	—
	22	10	—	5.05	6.90	21 000	**BTM1710**	—
	22	13	—	10.6	21.6	7 500	—	—
	23	12	9.6	10.3	17.9	7 300	—	—
	23	12	—	7.65	10.2	21 000	**BTM172312**	—
	23	20	—	18.0	36.7	7 300	—	—

[Notes] 1) The limiting speeds shown above are applicable when oil seal is used and the bearing is lubricated with grease.
2) FN in bearing number indicates a bearing comprising polyamide molded cage.
3) The recommended dimensional tolerances of shaft shown above are applicable except h6.
4) The recommended dimensional tolerances of housing bore shown above are applicable except N7.

Full complement type

With open ends

With closed end



BM, BHM YM MM

Full complement type With open ends	Full complement type With closed end	Recommended dimensions (mm) Shaft dia. (h6) min.	Shaft dia. (h6) max.	Housing bore dia. (N7) min.	Housing bore dia. (N7) max.	(Refer.) Mass (g) With open ends	(Refer.) Mass (g) With closed end
—	—	14.989	15.000	19.991 [4]	20.012 [4]	12	—
15BM2110	—	14.989	15.000	20.972	20.993	9.4	—
—	—	14.989	15.000	20.991 [4]	21.012 [4]	9.5	—
15BM2112	**15MM2112**	14.989	15.000	20.972	20.993	12	13
—	—	14.989	15.000	20.972	20.993	11	12
15BM2116	**15MM2116**	14.989	15.000	20.972	20.993	16	18
—	—	14.989	15.000	20.972	20.993	14	16
—	—	14.989	15.000	20.991 [4]	21.012 [4]	20	—
—	—	14.989	15.000	21.972	21.993	9.9	11
—	—	14.989	15.000	21.991 [4]	22.012 [4]	12	14
—	—	14.989	15.000	21.972	21.993	10	—
—	—	14.989	15.000	21.972	21.993	20	23
—	—	14.989	15.000	21.972	21.993	26	—
16BM2212	**16MM2212**	15.989	16.000	21.972	21.993	12	14
—	—	15.989	16.000	21.991 [4]	22.012 [4]	11	12
16BM2216	**16MM2216**	15.989	16.000	21.972	21.993	17	19
—	—	15.989	16.000	21.972	21.993	15	17
—	—	15.989	16.000	21.991 [4]	22.012 [4]	20	—
—	—	15.989	16.000	23.972	23.993	15	—
—	—	15.989	16.000	23.991 [4]	24.012 [4]	20	23
—	—	15.989	16.000	24.122	24.143	—	19
—	—	16.989	17.000	21.472	21.493	10	—
—	—	16.989	17.000	21.972	21.993	8.2	—
BM1713-1	—	16.989	17.000	21.972	21.993	12	—
17BM2312	**17MM2312**	16.989	17.000	22.972	22.993	13	15
—	—	16.989	17.000	22.972	22.993	12	—
17BM2320	—	16.989	17.000	22.972	22.993	23	—

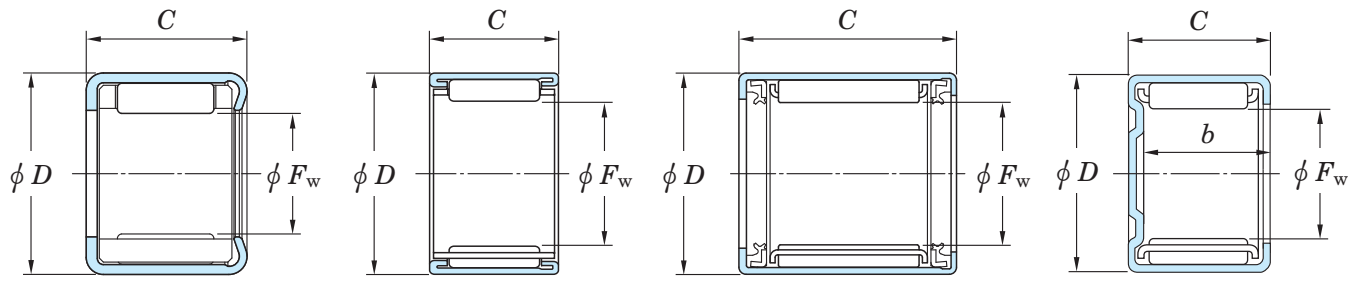
[Remark] Limiting speed of grease lubrication should be kept to under 60 % of that for oil lubrication.

Metric series
F_w (17) ~ 19 mm

Caged type

With open ends

With closed end



BFNM | BTM, BHTM | BKM | MKM, MHKM

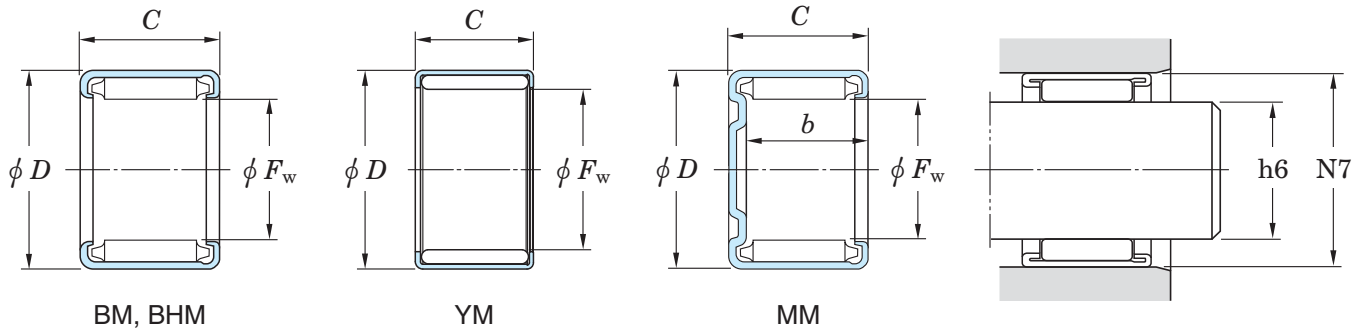
Boundary dimensions (mm)				Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No. [2]	
							Caged type	
F_w	D	C	b min.	C_r	C_{0r}	Oil lub.	With open ends	With closed end
17	24	12	—	12.8	21.0	7 200	—	—
	24	15	—	11.2	14.8	20 000	**BHTM1715-1**	—
	24	17	—	16.0	27.9	7 200	—	—
	24	20	—	12.9	17.6	11 000[1]	**BHKM1720JBU**	—
	24	20	—	19.0	21.9	7 200	—	—
	24	20	17.3	15.1	21.6	20 000	**BHTM1720-1**	**MHKM1720**
	24	25	—	23.8	46.6	7 200	—	—
	24	25	—	19.0	29.0	20 000	**BTM172425**	—
	24	26	—	16.0	23.3	11 000[1]	**BHKM1726JUU**	—
	24	30	—	20.1	31.3	11 000[1]	**BHKM1730JU**	—
	25	14	—	7.30	7.90	11 000[1]	**BKM172514UH-1**	—
	25	15	—	10.9	13.1	20 000	**BKM172515**	—
	25	16.70	—	7.30	7.90	11 000[1]	**17BKM2517JBUUH**	—
	25	18	—	10.9	13.1	11 000[1]	**BKM172518UH**	—
	25	20	—	12.9	16.3	11 000[1]	**BKM172520UH-1**	—
18	24	12	9.6	10.8	19.2	6 900	—	—
	24	12	—	7.90	10.9	20 000	**18BTM2412**	—
	24	16	13.7	16.5	29.1	6 900	—	—
	24	16	—	17.2	30.7	6 900	—	—
	24	16	—	11.1	16.8	20 000	**BTM182416**	—
	25	13	—	9.40	11.8	19 000	**BTM1813**	—
	25	15	—	10.4	9.25	19 000	**BTM1815**	—
	25	17	—	12.2	17.7	19 000	**BTM1817A**	—
	25	19	—	14.4	20.5	19 000	**BTM1819**	—
	25	20	17.3	15.2	22.1	19 000	**BTM182520**	**MKM1820**
	25	25	—	18.9	29.2	19 000	**BTM1825A**	—
19	27	20	—	17.0	23.4	18 000	**BHTM1920**	—

[Notes] 1) The limiting speeds shown above are applicable when oil seal is used and the bearing is lubricated with grease.
2) FN in bearing number indicates a bearing comprising polyamide molded cage.
3) The recommended dimensional tolerances of shaft shown above are applicable except h6.
4) The recommended dimensional tolerances of housing bore shown above are applicable except N7.

Full complement type

With open ends

With closed end



BM, BHM YM MM

Full complement type With open ends	With closed end	Recommended dimensions (mm) Shaft dia. (h6) min.	max.	Housing bore dia. (N7) min.	max.	(Refer.) Mass (g) With open ends	With closed end
YM172412-1	—	16.983 3)	16.994 3)	23.985 4)	24.006 4)	17	—
—	—	16.989	17.000	23.972	23.993	17	—
BM172417-1	—	16.989	17.000	23.991 4)	24.012 4)	23	—
—	—	16.989	17.000	23.972	23.993	22	—
BHM1720A	—	16.983 3)	16.994 3)	23.985 4)	24.006 4)	27	—
—	—	16.989	17.000	23.972	23.993	24	27
BHM1725	—	16.989	17.000	23.991 4)	24.012 4)	35	—
—	—	16.983 3)	16.994 3)	23.972	23.993	22	—
—	—	16.999	17.000	23.972	23.993	29	—
—	—	16.989	17.000	23.972	23.993	35	—
—	—	16.989	17.000	24.991 4)	25.012 4)	18	—
—	—	16.989	17.000	24.991 4)	25.012 4)	20	—
—	—	16.989	17.000	24.972	24.993	20	—
—	—	16.989	17.000	24.991 4)	25.012 4)	24	—
—	—	16.989	17.000	24.991 4)	25.012 4)	27	—
18BM2412	**18MM2412**	17.989	18.000	23.972	23.993	17	20
—	—	17.989	18.000	23.991 4)	24.012 4)	12	—
18BM2416	**18MM2416**	17.989	18.000	23.972	23.993	18	21
18YM2416	—	17.989	18.000	23.972	23.993	19	—
—	—	17.989	18.000	23.972	23.993	17	—
—	—	17.989	18.000	24.972	24.993	15	—
—	—	17.989	18.000	24.972	24.993	18	—
—	—	17.989	18.000	24.991 4)	25.012 4)	20	—
—	—	17.989	18.000	24.972	24.993	22	—
—	—	17.989	18.000	24.972	24.993	24	27
—	—	17.989	18.000	24.972	24.993	29	—
—	—	18.987	19.000	26.972	26.993	30	—

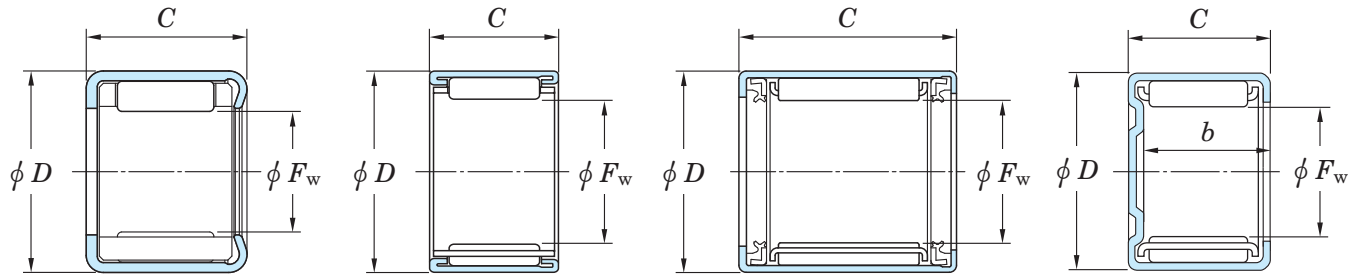
[Remark] Limiting speed of grease lubrication should be kept to under 60 % of that for oil lubrication.

Metric series
F_w 19.50 ~ (22) mm

Caged type

With open ends

With closed end



BFNM | BTM, BHTM | BKM | MKM, MHKM

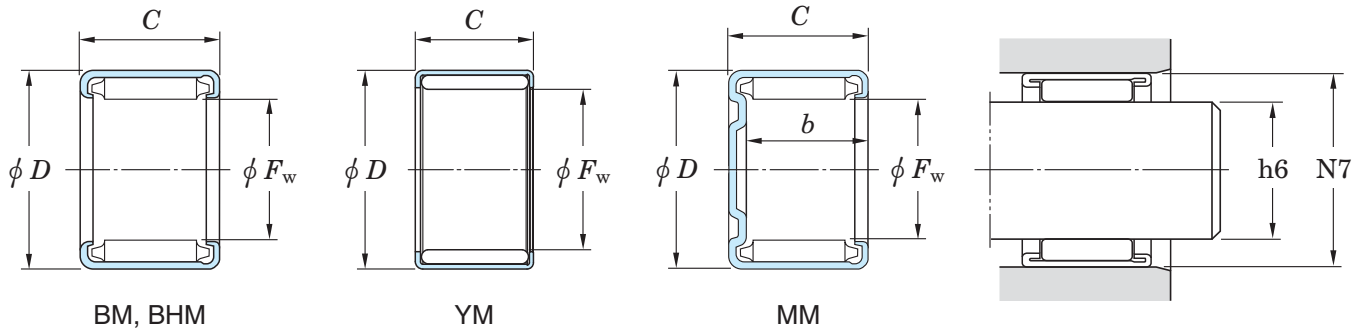
Boundary dimensions (mm)				Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No. [2]	
							Caged type	
F_w	D	C	b min.	C_r	C_{0r}	Oil lub.	With open ends	With closed end
19.50	29	20	—	18.8	23.6	17 000	**20BTM2920**	—
20	26	12	9.6	10.6	20.4	6 300	—	—
	26	12	9.3	8.50	12.6	18 000	**20BTM2612**	**20MKM2612**
	26	14	—	15.1	31.4	6 300	—	—
	26	16	13.7	14.8	31.4	6 300	—	—
	26	16	13.3	12.4	20.3	18 000	**BTM202616**	**20MKM2616**
	26	20	17.2	18.8	42.5	6 300	—	—
	26	20	—	15.2	26.4	18 000	**20BTM2620A**	—
	27	13	10.6	13.1	22.2	6 200	—	—
	27	15	—	15.6	27.7	6 200	—	—
	27	15	—	13.1	18.7	18 000	**BTM2015**	—
	27	20	17.3	17.7	27.6	18 000	**BTM202720-1**	**MKM2020**
	27	23.50	—	18.4	28.8	10 000 [1]	**BKM2024JAU**	—
	27	25	—	22.1	36.6	18 000	**BTM202725**	—
	27	26	—	18.4	28.8	10 000 [1]	**BKM2026JUU**	—
	27	26	—	27.6	58.0	6 200	—	—
	27	30	—	21.8	36.0	10 000 [1]	**BKM2030JUU**	—
	27	30	27.3	25.4	43.8	18 000	**BTM202730**	**MKM2030**
	27	35	—	28.7	45.4	10 000 [1]	**BKM2035JUU**	—
	28	20	—	17.4	22.3	17 000	**20BTM2820A**	—
21	27	20	—	20.5	47.6	6 100	—	—
22	28	12	9.6	11.6	22.9	5 800	—	—
	28	12	9.3	9.10	13.5	16 000	**22BTM2812**	**22MKM2812**
	28	16	13.7	16.1	35.0	5 800	—	—
	28	16	13.3	12.7	20.8	16 000	**22BTM2816A**	**22MKM2816**
	28	20	17.2	20.3	47.2	5 800	—	—

[Notes] 1) The limiting speeds shown above are applicable when oil seal is used and the bearing is lubricated with grease.
2) FN in bearing number indicates a bearing comprising polyamide molded cage.
3) The recommended dimensional tolerances of shaft shown above are applicable except h6.
4) The recommended dimensional tolerances of housing bore shown above are applicable except N7.

Full complement type

With open ends

With closed end



BM, BHM YM MM

Full complement type With open ends	Full complement type With closed end	Recommended dimensions (mm) Shaft dia. (h6) min.	Shaft dia. (h6) max.	Housing bore dia. (N7) min.	Housing bore dia. (N7) max.	(Refer.) Mass (g) With open ends	(Refer.) Mass (g) With closed end
—	—	19.487	19.500	28.972	28.993	36	—
20BM2612	**20MM2612**	19.987	20.000	25.972	25.993	15	17
—	—	19.987	20.000	25.972	25.993	14	16
YM202614	—	19.987	20.000	25.972	25.993	19	—
20BM2616	**20MM2616**	19.987	20.000	25.972	25.993	21	23
—	—	19.987	20.000	25.972	25.993	19	21
20BM2620	**20MM2620**	19.987	20.000	25.972	25.993	26	30
—	—	19.987	20.000	25.972	25.993	24	—
BM2013	**MM2013**	19.987	20.000	26.972	26.993	18	21
BM2015	—	19.987	20.000	26.972	26.993	22	—
—	—	19.870	20.000	26.972	26.993	20	—
—	—	19.987	20.000	26.972	26.993	25	28
—	—	19.987	20.000	26.972	26.993	32	—
—	—	19.987	20.000	26.972	26.993	33	—
—	—	19.987	20.000	26.972	26.993	33	—
BM2026	—	19.987	20.000	26.972	26.993	40	—
—	—	19.987	20.000	26.972	26.993	38	—
—	—	19.987	20.000	26.972	26.993	40	45
—	—	19.987	20.000	26.972	26.993	45	—
—	—	19.987	20.000	27.991 [4)]	28.012 [4)]	31	—
21YM2720J	—	20.987	21.000	26.972	26.993	29	—
22BM2812	**22MM2812**	21.987	22.000	27.972	27.993	16	18
—	—	21.987	22.000	27.972	27.993	14	16
22BM2816	**22MM2816**	21.987	22.000	27.972	27.993	22	25
—	—	21.987	22.000	27.972	27.993	19	22
22BM2820	**22MM2820**	21.987	22.000	27.972	27.993	29	32

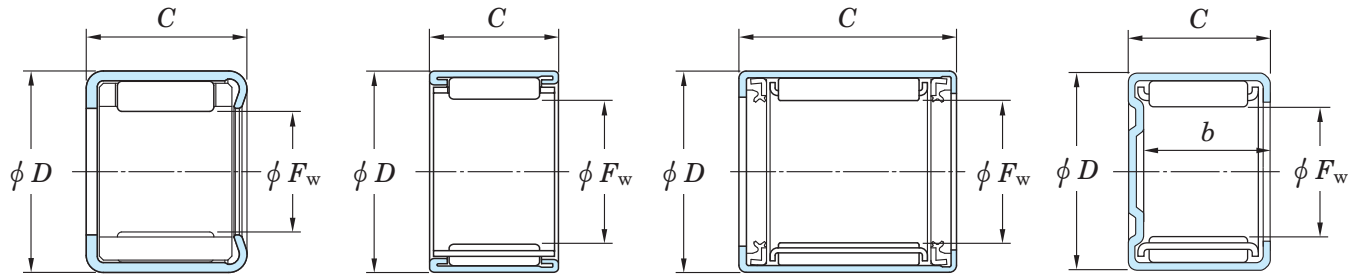
[Remark] Limiting speed of grease lubrication should be kept to under 60 % of that for oil lubrication.

Metric series
F_w (22) ~ (25) mm

Caged type

With open ends

With closed end



BFNM | BTM, BHTM | BKM | MKM, MHKM

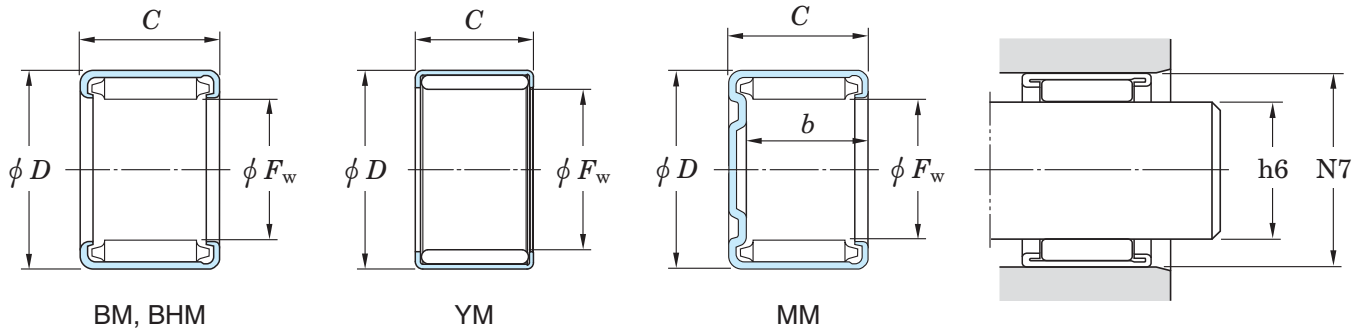
Boundary dimensions (mm)				Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No. [2]	
F_w	D	C	b min.	C_r	C_{0r}	Oil lub.	Caged type With open ends	With closed end
22	28	20	17.3	14.9	26.5	17 000	**22BTM2820**	**22MKM2820**
	28	20	—	21.0	49.5	5 800	—	—
	29	12	—	9.22	13.0	16 000	**BTM2212**	—
	29	15	—	12.0	18.3	16 000	**BTM2215**	—
	29	20	—	21.9	45.2	5 700	—	—
	29	20	17.3	16.2	26.7	16 000	**BTM2220A**	**MKM2220**
	29	25	—	20.4	36.1	16 000	**BTM2225**	—
	30	18	—	16.7	24.5	16 000	**22BTM3018**	—
24	30	13	—	9.55	15.7	15 000	**BTM243013J**	—
	31	20	17.3	17.7	29.4	15 000	**BTM2420**	**MKM2420**
	31	25	—	31.6	65.4	5 200	—	—
	31	28	—	23.9	43.0	15 000	**BTM2428**	—
	35	20	18.0	21.0	25.8	14 000	—	**24MKM3520**
25	31	19	—	16.3	30.1	15 000	**25BTM3119A**	—
	32	12	9.3	9.05	12.4	14 000	**BTM2512**	**MKM2512**
	32	16	—	18.7	37.9	5 100	—	—
	32	16	13.3	15.3	24.6	14 000	**BTM2516**	**MKM2516**
	32	20	17.2	23.8	51.7	5 100	—	—
	32	20	—	19.1	32.5	14 000	**BTM2520A**	**MTM2520M**
	32	26	—	30.9	72.4	5 100	—	—
	32	26	23.3	23.7	43.1	14 000	**BTM2526**	**MKM2526**
	33	10	—	8.50	10.3	14 000	**BHTM2510A**	—
	33	15	—	19.5	32.0	5 000	—	—
	33	15	—	13.9	19.7	14 000	**BHTM2515-1**	—
	33	20	17.3	19.2	29.7	14 000	**BHTM2520-1**	**MHKM2520**
	33	25	—	31.3	66.3	5 000	—	—
	33	25	—	24.5	40.6	14 000	**BHTM2525**	—

[Notes] 1) The limiting speeds shown above are applicable when oil seal is used and the bearing is lubricated with grease.
2) FN in bearing number indicates a bearing comprising polyamide molded cage.
3) The recommended dimensional tolerances of shaft shown above are applicable except h6.
4) The recommended dimensional tolerances of housing bore shown above are applicable except N7.

Full complement type

With open ends

With closed end



BM, BHM YM MM

Full complement type		Recommended dimensions (mm)				(Refer.) Mass (g)	
		Shaft dia. (h6)		Housing bore dia. (N7)			
With open ends	With closed end	min.	max.	min.	max.	With open ends	With closed end
—	—	21.987	22.000	27.972	27.993	25	28
YM222820	—	21.987	22.000	27.972	27.993	30	—
—	—	21.987	22.000	28.972	28.993	19	—
—	—	21.987	22.000	28.972	28.993	22	—
BM2220B	—	21.987	22.000	28.972	28.993	33	—
—	—	21.987	22.000	28.972	28.993	30	33
—	—	21.987	22.000	28.972	28.993	37	—
—	—	21.987	22.000	29.972	29.993	31	—
—	—	23.987	24.000	29.991 [4]	30.012 [4]	47	—
—	—	23.987	24.000	30.967	30.992	31	35
BM2425A	—	23.987	24.000	30.989 [4]	31.014 [4]	45	—
—	—	23.987	24.000	30.967	30.992	44	—
—	—	23.987	24.000	34.967	34.992	—	52
—	—	24.987	25.000	30.967	30.992	26	—
—	—	24.987	25.000	31.967	31.992	19	21
BM2516	—	24.987	25.000	31.967	31.992	28	—
—	—	24.987	25.000	31.967	31.992	26	30
BM2520	**MM2520**	24.987	25.000	31.967	31.992	36	41
—	—	24.987	25.000	31.967	31.992	33	—
BM2526	—	24.987	25.000	31.967	31.992	48	—
—	—	24.987	25.000	31.967	31.992	42	48
—	—	24.987	25.000	32.989 [4]	33.014 [4]	18	—
BHM2515	—	24.987	25.000	32.989 [4]	33.014 [4]	30	—
—	—	24.987	25.000	32.967	32.992	27	—
—	—	24.987	25.000	32.967	32.992	37	41
BHM2525	—	24.987	25.000	32.967	32.992	53	—
—	—	24.987	25.000	32.967	32.992	46	—

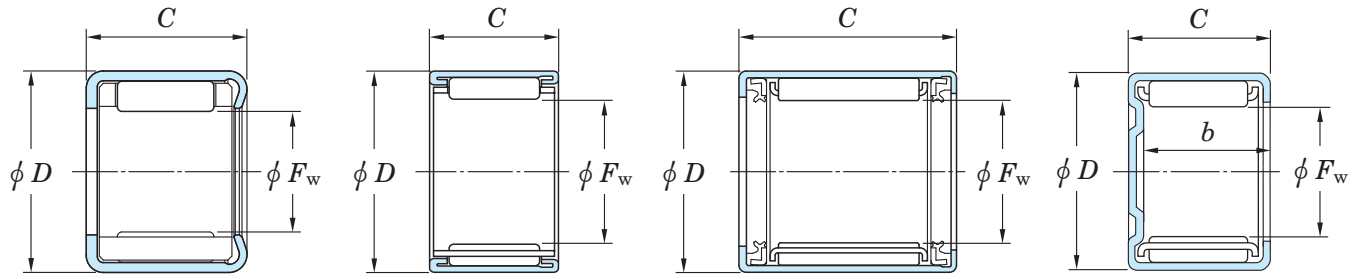
[Remark] Limiting speed of grease lubrication should be kept to under 60 % of that for oil lubrication.

Metric series
F_w (25) ~ (30) mm

Caged type

With open ends

With closed end



BFNM | BTM, BHTM | BKM | MKM, MHKM

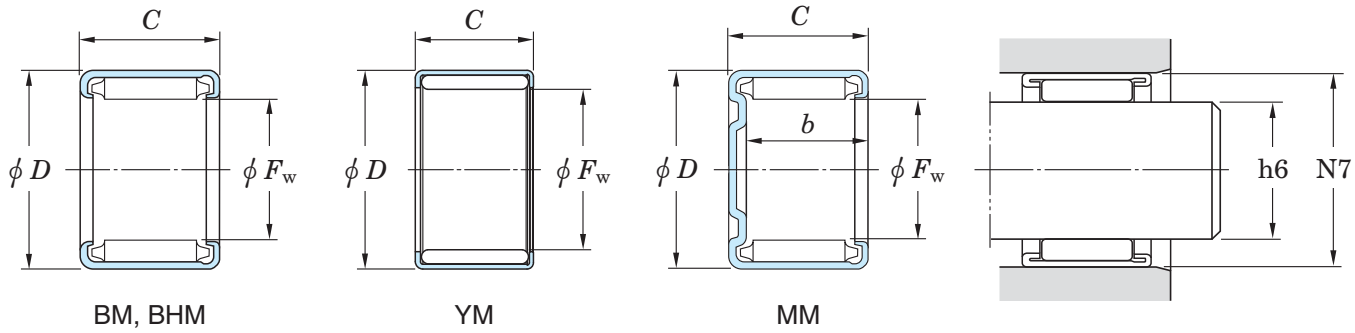
Boundary dimensions (mm)				Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No. [2]	
							Caged type	
F_w	D	C	b min.	C_r	C_{0r}	Oil lub.	With open ends	With closed end
25	33	30	—	37.4	83.3	5 000	—	—
	33	30	27.3	27.7	47.4	14 000	**BHTM2530-1**	**MHKM2530**
	33	35	—	29.8	52.3	8 000[1]	**BHKM2535JU**	—
25.80	33	16	—	14.2	22.4	14 000	**BTM263316A**	—
26	31.40	12	—	8.60	14.5	14 000	**BKM263112A**	—
	34	16	13.3	15.3	22.5	14 000	**BHTM2616**	**MHKM2616**
	34	20	17.3	20.0	31.6	14 000	**BHTM2620A**	**MHKM2620**
28	34	17	—	16.8	49.7	4 600	—	—
	34	24	—	29.0	76.7	4 600	—	—
	34	25	—	34.8	85.9	4 600	—	—
	35	16	13.7	20.2	42.9	4 600	—	—
	35	16	13.3	15.9	26.2	13 000	**28BTM3516**	**28MKM3516**
	35	20	17.2	25.7	58.3	4 600	—	—
	35	20	17.3	19.0	33.1	13 000	**28BTM3520**	**28MKM3520**
	36	20.75	—	22.8	39.3	13 000	**BTM283621JA**	—
	36	23	—	22.8	39.3	13 000	**BTM283623J**	—
	37	20	17.3	21.6	33.0	13 000	**BTM283720**	**MHKM2820**
	37	30	—	43.7	94.7	4 400	—	—
	37	30	27.3	32.8	56.5	13 000	**BHTM2830**	**MHKM2830**
	39	30	—	44.5	85.9	4 300	—	—
30	37	12	9.3	12.1	18.8	12 000	**BTM303712**	**30MKM3712**
	37	16	—	21.1	28.2	4 300	—	—
	37	16	13.3	17.1	29.3	12 000	**30BTM3716BM**	**30MKM3716**
	37	20	17.2	26.8	62.5	4 300	—	—
	37	20	17.3	20.7	40.4	12 000	**30BTM3720**	**30MKM3720**
	37	20	—	32.2	70.1	4 300	—	—

[Notes] 1) The limiting speeds shown above are applicable when oil seal is used and the bearing is lubricated with grease.
2) FN in bearing number indicates a bearing comprising polyamide molded cage.
3) The recommended dimensional tolerances of shaft shown above are applicable except h6.
4) The recommended dimensional tolerances of housing bore shown above are applicable except N7.

Full complement type

With open ends

With closed end



BM, BHM YM MM

Full complement type With open ends	With closed end	Recommended dimensions (mm) Shaft dia. (h6) min.	max.	Housing bore dia. (N7) min.	max.	(Refer.) Mass (g) With open ends	With closed end
BHM2530	—	24.987	25.000	32.989 [4]	33.014 [4]	65	—
—	—	24.987	25.000	32.967	32.992	54	61
—	—	24.987	25.000	32.967	32.992	62	—
—	—	25.787	25.800	32.967	32.992	28	—
—	—	25.987	26.000	31.389 [4]	31.414 [4]	14	—
—	—	25.987	26.000	33.967	33.992	30	34
—	—	25.987	26.000	33.967	33.992	38	43
BM2817	—	27.987	28.000	33.967	33.992	29	—
BM2824	—	27.987	28.000	33.967	33.992	42	—
YM2825B	—	27.991 [3]	28.000 [3]	33.975 [4]	34.000 [4]	45	—
28BM3516	**28MM3516**	27.987	28.000	34.967	34.992	95	107
—	—	27.987	28.000	34.967	34.992	28	31
28BM3520	**28MM3520**	27.987	28.000	34.967	34.992	118	133
—	—	27.987	28.000	34.967	34.992	35	39
—	—	27.987	28.000	35.967	35.992	43	—
—	—	27.987	28.000	35.967	35.992	49	—
—	—	27.987	28.000	36.967	36.992	46	52
28BHM3730	—	27.980 [3]	27.993 [3]	36.989 [4]	37.014 [4]	80	—
—	—	27.987	28.000	36.967	36.992	70	79
BM283930A	—	27.980 [3]	27.993 [3]	38.989 [4]	39.014 [4]	100	—
—	—	29.987	30.000	36.967	36.992	22	25
30BM3716	—	29.987	30.000	36.967	36.992	33	—
—	—	29.987	30.000	36.967	36.992	30	33
30BM3720	**30MM3720**	29.987	30.000	36.967	36.992	42	48
—	—	29.987	30.000	36.967	36.992	40	45
30YM3720	—	29.987	30.000	36.967	36.992	45	—

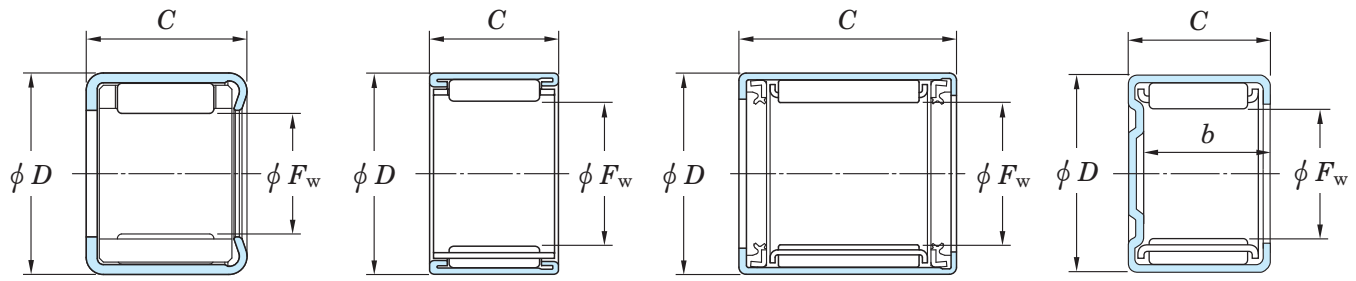
[Remark] Limiting speed of grease lubrication should be kept to under 60 % of that for oil lubrication.

Metric series
F_w (30) ~ (35) mm

Caged type

With open ends

With closed end



BFNM | BTM, BHTM | BKM | MKM, MHKM

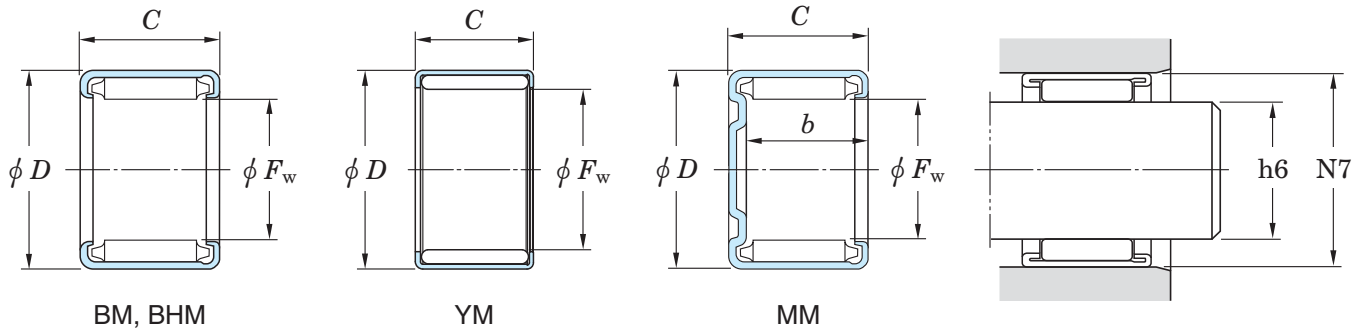
Boundary dimensions (mm)				Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No. [2]	
							Caged type	
F_w	D	C	b min.	C_r	C_{0r}	Oil lub.	With open ends	With closed end
30	37	26	—	34.8	87.3	4 300	—	—
	37	26	23.3	26.7	52.0	12 000	**30BTM3726**	**30MKM3726**
	37	26	—	37.1	94.9	4 300	—	—
	38	21	—	23.4	40.4	12 000	**BTM3021A**	—
	38	25	—	38.0	79.8	4 200	—	—
	40	15	—	16.6	22.3	12 000	**BHTM3015**	—
	40	20	17.3	23.1	34.0	12 000	**BHTM3020**	**MHKM3020**
	40	25	—	37.3	75.4	4 100	—	—
	40	25	—	29.4	46.5	12 000	**BHTM3025-1**	—
	40	30	27.3	35.3	58.8	12 000	**BHTM3030-1A**	**MHKM3030**
	40	30	—	30.8	49.3	6 600 [1]	**BKM304030JU**	—
31	39	17.80	—	20.6	34.6	12 000	**31BTM3918A**	—
32	38	11	—	4.90	6.75	12 000	**32BTM3811A**	—
	40	20	—	31.9	73.3	4 000	—	—
	40	25	—	27.6	50.8	11 000	**32BTM4025PL**	—
	42	20	17.3	23.4	34.8	11 000	**BHTM3220A**	**MHKM3220**
	42	20	—	37.4	69.1	3 900	—	—
	42	30	27.3	36.6	61.9	11 000	**BHTM3230**	**MHKM3230**
	42	30	—	55.0	113	3 900	—	—
33.50	40	17	—	16.8	33.5	11 000	**BTM344017A**	—
34	40	12	—	7.30	11.7	11 000	**34BTM4012A**	—
	42	25	—	37.2	94.1	3 800	—	—
35	40.50	26	—	22.7	56.0	11 000	**BSM354126AJ**	—
	42	12	—	13.3	22.8	11 000	**BTM3512**	—
	42	16	—	22.2	52.9	3 700	—	—

[Notes] 1) The limiting speeds shown above are applicable when oil seal is used and the bearing is lubricated with grease.
2) FN in bearing number indicates a bearing comprising polyamide molded cage.
3) The recommended dimensional tolerances of shaft shown above are applicable except h6.
4) The recommended dimensional tolerances of housing bore shown above are applicable except N7.

Full complement type

With open ends

With closed end



BM, BHM YM MM

Full complement type With open ends	Full complement type With closed end	Recommended dimensions (mm) Shaft dia. (h6) min.	Shaft dia. (h6) max.	Housing bore dia. (N7) min.	Housing bore dia. (N7) max.	(Refer.) Mass (g) With open ends	(Refer.) Mass (g) With closed end
30BM3726	—	29.987	30.000	36.967	36.992	56	—
—	—	29.987	30.000	36.967	36.992	48	55
30YM3726	—	29.987	30.000	36.967	36.992	60	—
—	—	29.987	30.000	37.967	37.992	45	—
BM3025	—	29.987	30.000	37.989 [4]	38.014 [4]	62	—
—	—	29.987	30.000	39.967	39.992	41	—
—	—	29.987	30.000	39.967	39.992	55	62
BHM3025	—	29.987	30.000	39.987 [4]	40.013 [4]	80	—
—	—	29.987	30.000	39.967	39.992	69	—
—	—	29.987	30.000	39.967	39.992	83	94
—	—	29.987	30.000	39.967	39.992	77	—
—	—	30.984	31.000	38.967	38.992	39	—
—	—	31.975 [3]	31.991 [3]	38.000 [4]	38.025 [4]	15	—
32YM4020P	—	31.984	32.000	39.989 [4]	40.014 [4]	56	—
—	—	31.984	32.000	39.989 [4]	40.014 [4]	57	—
—	—	31.984	32.000	41.989 [4]	42.014 [4]	57	64
YM3220	—	31.995 [3]	32.011 [3]	41.989 [4]	42.014 [4]	71	—
—	—	31.984	32.000	41.967	41.992	86	98
YM3230	—	31.995 [3]	32.011 [3]	41.989 [4]	42.014 [4]	109	—
—	—	33.484	33.500	39.967	39.992	34	—
—	—	33.984	34.000	39.967	39.992	20	—
34YM4225	—	33.959 [3]	33.975 [3]	41.967	41.992	74	—
—	—	34.984	35.000	40.467	40.492	44	—
—	—	34.984	35.000	41.967	41.992	26	—
BM3516	—	34.984	35.000	41.967	41.992	38	—

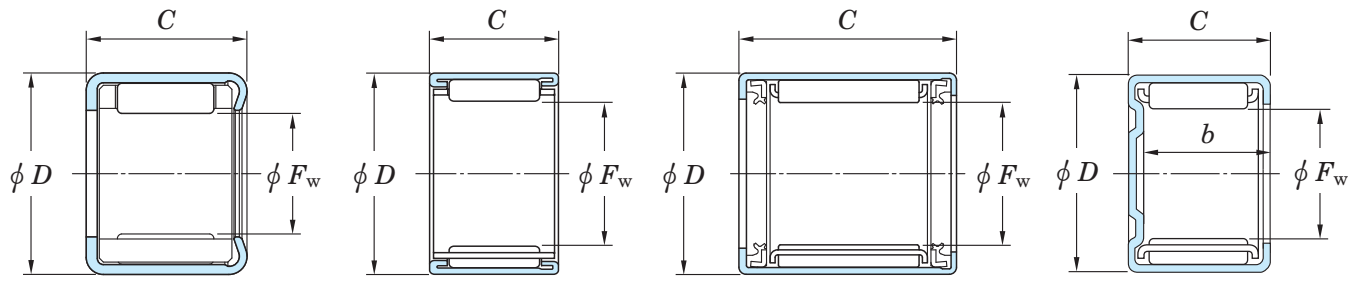
[Remark] Limiting speed of grease lubrication should be kept to under 60 % of that for oil lubrication.

Metric series
F_w (35) ~ (40) mm

Caged type

With open ends

With closed end



BFNM | BTM, BHTM | BKM | MKM, MHKM

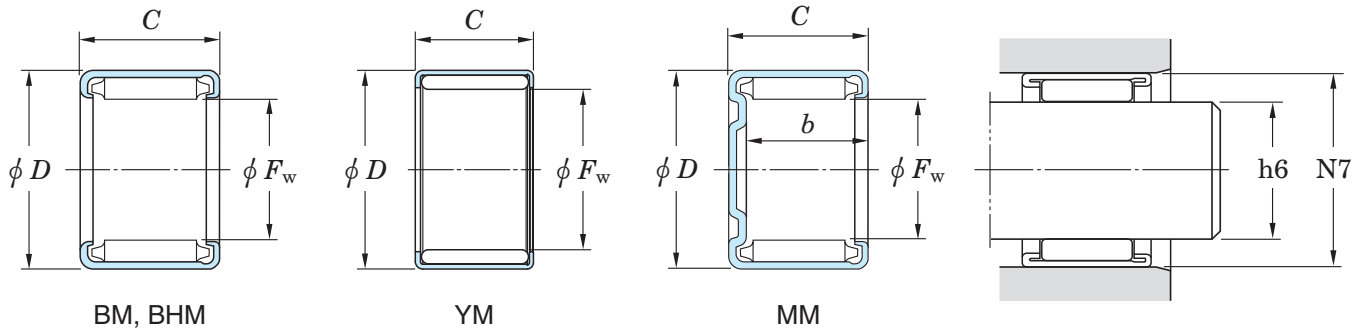
Boundary dimensions (mm)				Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No. [2]	
							Caged type	
F_w	D	C	b min.	C_r	C_{0r}	Oil lub.	With open ends	With closed end
35	42	16	13.3	18.5	34.7	11 000	**BTM3516**	**MKM3516**
	42	20	—	13.3	22.8	5 700[1]	**BKM354220-1UU**	—
	42	20	17.2	28.2	72.2	3 700	—	—
	42	20	17.3	23.4	47.0	11 000	**BTM3520**	**MKM3520**
	42	21	—	28.8	79.2	3 700	—	—
	42	26	—	36.7	101	3 700	—	—
	42	26	23.3	30.1	65.2	11 000	**BTM3526**	**MKM3526**
	42	28	—	31.3	68.6	11 000	**BTM3528**	—
	42	46	—	26.2	57.5	5 700[1]	**BKM354246UUH**	—
	45	15	—	18.4	26.6	10 000	**BHTM3515**	—
	45	18	—	20.5	33.4	3 600	—	—
	45	20	17.3	26.0	41.7	10 000	**BHTM3520**	**MHKM3520**
	45	25	—	32.8	56.2	10 000	**BHTM3525**	—
	45	30	27.3	39.4	71.0	10 000	**BHTM3530**	**MHKM3530**
36	42	16	—	19.6	55.9	3 700	—	—
	44	25	—	42.0	99.2	3 600	—	—
	48	24	—	33.2	48.7	9 800	**36BTM4824**	—
37	43	12	—	8.00	13.6	10 000	**37BTM4312A**	—
	47	20	17.3	25.1	39.9	9 800	**BTM3720**	**MKM3720**
	47	30	27.3	38.2	68.4	9 800	**BTM3730**	**MKM3730**
38	45	12	—	12.7	23.0	9 800	**BTM384512A**	—
	48	20	17.3	27.1	44.5	9 500	**BTM3820A**	**MKM3820**
	48	20	—	42.0	82.8	3 300	—	—
	48	30	27.3	41.2	76.2	9 500	**BTM3830PL**	**MKM3830**
	48	45	—	58.9	121	9 500	**BTM3845-OH**	—
40	47	12	—	9.75	10.4	9 400	**40BTM4712A**	—

[Notes] 1) The limiting speeds shown above are applicable when oil seal is used and the bearing is lubricated with grease.
2) FN in bearing number indicates a bearing comprising polyamide molded cage.
3) The recommended dimensional tolerances of shaft shown above are applicable except h6.
4) The recommended dimensional tolerances of housing bore shown above are applicable except N7.

Full complement type

With open ends

With closed end



BM, BHM YM MM

Full complement type With open ends	Full complement type With closed end	Recommended dimensions (mm) Shaft dia. (h6) min.	Shaft dia. (h6) max.	Housing bore dia. (N7) min.	Housing bore dia. (N7) max.	(Refer.) Mass (g) With open ends	(Refer.) Mass (g) With closed end
—	—	34.984	35.000	41.967	41.992	35	39
—	—	34.984	35.000	41.967	41.992	38	—
BM3520	**MM3520**	34.984	35.000	41.967	41.992	49	56
—	—	34.984	35.000	41.989 [4]	42.014 [4]	43	49
YM3521A	—	34.984	35.000	41.989 [4]	42.014 [4]	55	—
BM3526	—	34.984	35.000	41.967	41.992	66	—
—	—	34.984	35.000	41.967	41.992	57	64
—	—	34.984	35.000	41.967	41.992	63	—
—	—	34.984	35.000	41.967	41.992	101	—
—	—	34.984	35.000	44.967	44.992	47	—
BHM3518	—	34.984	35.000	44.967	44.992	62	—
—	—	34.984	35.000	44.967	44.992	64	72
—	—	34.984	35.000	44.967	44.992	80	—
—	—	34.984	35.000	44.967	44.992	96	109
36BM4216	—	35.984	36.000	41.967	41.992	35	—
36YM4425L	—	35.975 [3]	35.991 [3]	43.967	43.992	78	—
—	—	35.984	36.000	47.967	47.992	95	—
—	—	36.984	37.000	42.967	42.992	23	—
—	—	36.984	37.000	46.967	46.992	64	72
—	—	36.984	37.000	46.967	46.992	96	109
—	—	37.984	38.000	44.967	44.992	29	—
—	—	37.984	38.000	47.967	47.992	67	76
YM3820P	—	37.984	38.000	47.967	47.992	82	—
—	—	37.984	38.000	47.967	47.992	102	115
—	—	37.984	38.000	47.967	47.992	151	—
—	—	39.984	40.000	46.967	46.992	27	—

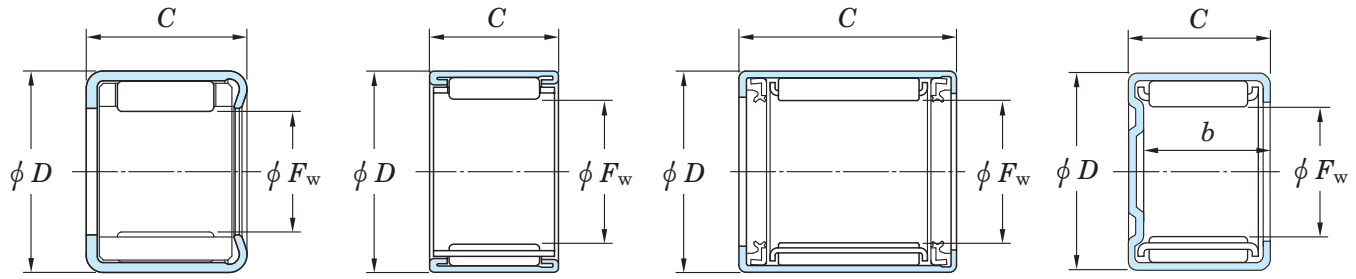
[Remark] Limiting speed of grease lubrication should be kept to under 60 % of that for oil lubrication.

Metric series
F_w (40) ~ 45 mm

Caged type

With open ends

With closed end



BFNM | BTM, BHTM | BKM | MKM, MHKM

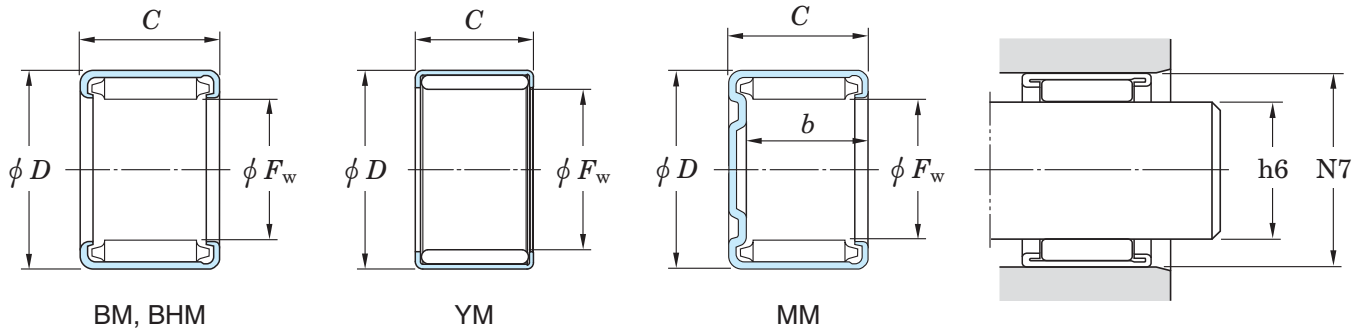
Boundary dimensions (mm)				Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No. [2]	
							Caged type	
F_w	D	C	b min.	C_r	C_{0r}	Oil lub.	With open ends	With closed end
40	47	16	—	23.8	60.5	3 300	—	—
	47	16	13.3	18.7	37.1	9 400	**40BTM4716**	**40MKM4716**
	47	20	17.2	30.3	82.6	3 300	—	—
	47	20	17.3	23.7	50.4	9 400	**40BTM4720**	**40MKM4720**
	50	15	—	23.4	45.2	3 200	—	—
	50	15	—	20.2	31.2	9 100	**BTM4015**	—
	50	20	17.3	28.5	48.5	9 100	**BTM4020**	**MKM4020**
	50	25	—	36.2	66.2	9 100	**BTM4025**	—
	50	30	27.3	43.0	82.5	9 100	**BTM4030-1**	**MKM4030**
	50	40	—	54.8	113	9 100	**BTM4040-OH**	—
	51	20	—	40.2	84.7	3 200	—	—
	51	30	—	43.5	76.6	9 000	**40BTM5130J**	—
	53	20	—	46.7	87.3	3 100	—	—
41.50	46.50	8.50	—	7.00	13.9	9 200	**BTM424709AJ**	—
42	53	30	—	45.7	83.9	8 600	**BTM425330J**	—
43	49	12	—	8.35	15.1	8 800	**43BTM4912A**	—
43.52	48.52	14	—	12.0	29.0	8 800	**44BTM4914A**	—
45	52	12	—	13.7	26.9	8 400	**45BTM5212A**	—
	52	16	—	23.8	65.9	2 900	—	—
	52	16	13.3	19.1	41.3	8 400	**45BTM5216**	**45MKM5216**
	52	20	17.2	30.4	90.1	2 900	—	—
	52	20	17.3	23.3	33.4	8 200	**45BTM5220A**	**MKM4520**
	52	30	27.3	45.3	91.7	8 200	**BTM4530**	**MKM4530**
	55	20	—	30.0	53.9	8 200	**BTM4520A**	—

[Notes] 1) The limiting speeds shown above are applicable when oil seal is used and the bearing is lubricated with grease.
2) FN in bearing number indicates a bearing comprising polyamide molded cage.
3) The recommended dimensional tolerances of shaft shown above are applicable except h6.
4) The recommended dimensional tolerances of housing bore shown above are applicable except N7.

Full complement type

With open ends

With closed end



BM, BHM YM MM

Full complement type With open ends	With closed end	Recommended dimensions (mm) Shaft dia. (h6) min.	max.	Housing bore dia. (N7) min.	max.	(Refer.) Mass (g) With open ends	With closed end
40BM4716	—	39.984	40.000	46.967	46.992	43	—
—	—	39.984	40.000	46.967	46.992	39	44
40BM4720	**40MM4720**	39.984	40.000	46.967	46.992	56	63
—	—	39.984	40.000	46.967	46.992	48	55
BM4015-1	—	39.984	40.000	49.967	49.992	55	—
—	—	39.984	40.000	49.967	49.992	54	—
—	—	39.984	40.000	49.967	49.992	73	82
—	—	39.984	40.000	49.967	49.992	91	—
—	—	39.984	40.000	49.967	49.992	109	123
—	—	39.984	40.000	49.967	49.992	141	—
YM405120J	—	39.984	40.000	50.961	50.991	96	—
—	—	39.984	40.000	50.961	50.991	112	—
YM405320JM	—	39.984	40.000	52.961	52.991	114	—
—	—	41.484	41.500	46.467	46.492	15	—
—	—	41.984	42.000	52.961	52.991	121	—
—	—	42.984	43.000	48.989 [4)]	49.014 [4)]	25	—
—	—	43.504	43.520	48.487	48.512	28	—
—	—	44.984	45.000	51.961	51.991	34	—
45BM5216	—	44.984	45.000	51.961	51.991	49	—
—	—	44.984	45.000	51.961	51.991	45	51
45BM5220	**45MM5220**	44.984	45.000	51.961	51.991	62	71
—	—	44.984	45.000	54.961	54.991	79	90
—	—	44.984	45.000	54.961	54.991	120	136
—	—	44.984	45.000	54.961	54.991	79	—

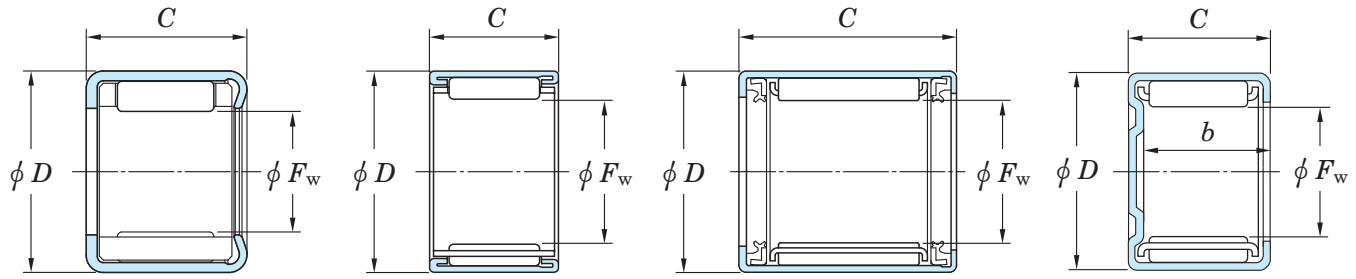
[Remark] Limiting speed of grease lubrication should be kept to under 60 % of that for oil lubrication.

Metric series
F_w 48 ~ 76.50 mm

Caged type

With open ends

With closed end



BFNM | BTM, BHTM | BKM | MKM, MHKM

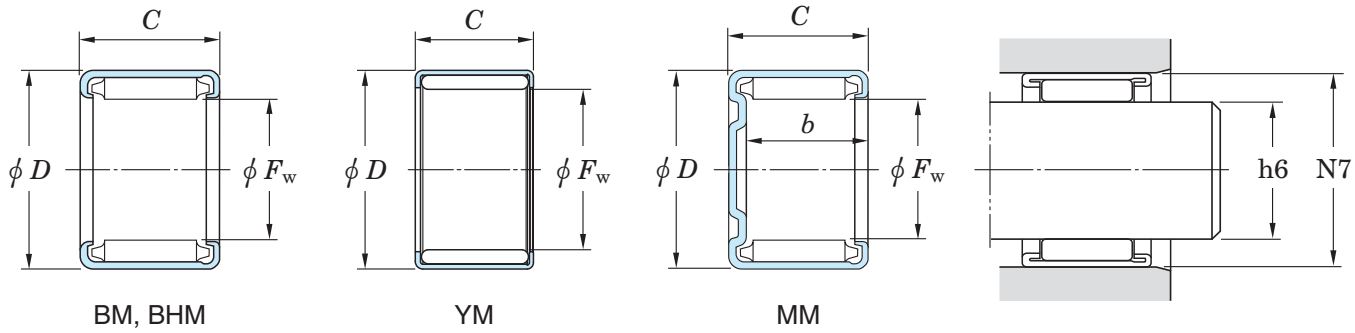
Boundary dimensions (mm)				Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No. [2]	
							Caged type	
F_w	D	C	b min.	C_r	C_{0r}	Oil lub.	With open ends	With closed end
48	56	30	—	41.0	100	7 800	**BTM485630J**	—
50	58	16	—	21.9	43.8	7 500	**BTM505816J**	—
	58	20	—	35.8	98.0	2 600	—	—
	58	20	17.3	28.4	61.0	7 500	**50BTM5820J**	**50MKM5820**
	58	25	—	45.2	133	2 600	—	—
	58	25	22.3	35.9	82.5	7 500	**50BTM5825**	**50MKM5825**
	62	15	—	24.3	36.4	7 300	**BTM5015**	—
	62	20	17.3	34.5	57.1	7 300	**BTM5020**	**MKM5020**
	62	25	—	43.9	77.8	7 300	**BTM5025**	—
	62	30	27.3	52.8	98.5	7 300	**BTM5030**	**MKM5030**
55	63	20	—	29.1	65.1	6 900	**55BTM6320**	—
	67	20	—	36.4	63.1	6 700	**55BTM6720A**	—
64	73.178	21.10	—	36.1	83.8	5 900	**64BTM7321A**	—
66	72	16	—	21.9	61.1	5 900	**BTM667216J**	—
71.60	78.60	15	—	22.9	61.9	5 400	**BTM727915AJ**	—
76.50	83.50	15	—	23.5	65.4	5 000	**BTM778415AJ**	—

[Notes] 1) The limiting speeds shown above are applicable when oil seal is used and the bearing is lubricated with grease.
2) FN in bearing number indicates a bearing comprising polyamide molded cage.
3) The recommended dimensional tolerances of shaft shown above are applicable except h6.
4) The recommended dimensional tolerances of housing bore shown above are applicable except N7.

Full complement type

With open ends

With closed end



BM, BHM YM MM

Full complement type With open ends	Full complement type With closed end	Recommended dimensions (mm) Shaft dia. (h6) min.	Shaft dia. (h6) max.	Housing bore dia. (N7) min.	Housing bore dia. (N7) max.	(Refer.) Mass (g) With open ends	(Refer.) Mass (g) With closed end
—	—	47.984	48.000	55.961	55.991	102	—
—	—	49.984	50.000	57.961	57.991	54	—
50BM5820	—	49.984	50.000	57.961	57.991	78	—
—	—	49.984	50.000	57.961	57.991	68	76
50BM5825	—	49.984	50.000	57.961	57.991	98	—
—	—	49.984	50.000	57.961	57.991	86	97
—	—	49.984	50.000	61.961	61.991	73	—
—	—	49.984	50.000	61.961	61.991	99	112
—	—	49.984	50.000	61.961	61.991	125	—
—	—	49.984	50.000	61.961	61.991	153	173
—	—	54.981	55.000	62.961	62.991	73	—
—	—	54.981	55.000	66.961	62.991	110	—
—	—	63.981	64.000	73.139	73.129	110	—
—	—	65.981	66.000	71.961	71.991	54	—
—	—	71.581	71.600	78.561	78.591	66	—
—	—	76.481	76.500	83.455	83.490	70	—

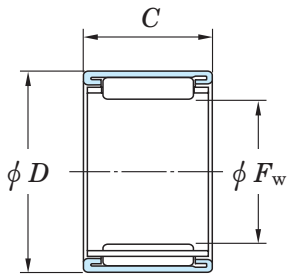
[Remark] Limiting speed of grease lubrication should be kept to under 60 % of that for oil lubrication.

Inch series

F_w 7.938 ~ (12.700) mm

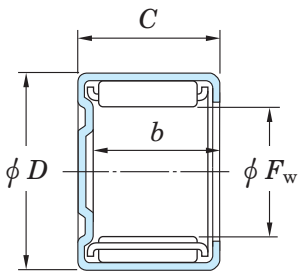
Caged type

With open ends



BT, BHT

With closed end



MK, MHK

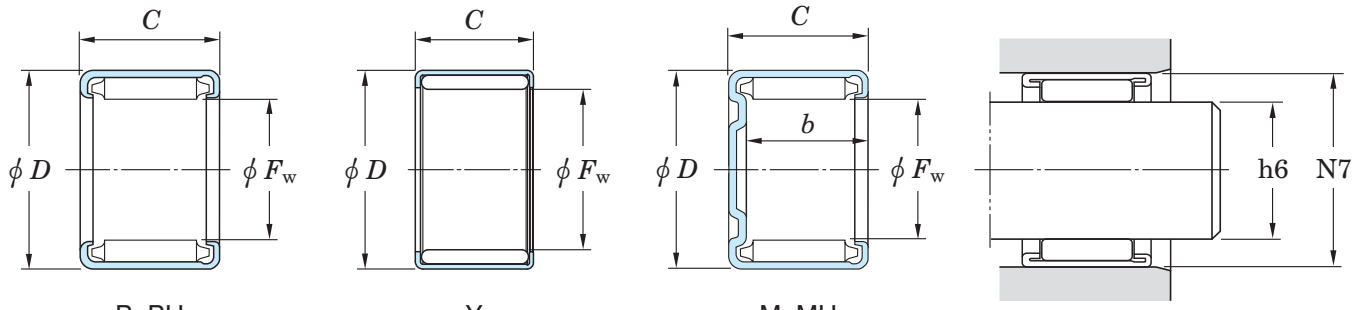
Boundary dimensions							Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No. [1]	
F_w		D		C		b	C_r	C_{0r}	Oil lub.	Caged type	
mm	inch	mm	inch	mm	inch	min.				With open ends	With closed end
7.938	5/16	12.700	1/2	7.940	5/16	5.8	3.55	4.50	13 000	—	—
	5/16	12.700	1/2	7.940	5/16	5.8	2.60	2.55	36 000	**BT55**	**MK551**
	5/16	12.700	1/2	7.940	5/16	—	4.05	5.35	13 000	—	—
	5/16	12.700	1/2	11.110	7/16	8.8	5.55	7.95	13 000	—	—
	5/16	12.700	1/2	11.110	7/16	8.8	4.25	4.75	36 000	**BT57**	**MK571**
	5/16	12.700	1/2	11.110	7/16	—	5.95	8.75	13 000	—	—
	5/16	12.700	1/2	14.290	9/16	12.1	7.35	11.5	13 000	—	—
	5/16	14.288	9/16	11.110	7/16	8.6	4.25	3.90	35 000	**BHT57**	**MHK571**
9.525	3/8	14.288	9/16	7.940	5/16	5.8	3.95	5.45	12 000	—	—
	3/8	14.288	9/16	7.940	5/16	5.8	2.80	2.85	33 000	**BT65**	**MK651**
	3/8	14.288	9/16	7.940	5/16	—	4.50	6.40	12 000	—	—
	3/8	14.288	9/16	9.520	3/8	7.3	5.15	7.60	12 000	—	—
	3/8	14.288	9/16	9.520	3/8	7.3	3.65	4.05	33 000	**BT66**	**MK661**
	3/8	14.288	9/16	9.520	3/8	—	5.60	8.45	12 000	—	—
	3/8	14.288	9/16	12.700	1/2	10.4	7.25	11.8	12 000	—	—
	3/8	14.288	9/16	12.700	1/2	10.4	5.25	6.45	33 000	**BT68**	**MK681**
	3/8	14.288	9/16	12.700	1/2	—	8.10	13.6	12 000	—	—
	3/8	14.288	9/16	15.880	5/8	13.7	9.10	15.8	12 000	—	—
	3/8	15.875	5/8	12.700	1/2	10.1	7.85	10.6	11 000	—	—
11.112	7/16	15.875	5/8	11.110	7/16	—	6.80	11.3	10 000	—	—
	7/16	15.875	5/8	12.700	1/2	10.4	7.95	13.8	10 000	—	—
	7/16	15.875	5/8	12.700	1/2	10.4	5.75	7.60	29 000	**BT78**	**MK781**
12.700	1/2	17.462	11/16	7.940	5/16	5.8	4.75	7.45	9 400	—	—
	1/2	17.462	11/16	7.940	5/16	5.8	3.40	4.05	27 000	**BT85**	**MK851**
	1/2	17.462	11/16	9.520	3/8	7.3	6.10	10.1	9 400	—	—
	1/2	17.462	11/16	11.110	7/16	8.8	5.40	7.25	27 000	**BT87**	**MK871**
	1/2	17.462	11/16	12.700	1/2	10.4	8.55	15.7	9 400	—	—

[Notes] 1) FN in bearing number indicates a bearing comprising polyamide molded cage.
2) The recommended dimensional tolerances of shaft shown above are applicable except h6.
3) The recommended dimensional tolerances of housing bore shown above are applicable except J7.

Full complement type

With open ends

With closed end



B, BH　　Y　　M, MH

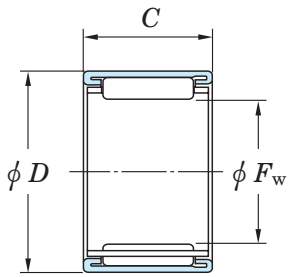
Full complement type With open ends	With closed end	Recommended dimensions (mm) Shaft dia. (h6) min.	max.	Housing bore dia. (J7) min.	max.	(Refer.) Mass (g) With open ends	With closed end
B55	**M551**	7.929	7.938	12.692	12.710	3.5	4.0
—	—	7.925[2)]	7.938[2)]	12.692	12.710	3.4	3.9
Y55	—	7.929	7.938	12.692	12.710	3.8	—
B57	**M571**	7.929	7.938	12.692	12.710	5.0	5.6
—	—	7.925[2)]	7.938[2)]	12.692	12.710	4.5	5.1
Y57	—	7.929	7.938	12.692	12.710	5.3	—
B59	**M591**	7.929	7.938	12.692	12.710	6.7	7.5
—	—	7.929	7.938	14.280	14.298	6.8	7.6
B65	**M651**	9.516	9.525	14.280	14.298	4.1	4.6
—	—	9.512[2)]	9.525[2)]	14.280	14.298	3.9	4.4
Y65	—	9.516	9.525	14.280	14.298	4.4	—
B66	**M661**	9.512[2)]	9.525[2)]	14.280	14.298	4.8	5.4
—	—	9.512[2)]	9.525[2)]	14.280	14.298	4.7	5.3
Y66	—	9.516	9.525	14.280	14.298	5.3	—
B68-1	**M681**	9.516	9.525	14.280	14.298	6.7	7.6
—	—	9.516	9.525	14.280	14.298	6.1	6.9
Y68	—	9.516	9.525	14.280	14.298	7.1	—
B610-1	**M6101**	9.516	9.525	14.280	14.298	8.5	9.6
BH68	**MH681**	9.516	9.525	15.867	15.885	9.3	11
B77	—	11.101	11.112	15.867	15.885	6.5	—
B78	**M781**	11.101	11.112	15.867	15.885	7.6	8.6
—	—	11.099[2)]	11.112[2)]	15.867	15.885	6.9	7.8
B85	**M851**	12.689	12.700	17.454	17.472	4.9	5.6
—	—	12.689	12.700	17.454	17.472	4.7	5.3
B86	**M861**	12.689	12.700	17.454	17.472	6.1	6.9
—	—	12.689	12.700	17.454	17.472	6.6	7.4
B88	**M881**	12.689	12.700	17.454	17.472	8.5	9.6

[Remark]　Limiting speed of grease lubrication should be kept to under 60 % of that for oil lubrication.

Inch series
F_w (12.700) ~ (15.875) mm

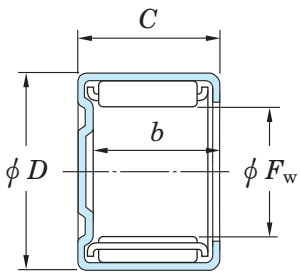
Caged type

With open ends



BT, BHT

With closed end



MK, MHK

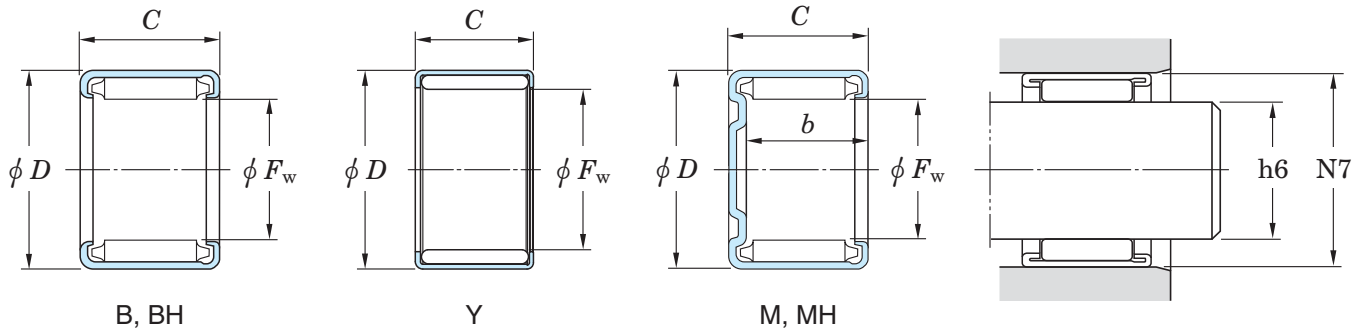
Boundary dimensions							Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No. [1]	
F_w		D		C		b	C_r	C_{0r}	Oil lub.	Caged type	
mm	inch	mm	inch	mm	inch	min.				With open ends	With closed end
12.700	1/2	17.462	11/16	12.700	1/2	10.4	6.25	8.80	27 000	**BT88-1**	**MK881**
	1/2	17.462	11/16	15.880	5/8	—	11.9	24.0	9 400	—	—
	1/2	17.462	11/16	19.050	3/4	16.7	13.0	26.8	9 400	—	—
	1/2	17.462	11/16	19.050	3/4	16.7	9.70	15.5	27 000	**BT812**	**MK8121**
	1/2	17.462	11/16	19.050	3/4	—	13.8	29.1	9 400	—	—
	1/2	19.050	3/4	12.700	1/2	10.4	7.40	8.70	26 000	**BHT88**	**MHK881**
	1/2	19.050	3/4	19.050	3/4	16.5	11.3	15.0	26 000	**BHT812**	**MHK8121**
14.288	9/16	19.050	3/4	7.940	5/16	5.8	5.00	8.15	8 800	—	—
	9/16	19.050	3/4	9.520	3/8	—	6.45	11.4	8 800	—	—
	9/16	19.050	3/4	9.520	3/8	7.3	4.75	6.40	25 000	**BT96P**	**MK961**
	9/16	19.050	3/4	12.700	1/2	10.4	9.10	17.7	8 800	—	—
	9/16	19.050	3/4	12.700	1/2	10.4	6.80	10.2	25 000	**BT98**	**MK981**
	9/16	19.050	3/4	12.700	1/2	—	10.1	20.4	8 800	—	—
	9/16	19.050	3/4	15.880	5/8	13.7	11.4	23.7	8 800	—	—
	9/16	19.050	3/4	15.880	5/8	13.7	8.55	13.7	25 000	**BT910**	**MK9101**
	9/16	20.638	13/16	12.700	1/2	16.5	7.85	9.65	24 000	**BHT98**	**MHK981**
	9/16	20.638	13/16	19.050	3/4	16.5	15.9	28.6	8 400	—	—
15.875	5/8	20.638	13/16	7.940	5/16	5.8	5.40	9.30	8 000	—	—
	5/8	20.638	13/16	7.940	5/16	5.8	3.30	4.15	23 000	**BT105**	**MK1051**
	5/8	20.638	13/16	7.940	5/16	—	6.00	10.7	8 000	—	—
	5/8	20.638	13/16	11.110	7/16	8.8	5.30	7.55	23 000	**BT107**	**MK1071**
	5/8	20.638	13/16	12.700	1/2	10.4	9.65	19.7	8 000	—	—
	5/8	20.638	13/16	12.700	1/2	—	6.10	9.00	23 000	**BT108A**	—
	5/8	20.638	13/16	12.700	1/2	—	10.7	22.6	8 000	—	—
	5/8	20.638	13/16	19.050	3/4	—	9.45	15.9	23 000	**BT1012**	—
	5/8	20.638	13/16	19.050	3/4	—	15.1	35.0	8 000	—	—
	5/8	20.638	13/16	25.400	1	22.8	12.3	22.4	23 000	**BT1016**	**MK10161**

[Notes] 1) FN in bearing number indicates a bearing comprising polyamide molded cage.
2) The recommended dimensional tolerances of shaft shown above are applicable except h6.
3) The recommended dimensional tolerances of housing bore shown above are applicable except J7.

Full complement type

With open ends

With closed end



B, BH　　Y　　M, MH

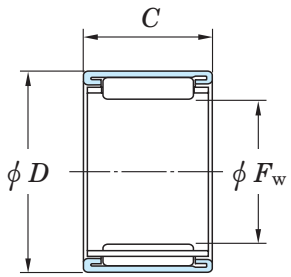
Full complement type With open ends	Full complement type With closed end	Recommended dimensions (mm) Shaft dia. (h6) min.	Shaft dia. (h6) max.	Housing bore dia. (J7) min.	Housing bore dia. (J7) max.	(Refer.) Mass (g) With open ends	(Refer.) Mass (g) With closed end
—	—	12.689	12.700	17.454	17.472	7.7	8.7
Y810	—	12.689	12.700	17.454	17.472	12	—
B812	**M8121**	12.689	12.700	17.454	17.472	13	15
—	—	12.689	12.700	17.454	17.472	12	13
Y812	—	12.689	12.700	17.454	17.472	13	—
—	—	12.689	12.700	19.041	19.062	11	12
—	—	12.689	12.700	19.041	19.062	16	18
B95	**M951**	14.277	14.288	19.041	19.062	5.7	6.5
B96-1	—	14.277	14.288	19.041	19.062	6.7	—
—	—	14.277	14.288	19.041	19.062	6.5	7.3
B98	**M981**	14.277	14.288	19.041	19.062	9.2	10
—	—	14.277	14.288	19.041	19.062	8.1	9.2
Y98	—	14.277	14.288	19.041	19.062	9.9	—
B910	**M9101**	14.277	14.288	19.041	19.062	12	13
—	—	14.277	14.288	19.041	19.062	10	12
—	—	14.277	14.288	20.629	20.650	11	13
BH912	**MH9121**	14.277	14.288	20.629	20.650	19	22
B105	**M1051**	15.864	15.875	20.629	20.650	5.9	6.7
—	—	15.864	15.875	20.629	20.650	5.5	6.2
Y105	—	15.864	15.875	20.629	20.650	6.7	—
—	—	15.864	15.875	20.629	20.650	7.7	8.7
B108	**M1081**	15.864	15.875	20.629	20.650	10	12
—	—	15.862 [2)]	15.875 [2)]	20.629	20.650	8.8	—
Y108	—	15.864	15.875	20.629	20.650	11	—
—	—	15.864	15.875	20.629	20.650	13	—
Y1012	—	15.864	15.875	20.629	20.650	16	—
—	—	15.864	15.875	20.629	20.650	18	20

[Remark]　Limiting speed of grease lubrication should be kept to under 60 % of that for oil lubrication.

Inch series
F_w (15.875) ~ (19.050) mm

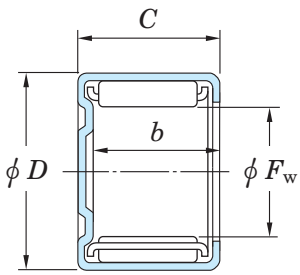
Caged type

With open ends



BT, BHT

With closed end



MK, MHK

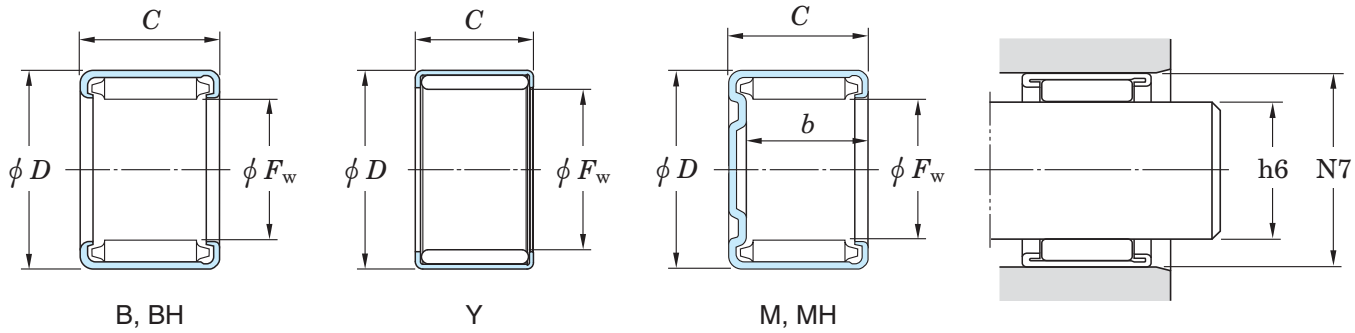
Boundary dimensions							Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No. [1]	
F_w		D		C		b	C_r	C_{0r}	Oil lub.	Caged type	
mm	inch	mm	inch	mm	inch	min.				With open ends	With closed end
15.875	5/8	22.225	7/8	12.700	1/2	10.1	10.9	18.1	7 700	—	—
	5/8	22.225	7/8	12.700	1/2	10.1	8.25	10.6	22 000	**BHT108**	**MHK1081**
	5/8	22.225	7/8	19.050	3/4	16.5	17.0	32.0	7 700	—	—
	5/8	22.225	7/8	25.400	1	—	22.5	45.8	7 700	—	—
	5/8	22.225	7/8	25.400	1	16.5	16.6	25.9	22 000	**BHT1016**	**MHK10161**
17.462	11/16	22.225	7/8	9.520	3/8	7.3	7.25	14.0	7 300	—	—
	11/16	22.225	7/8	12.700	1/2	10.4	10.2	21.7	7 300	—	—
	11/16	22.225	7/8	12.700	1/2	—	10.7	23.2	7 300	—	—
	11/16	22.225	7/8	15.880	5/8	13.2	12.8	29.0	7 300	—	—
	11/16	22.225	7/8	15.880	5/8	13.7	9.15	15.7	21 000	**BT1110**	**MK11101**
	11/16	22.225	7/8	19.050	3/4	16.7	15.3	36.7	7 300	—	—
	11/16	22.225	7/8	19.050	3/4	16.7	11.5	21.2	21 000	**BT1112-1**	**MK11121**
	11/16	22.225	7/8	19.050	3/4	—	15.9	38.5	7 300	—	—
	11/16	23.812	15/16	15.880	5/8	13.2	14.9	27.5	7 100	—	—
	11/16	23.812	15/16	15.880	5/8	13.2	10.8	15.2	20 000	**BHT1110**	**MHK11101**
	11/16	23.812	15/16	19.050	3/4	—	18.0	35.1	7 100	—	—
	11/16	23.812	15/16	19.050	3/4	16.5	13.9	21.2	20 000	**BHT1112**	**MHK11121**
19.050	3/4	25.400	1	9.520	3/8	6.8	6.35	7.95	19 000	**BT126**	**MK1261**
	3/4	25.400	1	9.520	3/8	—	8.55	13.9	6 500	—	—
	3/4	25.400	1	12.700	1/2	10.1	13.4	21.8	6 500	—	—
	3/4	25.400	1	12.700	1/2	10.1	9.35	13.1	19 000	**BT128**	**MK1281**
	3/4	25.400	1	12.700	1/2	—	12.4	22.3	6 500	—	—
	3/4	25.400	1	15.880	5/8	13.2	15.6	30.0	6 500	—	—
	3/4	25.400	1	15.880	5/8	13.2	12.0	18.0	19 000	**BT1210**	**MK12101**
	3/4	25.400	1	15.880	5/8	—	15.8	30.6	6 500	—	—
	3/4	25.400	1	19.050	3/4	16.5	18.9	38.4	6 500	—	—
	3/4	25.400	1	19.050	3/4	16.5	14.4	22.8	19 000	**BT1212A**	**MK12121**
	3/4	25.400	1	19.050	3/4	—	20.2	42.0	6 500	—	—

[Notes] 1) FN in bearing number indicates a bearing comprising polyamide molded cage.
2) The recommended dimensional tolerances of shaft shown above are applicable except h6.
3) The recommended dimensional tolerances of housing bore shown above are applicable except J7.

Full complement type

With open ends

With closed end



B, BH Y M, MH

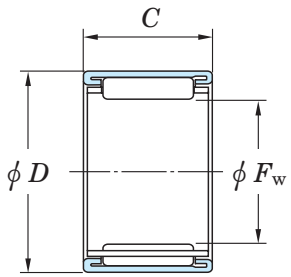
Full complement type With open ends	With closed end	Recommended dimensions (mm) Shaft dia. (h6) min.	max.	Housing bore dia. (J7) min.	max.	(Refer.) Mass (g) With open ends	With closed end
BH108	**MH1081**	15.864	15.875	22.216	22.237	14	16
—	—	15.864	15.875	22.216	22.237	12	14
BH1012	**MH10121**	15.864	15.875	22.216	22.237	22	24
BH1016	—	15.864	15.875	22.216	22.237	28	—
—	—	15.864	15.875	22.216	22.237	24	28
B116E	**M1161**	17.451	17.462	22.216	22.237	7.9	8.9
B118	**M1181**	17.449 [2)]	17.462 [2)]	22.216	22.237	11	13
Y118	—	17.451	17.462	22.216	22.237	12	—
B1110	**M11101**	17.451	17.462	22.216	22.237	14	15
—	—	17.451	17.462	22.216	22.237	12	13
B1112	**M11121**	17.451	17.462	22.216	22.237	16	19
—	—	17.449 [2)]	17.462 [2)]	22.216	22.237	14	16
Y1112	—	17.451	17.462	22.216	22.237	18	—
BH1110	**MH11101**	17.451	17.462	23.803	23.824	19	21
—	—	17.449 [2)]	17.462 [2)]	23.803	23.824	16	18
BH1112	—	17.451	17.462	23.803	23.824	23	—
—	—	17.451	17.462	23.803	23.824	20	22
—	—	19.037	19.050	25.391	25.412	10	12
Y126	—	19.037	19.050	25.391	25.412	13	—
B128	**M1281**	19.037	19.050	25.391	25.412	16	18
—	—	19.037	19.050	25.391	25.412	14	16
Y128	—	19.037	19.050	25.391	25.412	18	—
B1210	**M12101**	19.037	19.050	25.391	25.412	20	23
—	—	19.037	19.050	25.391	25.412	17	19
Y1210	—	19.037	19.050	25.391	25.412	22	—
B1212	**M12121**	19.037	19.050	25.391	25.412	25	28
—	—	19.037	19.050	25.391	25.412	21	23
Y1212	—	19.037	19.050	25.391	25.412	26	—

[Remark] Limiting speed of grease lubrication should be kept to under 60 % of that for oil lubrication.

Inch series
F_w (19.050) ~ (22.225) mm

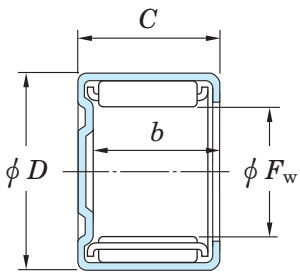
Caged type

With open ends



BT, BHT

With closed end



MK, MHK

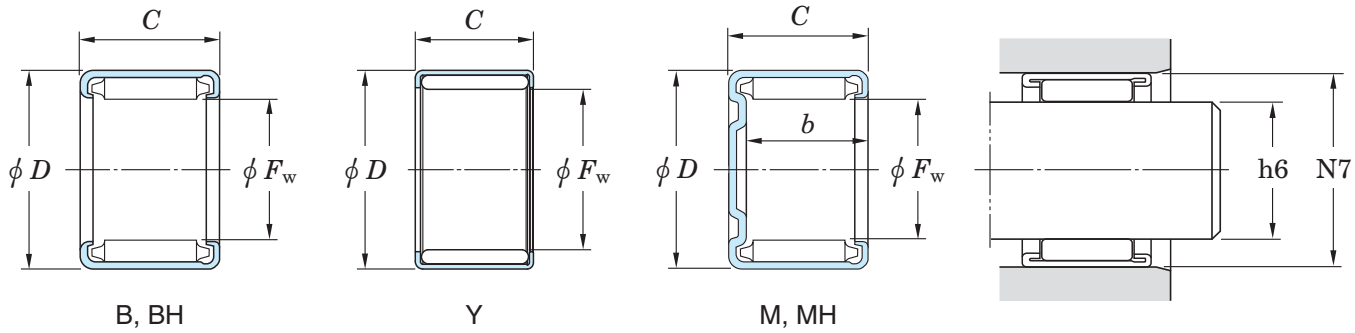
Boundary dimensions							Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No. [1]	
F_w		D		C		b	C_r	C_{0r}	Oil lub.	Caged type	
mm	inch	mm	inch	mm	inch	min.				With open ends	With closed end
19.050	3/4	25.400	1	25.400	1	22.8	18.9	32.3	19 000	**BT1216**	**MK12161**
20.638	13/16	26.988	11/16	9.520	3/8	—	8.70	14.5	6 100	—	—
	13/16	26.988	11/16	9.520	3/8	6.8	6.30	8.00	17 000	**BT136**	**MK1361**
	13/16	26.988	11/16	9.520	3/8	—	9.55	16.4	6 100	—	—
	13/16	26.988	11/16	12.700	1/2	10.1	12.7	23.6	6 100	—	—
	13/16	26.988	11/16	12.700	1/2	—	9.50	13.6	17 000	**BT138A**	—
	13/16	26.988	11/16	12.700	1/2	—	13.5	25.5	6 100	—	—
	13/16	26.988	11/16	19.050	3/4	16.5	15.2	24.9	17 000	**BT1312**	**MK13121**
	13/16	26.988	11/16	22.220	7/8	19.5	23.0	50.8	6 100	—	—
	13/16	26.988	11/16	22.220	7/8	19.5	17.5	29.9	17 000	**BT1314**	**MK13141**
	13/16	26.988	11/16	22.220	7/8	—	23.7	52.7	6 100	—	—
	13/16	26.988	11/16	25.400	1	22.8	26.2	60.0	6 100	—	—
	13/16	26.988	11/16	25.400	1	22.8	19.9	35.3	17 000	**BT1316**	**MK13161**
	13/16	26.988	11/16	25.400	1	—	26.8	61.8	6 100	—	—
	13/16	28.575	1 1/8	15.880	5/8	12.9	16.8	28.6	5 900	—	—
	13/16	28.575	1 1/8	19.050	3/4	16.0	21.4	38.8	5 900	—	—
	13/16	28.575	1 1/8	19.050	3/4	16.0	15.6	21.7	17 000	**BHT1312**	**MHK13121**
22.225	7/8	28.575	1 1/8	9.520	3/8	6.8	8.75	15.3	5 700	—	—
	7/8	28.575	1 1/8	9.520	3/8	—	6.50	8.75	16 000	**BT146P**	—
	7/8	28.575	1 1/8	9.520	3/8	—	9.65	17.4	5 700	—	—
	7/8	28.575	1 1/8	12.700	1/2	10.1	12.9	25.1	5 700	—	—
	7/8	28.575	1 1/8	12.700	1/2	10.1	9.75	14.7	16 000	**BT148A**	**MK1481**
	7/8	28.575	1 1/8	12.700	1/2	—	13.7	27.2	5 700	—	—
	7/8	28.575	1 1/8	19.050	3/4	16.5	20.1	44.6	5 700	—	—
	7/8	28.575	1 1/8	19.050	3/4	16.5	15.5	26.5	16 000	**BT1412**	**MK14121**
	7/8	28.575	1 1/8	19.050	3/4	—	21.6	48.8	5 700	—	—
	7/8	28.575	1 1/8	25.400	1	22.8	26.6	64.0	5 700	—	—

[Notes] 1) FN in bearing number indicates a bearing comprising polyamide molded cage.
2) The recommended dimensional tolerances of shaft shown above are applicable except h6.
3) The recommended dimensional tolerances of housing bore shown above are applicable except J7.

Full complement type

With open ends

With closed end



B, BH Y M, MH

Full complement type With open ends	With closed end	Recommended dimensions (mm) Shaft dia. (h6) min.	max.	Housing bore dia. (J7) min.	max.	(Refer.) Mass (g) With open ends	With closed end
—	—	19.037	19.050	25.391	25.412	28	31
B136	—	20.625	20.638	26.979	27.000	13	—
—	—	20.625	20.638	26.979	27.000	12	13
Y136	—	20.625	20.638	26.979	27.000	14	—
B138	**M1381**	20.625	20.638	26.979	27.000	17	19
—	—	20.625	20.638	26.979	27.000	16	—
Y138	—	20.625	20.638	26.979	27.000	19	—
—	—	20.625	20.638	26.979	27.000	22	15
B1314	**M13141**	20.625	20.638	26.979	27.000	32	36
—	—	20.625	20.638	26.979	27.000	28	31
Y1314	—	20.625	20.638	26.979	27.000	33	—
B1316	**M13161**	20.625	20.638	26.979	27.000	37	42
—	—	20.625	20.638	26.979	27.000	31	36
Y1316	—	20.625	20.638	26.979	27.000	37	—
BH1310	**MH13101**	20.625	20.638	28.566	28.587	28	32
BH1312	**MH13121**	20.625	20.638	28.566	28.587	34	38
—	—	20.625	20.638	28.566	28.587	28	32
B146	**M1461**	22.212	22.225	28.566	28.587	13	15
—	—	22.212	22.225	28.566	28.587	13	—
Y146	—	22.212	22.225	28.566	28.587	15	—
B148	**M1481**	22.212	22.225	28.566	28.587	19	21
—	—	22.212	22.225	28.566	28.587	15	17
Y148	—	22.212	22.225	28.566	28.587	20	—
B1412	**M14121**	22.212	22.225	28.567 [3)]	28.588 [3)]	28	32
—	—	22.212	22.225	28.566	28.587	26	29
Y1412	—	22.212	22.225	28.566	28.587	31	—
B1416	**M14161**	22.212	22.225	28.566	28.587	39	44

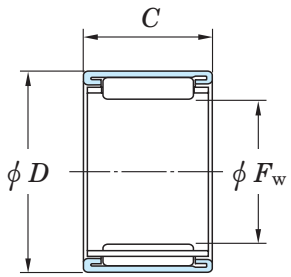
[Remark] Limiting speed of grease lubrication should be kept to under 60 % of that for oil lubrication.

Inch series

F_w (22.225) ~ (25.400) mm

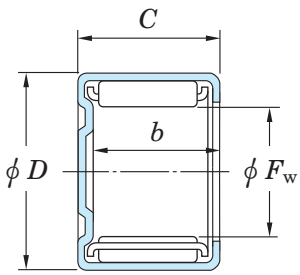
Caged type

With open ends



BT, BHT

With closed end



MK, MHK

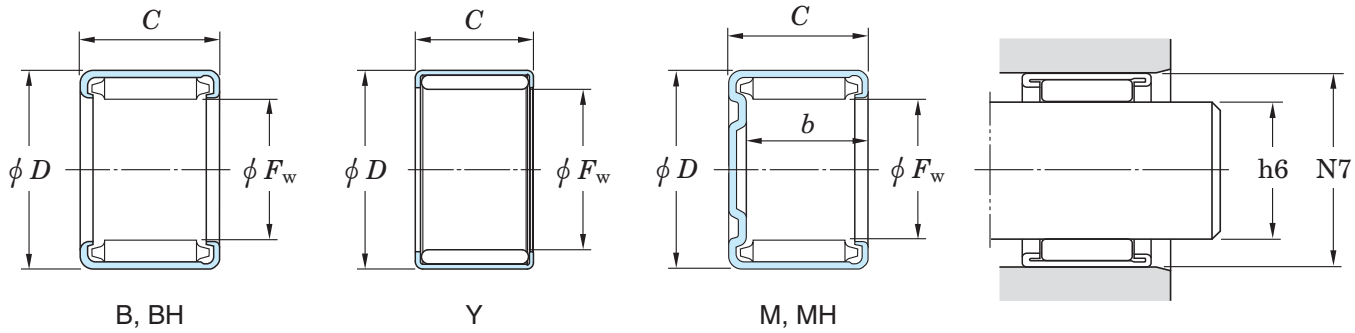
Boundary dimensions							Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No. [1]	
F_w		D		C		b	C_r	C_{0r}	Oil lub.	Caged type	
mm	inch	mm	inch	mm	inch	min.				With open ends	With closed end
22.225	7/8	28.575	1 1/8	25.400	1	22.8	20.6	38.4	16 000	**BT1416A**	**MK14161**
	7/8	28.575	1 1/8	25.400	1	—	27.3	66.1	5 700	—	—
	7/8	30.162	13/16	15.880	5/8	12.7	17.3	30.5	5 500	—	—
	7/8	30.162	13/16	19.050	3/4	16.5	21.4	40.1	5 500	—	—
	7/8	30.162	13/16	19.050	3/4	16.5	16.8	24.7	16 000	**BHT1412**	**MHK14121**
	7/8	30.162	13/16	25.400	1	22.8	23.5	37.9	16 000	**BHT1416**	**MHK14161**
23.812	15/16	30.162	13/16	15.880	5/8	12.7	13.7	22.7	15 000	**BT1510**	**MK15101**
	15/16	30.162	13/16	25.400	1	22.8	28.3	68.8	5 300	—	—
	15/16	30.162	13/16	25.400	1	22.8	22.3	42.4	15 000	**BT1516**	**MK15161**
	15/16	30.162	13/16	25.400	1	—	29.0	71.2	5 300	—	—
25.400	1	31.750	1 1/4	9.520	3/8	—	9.65	17.9	5 000	—	—
	1	31.750	1 1/4	9.520	3/8	6.8	6.50	9.10	14 000	**BT166**	**MK1661**
	1	31.750	1 1/4	11.110	7/16	8.6	11.9	23.5	5 000	—	—
	1	31.750	1 1/4	11.110	7/16	8.8	8.40	7.25	14 000	**BT167**	**MK1671**
	1	31.750	1 1/4	11.110	7/16	—	12.7	25.5	5 000	—	—
	1	31.750	1 1/4	12.700	1/2	10.1	14.1	29.1	5 000	—	—
	1	31.750	1 1/4	12.700	1/2	10.1	10.5	16.7	14 000	**BT168**	**MK1681**
	1	31.750	1 1/4	12.700	1/2	—	14.8	31.1	5 000	—	—
	1	31.750	1 1/4	19.050	3/4	16.5	21.9	51.3	5 000	—	—
	1	31.750	1 1/4	19.050	3/4	16.5	16.5	29.8	14 000	**BT1612**	**MK16121**
	1	31.750	1 1/4	19.050	3/4	—	23.5	56.2	5 000	—	—
	1	31.750	1 1/4	25.400	1	22.8	28.9	73.4	5 000	—	—
	1	31.750	1 1/4	25.400	1	22.8	22.0	43.1	14 000	**BT1616A**	**MK16161**
	1	31.750	1 1/4	25.400	1	—	30.4	78.3	5 000	—	—
	1	33.338	15/16	12.700	1/2	9.6	13.9	24.0	4 900	—	—
	1	33.338	15/16	15.880	5/8	—	18.8	35.2	4 900	—	—
	1	33.338	15/16	19.050	3/4	16.0	23.8	47.6	4 900	—	—
	1	33.338	15/16	19.050	3/4	16.0	17.5	26.9	14 000	**BHT1612**	**MHK16121**

[Notes] 1) FN in bearing number indicates a bearing comprising polyamide molded cage.
2) The recommended dimensional tolerances of shaft shown above are applicable except h6.
3) The recommended dimensional tolerances of housing bore shown above are applicable except J7.

Full complement type

With open ends

With closed end



B, BH Y M, MH

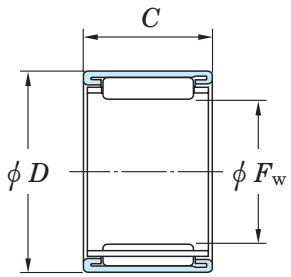
Full complement type With open ends	Full complement type With closed end	Recommended dimensions (mm) Shaft dia. (h6) min.	Shaft dia. (h6) max.	Housing bore dia. (J7) min.	Housing bore dia. (J7) max.	(Refer.) Mass (g) With open ends	(Refer.) Mass (g) With closed end
—	—	22.212	22.225	28.566	28.587	35	39
Y1416	—	22.212	22.225	28.566	28.587	40	—
BH1410	**MH14101**	22.212	22.225	30.151	30.176	30	34
BH1412	**MH14121**	22.212	22.225	30.151	30.176	36	41
—	—	22.212	22.225	30.151	30.176	29	33
—	—	22.212	22.225	30.151	30.176	39	44
—	—	23.799	23.812	30.151	30.176	22	25
B1516	**M15161**	23.799	23.812	30.151	30.176	42	47
—	—	23.799	23.812	30.151	30.176	35	40
Y1516	—	23.799	23.812	30.151	30.176	42	—
B166	—	25.387	25.400	31.739	31.764	15	—
—	—	25.387	25.400	31.739	31.764	14	16
B167	**M1671**	25.387	25.400	31.739	31.764	18	21
—	—	25.387	25.400	31.739	31.764	16	19
Y167	—	25.387	25.400	31.739	31.764	20	—
B168	**M1681**	25.387	25.400	31.739	31.764	21	23
—	—	25.387	25.400	31.739	31.764	19	21
Y168	—	25.387	25.400	31.739	31.764	23	—
B1612	**M16121-1**	25.387	25.400	31.739	31.764	32	37
—	—	25.387	25.400	31.739	31.764	29	33
Y1612	—	25.387	25.400	31.739	31.764	34	—
B1616	**M16161**	25.387	25.400	31.739	31.764	44	50
—	—	25.387	25.400	31.739	31.764	38	43
Y1616	—	25.387	25.400	31.739	31.764	45	—
BH168	**MH1681**	25.387	25.400	33.327	33.352	27	30
BH1610	—	25.387	25.400	33.327	33.352	34	—
BH1612	**MH16121**	25.387	25.400	33.327	33.352	39	44
—	—	25.387	25.400	33.327	33.352	32	36

[Remark] Limiting speed of grease lubrication should be kept to under 60 % of that for oil lubrication.

Inch series
F_w (25.400) ~ 30.162 mm

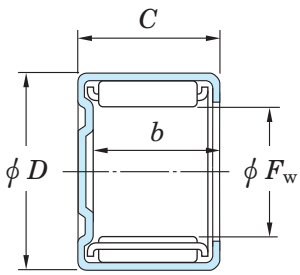
Caged type

With open ends



BT, BHT

With closed end



MK, MHK

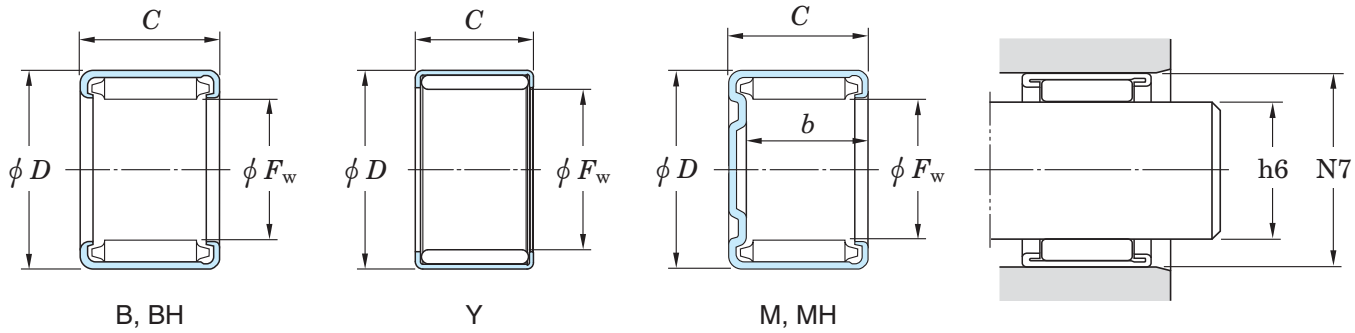
Boundary dimensions							Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No. [1]	
F_w		D		C		b	C_r	C_{0r}	Oil lub.	Caged type	
mm	inch	mm	inch	mm	inch	min.				With open ends	With closed end
25.400	1	33.338	15/16	25.400	1	22.3	32.0	69.7	4 900	—	—
	1	33.338	15/16	25.400	1	22.3	23.5	39.2	14 000	**BHT1616**	**MHK16161**
	1	33.338	15/16	31.750	1 1/4	—	39.2	90.7	4 900	—	—
	1	33.338	15/16	38.100	1 1/2	35.0	46.6	113	4 900	—	—
26.988	11/16	33.338	15/16	15.880	5/8	13.2	19.0	43.4	4 800	—	—
	11/16	33.338	15/16	15.880	5/8	—	18.6	42.3	4 800	—	—
	11/16	33.338	15/16	25.400	1	—	30.2	78.8	4 800	—	—
28.575	1 1/8	34.925	1 3/8	9.520	3/8	6.8	10.3	20.1	4 500	—	—
	1 1/8	34.925	1 3/8	12.700	1/2	10.1	14.7	31.8	4 500	—	—
	1 1/8	34.925	1 3/8	12.700	1/2	10.1	11.9	20.3	13 000	**BT188**	**MK1881**
	1 1/8	34.925	1 3/8	19.050	3/4	16.5	23.3	57.6	4 500	—	—
	1 1/8	34.925	1 3/8	19.050	3/4	16.5	18.6	36.0	13 000	**BT1812-1**	**MK18121**
	1 1/8	34.925	1 3/8	19.050	3/4	—	25.3	64.1	4 500	—	—
	1 1/8	34.925	1 3/8	25.400	1	22.8	30.9	82.6	4 500	—	—
	1 1/8	38.100	1 1/2	19.050	3/4	15.4	26.2	48.6	4 300	—	—
	1 1/8	38.100	1 1/2	19.050	3/4	15.4	20.8	30.3	12 000	**BHT1812**	**MHK18121**
	1 1/8	38.100	1 1/2	25.400	1	21.8	36.1	73.6	4 300	—	—
	1 1/8	38.100	1 1/2	25.400	1	21.8	27.9	44.3	12 000	**BHT1816**	**MHK18161**
	1 1/8	38.100	1 1/2	28.580	1 1/8	25.8	31.9	52.5	12 000	**BHT1818**	**MHK18181**
	1 1/8	38.100	1 1/2	31.750	1 1/4	28.1	45.3	98.4	4 300	—	—
30.162	13/16	38.100	1 1/2	15.880	5/8	12.4	21.2	42.4	4 200	—	—
	13/16	38.100	1 1/2	15.880	5/8	12.4	17.5	27.7	12 000	**BT1910**	**MK19101**
	13/16	38.100	1 1/2	15.880	5/8	—	22.7	46.5	4 200	—	—
	13/16	38.100	1 1/2	19.050	3/4	—	26.2	55.7	4 200	—	—
	13/16	38.100	1 1/2	19.050	3/4	—	29.4	64.7	4 200	—	—
	13/16	38.100	1 1/2	25.400	1	—	35.3	81.7	4 200	—	—
	13/16	38.100	1 1/2	25.400	1	21.8	28.4	51.9	12 000	**BT1916M**	**MK19161**

[Notes] 1) FN in bearing number indicates a bearing comprising polyamide molded cage.
2) The recommended dimensional tolerances of shaft shown above are applicable except h6.
3) The recommended dimensional tolerances of housing bore shown above are applicable except J7.

Full complement type

With open ends

With closed end



B, BH Y M, MH

Full complement type With open ends	With closed end	Recommended dimensions (mm) Shaft dia. (h6) min.	max.	Housing bore dia. (J7) min.	max.	(Refer.) Mass (g) With open ends	With closed end
BH1616	**MH16161**	25.387	25.400	33.327	33.352	55	62
—	—	25.387	25.400	33.327	33.352	42	48
BH1620	—	25.387	25.400	33.327	33.352	67	—
BH1624	**M16241**	25.387	25.400	33.327	33.352	85	96
B1710	**M17101**	26.975	26.988	33.327	33.352	28	32
Y1710	—	26.975	26.988	33.327	33.352	30	—
B1716	—	26.975	26.988	33.327	33.352	47	—
B186	**M1861**	28.562	28.575	34.914	34.939	17	19
B188-1	**M1881**	28.562	28.575	34.914	34.939	22	25
—	—	28.562	28.575	34.914	34.939	21	24
B1812	**M18121**	28.562	28.575	34.914	34.939	36	41
—	—	28.562	28.575	34.914	34.939	26	30
Y1812MU	—	28.562	28.575	34.914	34.939	38	—
B1816A	**M18161**	28.562	28.575	34.914	34.939	49	56
BH1812	**MH18121**	28.562	28.575	38.089	38.114	55	62
—	—	28.562	28.575	38.089	38.114	42	47
BH1816	**MH18161**	28.562	28.575	38.089	38.114	73	82
—	—	28.562	28.575	38.089	38.114	55	63
—	—	28.562	28.575	38.089	38.114	62	70
BH1820	**MH18201**	28.562	28.575	38.089	38.114	91	103
B1910	**M19101**	30.146	30.162	38.089	38.114	38	42
—	—	30.146	30.162	38.089	38.114	33	37
Y1910	—	30.146	30.162	38.089	38.114	42	—
B1912	—	30.146	30.162	38.089	38.114	46	—
Y1912AM	—	30.146	30.162	38.089	38.114	50	—
B1916	—	30.146	30.162	38.089	38.114	63	—
—	—	30.146	30.162	38.089	38.114	54	61

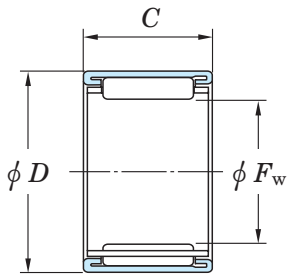
[Remark] Limiting speed of grease lubrication should be kept to under 60 % of that for oil lubrication.

Inch series

F_w 31.750 ~ (34.925) mm

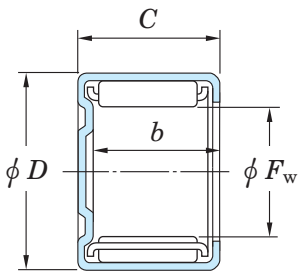
Caged type

With open ends



BT, BHT

With closed end



MK, MHK

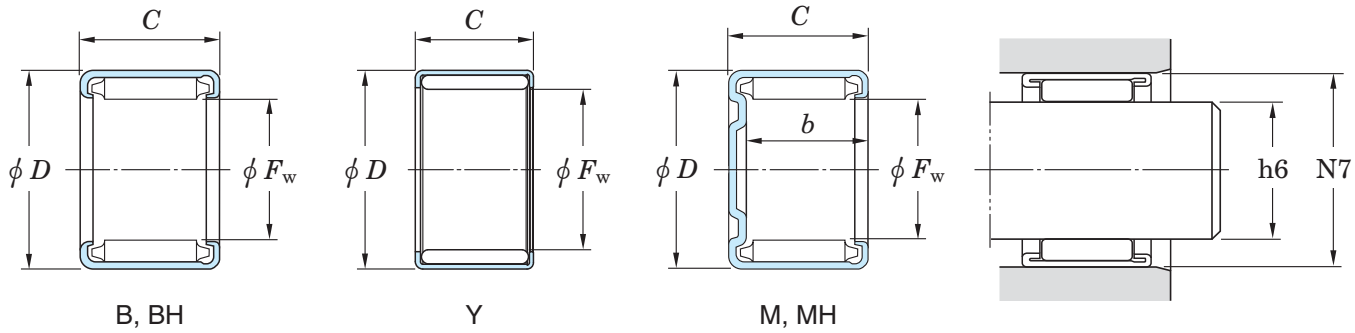
Boundary dimensions							Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No. [1]	
F_w		D		C		b	C_r	C_{0r}	Oil lub.	Caged type	
mm	inch	mm	inch	mm	inch	min.				With open ends	With closed end
31.750	1 1/4	38.100	1 1/2	12.700	1/2	10.1	15.9	36.4	4 100	—	—
	1 1/4	38.100	1 1/2	12.700	1/2	10.1	7.80	11.5	12 000	**BT208A**	**MK2081**
	1 1/4	38.100	1 1/2	15.880	5/8	13.2	20.3	50.0	4 100	—	—
	1 1/4	38.100	1 1/2	15.880	5/8	—	20.9	51.8	4 100	—	—
	1 1/4	38.100	1 1/2	19.050	3/4	16.5	24.1	38.0	4 100	—	—
	1 1/4	38.100	1 1/2	19.050	3/4	16.5	19.4	39.0	12 000	**BT2012**	**MK20121**
	1 1/4	38.100	1 1/2	19.050	3/4	—	26.4	70.2	4 100	—	—
	1 1/4	38.100	1 1/2	25.400	1	—	32.3	90.9	4 100	—	—
	1 1/4	38.100	1 1/2	25.400	1	22.8	25.4	55.4	12 000	**BT2016**	**MK20161**
	1 1/4	38.100	1 1/2	25.400	1	—	34.7	99.4	4 100	—	—
	1 1/4	38.100	1 1/2	31.750	1 1/4	29.2	39.8	119	4 100	—	—
	1 1/4	38.100	1 1/2	31.750	1 1/4	—	40.5	121	4 100	—	—
	1 1/4	41.275	1 5/8	19.050	3/4	15.4	28.3	54.7	3 900	—	—
	1 1/4	41.275	1 5/8	25.400	1	21.8	39.0	82.5	3 900	—	—
	1 1/4	41.275	1 5/8	25.400	1	21.8	29.8	48.8	11 000	**BHT2016**	**MHK20161**
	1 1/4	41.275	1 5/8	31.750	1 1/4	28.1	48.9	110	3 900	—	—
33.338	15/16	41.275	1 5/8	12.700	1/2	9.1	16.8	33.6	3 900	—	—
	15/16	41.275	1 5/8	12.700	1/2	—	17.2	34.5	3 900	—	—
	15/16	41.275	1 5/8	15.880	5/8	12.4	22.3	48.3	3 900	—	—
	15/16	41.275	1 5/8	15.880	5/8	—	22.6	49.2	3 900	—	—
34.925	1 3/8	41.275	1 5/8	12.700	1/2	10.1	16.1	39.0	3 800	—	—
	1 3/8	41.275	1 5/8	12.700	1/2	10.1	12.8	24.3	11 000	**BT228**	**MK2281**
	1 3/8	41.275	1 5/8	12.700	1/2	—	16.7	41.1	3 800	—	—
	1 3/8	41.275	1 5/8	19.050	3/4	16.5	25.4	70.1	3 800	—	—
	1 3/8	41.275	1 5/8	19.050	3/4	16.5	19.5	41.9	11 000	**BT2212**	**MK22121**
	1 3/8	41.275	1 5/8	19.050	3/4	—	25.9	72.2	3 800	—	—
	1 3/8	41.275	1 5/8	25.400	1	—	33.6	101	3 800	—	—

[Notes] 1) FN in bearing number indicates a bearing comprising polyamide molded cage.
2) The recommended dimensional tolerances of shaft shown above are applicable except h6.
3) The recommended dimensional tolerances of housing bore shown above are applicable except J7.

Full complement type

With open ends

With closed end



B, BH Y M, MH

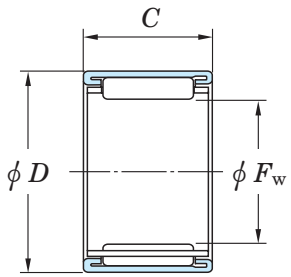
Full complement type With open ends	With closed end	Recommended dimensions (mm) Shaft dia. (h6) min.	max.	Housing bore dia. (J7) min.	max.	(Refer.) Mass (g) With open ends	With closed end
B208	**M2081**	31.734	31.750	38.089	38.114	25	28
—	—	31.734	31.750	38.089	38.114	22	25
B2010	**M20101**	31.734	31.750	38.089	38.114	33	37
Y2010	—	31.734	31.750	38.089	38.114	34	—
B2012	**M20121**	31.734	31.750	38.089	38.114	40	45
—	—	31.734	31.750	38.089	38.114	35	40
Y2012	—	31.734	31.750	38.089	38.114	41	—
B2016	—	31.734	31.750	38.089	38.114	54	—
—	—	31.734	31.750	38.089	38.114	47	53
Y2016	—	31.734	31.750	38.089	38.114	56	—
B2020	**M20201**	31.734	31.750	38.089	38.114	68	77
Y2020	—	31.734	31.750	38.089	38.114	9	—
BH2012	**MH20121**	31.734	31.750	41.264	41.289	57	64
BH2016	**MH20161**	31.734	31.750	41.264	41.289	80	91
—	—	31.734	31.750	41.264	41.289	69	78
BH2020	**MH20201**	31.734	31.750	41.264	41.289	100	113
B218	**M2181**	33.322	33.338	41.264	41.289	34	39
Y218	—	33.322	33.338	41.264	41.289	37	—
B2110	**M21101**	33.322	33.338	41.264	41.289	42	47
Y2110	—	33.322	33.338	41.264	41.289	46	—
B228	**M2281**	34.909	34.925	41.264	41.289	27	31
—	—	34.909	34.925	41.264	41.289	24	27
Y228	—	34.909	34.925	41.264	41.289	30	—
B2212	**M22121**	34.909	34.925	41.264	41.289	44	49
—	—	34.909	34.925	41.264	41.289	36	41
Y2212	—	34.909	34.925	41.264	41.289	50	—
B2216	—	34.909	34.925	41.264	41.289	59	—

[Remark] Limiting speed of grease lubrication should be kept to under 60 % of that for oil lubrication.

Inch series
F_w (34.925) ~ 41.275 mm

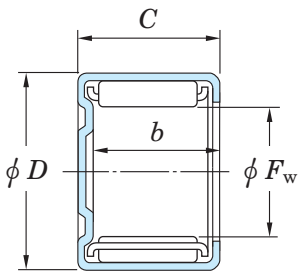
Caged type

With open ends



BT, BHT

With closed end



MK, MHK

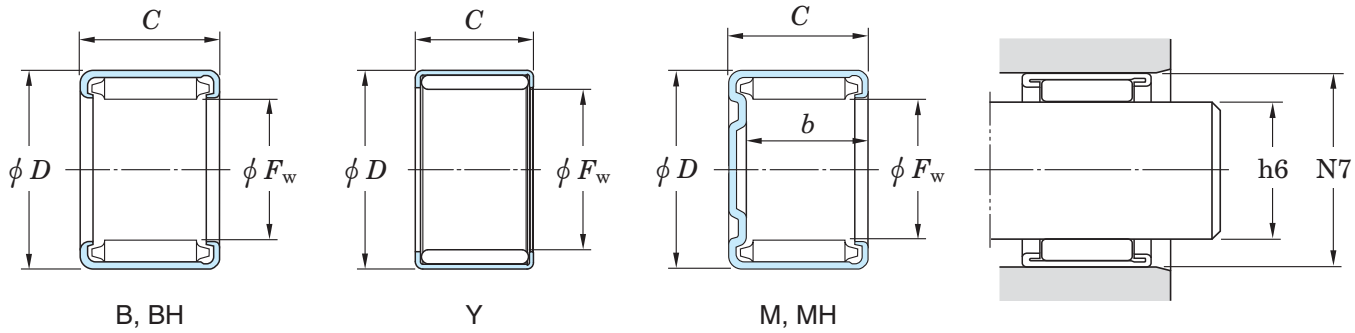
Boundary dimensions							Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No. [1]	
F_w		D		C		b	C_r	C_{0r}	Oil lub.	Caged type	
mm	inch	mm	inch	mm	inch	min.				With open ends	With closed end
34.925	1 3/8	41.275	1 5/8	31.750	1 1/4	29.2	41.3	131	3 800	—	—
	1 3/8	41.275	1 5/8	31.750	1 1/4	—	41.8	133	3 800	—	—
	1 3/8	44.450	1 3/4	12.700	1/2	—	11.6	14.9	10 000	**BHT228E**	—
	1 3/8	44.450	1 3/4	19.050	3/4	15.4	23.4	37.2	10 000	**BHT2212**	**MHK22121**
	1 3/8	44.450	1 3/4	25.400	1	21.8	31.4	54.3	10 000	**BHT2216**	**MHK22161**
38.100	1 1/2	47.625	1 7/8	12.700	1/2	9.3	17.5	31.8	3 300	—	—
	1 1/2	47.625	1 7/8	12.700	1/2	—	23.3	45.7	3 300	—	—
	1 1/2	47.625	1 7/8	15.880	5/8	12.4	24.3	48.3	3 300	—	—
	1 1/2	47.625	1 7/8	15.880	5/8	—	26.6	54.2	3 300	—	—
	1 1/2	47.625	1 7/8	19.050	3/4	—	30.6	64.9	3 300	—	—
	1 1/2	47.625	1 7/8	19.050	3/4	15.4	24.6	41.0	9 600	**BT2412**	**MK24121**
	1 1/2	47.625	1 7/8	22.220	7/8	18.7	36.5	81.5	3 300	—	—
	1 1/2	47.625	1 7/8	22.220	7/8	—	38.6	87.6	3 300	—	—
	1 1/2	47.625	1 7/8	25.400	1	21.8	42.2	98.3	3 300	—	—
	1 1/2	47.625	1 7/8	25.400	1	21.8	33.1	59.9	9 600	**BT2416**	**MK24161**
	1 1/2	47.625	1 7/8	25.400	1	—	44.1	104	3 300	—	—
	1 1/2	47.625	1 7/8	31.750	1 1/4	28.1	53.0	132	3 300	—	—
	1 1/2	47.625	1 7/8	31.750	1 1/4	28.1	43.7	85.9	9 600	**BT2420**	**MK24201**
	1 1/2	47.625	1 7/8	31.750	1 1/4	—	54.9	138	3 300	—	—
41.275	1 5/8	50.800	2	12.700	1/2	—	17.9	33.6	3 100	—	—
	1 5/8	50.800	2	12.700	1/2	—	20.9	41.0	3 100	—	—
	1 5/8	50.800	2	15.880	5/8	12.4	25.1	51.8	3 100	—	—
	1 5/8	50.800	2	15.880	5/8	12.4	21.0	34.5	8 900	**BT2610**	**MK26101**
	1 5/8	50.800	2	15.880	5/8	—	27.6	58.7	3 100	—	—
	1 5/8	50.800	—	22.220	7/8	17.2	28.7	29.8	8 900	**BT2614**	—
	1 5/8	50.800	2	31.750	1 1/4	31.7	55.1	142	3 100	—	—
	1 5/8	50.800	2	31.750	1 1/4	28.1	44.1	89.6	8 900	**BT2620**	**MK26201**

[Notes] 1) FN in bearing number indicates a bearing comprising polyamide molded cage.
2) The recommended dimensional tolerances of shaft shown above are applicable except h6.
3) The recommended dimensional tolerances of housing bore shown above are applicable except J7.

Full complement type

With open ends

With closed end



B, BH　　Y　　M, MH

Full complement type With open ends	Full complement type With closed end	Recommended dimensions (mm) Shaft dia. (h6) min.	Shaft dia. (h6) max.	Housing bore dia. (J7) min.	Housing bore dia. (J7) max.	(Refer.) Mass (g) With open ends	(Refer.) Mass (g) With closed end
B2220	**M22201**	34.909	34.925	41.264	41.289	75	85
Y2220	—	34.909	34.925	41.264	41.289	75	—
—	—	34.912 2)	34.925 2)	44.417 3)	44.442 3)	38	—
—	—	34.909	34.925	44.439	44.464	56	64
—	—	34.909	34.925	44.439	44.464	75	85
B248	**M2481**	38.084	38.100	47.614	47.639	47	53
Y248	—	38.084	38.100	47.614	47.639	47	—
B2410	**M24101**	38.084	38.100	47.614	47.639	54	61
Y2410	—	38.084	38.100	47.614	47.639	63	—
B2412	—	38.084	38.100	47.614	47.639	67	—
—	—	38.084	38.100	47.614	47.639	61	69
B2414	**M24141**	38.084	38.100	47.614	47.639	80	91
Y2414	—	38.084	38.100	47.614	47.639	88	—
B2416	**M24161**	38.084	38.100	47.614	47.639	94	106
—	—	38.084	38.100	47.614	47.639	81	92
Y2416	—	38.084	38.100	47.614	47.639	101	—
B2420	**M24201**	38.084	38.100	47.614	47.639	120	135
—	—	38.084	38.100	47.614	47.639	105	119
Y2420	—	38.084	38.100	47.614	47.639	126	—
B268	—	41.259	41.275	50.788	50.818	51	—
Y268	—	41.259	41.275	50.788	50.818	54	—
B2610	**M26101**	41.259	41.275	50.788	50.818	58	66
—	—	41.259	41.275	50.788	50.818	54	61
Y2610	—	41.259	41.275	50.788	50.818	68	—
—	—	41.259	41.275	50.788	50.818	78	—
B2620	**M26201**	41.259	41.275	50.788	50.818	129	146
—	—	41.259	41.275	50.788	50.818	109	123

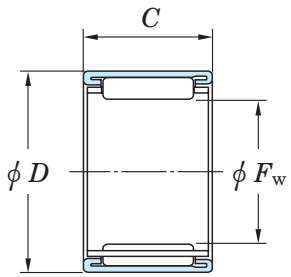
[Remark]　Limiting speed of grease lubrication should be kept to under 60 % of that for oil lubrication.

Inch series

F_w 44.450 ~ 52.388 mm

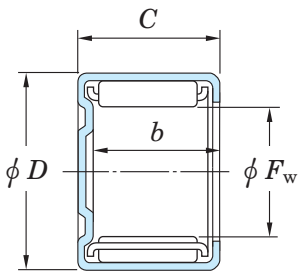
Caged type

With open ends



BT, BHT

With closed end



MK, MHK

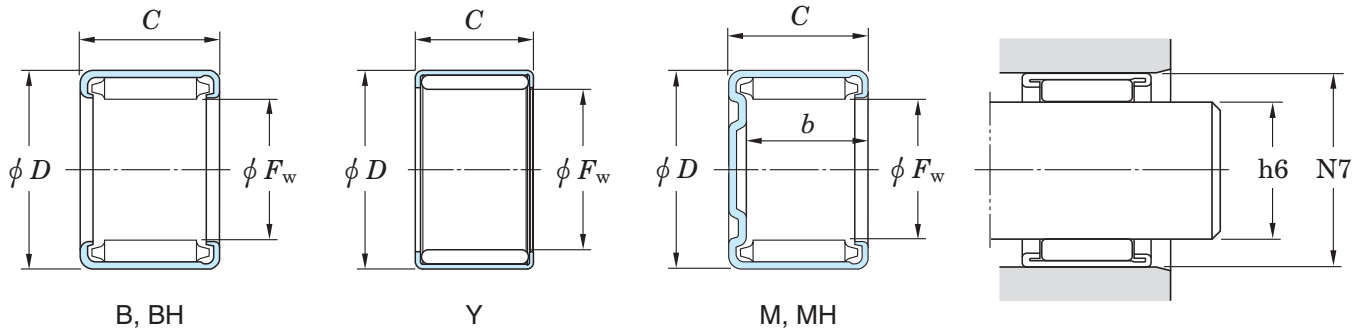
Boundary dimensions							Basic load ratings (kN)		Limiting speeds (min^{-1})	Bearing No. [1]	
F_w		D		C		b	C_r	C_{0r}	Oil lub.	Caged type	
mm	inch	mm	inch	mm	inch	min.				With open ends	With closed end
44.450	1 3/4	53.975	2 1/8	19.050	3/4	15.7	32.7	75.1	2 900	—	—
	1 3/4	53.975	2 1/8	19.050	3/4	15.7	26.8	48.6	8 300	**BT2812**	**MK28121**
	1 3/4	53.975	2 1/8	25.400	1	21.8	47.1	120	2 900	—	—
	1 3/4	53.975	2 1/8	25.400	1	—	36.6	72.6	8 300	**BT2816**	—
	1 3/4	53.975	2 1/8	25.400	1	—	47.1	120	2 900	—	—
	1 3/4	53.975	2 1/8	38.100	1 1/2	34.5	67.8	192	2 900	—	—
	1 3/4	53.975	2 1/8	38.100	1 1/2	34.5	54.0	120	8 300	**BT2824**	**MK28241**
47.625	1 7/8	57.150	2 1/4	12.700	1/2	9.1	19.6	39.4	2 700	—	—
	1 7/8	57.150	2 1/4	12.700	1/2	9.1	17.3	27.8	7 800	**BT308**	**MK3081**
	1 7/8	57.150	2 1/4	12.700	1/2	—	22.4	46.8	2 700	—	—
	1 7/8	57.150	2 1/4	15.880	5/8	11.0	23.0	40.1	7 800	**BT3010-1**	—
	1 7/8	57.150	2 1/4	25.400	1	21.8	47.7	124	2 700	—	—
	1 7/8	57.150	2 1/4	25.400	1	21.8	37.5	75.5	7 800	**BT3016**	**MK30161**
50.800	2	60.325	2 3/8	12.700	1/2	9.1	19.9	41.3	2 600	—	—
	2	60.325	2 3/8	12.700	1/2	—	23.2	50.4	2 600	—	—
	2	60.325	2 3/8	25.400	1	21.8	48.5	130	2 600	—	—
	2	60.325	2 3/8	25.400	1	21.8	37.7	78.1	7 300	**BT3216**	**MK32161**
	2	60.325	2 3/8	25.400	1	—	51.1	139	2 600	—	—
	2	60.325	2 3/8	31.750	1 1/4	28.1	61.0	175	2 600	—	—
	2	60.325	2 3/8	38.100	1 1/2	—	72.7	219	2 600	—	—
	2	60.325	2 3/8	44.450	1 3/4	40.8	84.0	264	2 600	—	—
	2	60.325	2 3/8	44.450	1 3/4	40.8	63.4	152	7 300	**BT3228**	**MK32281**
52.388	2 1/16	64.294	2 17/32	25.400	1	21.8	57.2	131	2 400	—	—
	2 1/16	64.294	2 17/32	25.400	1	—	48.7	89.2	7 000	**BHT3316**	—
	2 1/16	64.294	2 17/32	38.100	1 1/2	34.5	86.3	223	2 400	—	—

[Notes] 1) FN in bearing number indicates a bearing comprising polyamide molded cage.
2) The recommended dimensional tolerances of shaft shown above are applicable except h6.
3) The recommended dimensional tolerances of housing bore shown above are applicable except J7.

Full complement type

With open ends

With closed end



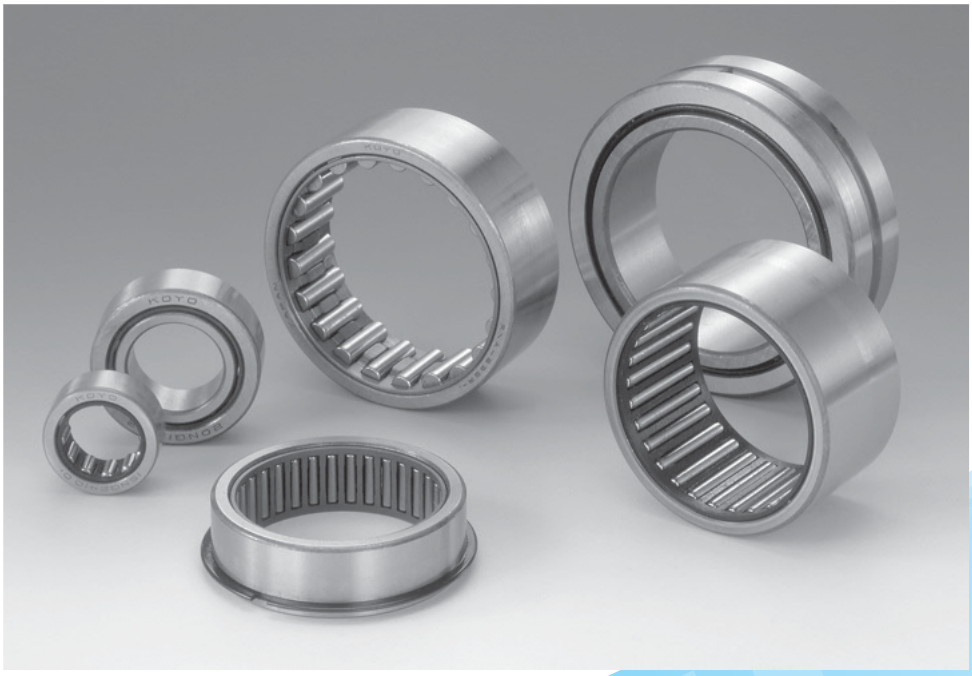
B, BH Y M, MH

Full complement type With open ends	Full complement type With closed end	Recommended dimensions (mm) Shaft dia. (h6) min.	Shaft dia. (h6) max.	Housing bore dia. (J7) min.	Housing bore dia. (J7) max.	(Refer.) Mass (g) With open ends	(Refer.) Mass (g) With closed end
B2812	**M28121**	44.434	44.450	53.963	53.993	78	88
—	—	44.434	44.450	53.963	53.993	70	79
B2816	**M28161**	44.434	44.450	53.963	53.993	110	125
—	—	44.434	44.450	53.963	53.993	93	—
Y2816	—	44.434	44.450	53.963	53.993	116	—
B2824	**M28241**	44.434	44.450	53.963	53.993	169	191
—	—	44.434	44.450	53.963	53.993	140	158
B308	**M3081**	47.609	47.625	57.138	57.168	58	65
—	—	47.609	47.625	57.138	57.168	50	56
Y308	—	47.609	47.625	57.138	57.168	62	—
—	—	47.609	47.625	57.138	57.168	64	—
B3016	**M30161**	47.609	47.625	57.138	57.168	114	129
—	—	47.609	47.625	57.138	57.168	99	112
B328	**M3281**	50.781	50.800	60.313	60.343	61	69
Y328	—	50.781	50.800	60.313	60.343	66	—
B3216	**M32161**	50.781	50.800	60.313	60.343	121	137
—	—	50.781	50.800	60.313	60.343	105	119
Y3216	—	50.781	50.800	60.313	60.343	131	—
B3220	**M32201**	50.781	50.800	60.313	60.343	152	172
B3224	—	50.781	50.800	60.313	60.343	183	—
B3228	**M32281**	50.781	50.800	60.313	60.343	223	252
—	—	50.781	50.800	60.313	60.343	188	213
BH3316	**MH33161**	52.369	52.388	64.282	64.312	160	181
—	—	52.372 [2)]	52.388 [2)]	64.280 [3)]	64.305 [3)]	138	—
BH3324	**MH33241**	52.369	52.388	64.282	64.312	240	271

[Remark] Limiting speed of grease lubrication should be kept to under 60 % of that for oil lubrication.

Koyo®

Machined ring needle roller bearings



NEEDLE ROLLER BEARINGS

Machined ring needle roller bearings

The Koyo machined ring needle roller bearings are provided with cages. The inner rings, outer rings and rollers, made of high carbon chromium bearing steel, are precisely machined and after heat treatment, are finished by grinding.

■ **It can withstand heavy load and impact load.**
■ **Permit installation in split housings.**

1 Bearing number

(Ex. 1)

15 NQ 24 10 D

- D — Supplementary code (refer to **Table 1**)
- 10 — Width (10 mm)
- 24 — Outside diameter (24 mm)
- NQ — Bearing type code (refer to **Table 2**)
- 15 — Roller set bore diameter (15 mm)

(Ex. 2)

NQI 15 / 16 C3

- C3 — Clearance code (refer to **Table 8** on page 121)
- 16 — Width (16 mm)
- 15 — Bore diameter (15 mm)
- NQI — Bearing type code (refer to **Table 2**)

(Ex. 3) Applicable to NA (or RNA) 49, 59 and 69.

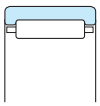
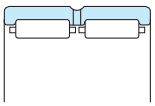
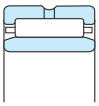
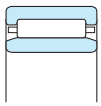
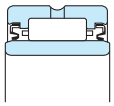
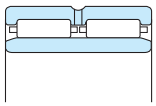
NA 49 05 UU

- UU — Seal code (Both sides sealed)
- 05 — Bore diameter (05 × 5 = 25 mm)
- 49 — Dimension series code (Diameter series = 9, Dimension series = 49)
- NA — Bearing type code (refer to **Table 2**)

Table 1 Supplementary code (Applicable to NQ, NQS, NQI and NQIS.)

Code	Description
D	Using case carburizing steel for outer rings
W	With lubrication holes and lubrication groove (outer ring)
W10	With anti-rotation pin hole (outer ring)
W11	With lubrication holes and anti-rotation pin hole (outer ring)
N	With snap ring groove (outer ring)
NR	With locating snap ring (outer ring)

Table 2 Type code of machined ring needle roller bearings

Type	Without inner ring			With inner ring			
						 (Sealed)	
Type code	RNA49 RNA59	NQ NQS	RNA69	NA49 NA59	NQI NQIS	NA49...UU	NA69

2 Shaft and Housing

The machined ring needle roller bearing is usually mounted on the hardened shaft without using an inner ring.

It is therefore necessary to satisfy the specifications in **Table 3** when designing the shaft and housing.

Table 3 Specifications of shafts and housings

	Shaft		Housing bore (Fitting surface)
	Raceway surface	Fitting surface	
Roundness	Best if less than one half or one third of the shaft diameter (housing bore diameter) tolerance.		
Cylindricity	5 μm or less per 25 mm, or one half or less of the shaft diameter (housing bore diameter) tolerance.		
Roughness (Ra)	0.4 a or less	0.8 a or less	1.6 a or less
Hardness[1)]	58 HRC or harder (60 to 64 HRC are best.)	—	—
Shaft Slope	13 μm or less per 25 mm		

[Note] 1) Case hardened steel which is carburized or induction-hardened should not only meet the surface hardness requirement specified above but also have a case depth of 52.3 HRC (550 HV) to a depth in the range (0.08 to 0.1) $\times D_w$ mm. (D_w : roller diameter)
In general, 30 thru 45 HRC is best for the center hardness.

3 Tolerances

The dimensional and running accuracy of Koyo machined ring needle roller bearing are as specified in JIS B 1536-1.

Variation of minimum roller set/roller complement bore diameter, $F_{ws\,min}$ (class F6) is described in **Table 4**; radial bearing tolerance is described in **Table 5**.

Table 4 Machined ring needle roller bearings variation of minimum roller set/roller complement bore diameter $F_{ws\,min}$[1)] (for interchangeable bearings[2)] and bearings without inner ring)

Unit : μm

Nominal roller set/roller complement bore diameter F_w (mm)		$F_{ws\,min}$ tolerance (F6)	
over	up to	upper	lower
6	**10**	+22	+13
10	**18**	+27	+16
18	**30**	+33	+20
30	**50**	+41	+25
50	**80**	+49	+30
80	**120**	+58	+36
120	**180**	+68	+43
180	**250**	+79	+50

[Notes] 1) The minimum single roller set bore diameter of roller complement is the diameter of a cylinder whose radial internal clearance disappears completely, at least in one radial direction.
2) A group of bearings with inner rings that have the same bearing number. Outer ring, cage and needle roller assemblies and inner rings are interchangeable among them.

Table 5 Radial bearing tolerances = JIS B 1536 =

(1-1) Inner ring

Unit : μm

Nominal bore diameter d mm		Single plane mean bore diameter deviation Δ_{dmp}								Single plane bore diameter variation V_{dsp} Diameter series 9				Mean bore diameter variation V_{dmp}			
		class 0		class 6		class 5		class 4		class 0	class 6	class 5	class 4	class 0	class 6	class 5	class 4
over	up to	upper	lower	upper	lower	upper	lower	upper	lower	max.				max.			
2.5	**10**	0	– 8	*0*	*– 7*	*0*	*– 5*	*0*	*– 4*	*10*	*9*	*5*	*4*	6	*5*	*3*	*2*
10	**18**	0	– 8	*0*	*– 7*	*0*	*– 5*	*0*	*– 4*	*10*	*9*	*5*	*4*	6	*5*	*3*	*2*
18	**30**	0	–10	*0*	*– 8*	*0*	*– 6*	*0*	*– 5*	*13*	*10*	*6*	*5*	8	*6*	*3*	*2.5*
30	**50**	0	–12	*0*	*–10*	*0*	*– 8*	*0*	*– 6*	*15*	*13*	*8*	*6*	9	*8*	*4*	*3*
50	**80**	0	–15	*0*	*–12*	*0*	*– 9*	*0*	*– 7*	*19*	*15*	*9*	*7*	11	*9*	*5*	*3.5*
80	**120**	0	–20	*0*	*–15*	*0*	*–10*	*0*	*– 8*	*25*	*19*	*10*	*8*	15	*11*	*5*	*4*
120	**150**	0	–25	*0*	*–18*	*0*	*–13*	*0*	*–10*	*31*	*23*	*13*	*10*	19	*14*	*7*	*5*
150	**180**	0	–25	*0*	*–18*	*0*	*–13*	*0*	*–10*	*31*	*23*	*13*	*10*	19	*14*	*7*	*5*
180	**250**	0	–30	*0*	*–22*	*0*	*–15*	*0*	*–12*	*38*	*28*	*15*	*12*	23	*17*	*8*	*6*

[Remark] Values in Italics are prescribed in JTEKT standards.

(1-2) Inner ring

Unit : μm

Nominal bore diameter d mm		Radial runout of assembled bearing inner ring K_{ia}				Perpendicularity of inner ring face with respect to the bore S_d		Single inner ring width deviation Δ_{Bs}								Inner ring width variation V_{Bs}				
		class 0	class 6	class 5	class 4	class 5	class 4	class 0		class 6		class 5		class 4		class 0	class 6	class 5	class 4	class 2
over	up to	max.				max.		upper	lower	upper	lower	upper	lower	upper	lower	max.				
2.5	**10**	10	*6*	*4*	*2.5*	*7*	*3*	0	–120	*0*	*–120*	*0*	*– 40*	*0*	*– 40*	15	*15*	*5*	*2.5*	*1.5*
10	**18**	10	*7*	*4*	*2.5*	*7*	*3*	0	–120	*0*	*–120*	*0*	*– 80*	*0*	*– 80*	20	*20*	*5*	*2.5*	*1.5*
18	**30**	13	*8*	*4*	*3*	*8*	*4*	0	–120	*0*	*–120*	*0*	*–120*	*0*	*–120*	20	*20*	*5*	*2.5*	*1.5*
30	**50**	15	*10*	*5*	*4*	*8*	*4*	0	–120	*0*	*–120*	*0*	*–120*	*0*	*–120*	20	*20*	*5*	*3*	*1.5*
50	**80**	20	*10*	*5*	*4*	*8*	*5*	0	–150	*0*	*–150*	*0*	*–150*	*0*	*–150*	25	*25*	*6*	*4*	*1.5*
80	**120**	25	*13*	*6*	*5*	*9*	*5*	0	–200	*0*	*–200*	*0*	*–200*	*0*	*–200*	25	*25*	*7*	*4*	*2.5*
120	**150**	30	*18*	*8*	*6*	*10*	*6*	0	–250	*0*	*–250*	*0*	*–250*	*0*	*–250*	30	*30*	*8*	*5*	*2.5*
150	**180**	30	*18*	*8*	*6*	*10*	*6*	0	–250	*0*	*–250*	*0*	*–250*	*0*	*–250*	30	*30*	*8*	*5*	*4*
180	**250**	40	*20*	*10*	*8*	*11*	*7*	0	–300	*0*	*–300*	*0*	*–300*	*0*	*–300*	30	*30*	*10*	*6*	*5*

[Remark] Values in Italics are prescribed in JTEKT standards.

Table 5 Radial bearing tolerances = JIS B 1536 =

(2-1) Outer ring

Unit : μm

Nominal outside dia. D mm		Single plane mean outside diameter deviation Δ_{Dmp}								Single plane outside diameter variation V_{Dsp} Diameter series 9				Mean outside diameter variation V_{Dmp}			
		class 0		class 6		class 5		class 4		class 0[1]	class 6[1]	class 5	class 4	class 0[1]	class 6[1]	class 5	class 4
over	up to	upper	lower	upper	lower	upper	lower	upper	lower	max.				max.			
6	**18**	0	– 8	*0*	*– 7*	*0*	*– 5*	*0*	*– 4*	*10*	*9*	*5*	*4*	6	*5*	*3*	*2*
18	**30**	0	– 9	*0*	*– 8*	*0*	*– 6*	*0*	*– 5*	*12*	*10*	*6*	*5*	7	*6*	*3*	*2.5*
30	**50**	0	–11	*0*	*– 9*	*0*	*– 7*	*0*	*– 6*	*14*	*11*	*7*	*6*	8	*7*	*4*	*3*
50	**80**	0	–13	*0*	*–11*	*0*	*– 9*	*0*	*– 7*	*16*	*14*	*9*	*7*	10	*8*	*5*	*3.5*
80	**120**	0	–15	*0*	*–13*	*0*	*–10*	*0*	*– 8*	*19*	*16*	*10*	*8*	11	*10*	*5*	*4*
120	**150**	0	–18	*0*	*–15*	*0*	*–11*	*0*	*– 9*	*23*	*19*	*11*	*9*	14	*11*	*6*	*5*
150	**180**	0	–25	*0*	*–18*	*0*	*–13*	*0*	*–10*	*31*	*23*	*13*	*10*	19	*14*	*7*	*5*
180	**250**	0	–30	*0*	*–20*	*0*	*–15*	*0*	*–11*	*38*	*25*	*15*	*11*	23	*15*	*8*	*6*
250	**315**	0	–35	*0*	*–25*	*0*	*–18*	*0*	*–13*	*44*	*31*	*18*	*13*	26	*19*	*9*	*7*

[Note] 1) Shall be applied when locating snap ring is not fitted.
[Remark] Values in Italics are prescribed in JTEKT standards.

(2-2) Outer ring

Unit : μm

Nominal outside dia. D mm		Radial runout of assembled bearing outer ring K_{ea}				Perpendicularity of outer ring outside surface with respect to the face S_D		Deviation of a single outer ring width Δ_{Cs}		Ring width variation V_{Cs}			
		class 0	class 6	class 5	class 4	class 5	class 4	class 0, 6, 5, 4		class 0	class 6	class 5	class 4
over	up to	max.				max.		upper	lower	max.			
6	**18**	15	*8*	*5*	*3*	*8*	*4*					*5*	*2.5*
18	**30**	15	*9*	*6*	*4*	*8*	*4*					*5*	*2.5*
30	**50**	20	*10*	*7*	*5*	*8*	*4*					*5*	*2.5*
50	**80**	25	*13*	*8*	*5*	*8*	*4*					*6*	*3*
80	**120**	35	*18*	*10*	*6*	*9*	*5*					*8*	*4*
120	**150**	40	*20*	*11*	*7*	*10*	*5*					*8*	*5*
150	**180**	45	*23*	*13*	*8*	*10*	*5*					*8*	*5*
180	**250**	50	*25*	*15*	*10*	*11*	*7*					*10*	*7*
250	**315**	60	*30*	*18*	*11*	*13*	*8*					*11*	*7*

Shall conform to the tolerance Δ_{Bs} on d of the same bearing

Shall conform to the tolerance V_{Bs} on d of the same bearing

[Note] 1) Shall be applied when locating snap ring is not fitted.
[Remark] Values in Italics are prescribed in JTEKT standards.

4 Fits

When mounting the bearing onto the shaft or housing, the fit must be determined by taking into account the operating conditions, such as load magnitude and types, material the parts fitted, dimensions and shapes, size and type of the bearing, temperature, and running accuracy.

Generally, in the case of an inner ring rotating load, the fit for the inner ring must be interference fit in order to prevent creep, while the fit for outer ring may be clearance fit.

In the case of an outer ring rotating load, the conditions must be the opposite those of an inner ring ratating load. In the case of an indeterminate direction load, a interference fit is usual for both inner and outer rings, although there are some exceptions.

Fits between the inner ring and the shaft and between the outer ring and the housing are shown in **Table 6** and **Table 7**.

(Tolerances for the shaft and housing are shown on pages 196 to 199)

Table 6 Recommended fits of inner ring and shaft

Operating condition		Shaft diameter (mm)	Class of shaft tolerance range	Applications (for reference)
Stationary inner ring load	Inner ring needs to move smoothly on shaft.	All shaft diameters	g 6	Stationary shaft wheels, tension pulleys, rope sheaves etc.
	Inner ring does not need to move smoothly on shaft.		h 6	
	High accuracy or noiseless rotation is required.		h 5	
Rotating inner ring load	Light load	40 mm or less	js 6	Electric appliances, machine tools, pumps, blowers, carriers etc.
	Normal load	40 mm or less	k 5	Electric motors, turbines, internal combustion engines, wood-working machines etc.
		over 40 100 mm or less	m 5	
		over 100 mm	m 6	
	Heavy load or impact load	140 mm or less	n 6	Railway rolling stock axle journals, traction motors
		over 140 mm	p 6	

Table 7 Recommended fits of the outer ring and housing

Operating condition		Class of housing bore tolerance range	Applications (for reference)
Rotating outer ring load	Heavy load with shock	P 7	Fly wheels
	Normal load	N 7	Loose wheels, crank shaft, gears
	Light fluctuating load	M 7	Rope pulley, jockey puller
Indeterminate direction load	Extreme impact load		Eccentric pump wheel
	Normal load	K 7	Compressor
	Light load	J 7	Compressor, crank shaft
Stationary outer ring load	Split housing, normal load	H 7	General use
	High accuracy and rigidity are required	K 6	Machine tool spindle

[Notes] 1) This table is applicable to cast iron or steel housing. For light alloy housings, somewhat more interference fits than shown are recommended.
2) Interference fits larger than J7 should not be used in split housings.

5 Clearance

When a machined ring needle roller bearing is used, the selection of clearance before mounting must take into account the change of clearance after mounting and the variation during operation. This is important in order to maintain the correct operating clearance resulting into the most of bearing performance and life. (For details, refer to page 20)

The radial internal clearances before mounting are shown in **Table 8**. They are classified into 5 groups according to size -- C2, standard clearance (no mark), C3, C4 and C5.

The roller set/roller complement bore diameter of Koyo machined ring needle roller bearings is of F6 class. If there is no inner ring, the relation between the radial internal clearance and the shaft used is as shown in **Table 9**.

Table 9 Relation between radial internal clearance and tolerance class of a shaft

Roller set/roller complement bore diameter (mm)	C 2	Standard	C 3	C 4
Over 3 up to 180	k 5	h 5	f 6	e 6

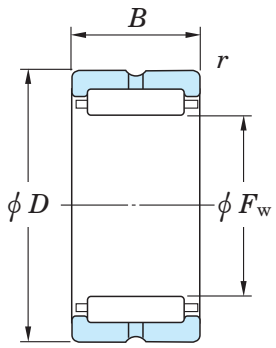
Table 8 Radial internal clearances of machined ring needle roller bearings

Unit : μm

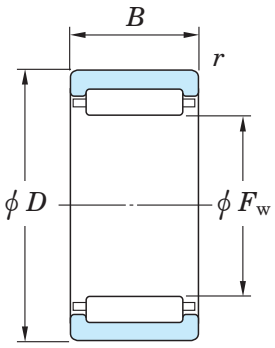
Nominal bore diameter d, mm		Clearance									
		C 2		C N		C 3		C 4		C 5	
over	up to	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
—	10	0	25	20	45	35	60	50	75	—	—
10	24	0	25	20	45	35	60	50	75	65	90
24	30	0	25	20	45	35	60	50	75	70	95
30	40	5	30	25	50	45	70	60	85	80	105
40	50	5	35	30	60	50	80	70	100	95	125
50	65	10	40	40	70	60	90	80	110	110	140
65	80	10	45	40	75	65	100	90	125	130	165
80	100	15	50	50	85	75	110	105	140	155	190
100	120	15	55	50	90	85	125	125	165	180	220
120	140	15	60	60	105	100	145	145	190	200	245
140	160	20	70	70	120	115	165	165	215	225	275
160	180	25	75	75	125	120	170	170	220	250	300
180	200	35	90	90	145	140	195	195	250	275	330
200	225	45	105	105	165	160	220	220	280	305	365
225	250	45	110	110	175	170	235	235	300	330	395

F_w 12 ~ 17 mm

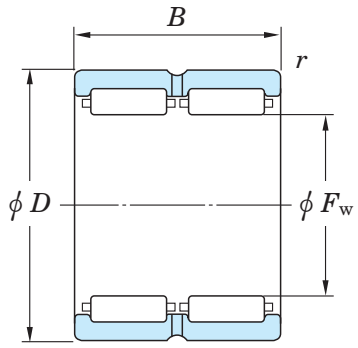
Without inner ring



RNA49, RNA59



NQ, NQS

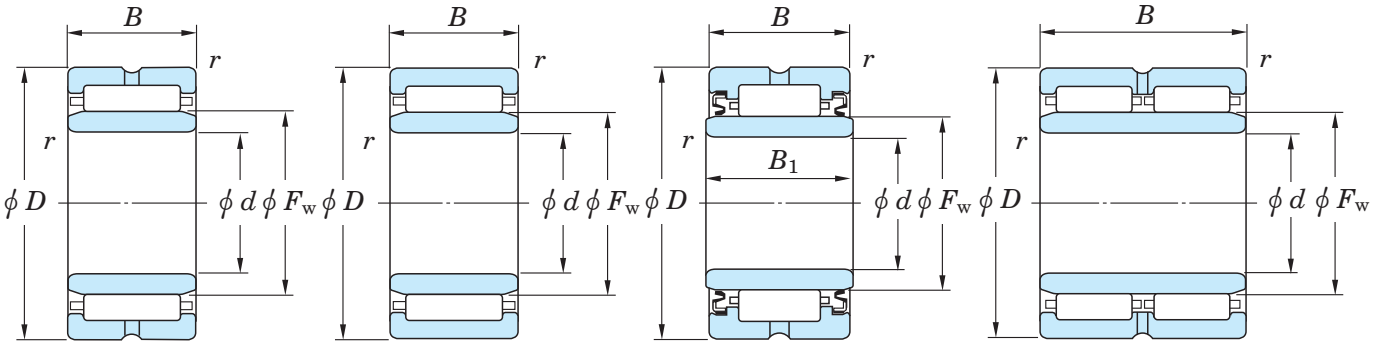


RNA69

Boundary dimensions (mm)						Basic load ratings (kN)		Limiting speeds [1] (min^{-1})	Bearing No.
F_w	d	D	B	B_1	r min.	C_r	C_{0r}	Oil lub.	Without inner ring
12	—	19	10	—	0.3	5.9	6.3	35 000	**NQ12/10**
	—	24	9.8	—	0.3	5.9	6.3	35 000	**12NQ2410A**
14	10	22	13	14	0.3	7.5	7.7	14 000	—
	10	22	13	—	0.3	7.6	9.1	31 000	**RNA4900**
	10	22	13	—	0.3	9.3	10.1	30 000	**RNA4900R**
	—	22	16	—	0.5	11.7	13.7	30 000	**NQ14/16D**
15	—	23	12	—	0.3	8.8	9.7	29 000	**NQ15/12**
	—	24	10	—	0.3	8.5	8.2	28 000	**15NQ2410D**
	—	25	12	—	0.6	10.5	10.8	28 000	**NQ152512**
	—	26	16	—	0.3	13.4	14.8	28 000	**NQS15/16**
	—	28	15	—	1	7.9	9.8	28 000	**15NQ2815**
16	—	23	16	—	0.5	13.1	16.4	27 000	**16NQ2316**
	—	23	16	—	0.5	15.2	17.4	28 000	**NQ15/16B**
	—	23	22	—	0.5	17.1	23.0	27 000	**16NQ2322A**
	—	24	12	—	0.3	7.7	9.6	28 000	**NQ16/12**
	12	24	13	14	0.3	8.3	9.2	12 000	—
	12	24	13	—	0.3	8.6	11.1	28 000	**RNA4901**
	12	24	13	—	0.3	10.2	11.8	27 000	**RNA4901R**
	—	24	16	—	0.3	10.9	15.2	28 000	**NQ16/16D**
	12	24	16	16	0.3	10.9	15.2	28 000	—
	—	24	20	—	0.3	13.1	19.1	28 000	**NQ16/20**
	12	24	22	—	0.3	16.3	21.7	27 000	**RNA6901**
17	—	25	16	—	0.5	11.3	16.2	26 000	**NQ17/16D**
	—	25	20	—	0.3	13.7	20.6	26 000	**17NQ2520**
	—	30	13	—	0.3	10.0	10.5	25 000	**17NQ3013D**
	—	32	16	—	0.6	18.0	16.5	23 000	**17NQ3216D**

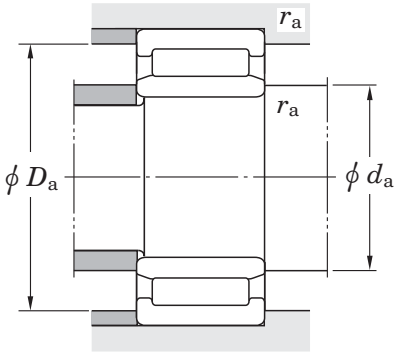
[Note] 1) Limiting speeds of bearing number NA49...UU indicates the value of sealed and grease lubricated bearings.
[Remark] Limiting speed of grease lubrication should be kept to unber 60 % of that for oil lubrication.

With inner ring



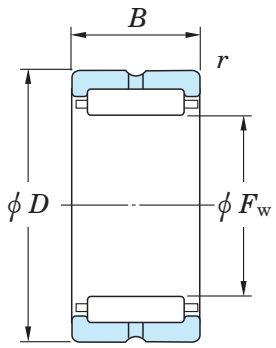
NA49, NA59 NQI, NQIS NA49...UU NA69

With inner ring	Mounting dimensions (mm) d_a min.	D_a max.	r_a max.	(Refer.) Mass (kg) Without inner ring	With inner ring	(Refer.) Applicable inner ring No.
—	—	17	0.3	0.010	—	—
—	—	22	0.3	0.023	—	—
NA4900UU	12	20	0.3	—	0.025	IRM101414
NA4900	12	20	0.3	0.017	0.025	IRM101413
NA4900R	12	20	0.3	0.016	0.023	IRM101413
—	—	19	0.5	0.021	—	—
—	—	21	0.3	0.017	—	—
—	—	22	0.3	0.016	—	—
—	—	21	0.6	0.022	—	—
—	—	24	0.3	0.034	—	—
—	—	23	1	0.043	—	—
—	—	20	0.5	0.018	—	—
—	—	20	0.5	0.020	—	—
—	—	20	0.5	0.025	—	—
—	—	22	0.3	0.019	—	—
NA4901UU	14	22	0.3	—	0.028	IRM121614
NA4901	14	22	0.3	0.019	0.028	IRM121613
NA4901R	14	22	0.3	0.018	0.027	IRM121613
—	—	22	0.3	0.025	—	—
NQI12/16D	14	22	0.3	—	0.036	—
—	—	22	0.3	0.032	—	—
NA6901	14	22	0.3	0.030	0.045	IRM121622
—	—	22	0.5	0.026	—	—
—	—	23	0.3	0.033	—	—
—	—	28	0.3	0.041	—	—
—	—	28	0.6	0.053	—	—

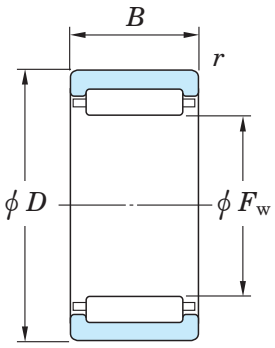


F_w 18 ~ (22) mm

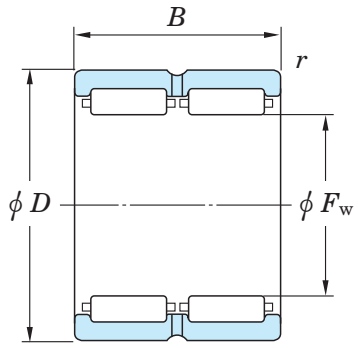
Without inner ring



RNA49, RNA59



NQ, NQS

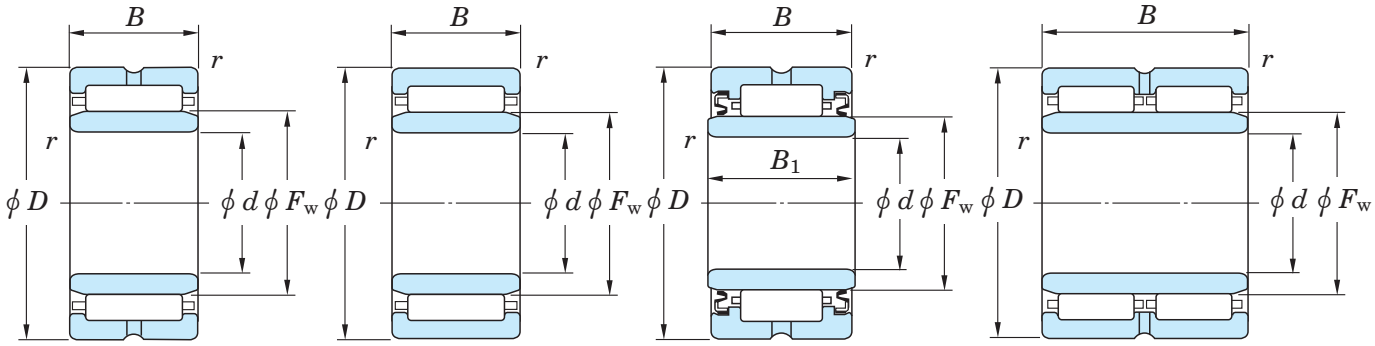


RNA69

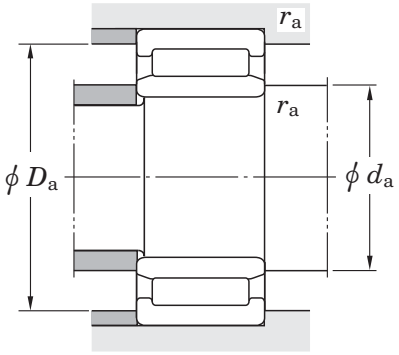
Boundary dimensions (mm)						Basic load ratings (kN)		Limiting speeds [1] (min^{-1})	Bearing No.
F_w	d	D	B	B_1	r min.	C_r	C_{0r}	Oil lub.	Without inner ring
18	—	25	16	—	0.3	11.7	17.2	25 000	**18NQ2516**
	—	26	13	—	0.3	11.0	13.6	24 000	**RNA49/14R**
	—	26	16	—	0.3	11.7	17.2	25 000	**NQ18/16**
	—	26	20	—	0.3	14.1	21.7	25 000	**NQ18/20**
	—	28	19	—	0.3	16.9	20.9	24 000	**18NQ2819**
	12	30	16	—	0.3	13.7	14.3	23 000	**NQS18/16**
19	15	27	16	—	0.3	12.1	18.2	24 000	—
20	—	27	17	—	0.3	14.7	20.4	22 000	**20NQ2717**
	15	28	13	14	0.3	9.2	11.1	10 000	—
	15	28	13	—	0.3	9.2	12.8	23 000	**RNA4902**
	15	28	13	—	0.3	11.3	14.6	22 000	**RNA4902R**
	—	28	16	—	0.3	12.0	18.2	23 000	**NQ20/16D**
	15	28	18	—	0.3	14.7	20.4	22 000	**RNA5902**
	—	28	20	—	0.3	14.4	23.0	23 000	**NQ20/20**
	—	28	23	—	0.3	18.4	27.1	22 000	**NQ202823**
	—	30	20	—	0.3	19.8	26.4	22 000	**20NQ3020**
	—	32	12	—	0.3	11.9	11.3	21 000	**20NQ3212**
	—	32	18	—	0.3	21.0	26.1	21 000	**NQ203218**
	—	33	15	—	0.6	14.0	16.9	21 000	**20NQ3315D**
	—	34	18	—	0.6	21.1	20.8	20 000	**20NQ3418D**
21	—	38	17	—	0.6	21.1	21.1	19 000	**21NQ3817**
22	17	30	13	14	0.3	9.4	11.8	9 100	—
	17	30	13	—	0.3	9.6	14.0	21 000	**RNA4903D**
	17	30	13	—	0.3	12.1	16.4	20 000	**RNA4903R**
	—	30	16	—	0.3	12.7	20.2	21 000	**NQ22/16**
	17	30	18	—	0.3	15.2	21.9	20 000	**RNA5903**
	—	30	20	—	0.3	15.3	25.6	21 000	**NQ22/20**

[Note] 1) Limiting speeds of bearing number NA49...UU indicates the value of sealed and grease lubricated bearings.
[Remark] Limiting speed of grease lubrication should be kept to unber 60 % of that for oil lubrication.

With inner ring



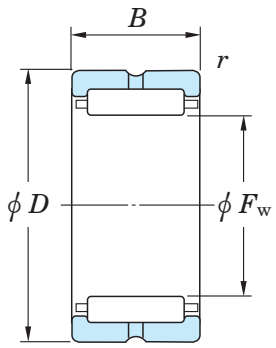
NA49, NA59 NQI, NQIS NA49...UU NA69



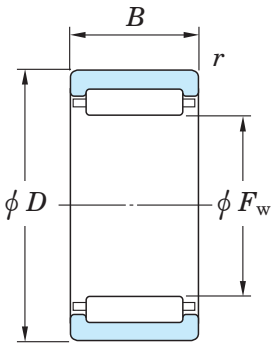
With inner ring	Mounting dimensions (mm) d_a min.	D_a max.	r_a max.	(Refer.) Mass (kg) Without inner ring	With inner ring	(Refer.) Applicable inner ring No.
—	—	23	0.3	0.023	—	—
—	—	24	0.3	0.020	—	—
—	—	24	0.3	0.027	—	—
—	—	24	0.3	0.035	—	—
—	—	26	0.3	0.042	—	—
NQIS12/16	14	28	0.3	0.044	0.057	—
NQI15/16	17	25	0.3	0.042	—	—
—	—	25	0.3	0.024	—	—
NA4902UU	17	26	0.3	—	0.037	IRM152014
NA4902	17	26	0.3	0.023	0.036	IRM152013
NA4902R	17	26	0.3	0.021	0.035	IRM152013
—	—	26	0.3	0.030	—	—
NA5902	17	26	0.3	0.029	0.048	IRM152018
—	—	26	0.3	0.038	—	—
—	—	26	0.3	0.040	—	—
—	—	28	0.3	0.048	—	—
—	—	30	0.3	0.033	—	—
—	—	30	0.3	0.053	—	—
—	—	29	0.6	0.052	—	—
—	—	30	0.6	0.060	—	—
—	—	34	0.6	0.082	—	—
NA4903UU	19	28	0.3	—	0.040	IRM172214
NA4903	19	28	0.3	0.025	0.040	IRM172213
NA4903R	19	28	0.3	0.023	0.038	IRM172213
—	—	28	0.3	0.032	—	—
NA5903	19	28	0.3	0.031	0.052	IRM172218
—	—	28	0.3	0.040	—	—

F_w (22) ~ 28 mm

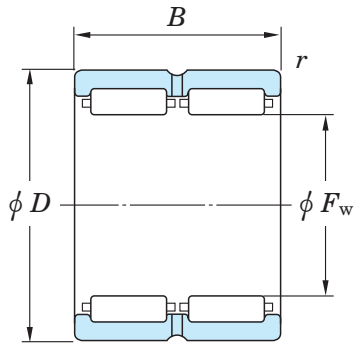
Without inner ring



RNA49, RNA59



NQ, NQS

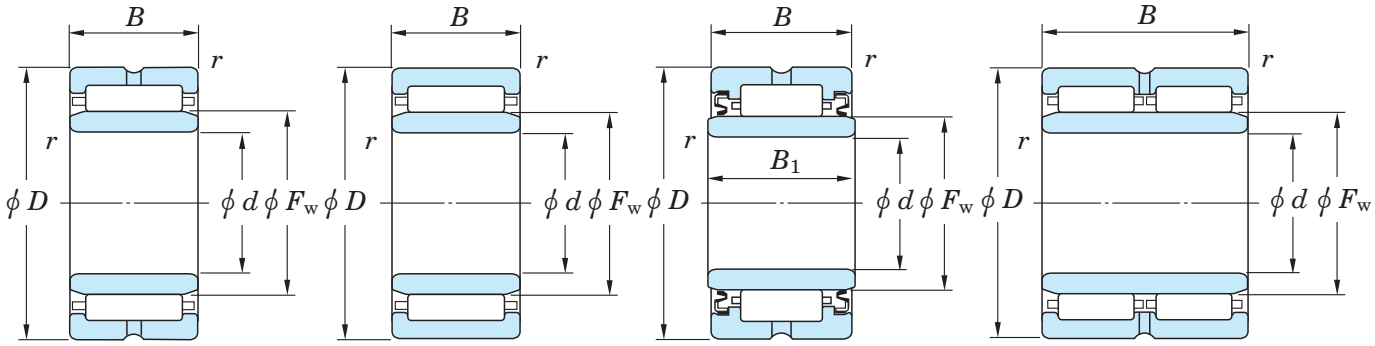


RNA69

Boundary dimensions (mm)						Basic load ratings (kN)		Limiting speeds [1] (min^{-1})	Bearing No.
F_w	d	D	B	B_1	r min.	C_r	C_{0r}	Oil lub.	Without inner ring
22	17	30	23	—	0.3	18.9	29.0	20 000	**RNA6903**
	—	32	25	—	0.3	22.4	31.7	20 000	**22NQ3225**
24	20	32	12	—	0.3	9.6	14.4	19 000	**NQ24/12**
	20	32	16	—	0.3	13.4	22.2	19 000	**NQ24/16**
	—	32	20	—	0.3	17.3	26.5	19 000	**NQ24/20AD**
	20	32	20	20	0.3	17.3	26.5	19 000	—
25	—	33	16	—	0.3	14.1	20.6	18 000	**NQ25/16**
	—	33	20	—	0.3	18.9	30.0	18 000	**NQ25/20**
	20	37	14	—	0.3	17.1	19.1	17 000	—
	—	37	17	—	1	19.3	22.5	17 000	**25NQ3717AD-1**
	20	37	17	18	0.3	16.4	18.2	8 000	—
	20	37	17	—	0.3	15.9	21.1	18 000	**RNA4904**
	—	37	17	—	0.9	21.5	25.7	17 000	**RNA4904ARD-1**
	20	37	23	—	0.3	28.0	36.1	17 000	**RNA5904**
	20	37	30	—	0.3	35.4	48.9	17 000	**RNA6904**
26	22	34	16	—	0.3	14.1	24.2	18 000	**NQ26/16**
	—	34	20	—	0.3	14.2	28.9	18 000	**26NQ3420**
	—	47	17	—	0.6	21.4	23.6	16 000	**26NQ4717**
	—	52	14	—	0.6	18.0	18.9	16 000	**26NQ5214**
28	—	37	20	—	0.3	20.6	34.7	16 000	**NQ283720D**
	—	37	30	—	0.3	29.1	54.1	16 000	**NQ28/30**
	22	39	17	—	0.3	17.8	25.4	16 000	**RNA49/22**
	—	39	17	—	0.3	21.8	29.8	16 000	**RNA49/22R**
	22	39	30	—	0.3	36.8	53.1	16 000	**RNA69/22**
	—	40	17	—	0.3	15.1	27.4	16 000	**28NQ4017**
	—	40	20	—	0.3	20.6	34.7	16 000	**28NQ4020**

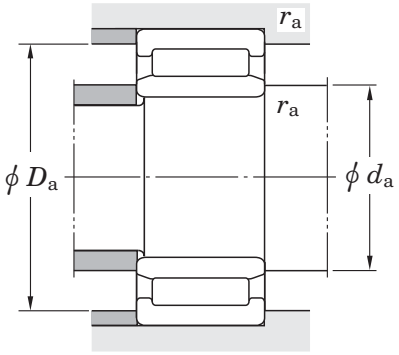
[Note] 1) Limiting speeds of bearing number NA49...UU indicates the value of sealed and grease lubricated bearings.
[Remark] Limiting speed of grease lubrication should be kept to unber 60 % of that for oil lubrication.

With inner ring



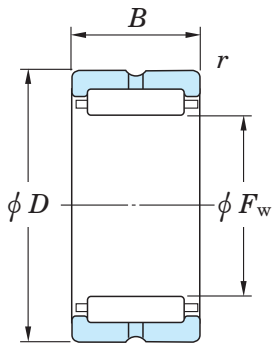
NA49, NA59 NQI, NQIS NA49...UU NA69

With inner ring	Mounting dimensions (mm) d_a min.	D_a max.	r_a max.	(Refer.) Mass (kg) Without inner ring	With inner ring	(Refer.) Applicable inner ring No.
NA6903	19	28	0.3	0.040	0.067	IRM172223
—	—	30	0.3	0.063	—	—
NQI20/12	22	30	0.3	0.025	0.038	—
NQI20/16	22	30	0.3	0.035	0.052	—
—	—	30	0.3	0.040	—	—
NQI203220AD	22	30	0.3	—	0.062	20IRM2420AD
—	—	31	0.3	0.034	—	—
—	—	31	0.3	0.043	—	—
20NQI3714	22	35	0.3	—	0.066	—
—	—	32	1	0.056	—	—
NA4904UU	22	35	0.3	—	0.078	IRM202518
NA4904	22	35	0.3	0.058	0.081	IRM202517
—	—	32	0.9	0.054	—	—
NA5904	22	35	0.3	0.073	0.104	IRM202523
NA6904	22	35	0.3	0.096	0.137	IRM202530
NQI22/16	24	32	0.3	0.037	0.056	—
—	—	32	0.3	0.042	—	—
—	—	43	0.6	0.113	—	—
—	—	48	0.6	0.136	—	—
—	—	35	0.3	0.056	—	—
—	—	35	0.3	0.083	—	—
NA49/22	24	37	0.3	0.056	0.086	IRM222817
—	—	37	0.3	0.055	—	—
NA69/22	24	37	0.3	0.100	0.154	IRM222830
—	—	38	0.3	0.068	—	—
—	—	38	0.3	0.087	—	—

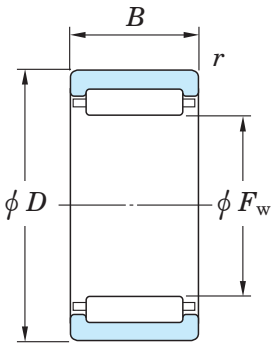


F_w 29 ~ 37 mm

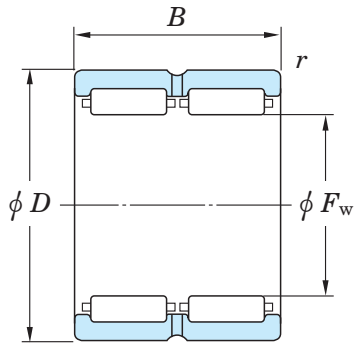
Without inner ring



RNA49, RNA59



NQ, NQS

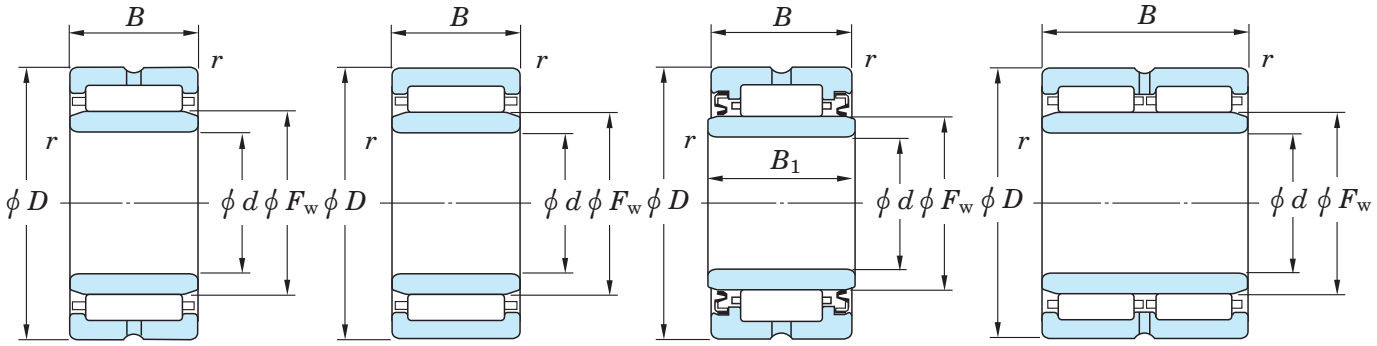


RNA69

Boundary dimensions (mm)						Basic load ratings (kN)		Limiting speeds [1] (min^{-1})	Bearing No.
F_w	d	D	B	B_1	r min.	C_r	C_{0r}	Oil lub.	Without inner ring
29	25	38	15	—	0.6	14.6	22.6	16 000	—
	—	38	20	—	0.6	20.4	34.8	16 000	**NQ29/20**
	25	38	30	—	0.3	28.9	54.3	16 000	**NQ29/30**
30	—	40	20	—	0.3	23.7	37.5	15 000	**NQ30/20**
	—	40	30	—	0.3	33.5	58.5	15 000	**NQ30/30**
	25	42	17	18	0.3	18.4	22.4	6 600	—
	25	42	17	—	0.3	18.6	27.4	15 000	**RNA4905**
	25	42	17	—	0.3	24.2	31.7	15 000	**RNA4905R**
	25	42	23	—	0.3	31.7	44.9	15 000	**RNA5905**
	—	42	30	—	0.6	40.1	60.7	15 000	**NQ304230**
	25	42	30	—	0.3	40.1	60.7	15 000	**RNA6905**
	25	44	25	25.5	0.3	36.0	48.8	14 000	—
32	28	42	20	—	0.3	24.3	39.4	14 000	**NQ32/20**
	28	42	30	—	0.3	34.4	61.6	14 000	**NQ32/30**
	28	45	17	—	0.3	25.0	33.8	14 000	**RNA49/28R**
	25	47	22	—	0.3	31.2	41.4	14 000	**NQS32/22**
35	—	45	14	—	0.6	16.9	29.0	13 000	**NQ354514**
	30	45	20	—	0.3	24.7	41.4	13 000	—
	30	47	17	18	0.3	19.5	25.3	5 700	—
	30	47	17	17	0.3	20.0	31.6	13 000	**RNA4906D**
	30	47	17	—	0.3	26.4	34.4	13 000	**RNA4906R**
	30	47	23	—	0.3	33.8	51.0	13 000	**RNA5906**
	—	47	30	—	0.3	42.7	69.0	13 000	**RNA6906**
	—	48	24	—	0.3	33.9	51.3	13 000	**35NQ4824D**
37	32	47	20	—	0.3	26.0	45.1	13 000	**NQ37/20**
	—	47	20	—	0.3	26.0	45.1	13 000	**NQ37/20D**

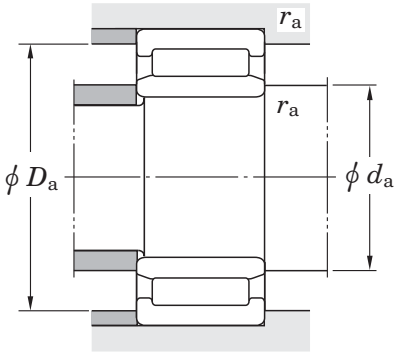
[Note] 1) Limiting speeds of bearing number NA49...UU indicates the value of sealed and grease lubricated bearings.
[Remark] Limiting speed of grease lubrication should be kept to unber 60 % of that for oil lubrication.

With inner ring



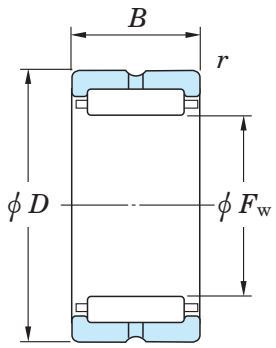
NA49, NA59 NQI, NQIS NA49...UU NA69

With inner ring	Mounting dimensions (mm) d_a min.	D_a max.	r_a max.	(Refer.) Mass (kg) Without inner ring	With inner ring	(Refer.) Applicable inner ring No.
NQI25/15	29	34	0.6	—	0.061	—
—	—	34	0.6	0.056	—	—
NQI25/30	27	36	0.3	0.085	0.125	—
—	—	38	0.3	0.066	—	—
—	—	38	0.3	0.099	—	—
NA4905UU	27	40	0.3	—	0.092	IRM253018
NA4905	27	40	0.3	0.065	0.096	IRM253017
NA4905R	27	40	0.3	0.065	0.092	IRM253017
NA5905	27	40	0.3	0.085	0.124	IRM253023
—	—	38	0.6	0.116	—	—
NA6905	27	40	0.3	0.112	0.162	IRM253030
25NQI4425A	27	42	0.3	—	0.161	—
NQI28/20	30	40	0.3	0.070	0.098	—
NQI28/30	30	40	0.3	0.104	0.141	—
NA49/28R	30	43	0.3	0.075	0.099	IRM283217
NQIS25/22	27	45	0.3	0.123	0.167	—
—	—	41	0.6	0.055	—	—
NQI30/20	32	43	0.3	—	0.108	—
NA4906UU	32	45	0.3	—	0.105	IRM303518
NA4906D	32	45	0.3	0.081	0.114	IRM303517D
NA4906R	32	45	0.3	0.070	0.103	IRM303517
NA5906	32	45	0.3	0.096	0.141	IRM303523
—	—	45	0.3	0.131	—	—
—	—	46	0.3	0.123	—	—
NQI32/20	34	45	0.3	0.079	0.114	—
—	—	45	0.3	0.079	—	—

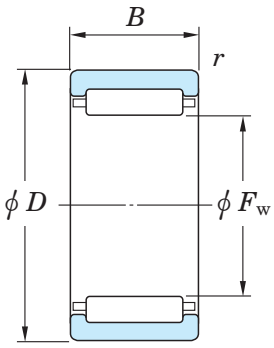


F_w 38 ~ 48 mm

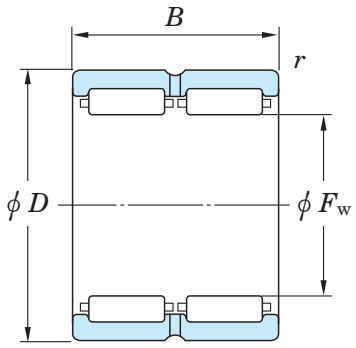
Without inner ring



RNA49, RNA59



NQ, NQS

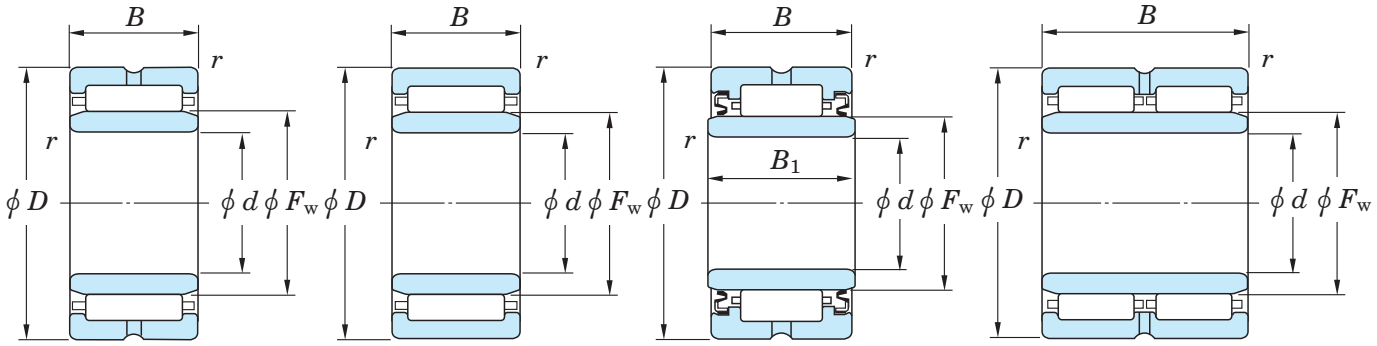


RNA69

Boundary dimensions (mm)						Basic load ratings (kN)		Limiting speeds [1] (min^{-1})	Bearing No.
F_w	d	D	B	B_1	r min.	C_r	C_{0r}	Oil lub.	Without inner ring
38	—	47	20	—	0.3	23.6	45.8	12 000	**38NQ4720**
	—	52	35	—	1	49.3	84.7	12 000	**38NQ5235**
40	—	48	20	—	0.3	20.9	39.8	12 000	**NQ404820**
	—	50	15	—	0.3	21.0	35.1	12 000	**NQ40/15AD**
	35	50	20	—	0.3	27.2	48.8	12 000	**NQ40/20**
	35	50	30	—	0.3	39.8	79.8	12 000	**NQ40/30**
	—	52	20	—	0.6	31.9	49.3	11 000	**RNA49/32R-1**
	—	52	30	—	0.6	47.0	81.0	11 000	**40NQ5230**
42	—	52	20	—	0.6	28.6	53.3	11 000	**NQ425220D**
	35	55	20	21	0.6	29.0	40.9	4 700	—
	35	55	20	—	0.6	26.9	49.0	11 000	**RNA4907**
	35	55	20	—	0.6	35.1	52.2	11 000	**RNA4907R**
	35	55	27	—	0.6	42.9	67.6	11 000	**RNA5907**
	35	55	36	—	0.6	51.4	85.1	11 000	**RNA6907**
43	38	53	30	30	0.6	41.3	85.9	10 000	—
45	—	55	20	—	0.6	27.9	52.7	10 000	**NQ45/20**
	40	55	30	—	0.6	40.9	86.1	10 000	**NQ45/30**
	—	58	20	—	0.6	36.0	55.0	10 000	**RNA49/38R-1**
47	42	57	20	—	0.6	29.0	56.4	10 000	—
	42	57	30	—	0.6	44.0	96.1	10 000	—
48	40	62	22	23	0.6	35.7	51.7	4 100	—
	40	62	22	—	0.6	32.6	58.5	9 700	**RNA4908**
	—	62	22	—	0.6	43.2	66.1	9 400	**RNA4908R-2**
	40	62	30	—	0.6	55.5	91.2	9 400	**RNA5908**
	40	62	40	—	0.6	66.7	115.0	9 400	**RNA6908**

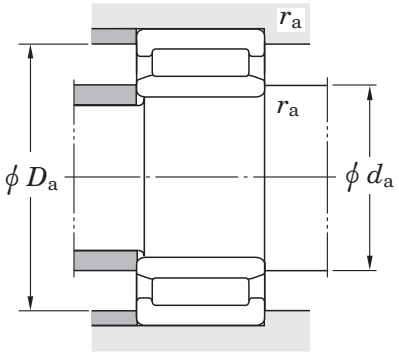
[Note] 1) Limiting speeds of bearing number NA49...UU indicates the value of sealed and grease lubricated bearings.
[Remark] Limiting speed of grease lubrication should be kept to unber 60 % of that for oil lubrication.

With inner ring



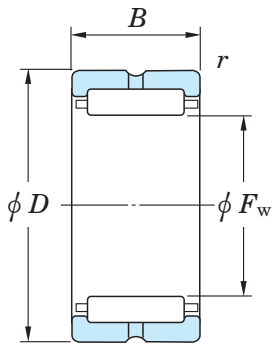
NA49, NA59 NQI, NQIS NA49...UU NA69

With inner ring	Mounting dimensions (mm) d_a min.	D_a max.	r_a max.	(Refer.) Mass (kg) Without inner ring	With inner ring	(Refer.) Applicable inner ring No.
—	—	45	0.3	0.073	—	—
—	—	47	1	0.203	—	—
—	—	46	0.3	0.064	—	—
—	—	48	0.3	0.063	—	—
NQI35/20	37	48	0.3	0.085	0.129	—
NQI35/30	37	48	0.3	0.120	0.192	—
—	—	48	0.6	0.098	—	—
—	—	48	0.6	0.148	—	—
—	—	48	0.6	0.087	—	—
NA4907UU	39	51	0.6	—	0.173	IRM354221
NA4907	39	51	0.6	0.122	0.186	IRM354220
NA4907R	39	51	0.6	0.104	0.168	IRM354220
NA5907	39	51	0.6	0.138	0.225	IRM354227
NA6907	39	51	0.6	0.182	0.297	IRM354236
NQI38/30	—	51	0.6	—	0.205	—
—	—	51	0.6	0.100	—	—
NQI40/30	44	51	0.6	0.138	0.214	—
—	—	54	0.6	0.116	—	—
NQI42/20	46	53	0.6	—	0.143	—
NQI42/30	46	53	0.6	—	0.219	—
NA4908UU	44	58	0.6	—	0.235	IRM404823
NA4908	44	58	0.6	0.157	0.249	IRM404822
—	—	58	0.6	0.142	—	—
NA5908	44	58	0.6	0.187	0.313	IRM404830
NA6908	44	58	0.6	0.256	0.415	IRM404840

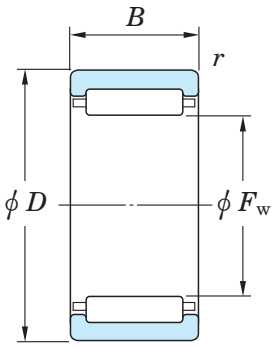


F_w 50 ~ 63 mm

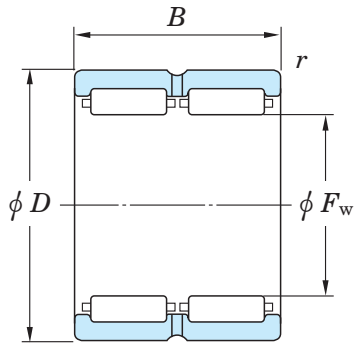
Without inner ring



RNA49, RNA59



NQ, NQS

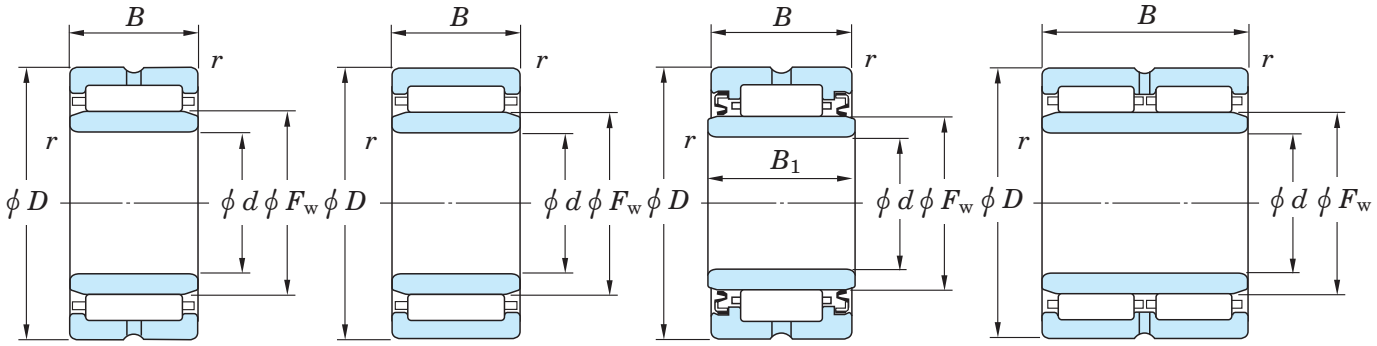


RNA69

Boundary dimensions (mm)						Basic load ratings (kN)		Limiting speeds [1] (min^{-1})	Bearing No.
F_w	d	D	B	B_1	r min.	C_r	C_{0r}	Oil lub.	Without inner ring
50	—	62	20	—	0.6	24.8	46.0	9 400	**NQ50/20A**
	45	62	25	—	0.6	41.9	82.5	9 300	—
	45	62	35	—	0.6	58.2	126.0	9 300	—
	—	65	25	—	0.6	48.3	77.8	9 100	**NQ506525**
52	45	68	22	23	0.6	37.7	56.8	3 800	—
	45	68	22	—	0.6	33.2	61.9	9 000	**RNA4909**
	45	68	22	—	0.6	45.8	72.9	8 800	**RNA4909R**
	45	68	30	—	0.6	58.9	101.0	8 800	**RNA5909**
	45	68	40	—	0.6	70.7	127.0	8 800	**RNA6909**
53	—	68	24.5	—	0.6	47.1	81.7	8 700	**NQ536825A**
55	—	67	20	—	0.6	24.1	46.2	8 600	**55NQ6720A**
	50	68	25	—	0.6	47.4	90.4	8 500	—
	—	70	22	—	0.6	46.9	76.5	8 300	**RNA49/48R**
	—	72	14	—	0.6	12.5	19.6	8 600	**55NQ7214**
	45	72	22	—	0.6	44.6	71.6	8 300	**NQS55/22**
58	50	72	22	—	0.6	35.7	70.6	8 100	**RNA4910**
	50	72	22	—	0.6	48.0	80.0	7 900	**RNA4910R**
	50	72	30	—	0.6	61.6	110.0	7 900	**RNA5910**
	50	72	40	—	0.6	74.0	140.0	7 900	**RNA6910**
60	—	72	25	—	0.6	45.4	97.3	7 900	**NQ60/25**
	—	75	22	—	0.6	49.1	83.4	7 700	**RNA49/52R**
63	55	80	25	—	1	44.4	87.2	7 500	**RNA4911**
	55	80	25	—	1	58.4	99.0	7 300	**RNA4911R**
	55	80	34	—	1	75.6	138.0	7 300	**RNA5911**
	55	80	45	—	1	86.7	165.0	7 300	**RNA6911**

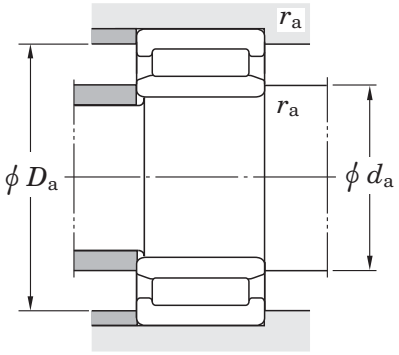
[Note] 1) Limiting speeds of bearing number NA49...UU indicates the value of sealed and grease lubricated bearings.
[Remark] Limiting speed of grease lubrication should be kept to unber 60 % of that for oil lubrication.

With inner ring



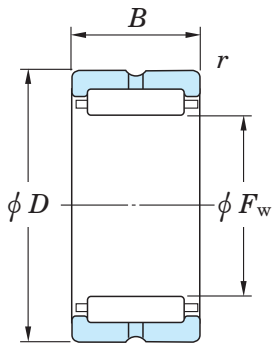
NA49, NA59 NQI, NQIS NA49...UU NA69

With inner ring	Mounting dimensions (mm) d_a min.	D_a max.	r_a max.	(Refer.) Mass (kg) Without inner ring	With inner ring	(Refer.) Applicable inner ring No.
—	—	58	0.6	0.126	—	—
NQI45/25	49	58	0.6	—	0.223	—
NQI45/35	49	58	0.6	—	0.316	—
—	—	61	0.6	0.190	—	—
NA4909UU	49	64	0.6	—	0.285	IRM455223
NA4909	49	64	0.6	0.205	0.294	IRM455222
NA4909R	49	64	0.6	0.185	0.274	IRM455222
NA5909	49	64	0.6	0.252	0.365	IRM455230
NA6909	49	64	0.6	0.334	0.496	IRM455240
—	—	64	0.6	0.207	—	—
—	—	63	0.6	0.136	—	—
NQI50/25	54	64	0.6	—	0.255	—
—	—	66	0.6	0.174	—	—
—	—	68	0.6	0.149	—	—
NQIS45/22	49	68	0.6	0.210	0.341	—
NA4910	54	68	0.6	0.191	0.298	IRM505822
NA4910R	54	68	0.6	0.172	0.276	IRM505822
NA5910	54	68	0.6	0.221	0.375	IRM505830
NA6910	54	68	0.6	0.291	0.497	IRM505840
—	—	68	0.6	0.164	—	—
—	—	71	0.6	0.188	—	—
NA4911	60	75	1	0.287	0.428	IRM556325
NA4911R	60	75	1	0.260	0.401	IRM556325
NA5911	60	75	1	0.354	0.546	IRM556334
NA6911	60	75	1	0.458	0.711	IRM556345

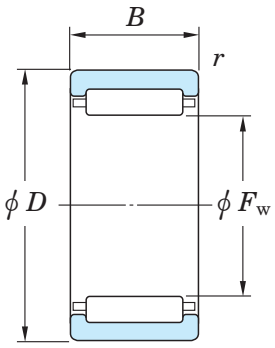


F_w 65 ~ 105 mm

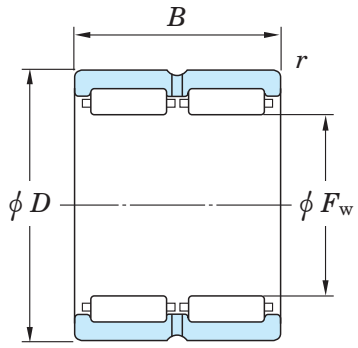
Without inner ring



RNA49, RNA59



NQ, NQS

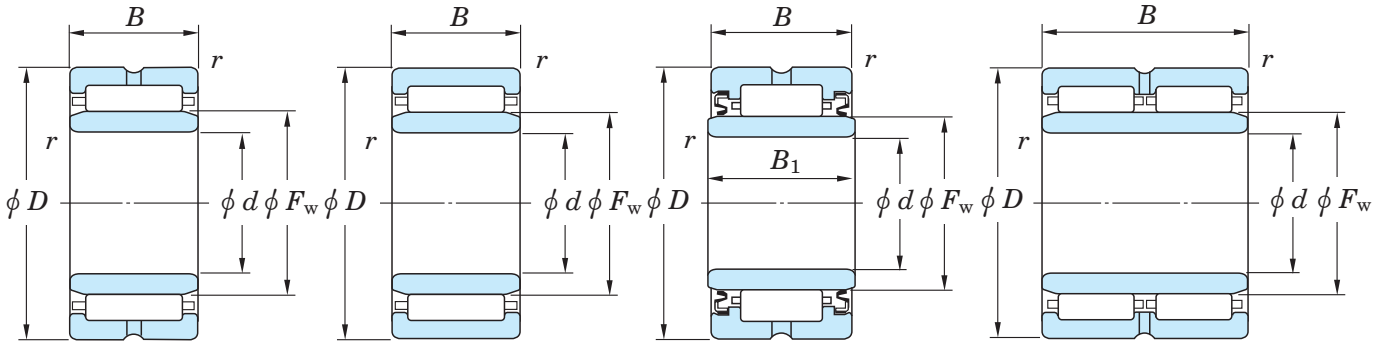


RNA69

Boundary dimensions (mm)						Basic load ratings (kN)		Limiting speeds [1] (min^{-1})	Bearing No.
F_w	d	D	B	B_1	r min.	C_r	C_{0r}	Oil lub.	Without inner ring
65	—	82	25	—	1	59.9	103.0	7 100	**RNA49/58R**
68	60	85	25	—	1	45.8	93.3	6 900	**RNA4912**
	60	85	34	—	1	79.2	150.0	6 800	**RNA5912**
70	—	88	25	—	1	64.5	109.0	6 600	**RNA49/62**
72	65	90	25	—	1	66.1	114.0	6 400	**RNA4913**
	65	90	34	—	1	85.4	158.0	6 400	**RNA5913**
	65	90	45	—	1	98.4	190.0	6 400	**RNA6913**
75	—	95	30	—	1	82.3	145.0	6 100	**RNA49/68**
80	70	100	30	—	1	86.4	157.0	5 700	**RNA4914**
	70	100	40	—	1	107.0	207.0	5 700	**RNA5914**
	70	100	54	—	1	132.0	271.0	5 700	**RNA6914**
85	75	105	30	—	1	88.0	164.0	5 400	**RNA4915**
	75	105	40	—	1	109.0	216.0	5 400	**RNA5915**
	75	105	54	—	1	135.0	283.0	5 400	**RNA6915**
90	80	110	30	—	1	91.6	176.0	5 100	**RNA4916**
	80	110	40	—	1	114.0	232.0	5 100	**RNA5916**
	80	110	54	—	1	140.0	304.0	5 100	**RNA6916**
95	—	115	30	—	1.1	92.8	183.0	4 900	**RNA49/82**
100	85	120	35	—	1.1	110.0	230.0	4 600	**RNA4917**
	85	120	46	—	1.1	126.0	293.0	4 700	**RNA5917**
	85	120	63	—	1.1	165.0	390.0	4 600	**RNA6917**
105	90	125	35	—	1.1	111.0	238.0	4 400	**RNA4918**
	90	125	46	—	1.1	137.0	311.0	4 400	**RNA5918**
	90	125	63	—	1.1	167.0	403.0	4 400	**RNA6918**

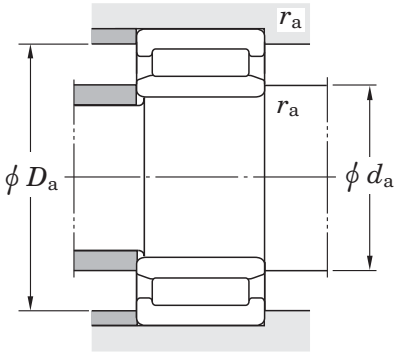
[Note] 1) Limiting speeds of bearing number NA49...UU indicates the value of sealed and grease lubricated bearings.
[Remark] Limiting speed of grease lubrication should be kept to unber 60 % of that for oil lubrication.

With inner ring



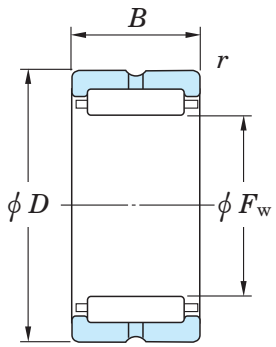
NA49, NA59 NQI, NQIS NA49...UU NA69

With inner ring	Mounting dimensions (mm) d_a min.	D_a max.	r_a max.	(Refer.) Mass (kg) Without inner ring	With inner ring	(Refer.) Applicable inner ring No.
—	—	77	1	0.277	—	—
NA4912	65	80	1	0.310	0.459	IRM606825
NA5912	65	80	1	0.380	0.587	IRM606834
—	—	83	1	0.298	—	—
NA4913	70	85	1	0.307	0.450	IRM657225
NA5913	70	85	1	0.419	0.613	IRM657234
NA6913	70	85	1	0.541	0.798	IRM657245
—	—	90	1	0.437	—	—
NA4914	75	95	1	0.483	0.733	IRM708030
NA5914	75	95	1	0.615	0.973	IRM708040
NA6914	75	95	1	0.895	1.37	IRM708054
NA4915	80	100	1	0.507	0.773	IRM758530
NA5915	80	100	1	0.644	1.03	IRM758540
NA6915	80	100	1	0.866	1.44	IRM758554
NA4916	85	105	1	0.540	0.819	IRM809030
NA5916	85	105	1	0.681	1.09	IRM809040
NA6916	85	105	1	0.916	1.46	IRM809054
—	—	108.5	1	0.537	—	—
NA4917	91.5	113.5	1	0.669	1.25	IRM8510035
NA5917	91.5	113.5	1	0.952	1.65	IRM8510046
NA6917	91.5	113.5	1	1.17	2.29	IRM8510063
NA4918	96.5	118.5	1	0.695	1.31	IRM9010535
NA5918	96.5	118.5	1	0.898	1.70	IRM9010546
NA6918	96.5	118.5	1	1.21	2.31	IRM9010563

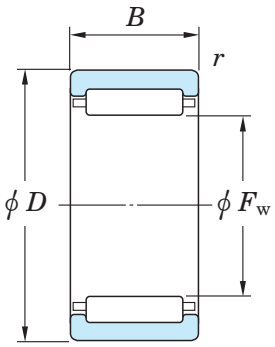


F_w 110 ~ 160 mm

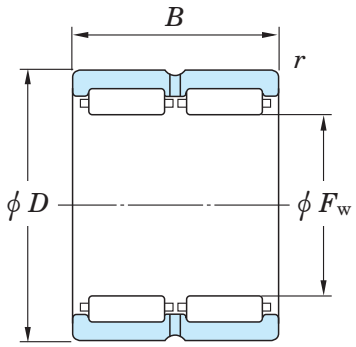
Without inner ring



RNA49, RNA59



NQ, NQS

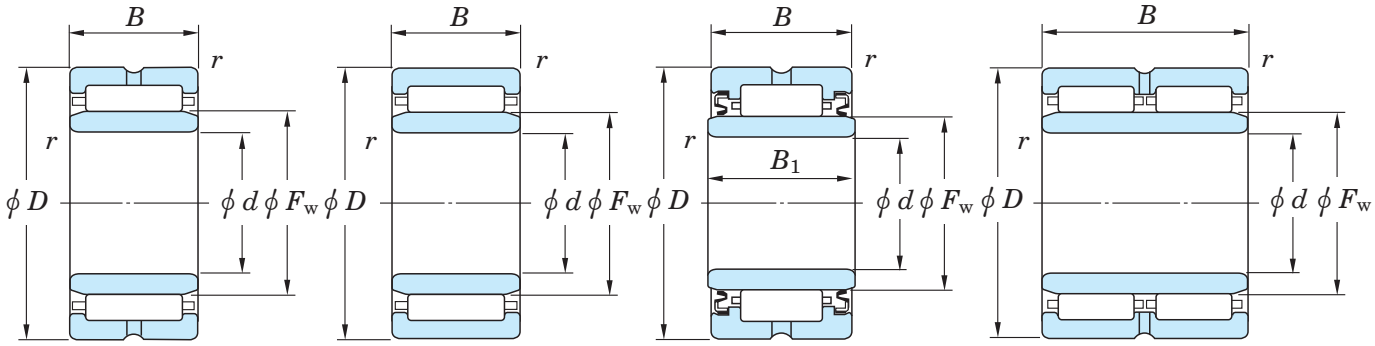


RNA69

Boundary dimensions (mm)						Basic load ratings (kN)		Limiting speeds [1] (min^{-1})	Bearing No.
F_w	d	D	B	B_1	r min.	C_r	C_{0r}	Oil lub.	Without inner ring
110	95	130	35	—	1.1	115.0	253.0	4 200	**RNA4919**
	95	130	46	—	1.1	141.0	331.0	4 200	**RNA5919**
	95	130	63	—	1.1	173.0	428.0	4 200	**RNA6919**
115	100	140	40	—	1.1	144.0	296.0	4 000	**RNA4920**
	100	140	54	—	1.1	189.0	418.0	4 000	**RNA5920**
125	110	150	40	—	1.1	149.0	317.0	3 700	**RNA4922**
	110	150	54	—	1.1	195.0	448.0	3 700	**RNA5922**
135	120	165	45	—	1.1	192.0	398.0	3 400	**RNA4924**
	120	165	60	—	1.1	244.0	564.0	3 400	**RNA5924**
150	130	180	50	—	1.5	225.0	508.0	3 000	**RNA4926**
	130	180	67	—	1.5	274.0	655.0	3 000	**RNA5926**
160	140	190	50	—	1.5	232.0	540.0	2 800	**RNA4928**
	140	190	67	—	1.5	283.0	696.0	2 800	**RNA5928**

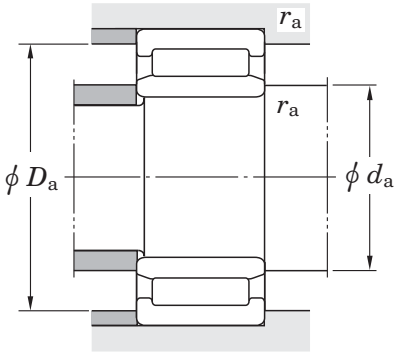
[Note] 1) Limiting speeds of bearing number NA49...UU indicates the value of sealed and grease lubricated bearings.
[Remark] Limiting speed of grease lubrication should be kept to unber 60 % of that for oil lubrication.

With inner ring



NA49, NA59 NQI, NQIS NA49...UU NA69

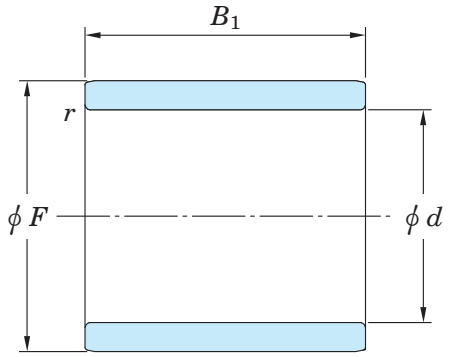
With inner ring	Mounting dimensions (mm) d_a min.	D_a max.	r_a max.	(Refer.) Mass (kg) Without inner ring	With inner ring	(Refer.) Applicable inner ring No.
NA4919	101.5	123.5	1	0.728	1.37	IRM9511035
NA5919	101.5	123.5	1	0.940	1.78	IRM9511046
NA6919	101.5	123.5	1	1.27	2.43	IRM9511063
NA4920	106.5	133.5	1	1.160	1.86	IRM10011540
NA5920	106.5	133.5	1	1.49	2.53	IRM10011554
NA4922	116.5	143.5	1	1.17	2.01	IRM11012540
NA5922	116.5	143.5	1	1.690	2.74	IRM11012554
NA4924	126.5	158.5	1	1.75	2.78	IRM12013545
NA5924	126.5	158.5	1	2.43	3.80	IRM12013560
NA4926	138	172	1.5	2.21	3.83	IRM13015050
NA5926	138	172	1.5	3.000	5.09	IRM13015067
NA4928	148	182	1.5	2.350	4.08	IRM14016050
NA5928	148	182	1.5	3.02	5.42	IRM14016067



Koyo®

Inner rings for needle roller bearings

NEEDLE ROLLER BEARINGS

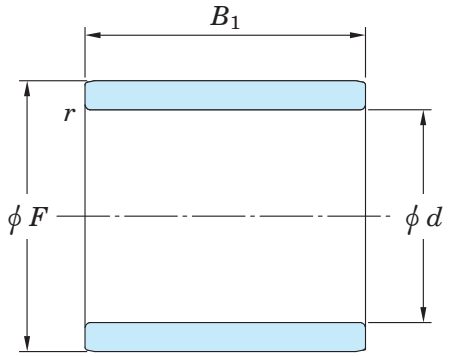


IRM

Boundary dimensions (mm) d	F	B_1	r min.	Bearing No.	Dimensional tolerances (μm) Raceway contact diameter F 1) Upper	Lower	(Refer.) Mass (g)
8	12	10.5	0.3	**IRM810**	0	–8	5.1
	12	12.5	0.3	**IRM812-1**	0	–8	6.1
	12	15.5	0.3	**IRM815**	0	–8	7.5
10	14	12.5	0.3	**IRM1012**	0	–8	7.3
	14	13.5	0.3	**IRM1013**	0	–8	7.9
	14	14	0.3	**IRM101414**	0	–8	8
12	15	12.5	0.3	**IRM1212**	0	–8	6.1
	15	16.5	0.3	**IRM1216**	0	–8	8.1
	16	13	0.3	**IRM121613**	0	–8	9
	16	14	0.3	**IRM121614**	0	–8	9.5
	16	16.5	0.3	**IRM1216-1**	0	–8	11
	16	22	0.3	**IRM121622**	0	–8	15
	17	15.0	0.3	**IRM1215**	0	–8	13
15	18	12.5	0.3	**IRM1512**	0	–8	7.3
	20	13	0.3	**IRM152013**	0	–8	13
	20	14	0.3	**IRM152014**	0	–8	15
	20	18	0.3	**IRM152018**	0	–8	19
	20	20.5	0.3	**15IRM2021**	0	–9	21
	20	23	0.3	**IRM152023**	0	–8	24
17	22	13	0.3	**IRM172213**	0	–8	15
	22	14	0.3	**IRM172214**	0	–8	16
	22	18	0.3	**IRM172218**	0	–8	21
	22	23	0.3	**IRM172223**	0	–8	27
20	25	15.5	0.3	**IRM2015**	0	–9	21
	25	16	0.3	**IRM2016A**	0	–9	21
	25	16.5	0.3	**IRM2016**	0	–9	23
	25	17	0.3	**IRM202517**	0	–9	23

[Note] 1) Tolerances of raceway contact diameter (F) conform to h5 of JIS B0401.
[Remark] Tolerances of bore (d) and width (B_1) conform to JIS B1536 (refer to page 119).

Boundary dimensions (mm)				Bearing No.	Dimensional tolerances (μm)		(Refer.) Mass (g)
d	F	B_1	r min.		Raceway contact diameter F [1] Upper	Lower	
20	25	18	0.3	**IRM202518**	0	–9	24
	25	23	0.3	**IRM202523**	0	–9	31
	25	25.5	0.3	**IRM2025**	0	–9	35
	25	26.5	0.3	**IRM2026**	0	–9	36
	25	27.5	0.3	**IRM2027**	0	–9	38
	25	30	0.3	**IRM202530**	0	–9	41
	30	16	0.3	**20IRM3016**	0	–9	48
22	28	17	0.3	**IRM222817**	0	–9	30
	28	30	0.3	**IRM222830**	0	–9	54
25	30	17	0.3	**IRM253017**	0	–9	28
	30	18	0.3	**IRM253018**	0	–9	30
	30	20.5	0.3	**IRM2520**	0	–9	34
	30	23	0.3	**IRM253023**	0	–9	39
	30	30	0.3	**IRM253030**	0	–9	50
28	32	17	0.3	**IRM283217**	0	–9	24
30	35	17	0.3	**IRM303517**	0	–9	33
	35	18	0.3	**IRM303518**	0	–9	35
	35	23	0.3	**IRM303523**	0	–9	45
	35	30	0.3	**IRM303530**	0	–9	60
32	40	20	0.6	**IRM324020**	0	–11	68
35	40	20.5	0.6	**IRM3520**	0	–11	46
	42	20	0.6	**IRM354220**	0	–11	65
	42	21	0.6	**IRM354221**	0	–11	68
	42	27.5	0.6	**IRM354227**	0	–11	87
	42	30	0.3	**35IRM4230**	0	–11	97
	42	36	0.6	**IRM354236**	0	–11	115



IRM

Boundary dimensions (mm) d	F	B_1	r min.	Bearing No.	Dimensional tolerances (μm) Raceway contact diameter F 1) Upper	Lower	(Refer.) Mass (g)
40	45	20.5	0.6	**IRM4020**	0	–11	52
	45	30.5	0.6	**IRM4030**	0	–11	77
	48	22	0.6	**IRM404822**	0	–11	92
	48	23	0.6	**IRM404823**	0	–11	97
	48	30	0.6	**IRM404830**	0	–11	126
	48	40	0.6	**IRM404840**	0	–11	168
45	52	22	0.6	**IRM455222**	0	–11	89
	52	23	0.6	**IRM455223**	0	–11	93
	52	30	0.6	**IRM455230**	0	–11	113
	52	40	0.6	**IRM455240**	0	–11	162
50	58	22	0.6	**IRM505822**	0	–11	114
	58	30	0.6	**IRM505830**	0	–11	154
	58	40	0.6	**IRM505840**	0	–11	206
55	63	25	1	**IRM556325**	0	–13	141
	63	34	1	**IRM556334**	0	–13	192
	63	45	1	**IRM556345**	0	–13	253
60	68	25	1	**IRM606825**	0	–13	153
	68	34	1	**IRM606834**	0	–13	207
	68	45	1	**IRM606845**	0	–13	275
65	72	25	1	**IRM657225**	0	–13	143
	72	34	1	**IRM657234**	0	–13	194
	72	45	1	**IRM657245**	0	–13	257
70	80	30	1	**IRM708030**	0	–13	268
	80	40	1	**IRM708040**	0	–13	358
	80	54	1	**IRM708054**	0	–13	543
75	85	30	1	**IRM758530**	0	–13	286

[Note] 1) Tolerances of raceway contact diameter (F) conform to h5 of JIS B0401.
[Remark] Tolerances of bore (d) and width (B_1) conform to JIS B1536 (refer to page 119).

Boundary dimensions (mm)				Bearing No.	Dimensional tolerances (μm)		(Refer.) Mass (g)
					Raceway contact diameter F [1]		
d	F	B_1	r min.		Upper	Lower	
75	85	40	1	**IRM758540**	0	–13	386
	85	54	1	**IRM758554**	0	–13	574
80	90	30	1	**IRM809030**	0	–13	304
	90	40	1	**IRM809040**	0	–13	409
	90	54	1	**IRM809054**	0	–13	544
85	100	35	1.1	**IRM8510035**	0	–15	581
	100	46	1.1	**IRM8510046**	0	–15	759
	100	63	1.1	**IRM8510063**	0	–15	1 120
90	105	35	1.1	**IRM9010535**	0	–15	615
	105	46	1.1	**IRM9010546**	0	–15	802
	105	63	1.1	**IRM9010563**	0	–15	1 100
95	110	35	1.1	**IRM9511035**	0	–15	642
	110	46	1.1	**IRM9511046**	0	–15	840
	110	63	1.1	**IRM9511063**	0	–15	1 160
100	115	40	1.1	**IRM10011540**	0	–15	767
	115	54	1.1	**IRM10011554**	0	–15	1 040
110	125	40	1.1	**IRM11012540**	0	–15	839
	125	54	1.1	**IRM11012554**	0	–15	1 140
120	135	45	1.1	**IRM12013545**	0	–15	1 026
	135	60	1.1	**IRM12013560**	0	–15	1 370
130	150	50	1.5	**IRM13015050**	0	–18	1 669
	150	67	1.5	**IRM13015067**	0	–18	2 240
140	160	50	1.5	**IRM14016050**	0	–18	1 793
	160	67	1.5	**IRM14016067**	0	–18	2 400

Koyo®

Needle roller thrust bearings

NEEDLE ROLLER BEARINGS

Needle roller thrust bearings

In Koyo needle roller thrust bearings, separable type comprising needle roller and cage thrust assemblies (TV, TP) and race (W, WS), and TVK and TPK in which precisely pressed race and needle roller and cage thrust assemblies are assembled as a non-separable type are available.

The needle roller thrust bearing does not occupy much space and can be used in the space where the conventional coller is used.

Furthermore, a compact machine set up is possible if it is used in combination with the radial type needle roller bearing. This type of bearing is widely employed in the speed reducers and transmission units of cars, cultivators, machine tools, etc.

[Remark] The race indicates the thrust washer or washer specified in JIS.

1 Bearing number

(Ex. 1)

TV 15 28

- 28 — Outside diameter (28 mm)
- 15 — Bore diameter (15 mm)
- TV — Bearing type code (refer to **Table 2**)

(Ex. 2)

TPWS 15 28 FF

- FF — Thrust race shape code (refer to **Table 1**)
- 28 — Outside diameter (28 mm)
- 15 — Bore diameter (15 mm)
- TPWS — Bearing type code (refer to **Table 2**)

(Ex. 3)

TVK 25 42 JL

- JL — Thrust race shape code (refer to **Table 1**)
- 42 — Outside diameter (42 mm)
- 25 — Bore diameter (25 mm)
- TVK — Bearing type code (refer to **Table 2**)

Table 1 Shape code of thrust races

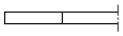
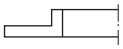
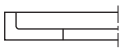
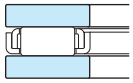
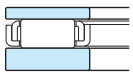
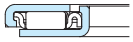
Code	Type	Profile
F	Flat race	
L	Bore diameter flanged (or claw)	
J	Outside diameter flanged (or claw)	
Z	Special shape	

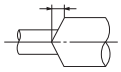
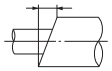
Table 2 Type code of bearings and thrust races

Type		Code	Remarks
Needle roller and cage thrust assembly		TV	
		TP	
Race		W	Thin plate race (pressed)
		WS	Thick plate race (machined)
Combination bearing examples		TPW ...F	TP+W
		TPWS ...FF	TP+WS+WS
		TPWWS ...FF	TP+W+WS
Non-separable bearing examples		TVK...	The non-separable type bearing comprises needle roller and cage thrust assembly and races.
		TPK...	

2 Mounting Surface Accuracy

When mounting the needle roller thrust bearig using the mounting surface of associated components as the raceway surface, the surface must satisfy the specifications shown in **Table 3**.

Table 3 Mounting surface accuracy

Squareness		25 μm or less per 25 mm
		12.5 μm or less per 25 mm
Roughness (Ra)		0.4 a or less
Hardness		58 HRC or harder (60 thru 64 HRC is best.) (refer to page 17 above regarding depth.)

3 Tolerances

The Koyo needle roller thrust bearing are manufactured according to specifications shown in **Tables 4** to **6**.

Table 4 Tolerances for needle roller and cage thrust assemblies (type code : TV, TP)

(1) Bore diameter Unit : μm

Cage bore diameter d_c (mm)		Minimum single bore ($d_{cs\ min}$) diameter deviation[1)]		Single plane bore diameter variation V_{dcsp}
over	up to	upper	lower	max.
6	**10**	+115	+25	90
10	**18**	+142	+32	110
18	**30**	+170	+40	130
30	**50**	+210	+50	160
50	**80**	+250	+60	190
80	**120**	+292	+72	220

[Note] 1) The tolerances indicate the limits of differences between $d_{cs\ min}$ and d_c.
[Remark] The tolerances of thickness conform to JIS B 1506 in a similar manner to roller diameter (D_w) (refer to page 177).

(2) Outside diameter Unit : μm

Cage outside diameter D_c (mm)		Maximum single outside ($D_{cs\ max}$) diameter deviation[1)]		Single plane outside diameter variation V_{Dcsp}
over	up to	upper	lower	max.
18	**30**	–110	–320	210
30	**40**	–120	–370	250
40	**50**	–130	–380	250
50	**65**	–140	–440	300
65	**80**	–150	–450	300
80	**100**	–170	–520	350
100	**120**	–180	–530	350
120	**140**	–200	–600	400

[Note] 1) The tolerances indicate the limits of differences between $D_{cs\ max}$ and D_c.
[Remark] The tolerances of thickness conform to JIS B 1506 in a similar manner to roller diameter (D_w) (refer to page 177).

Table 5 Tolerances for races = JIS B 1536 =

(1) Bore diameter (type code : W) Unit : μm

Race bore diameter d (mm)		Minimum single bore ($d_{s\ min}$) diameter deviation[1)]		Single plane bore diameter variation V_{dsp}
over	up to	upper	lower	max.
6	**10**	+175	+25	120
10	**18**	+212	+32	180
18	**30**	+250	+40	210
30	**50**	+300	+50	250
50	**80**	+360	+60	300
80	**120**	+422	+72	350

[Note] 1) The tolerances indicate the limits of differences between $d_{s\ min}$ and d.
[Remark] Tolerances of thickness (S) shall be equivalent to tolerance class js12 of JIS B 0401-2.

(2) Outside diameter (type code : W) Unit : μm

Race outside diameter D (mm)		Maximum single outside ($D_{s\ max}$) diameter deviation[1)]		Single plane outside diameter variation V_{Dsp}
over	up to	upper	lower	max.
18	**30**	–40	*–250*	330
30	**50**	–50	*–300*	390
50	**80**	–60	*–360*	460
80	**120**	–72	*–422*	540
120	**180**	–85	*–485*	630

[Note] 1) The tolerances indicate the limits of differences between $D_{s\ max}$ and D.
[Remarks] 1) Tolerances of thickness (S) shall be equivalent to tolerance class js12 of JIS B 0401-2.
2) Values in Italics are prescribed in JTEKT standards.

Table 5 Tolerances for races

(3) Bore diameter (type code : WS) Unit : μm

Race bore diameter d (mm)		Minimum single bore ($d_{s\,min}$) diameter deviation[1)]		Single plane bore diameter variation V_{dsp}
over	up to	upper	lower	max.
6	**10**	*+175*	*+25*	*120*
10	**18**	*+212*	*+32*	*180*
18	**30**	*+250*	*+40*	*210*
30	**50**	*+300*	*+50*	*250*
50	**80**	*+360*	*+60*	*300*
80	**120**	*+422*	*+72*	*350*

[Note] 1) The tolerances indicate the limits of differences between $d_{s\,min}$ and d.
[Remarks] 1) Tolerances of thickness (S) shall be equivalent to tolerance class js12 of JIS B 0401-2.
2) Values in Italics are prescribed in JTEKT standards.

(4) Outside diameter (type code : WS) Unit : μm

Race outside diameter D (mm)		Maximum single outside ($D_{s\,max}$) diameter deviation[1)]		Single plane outside diameter variation V_{Dsp}
over	up to	upper	lower	max.
18	**30**	*−40*	*−250*	*330*
30	**50**	*−50*	*−300*	*390*
50	**80**	*−60*	*−360*	*460*
80	**120**	*−72*	*−422*	*540*
120	**180**	*−85*	*−485*	*630*

[Note] 1) The tolerances indicate the limits of differences between $D_{s\,max}$ and D.
[Remarks] 1) Tolerances of thickness (S) shall be equivalent to tolerance class js12 of JIS B 0401-2.
2) Values in Italics are prescribed in JTEKT standards.

Table 6 Tolerances for non-separable needle roller thrust bearings (type code : TVK, TPK)

(1) Bore diameter Unit : μm

Race bore diameter d (mm)		Minimum single bore ($d_{s\,min}$) diameter deviation[1)]		Single plane bore diameter variation V_{dsp}
over	up to	upper	lower	max.
18	**30**	*+250*	*+40*	*210*
30	**50**	*+300*	*+50*	*250*
50	**80**	*+360*	*+60*	*300*

[Note] 1) The tolerances indicate the limits of differences between $d_{s\,min}$ and d.
[Remark] Values in Italics are prescribed in JTEKT standards.

(2) Outside diameter Unit : μm

Race outside diameter D (mm)		Maximum single outside ($D_{s\,max}$) diameter deviation[1)]		Single plane outside diameter variation V_{Dsp}
over	up to	upper	lower	max.
30	**50**	*−50*	*−300*	*250*
50	**80**	*−60*	*−360*	*300*
80	**120**	*−72*	*−422*	*350*

[Note] 1) The tolerances indicate the limits of differences between $D_{s\,max}$ and D.
[Remark] Values in Italics are prescribed in JTEKT standards.

4 Fits

Recommended fit for Koyo needle roller thrust bearings is as shown in **Table 7**.

Table 7 Recommended fit

Distinction	Type code	Guide	Tolerance class	
			Shaft	Housing bore
Needle roller and cage thrust assembly	TV TP	Inside	h8	—
		Outside	—	H8
Race	W WS	Inside	h8	—
		Outside	–	H8
Non-separable bearing	TVK (TPK) ...JL TVK (TPK) ...J TVK (TPK) ...L	Inside	h8	—
		Outside	—	H8

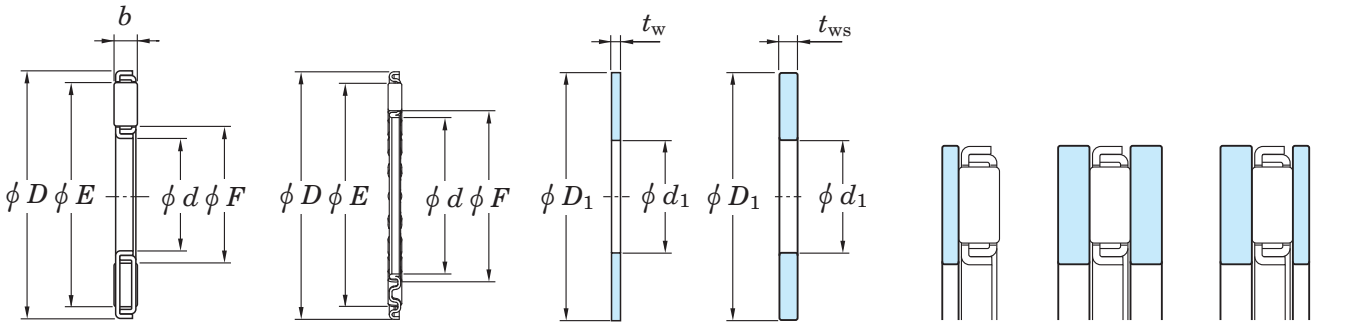
[Remark] This tolerance class is applicable when the tolerances of bore and outside diameters of bearings are standard.

$d\,(d_1)$ 10 ~ 22 mm

Separable type

Needle roller and cage thrust assembly

Race[1)]

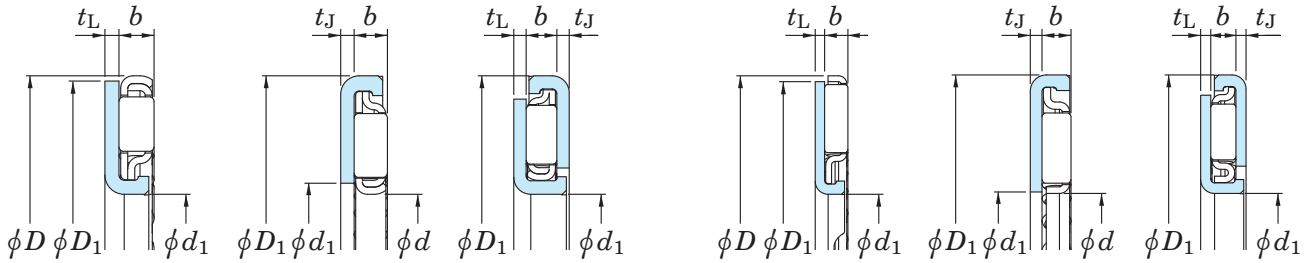


TP TV W WS TPW...F TPWS...FF TPWWS...FF

Boundary dimensions (mm)									Basic load ratings (kN)		Limiting speeds (min^{-1})	
d	d_1	D	D_1	b	t_w	t_J	t_{ws}	t_L	C_a	C_{0a}	Oil lub.	
10	**10**	24	24	2	1.0	—	2	—	6.35	18.3	12 000	
	—	23	—	2	—	—	—	—	8	24	12 000	
12	—	24	—	2	—	—	—	—	3.75	9	12 000	
	12	25.8	26	2	1.0	—	2	—	6.55	19.79	11 000	
	12	26	26	2	1.0	—	2	—	8.6	27.5	11 000	
14	**14**	27	27	2	1	—	2.75	—	6.55	19.8	11 000	
15	**15**	32.3	32	2	1.0	—	—	—	11	42.1	10 000	
	15	28	28	2	1.0	—	2	—	9.85	34.3	11 000	
16	**16**	29	29	2	1.5	—	2.75	—	9.15	31.4	11 000	
17	**17**	30	30	2	0.8	—	2.75	—	9.40	32.9	10 000	
	17	40	40	2.5	—	—	3	—	17.9	69.3	8 000	
	17	34	34	2.5	—	—	2.155	—	14.1	49.5	8 700	
18	**18**	31	31	2	1.0	—	2	—	9.65	34.4	10 200	
—	**18.1**	31.6	31	2.8	—	—	—	0.8	7.45	25.2	10 000	
—	**18.75**	—	39.7	3.584	—	0.8	—	0.8	9.8	37.4	9 000	
19.6	**21**	—	35.9	2.8	—	0.8	—	—	6	18.7	9 400	
20	**20**	35	35	2	1	—	2.75	—	13.2	53.6	9 600	
20.9	—	32	—	2	—	—	—	—	8.4	29.7	10 000	
21.9	—	34	—	2	—	—	—	—	8.05	28.6	9 700	
22	**22**	37	37	2	1	—	2.75	—	12.6	51.7	9 300	
—	**22**	41	41	2.8	—	—	—	0.8	13.2	56.8	8 800	

[Note] 1) In JIS, it is called a thrust washer or washer.

Non-separable type



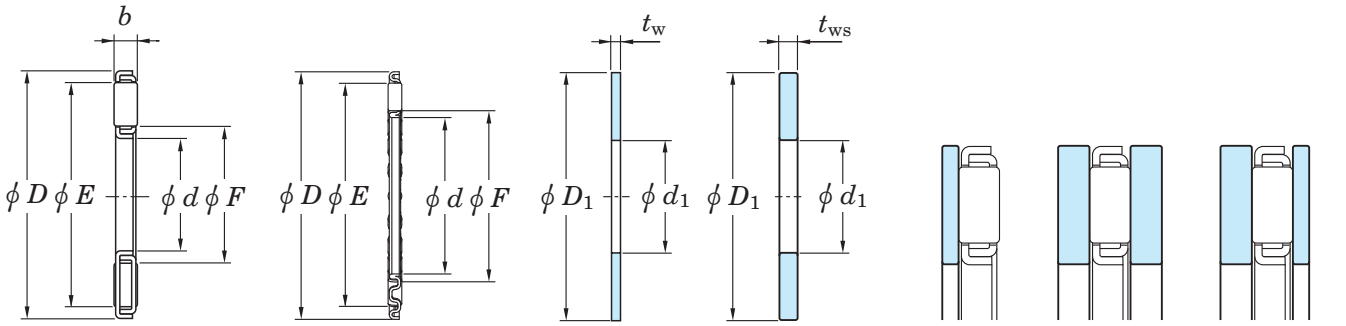
Bearing No.				Dimensions (mm)		(Refer.) Mass (g)			
Needle roller and cage thrust ass'y		Thin plate race (pressed)	Thick plate race (machined)						
Separable type	Non-separable type			E	F	[TP TV]	[TPK TVK]	(W)	(WS)
TP1024-1	—	**W1024F**	**WS1024F**	15.2	21.8	3.5	—	2.9	5.8
TV1023	—	—	—	12.6	21.8	2.5	—	—	—
TP1224	—	—	—	14.1	22.1	3.0	—	—	—
TP1226B	—	**W1226F**	**WS1226F**	17.3	23.5	3.6	—	3.3	6.6
TV1226	—	**W1226F**	**WS1226BF**	14.6	23.8	3.8	—	3.3	6.6
TP1427	—	**W1427F**	**WS1427F**	24.5	16.5	3.6	—	3.2	9.0
TP1532-1	—	**W1532F**	—	22.3	30.3	6.1	—	4.6	—
TV1528	—	**W1528F**	**WS1528F**	17.6	26.8	4.1	—	3.4	6.8
TP1629	—	**W1629AF**	**WS1629F**	26.5	18.5	4.4	—	5.4	9.9
TP1730	—	**W1730F**	**WS1730F**	27.5	19.5	4.4	—	3.0	10
TP1740	—	—	**WS1740F**	36.5	22.7	11	—	—	24
TV1734	—	—	**WS1734-2F**	21.1	32.5	8.2	—	—	11
TP1831	—	**W1831F**	**WS1831F**	20.4	28.4	5.0	—	3.9	7.8
—	**TPK1832L**	—	—	22.8	29.4	—	8	—	—
—	**TVK1940JL**	—	—	25	34.2	—	17	—	—
—	**TPK2036J-1**	—	—	21.8	28	—	10	—	—
TP2035-1	—	**W2035F**	**WS2035F**	32.5	22.9	5.9	—	5.1	14
TP2132D	—	—	—	23.5	29.7	4.6	—	—	—
TP2234	—	—	—	25	31.2	5.1	—	—	—
TP2237-1	—	**W2237F**	**WS2237F**	34.5	22.9	6.4	—	5.4	15
—	**TPK2241L**	—	—	28	38	—	15	—	—

$d\ (d_1)$ 22.2 ~ 31.85 mm

Separable type

Needle roller and cage thrust assembly

Race[1)]

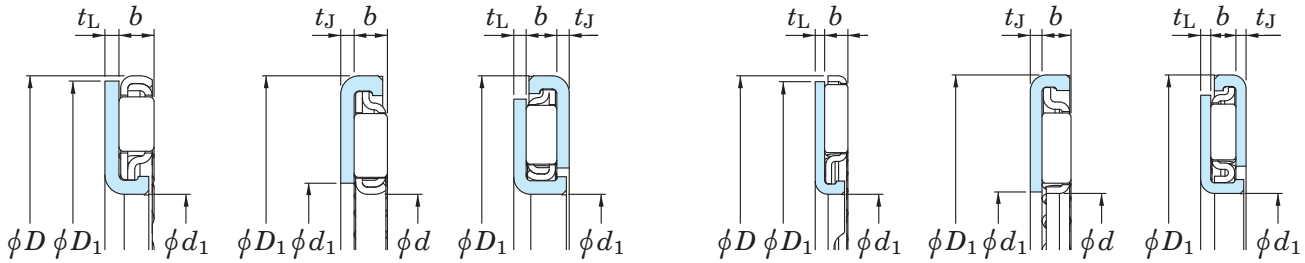


TP TV W WS TPW...F TPWS...FF TPWWS...FF

Boundary dimensions (mm)									Basic load ratings (kN)		Limiting speeds (min^{-1})	
d	d_1	D	D_1	b	t_w	t_J	t_{ws}	t_L	C_a	C_{0a}	Oil lub.	
22.2	—	36.1	—	1.984	—	—	—	—	9.95	38.2	9 500	
22.7	**22**	—	35.1	2.8	—	0.8	—	—	8.3	29.7	9 500	
22.8	**22**	—	37.95	2.784	—	0.8	—	—	10.6	40.9	9 200	
25	**25**	42	42	2	1.0	—	3	—	14.8	66.2	8 700	
	25	—	39.5	3.3	—	0.8	—	—	14	51.5	8 100	
25.8	**26**	—	42	2.784	—	0.8	—	—	12.8	54.4	8 800	
26	—	38.66	—	2	—	—	—	—	10.4	41.2	9 100	
—	**26**	—	43.4	3.584	—	0.8	—	0.8	11.5	49	8 600	
28	—	41	—	2	—	—	—	—	9.4	37.4	8 800	
	28	45	45	2	0.8	—	3	—	15.1	70.3	8 400	
	28	—	42.6	2.8	—	0.8	—	—	9.4	37.4	8 700	
28.5	**28.5**	46.15	46.15	2	0.8	—	—	—	12.1	52.4	8 300	
28.9	—	42	—	1.984	—	—	—	—	11.7	50.4	8 800	
—	**29**	47.21	47	3	—	—	—	1	15.9	76	8 300	
—	**29**	48.4	49	3.8	—	—	—	0.8	21.8	87.4	6 600	
30	**30**	47	47	2	1.0	—	2	—	16.2	78.6	8 300	
—	**30.1**	45.5	45.5	2.784	—	—	—	0.8	12.4	55.9	8 400	
—	**30.1**	—	47.3	3.584	—	0.8	—	0.8	12.4	55.9	8 300	
—	**30.7**	—	46.02	3.584	—	0.8	—	0.8	12.5	56.2	8 400	
—	**30.7**	—	46.43	3.784	—	1	—	0.8	12.5	56.2	8 300	
—	**31.85**	45.1	45.2	2.784	—	—	—	0.8	12.1	54.7	8 400	

[Note] 1) In JIS, it is called a thrust washer or washer.

Non-separable type



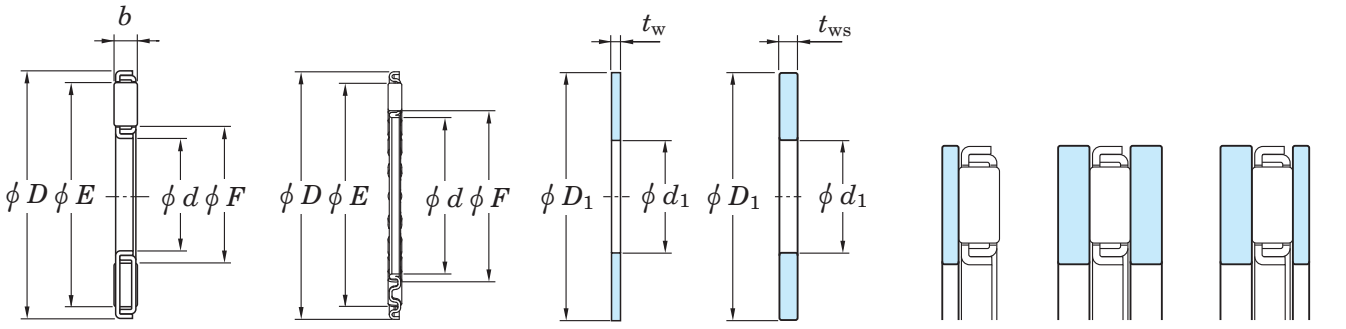
Bearing No.				Dimensions (mm)		(Refer.) Mass (g)			
Needle roller and cage thrust ass'y		Thin plate race (pressed)	Thick plate race (machined)						
Separable type	Non-separable type			E	F	TP TV	TPK TVK	(W)	(WS)
TP2236A-1	—	—	—	25.3	33.3	6.1	—	—	—
—	**TPK2235J**	—	—	25	31.2	—	9.1	—	—
—	**TVK2238J**	—	—	24	33.2	—	11	—	—
TP2542	—	**W2542F**	**WS2542KF**	28.6	39.2	8.6	—	7	21
—	**TVK2540J**	—	—	26.2	35.4	—	12.4	—	—
—	**TVK2642J**	—	—	27	37	—	13	—	—
TV2639-1	—	—	—	28.2	37.4	5.5	—	—	—
—	**TPK2643JL**	—	—	30.6	38.6	—	19	—	—
TP2841C	—	—	—	31.5	37.7	6.7	—	—	—
TP2845	—	**W2845F**	**WS2845F**	42.5	31.9	9.0	—	6.1	19
—	**TPK2843AJ**	—	—	31.5	37.7	—	13	—	—
TP2946A	—	**W2946AF**	—	32.4	40.4	9.3	—	6.5	—
TP2942A-1	—	—	—	31.6	39.6	7.2	—	—	—
—	**TVK2947L**	—	—	34	45	—	18	—	—
—	**TVK2949L**	—	—	35	47	—	22	—	—
TP3047-1	—	**W3047F**	**WS3047F**	34	44.6	10	—	8.1	16.2
—	**TPK3046L**	—	—	35	42.6	—	14	—	—
—	**TPK3047JL-1**	—	—	35	42.6	—	21	—	—
—	**TPK3146JL-4**	—	—	34.5	42.3	—	19	—	—
—	**TPK3146JL-5**	—	—	34.5	42.3	—	21	—	—
—	**TVK3245L**	—	—	36.2	44.2	—	12	—	—

$d\,(d_1)$ 32 ~ 43.45 mm

Separable type

Needle roller and cage thrust assembly

Race[1)]

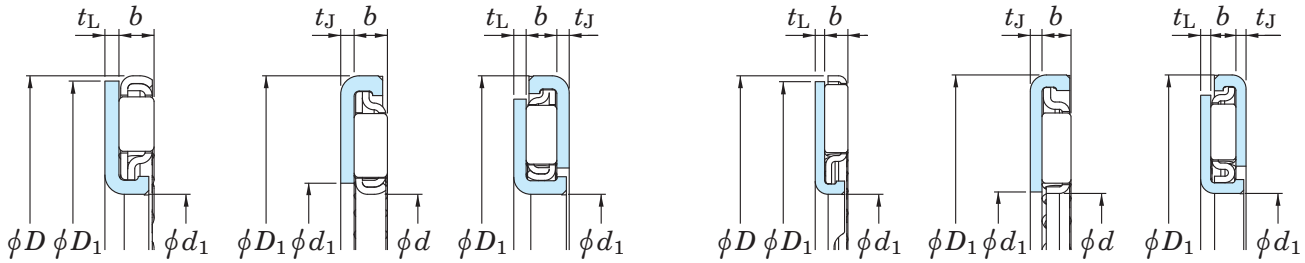


TP TV W WS TPW...F TPWS...FF TPWWS...FF

Boundary dimensions (mm)									Basic load ratings (kN)		Limiting speeds (min^{-1})	
d	d_1	D	D_1	b	t_w	t_J	t_{ws}	t_L	C_a	C_{0a}	Oil lub.	
32	**32**	49	49	2	1	—	3	—	17.3	86.2	8 100	
—	**32.9**	53.1	53.1	2.784	—	—	—	0.8	18.4	97.2	7 800	
33.5	—	45	—	2	—	—	—	—	8.5	34.3	8 400	
33.7	**33.8**	—	48.2	2.784	—	0.8	—	—	13.6	63	8 200	
—	**34**	—	51.4	3.6	—	0.8	—	0.8	12.6	58.1	7 900	
34.65	**35**	52	52	2	1.0	—	3	—	17.1	86.9	7 800	
	34.6	58.4	58.2	2	0.8	—	—	—	20.5	114	7 400	
	34.6	58.4	58.2	2	0.8	—	—	—	22.4	128	7 400	
—	**37.4**	57.3	57.3	2.784	—	—	—	0.8	19.3	106	7 500	
—	**38**	—	53	3.6	—	0.8	—	0.8	11.6	53.8	7 800	
—	**38**	—	58	4.8	—	0.8	—	1	24.9	91.5	6 100	
38.07	**38**	—	52	2.8	—	0.8	—	—	12	55.2	7 800	
38.15	**38.15**	55.29	55.29	1.984	0.8	—	3.0	—	19.9	108	7 600	
39.6	—	58.1	—	3	—	—	—	—	25.8	115	6 100	
40	**40**	60	60	3	1.0	—	2	—	23.5	103	6 000	
41	—	68	—	9	—	—	—	—	75.8	222	3 200	
42	—	62	—	3	—	—	—	—	17.5	71.4	5 900	
—	**42.5**	—	61.2	3.584	—	0.8	—	0.8	15.5	81.7	7 300	
—	**43.45**	—	61.2	3.584	—	0.8	—	0.8	14.6	74.9	7 300	
—	**43.45**	—	61.74	3.884	—	1.1	—	0.8	14.6	74.9	7 200	

[Note] 1) In JIS, it is called a thrust washer or washer.

Non-separable type



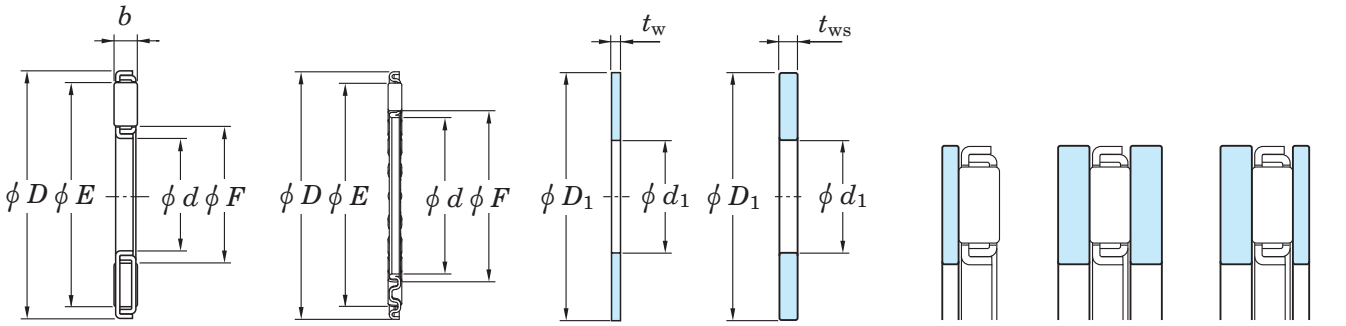
Bearing No.				Dimensions (mm)		(Refer.) Mass (g)			
Needle roller and cage thrust ass'y		Thin plate race (pressed)	Thick plate race (machined)						
Separable type	Non-separable type			E	F	TP TV	TPK TVK	(W)	(WS)
TP3249	—	**W3249F**	**WS3249F**	46.5	35.9	10	—	8.5	25
—	**TVK3353L**	—	—	39.8	51.8	—	20	—	—
TP3445A	—	—	—	37	42.6	6.8	—	—	—
—	**TVK3448J-1**	—	—	35	44.2	—	14	—	—
—	**TPK3451JL**	—	—	38.6	46.6	—	23	—	—
TP3552B	—	**W3552F**	**WS3552AF**	38.4	49	11	—	9.1	27
TP3558	—	**W3558F**	—	44	56	16	—	11	—
TP3558-1	—	**W3558F**	—	42	56	16	—	11	—
—	**TVK3757L**	—	—	44	56	—	23	—	—
—	**TPK3853JL**	—	—	42.4	49	—	22	—	—
—	**TPK3858JL**	—	—	43.2	53.2	—	41	—	—
—	**TVK3852J-1**	—	—	39.8	47.8	—	15	—	—
TP3855A	—	**W3855F**	**WS3855F**	40.59	52.59	13	—	13	49
TP4058-1	—	—	—	43.3	55.3	22	—	—	—
TP4060	—	**W4060F**	**WS4060F**	44.4	56	23	—	12	24
TP4168	—	—	—	45.4	63.8	104	—	—	—
TP4262	—	—	—	47.8	56.4	23	—	—	—
—	**TVK4361JL-2**	—	—	47.6	56.8	—	29	—	—
—	**TVK4361JL**	—	—	47.6	56.8	—	29	—	—
—	**TVK4362JL**	—	—	47.6	56.8	—	32	—	—

$d\,(d_1)$ 45 ~ 65 mm

Separable type

Needle roller and cage thrust assembly

Race[1)]

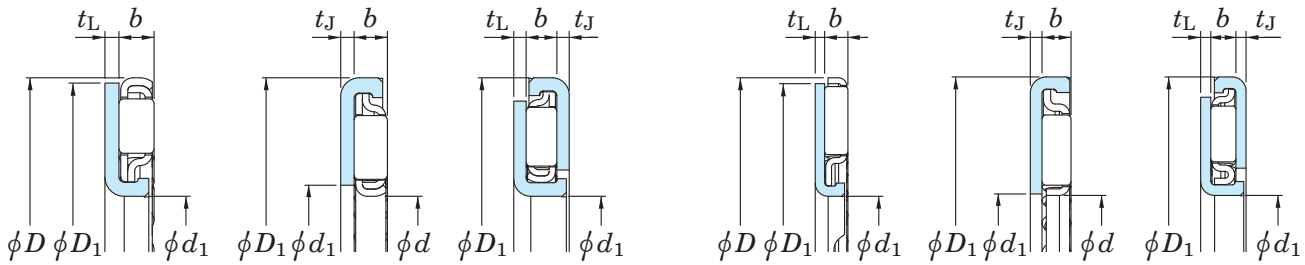


TP TV W WS TPW...F TPWS...FF TPWWS...FF

Boundary dimensions (mm)									Basic load ratings (kN)		Limiting speeds (min^{-1})
d	d_1	D	D_1	b	t_w	t_J	t_{ws}	t_L	C_a	C_{0a}	Oil lub.
45	**45.24**	62.19	62.2	1.984	0.8	—	2	—	20.3	115	7 200
	45	56	56	2	1.0	—	2	—	9	39.6	7 600
	45	65	65	3	1.5	—	2	—	25.2	116	5 700
46.4	—	68	—	3.5	—	—	—	—	38.4	182	5 200
—	**48.25**	—	72	4.6	—	0.8	—	0.8	30.9	129	5 400
49	**49.1**	70.65	71	1.984	0.8	—	1.84	—	18	105	6 800
50	**50**	70	70	3	1.0	—	2	—	26.7	129	5 500
52	—	72.6	—	1.984	—	—	—	—	26	169	6 700
—	**53.6**	—	69.6	3.584	—	0.8	—	0.8	15.9	89.3	6 800
—	**53.6**	—	70.18	3.884	—	1.1	—	0.8	15.9	89.3	6 800
55	**55**	78	78	3	1	—	4	—	32.4	171	5 200
55.48	**56.8**	—	69.6	2.784	—	0.8	—	—	15.9	89.3	6 800
—	**55.9**	—	76	3.584	—	0.8	—	0.8	16.2	91.9	6 500
—	**55.9**	—	76.6	3.884	—	1.1	—	0.8	16.2	91.9	6 500
—	**57**	70.8	71	2.784	—	—	—	0.8	14.6	80.7	6 700
60	**60**	85	85	3	1	—	5	—	38.3	218	5 000
—	**60.4**	—	78	3.6	—	0.8	—	0.8	17.9	107	6 400
62	—	80.25	—	2	—	—	—	—	23.3	151	6 300
—	**63**	77.73	78	2.8	—	—	—	0.8	13.6	75.5	6 400
65	**65**	90	90	3	1	—	5	—	40.1	236	4 900

[Note] 1) In JIS, it is called a thrust washer or washer.

Non-separable type



TPK...L TPK...J TPK...JL TVK...L TVK...J TVK...JL

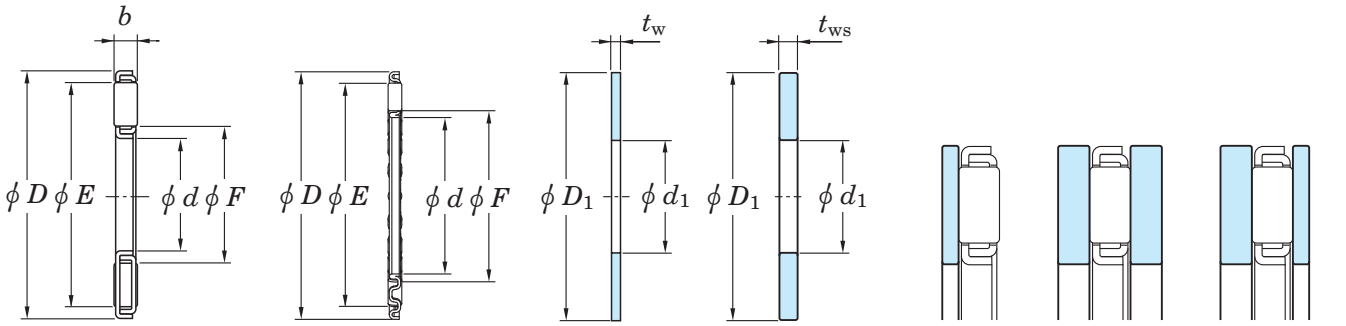
Bearing No.				Dimensions (mm)		(Refer.) Mass (g)			
Needle roller and cage thrust ass'y		Thin plate race (pressed)	Thick plate race (machined)						
Separable type	Non-separable type			E	F	TP TV	TPK TVK	(W)	(WS)
TV4562	—	**W4562F**	**WS4562AF**	46.2	58.6	14	—	8.8	22
TP4556	—	**W4556F**	**WS4556F**	47.5	53.7	8.4	—	6.8	13.6
TP4565A	—	**W4565AF**	**WS4565F**	49.4	61	26	—	20	27
TP4668-2	—	—	—	49.4	65	35	—	—	—
—	**TVK4872JL**	—	—	54	66	—	56	—	—
TV4971	—	**W4971AF**	**WS4971F-1**	58.4	68.4	17	—	13	30
TP5070	—	**W5070F**	**WS5070F**	54.4	66	28	—	15	30
TV5273	—	—	—	56	71.2	19	—	—	—
—	**TPK5470JL-3**	—	—	57.4	65.2	—	32	—	—
—	**TPK5470JL-4**	—	—	57.4	65.2	—	36	—	—
TP5578	—	**W5578F**	**WS5578F**	60.4	74	33	—	19	75
—	**TPK5570J**	—	—	57.4	65.2	—	20	—	—
—	**TVK5676JL**	—	—	60.6	69.8	—	40	—	—
—	**TVK5677JL**	—	—	60.6	69.8	—	41	—	—
—	**TVK5771L**	—	—	61.8	69.8	—	20	—	—
TP6085	—	**W6085F**	**WS6085F**	81	65.4	40	—	22	112
—	**TPK6078JL**	—	—	65.6	73.6	—	38	—	—
TP6280A	—	—	—	65.2	76.8	20	—	—	—
—	**TVK6378L**	—	—	68	76	—	23	—	—
TP6590	—	**W6590F**	**WS6590F**	86	70.4	43	—	24	119

$d\,(d_1)$ 70 ~ 100 mm

Separable type

Needle roller and cage thrust assembly

Race[1)]

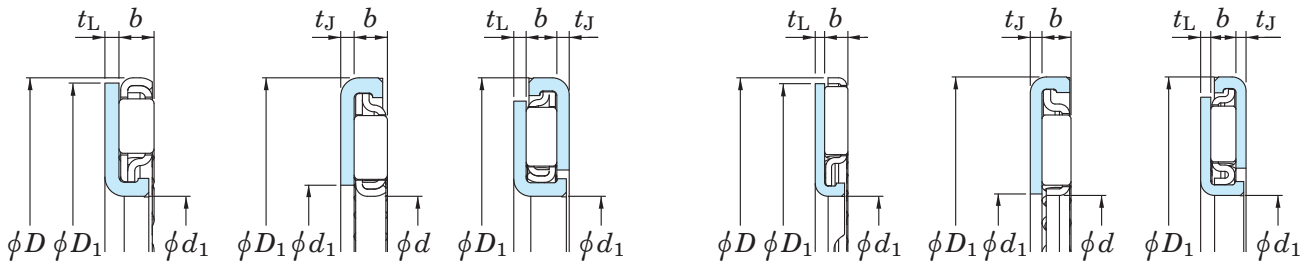


TP TV W WS TPW...F TPWS...FF TPWWS...FF

Boundary dimensions (mm)									Basic load ratings (kN)		Limiting speeds (min^{-1})	
d	d_1	D	D_1	b	t_w	t_J	t_{ws}	t_L	C_a	C_{0a}	Oil lub.	
70	**70**	95	95	4	1	—	3	—	52.1	275	4 100	
70.03	—	92.37	—	3.175	—	—	—	—	33.4	181	4 700	
—	**71.9**	85.6	85.5	2.8	—	0.8	—	—	14.1	82.4	6 100	
—	**73.6**	—	89.6	3.6	—	0.8	—	0.8	10	52.6	6 000	
75	**75**	100	100	4	2	—	5	—	46.7	243	4 000	
80	**80**	105	105	4	1	—	6	—	47.8	255	3 900	
82.68	—	114.3	—	9.525	—	—	—	—	117	453	2 400	
—	**83.1**	—	104	4.8	—	2	—	0.8	14.7	90	5 500	
85	**85**	110	110	4	1	—	6	—	48.9	266	3 800	
90	**90**	120	120	4	1	—	6	—	60.9	362	3 600	
100	**100**	135	135	4	1	—	6	—	76.3	503	3 400	

[Note] 1) In JIS, it is called a thrust washer or washer.

Non-separable type



Bearing No.				Dimensions (mm)		(Refer.) Mass (g)			
Needle roller and cage thrust ass'y		Thin plate race (pressed)	Thick plate race (machined)						
Separable type	Non-separable type			E	F	[TP TV]	[TPK TVK]	(W)	(WS)
TP7095	—	**W7095F**	**WS7095F**	74.2	90.2	70	—	25	75
TV7092A	—	—	—	75	87.4	34	—	—	—
—	**TPK7286L**	—	—	76.5	83.1	—	27	—	—
—	**TPK7490JL**	—	—	78	84.6	—	41	—	—
TP75100	—	**W75100F**	**WS75100F**	95	79.4	63	—	54	135
TP80105	—	**W80105F**	**WS80105F**	100	84.4	67	—	29	171
TP83114	—	—	—	88.6	109	218	—	—	—
—	**TVK83104JL**	—	—	88.8	96.8	—	77	—	—
TP85110	—	**W85110F**	**WS85110F**	105	89.4	70	—	30	180
TP90120	—	**W90120F**	**WS90120F**	115	95.4	92	—	39	234
TP100135	—	**W100135F**	**WS100135F**	130	106.4	122	—	51	304

Koyo®

Track rollers

NEEDLE ROLLER BEARINGS

Stud type track rollers (cam followers)

The Koyo stud type track rollers are stud bearings with needle rollers built into a thick section outer ring. They are available in various types, such as caged and sealed types, according to various applications.

- The full complement type is suited for low speed, heavy load and impact load, while the caged type is generally used for medium speed and heavy load.
- Since the stud is provided with a screw, it can be easily fitted to the machine with a nut.

1 Bearing number

(Ex. 1) Metric series

KM 10 UU R M

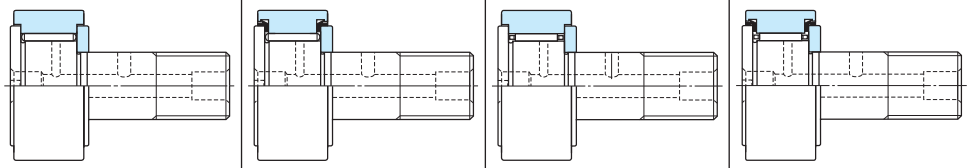
- M Series
- Outer ring outside diameter shape code (R = crowned outer ring; no mark = cylindrical outer ring)
- Seal code (Both sides sealed)
- Stud diameter (Shaft diameter) (10 mm)
- Bearing type code (refer to **Table 1**)

(Ex. 2) Inch series

CR 20 UU M

- M Series
- Seal code (Both sides sealed)
- Outside diameter ($20 \times \frac{1}{16} = 1\frac{1}{4}$ inch)
- Bearing type code (refer to **Table 1**)

Table 1 Type code of stud type track rollers (cam followers)

Type		Full complement type		Caged Type	
		Without seals	With seals	Without seals	With seals
					
Metric series	Cylindrical outer ring	CM...M	CM...UUM	KM...M	KM...UUM
	Crowned outer ring	CM...RM	CM...UURM	KM...RM	KM...UURM
Inch series	Cylindrical outer ring	CR...M	CR...UUM	—	—

2 Tolerances

The Koyo stud type track rollers are manufactured according to the dimensional tolerances (JIS B 1536-5) shown in **Table 2**.

Table 2 Outer ring tolerance
(1) Metric series

Unit : μm

Nominal outside diameter D (mm)		Single plane mean outside diameter deviation Δ_{Dmp}				Single outer ring width deviation Δ_{Cs}		Radial runout of assembled bearing outer ring K_{ea}
		Cylindrical outside surface		Crowning outside surface				
over	up to	upper	lower	upper	lower	upper	lower	max.
10	**18**	0	*– 8*	0	–50	0	–120	15
18	**30**	0	*– 9*	0	–50	0	–120	15
30	**50**	0	*–11*	0	–50	0	–120	20
50	**80**	0	*–13*	0	–50	0	–120	25
80	**120**	0	*–15*	0	–50	0	–120	*35*

[Remark] Values in Italics are prescribed in JTEKT standards.

Table 2 Outer ring tolerance
(2) Inch series

Unit : μm

Nominal outside diameter D (mm)		Single plane mean outside diameter deviation Δ_{Dmp}				Single outer ring width deviation Δ_{Cs}		Radial runout of assembled bearing outer ring K_{ea}
		Cylindrical outside surface		Crowning outside surface				
over	up to	upper	lower	upper	lower	upper	lower	max.
—	**57.15**	*0*	*−25*	*0*	*−50*	*0*	*−127*	*25*

[Remark] Values in Italics are prescribed in JTEKT standards.

Table 3 Tolerances of shank diameter

(1) Metric series Unit : μm

Shank diameter d_1 (mm)		Deviation of a single shank diameter Δ_{d1s}	
over	up to	upper	lower
3	**6**	0	−12
6	**10**	0	−15
10	**18**	0	−18
18	**30**	0	−21

(2) Inch series Unit : μm

Shank diameter d_1 (mm)		Deviation of a single shank diameter Δ_{d1s}	
over	up to	upper	lower
—	**22.225**	*+25*	*0*

[Remark] Values in Italics are prescribed in JTEKT standards.

Table 4 Tolerances of shank length

Unit : μm

Shank length B_2 (mm)	Deviation of a single shank length Δ_{B2s}	
	upper	lower
Total dimensions	*+0.8*	*−0.8*

[Remark] Values in Italics are prescribed in JTEKT standards.

3 Fits

As the Koyo stud type track roller is used as a cantilever, it should be mounted with snug fit between the stud and the fitting bore. The recommended tolerance for the stud fitting bore is shown in **Table 5**.

Table 5 Tolerances for stud fitting bore

Bearing type	Tolerance class
CM, KM	H7
CR	F7

4 Lubrication

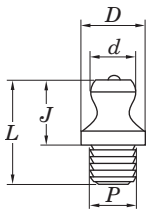
1) The Koyo stud type track roller with seal is filled with grease. It is high quality lithium soap base grease which can be used in a temperature range of −10 ℃ to +100 ℃.
2) The bearing without seal can be lubricated by feeding the lubricant into the lubrication holes located on both ends of the stud and into cross drilled hole of the stud.
3) The grease nipple can be fitted into the hole on the end of the stud; and the other hole not used should be closed with the attached plug.
The cross drilled hole of the stud is automatically closed when the stud is fitted in place.
4) When feeding the lubricant into the cross drilled hole located on the outside diameter of the stud, it is necessary to close the holes on both ends of the stud with the plugs.
5) Either grease or oil can be used as a lubricant. Oil is generally for high speed operation.

5 Accessories

Metric series ··· Grease nipple, plug, hexagon nut
Inch series ··· Plug, hexagon nut

Table 6 Dimensions of standard grease nipple (Metric series)

Unit : mm



Applicable Bearing No.	*P*	*d*	*D*	*J*	*L*
KM6M to KM10-1M CM6M to CM10-1M	4	6.6	8	9	13
KM12M to KM18M CM12M to CM18M	6	6.6	8	9	14
KM20M to KM30-2M CM20M to CM30-2M	8	6.6	10	10.5	18

6 Mounting Instruction

1) The lubrication hole in the stud should be free from the load.
2) The lubrication hole position should be square with driver groove. (refer to **Fig. 1**)
3) The shoulder holding the end plate should be at least the same size as "*F*" in the specification table.
4) The end plate should be firmly backed up by the flat housing shoulder, which is square with stud center line.

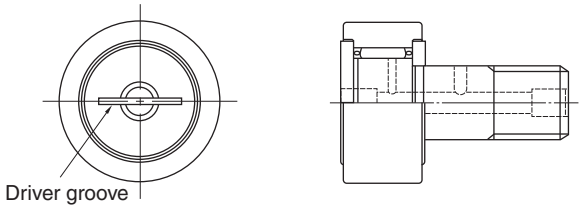
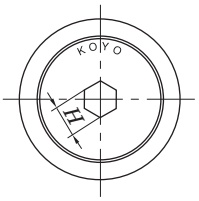


Fig. 1

7 Special Specifications

Stud type track roller with Hexagonal Hole
1) A hexagonal hole is provided instead of a driver groove.
2) Can be used with metric stud type track roller
3) Identified by their bearing no., which contains an *H*. Ex. KM6HM



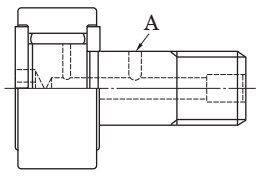


Table 7 Width across flat (*H*) of hexagonal hole

Stud Dia. (mm)	*H* (mm)	Stud Dia. (mm)	*H* (mm)
6	4	18	8
8	4	20	10
10	5	24	14
12	6	30	14
16	8		

[Note] The position of lubricating hole (A) is at top of stud when "Koyo" mark on stud type track roller is at twelve o'clock position. (refer to Fig. at left.)

8 Track capacity

Track capacity is the maximum load receivable without deformation or indentation of track surfaces contacted by the outer rings of track rollers to allow the track to be used continuously. The values in the specification table are track capacities obtained using track rollers with cylindrical outside surfaces made of HRC 40 steel.

Track capacity of the type track rollers with crowned outside surface is 80 % of the values listed in the specification table.

To obtain track capacity for hardness out of standard, multiply the track capacities by track capacity coefficient listed in the table at right.

Table 8 Track capacity

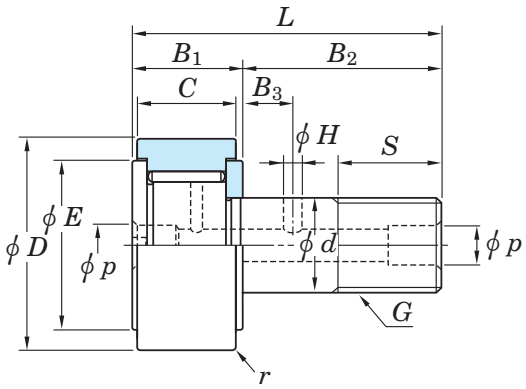
Hardness (HRC)	Track capacity coefficient
26	0.48
32	0.64
36	0.79
40	1
44	1.31
47	1.59
50	1.99
53	2.43
56	2.90
58	3.23

Stud type track rollers (cam followers)

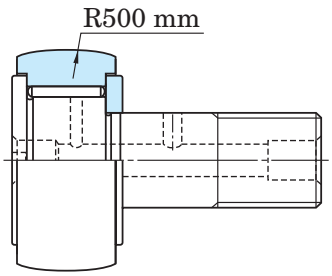
CM (metric series, full complement type)

D 16 ~ 90 mm

Without seals



CM...M

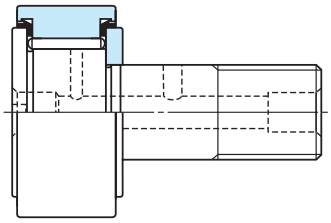


CM...RM

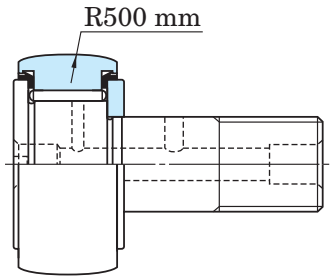
Boundary dimensions (mm)												Bearing No. Without seals	
Outer ring			Stud					Thread		Lubrication hole			
D	C	r min.	d	L	B_1	B_2	E	G	S	B_3	H	p	Cylindrical outer ring	Crowned outer ring
16	11	0.3	6	28	12	16	12	M6×1	9	—	—	4 [1]	**CM6M**	**CM6RM**
19	11	0.3	8	32	12	20	15	M8×1.25	11	—	—	4 [1]	**CM8M**	**CM8RM**
22	12	0.5	10	36	13	23	17	M10×1.25	13	—	—	4	**CM10M**	**CM10RM**
26	12	0.5	10	36	13	23	17	M10×1.25	13	—	—	4	**CM10-1M**	**CM10-1RM**
30	14	1	12	40	15	25	22	M12×1.5	14	6	3	6	**CM12M**	**CM12RM**
32	14	1	12	40	15	25	22	M12×1.5	14	6	3	6	**CM12-1M**	**CM12-1RM**
35	18	1	16	52	19.5	32.5	27	M16×1.5	18	8	3	6	**CM16M**	**CM16RM**
40	20	1.5	18	58	21.5	36.5	32	M18×1.5	20	8	3	6	**CM18M**	**CM18RM**
47	24	1.5	20	66	25.5	40.5	36	M20×1.5	22	9	4	8	**CM20M**	**CM20RM**
52	24	1.5	20	66	25.5	40.5	36	M20×1.5	22	9	4	8	**CM20-1M**	**CM20-1RM**
62	29	1.5	24	80	30.5	49.5	44	M24×1.5	25	11	4	8	**CM24M**	**CM24RM**
72	29	2	24	80	30.5	49.5	44	M24×1.5	25	11	4	8	**CM24-1M**	**CM24-1RM**
80	35	2	30	100	37	63	58	M30×1.5	32	15	4	8	**CM30M**	**CM30RM**
85	35	2	30	100	37	63	58	M30×1.5	32	15	4	8	**CM30-1M**	**CM30-1RM**
90	35	2	30	100	37	63	58	M30×1.5	32	15	4	8	**CM30-2M**	**CM30-2RM**

[Notes] 1) Stud type track rollers with no lubrication hole on the stud threaded end.
2) To calculate track roller rated service life, use these track roller load rating values (C_t).
Numerical values P_{max} refer to maximum load track roller can accommodate. If track roller is fixed in housing as with regular type bearings, JIS basic static load rating values (C_{0r}) may apply.
3) If track roller is fixed in housing, as with regular type bearings, rated service life can be calculated using JIS basic dynamic load rating values (C_r).

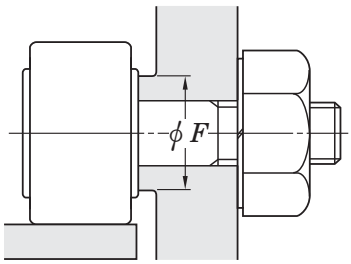
With seals



CM...UUM



CM...UURM



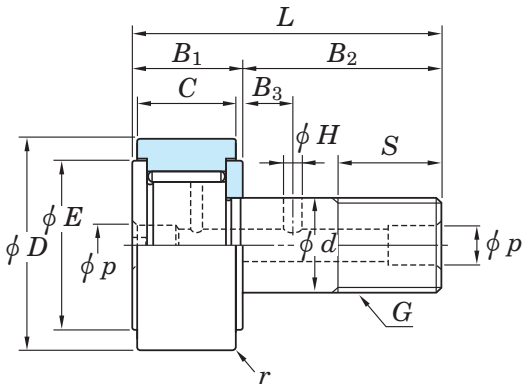
With seals Cylindrical outer ring	With seals Crowned outer ring	Clamping dia. F (mm)	Track roller load ratings [2] C_t (kN)	Track roller load ratings [2] P_{max} (kN)	JIS Basic load ratings [3] C_r (kN)	JIS Basic load ratings [3] C_{0r} (kN)	Track capacity [4] (kN)	Limiting speeds [5] (min^{-1}) Grease lub.	Limiting speeds [5] (min^{-1}) Oil lub.	Tightening torque [6] (N·m) max.	(Refer.) Mass (CM...M type) (kg)
CM6UUM	**CM6UURM**	10.5	5.85	2.25	7.00	8.25	3.55	9 200	13 000	3.0	0.019
CM8UUM	**CM8UURM**	12.5	6.70	5.20	8.05	10.4	4.25	8 200	12 000	7.3	0.029
CM10UUM	**CM10UURM**	15	7.80	9.30	9.35	12.3	5.20	7 200	10 000	15	0.044
CM10-1UUM	**CM10-1UURM**	15	7.80	9.30	9.35	12.3	6.15	7 200	10 000	15	0.056
CM12UUM	**CM12UURM**	19	11.0	13.9	13.2	18.0	7.75	5 900	8 300	26	0.089
CM12-1UUM	**CM12-1UURM**	19	11.0	13.9	13.2	18.0	8.25	5 900	8 300	26	0.099
CM16UUM	**CM16UURM**	24	16.8	25.7	20.2	33.9	12.0	4 600	6 400	64	0.171
CM18UUM	**CM18UURM**	27	19.2	31.9	23.1	38.2	14.6	4 000	5 700	92	0.248
CM20UUM	**CM20UURM**	30.5	25.6	39.1	30.7	57.2	21.2	3 600	5 000	130	0.393
CM20-1UUM	**CM20-1UURM**	30.5	25.6	39.1	30.7	57.2	23.5	3 600	5 000	130	0.455
CM24UUM	**CM24UURM**	37.5	38.8	55.7	46.5	92.0	34.6	2 900	4 100	220	0.810
CM24-1UUM	**CM24-1UURM**	37.5	38.8	55.7	46.5	92.0	38.7	2 900	4 100	220	1.05
CM30UUM	**CM30UURM**	51	64.0	95.2	76.8	159	53.3	2 100	3 000	440	1.64
CM30-1UUM	**CM30-1UURM**	51	64.0	95.2	76.8	159	56.6	2 100	3 000	440	1.81
CM30-2UUM	**CM30-2UURM**	51	64.0	95.2	76.8	159	60.0	2 100	3 000	440	2.00

4) Track capacity is described in Table 8 on page 161.
The values listed in the table are the capacities of cylindrical track rollers.
5) Limiting speeds are applicable to without seals type.
6) Tightening torque apply when threaded portion is dry; if thread is wet with oil or other fluid, torque is half these values.

CR (inch series, full complement type)

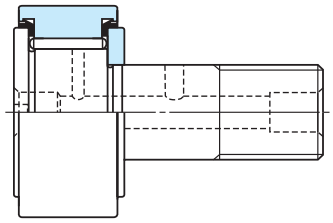
D 12.700 ~ 50.800 mm

Without seals



CR...M

With seals

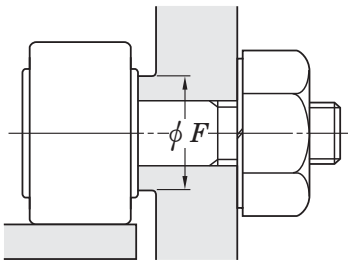


CR...UUM

Boundary dimensions (mm)

Outer ring D mm	D 1/25.4	C	r min.	Stud d mm	d 1/25.4	L	B_1	B_2	E	Thread G	S	Lubrication hole B_3	H	p
12.700	1/2	8.738	0.3	4.826	—	22.225	9.525	12.700	10.0	10×32	6.350	—	—	3.2 1)
	1/2	9.525	0.3	4.826	—	26.194	10.319	15.875	10.0	10×32	6.350	—	—	3.2 1)
14.288	9/16	9.525	0.4	4.826	—	26.194	10.319	15.875	10.0	10×32	6.350	—	—	3.2 1)
15.875	5/8	10.312	0.4	6.350	1/4	26.987	11.112	15.875	11.5	1/4 ×28	7.938	—	—	3.2 1)
	5/8	11.113	0.4	6.350	1/4	30.956	11.906	19.050	11.5	1/4 ×28	7.938	—	—	3.2 1)
17.463	11/16	11.113	0.4	6.350	—	30.956	11.906	19.050	11.5	1/4 ×28	7.938	—	—	3.2 1)
19.050	3/4	12.700	0.4	9.525	3/8	35.719	13.494	22.225	15.0	3/8 ×24	9.525	6.4	2.4	4.8
22.225	7/8	12.700	0.4	9.525	3/8	35.719	13.494	22.225	15.0	3/8 ×24	9.525	6.4	2.4	4.8
25.400	1	15.875	0.8	11.112	7/16	42.069	16.669	25.400	19.5	7/16 ×20	12.700	6.4	2.4	4.8
28.575	1 1/8	15.875	0.8	11.112	7/16	42.069	16.669	25.400	19.5	7/16 ×20	12.700	6.4	2.4	4.8
31.750	1 1/4	19.050	1.2	12.700	1/2	51.594	19.844	31.750	24.5	1/2 ×20	15.875	7.9	2.4	4.8
34.925	1 3/8	19.050	1.2	12.700	1/2	51.594	19.844	31.750	24.5	1/2 ×20	15.875	7.9	2.4	4.8
38.100	1 1/2	22.225	1.6	15.875	5/8	61.119	23.019	38.100	27.5	5/8 ×18	19.050	9.5	2.4	4.8
41.275	1 5/8	22.225	1.6	15.875	5/8	61.119	23.019	38.100	27.5	5/8 ×18	19.050	9.5	2.4	4.8
44.450	1 3/4	25.400	1.6	19.050	3/4	70.644	26.194	44.450	31.5	3/4 ×16	22.225	11.1	2.4	4.8
47.625	1 7/8	25.400	1.6	19.050	3/4	70.644	26.194	44.450	31.5	3/4 ×16	22.225	11.1	2.4	4.8
50.800	2	31.750	2.4	22.225	7/8	83.344	32.544	50.800	35.5	7/8 ×14	25.400	12.7	3.2	4.8

[Notes] 1) Stud type track rollers with no lubrication hole on the stud threaded end.
2) To calculate track roller rated service life, use these track roller load rating values (C_t).
Numerical values P_{max} refer to maximum load track roller can accommodate. If track roller is fixed in housing as with regular type bearings, JIS basic static load rating values (C_{0r}) may apply.
3) If track roller is fixed in housing, as with regular type bearings, rated service life can be calculated using JIS basic dynamic load rating values (C_r).



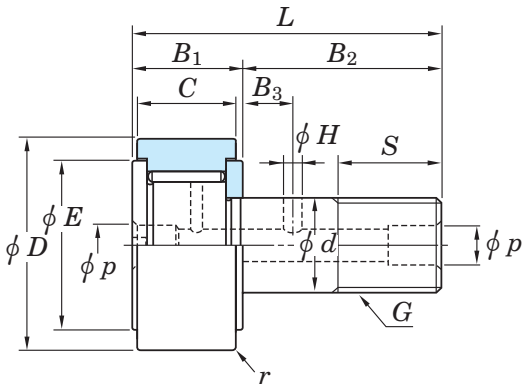
Bearing No.		Clamping dia.	Track roller load ratings [2]		JIS Basic load ratings [3]		Track capacity [4]	Limiting speeds [5] (min^{-1})		Tightening torque [6]	(Refer.) Mass
Without seals	With seals	F (mm)	C_t (kN)	P_{max} (kN)	C_r (kN)	C_{0r} (kN)	(kN)	Grease lub.	Oil lub.	(N·m) max.	(CR...M type) (kg)
CR8M	**CR8UUM**	9.1	3.55	1.50	4.25	4.60	2.20	10 000	14 000	1.6	0.016
CR8-1M	**CR8-1UUM**	9.1	4.00	1.40	4.80	5.40	2.45	10 000	14 000	1.6	0.018
CR9M	**CR9UUM**	9.1	4.00	1.40	4.80	5.40	2.65	10 000	14 000	1.6	0.019
CR10M	**CR10UUM**	10.5	4.85	2.90	5.85	7.45	3.25	9 200	13 000	3.7	0.022
CR10-1M	**CR10-1UUM**	10.5	5.30	2.70	6.35	8.35	3.50	9 200	13 000	3.7	0.023
CR11M	**CR11UUM**	10.5	5.30	2.70	6.35	8.35	3.85	9 200	13 000	3.7	0.027
CR12M	**CR12UUM**	14.4	8.25	7.80	9.90	14.2	4.85	7 400	10 000	13	0.032
CR14M	**CR14UUM**	14.4	8.25	7.80	9.90	14.2	5.70	7 400	10 000	13	0.041
CR16M	**CR16UUM**	18.0	10.6	10.0	12.7	21.3	7.80	6 100	8 500	21	0.077
CR18M	**CR18UUM**	18.0	10.6	10.0	12.7	21.3	8.75	6 100	8 500	21	0.086
CR20M	**CR20UUM**	22.7	19.2	12.7	23.0	29.5	11.4	5 100	7 200	32	0.136
CR22M	**CR22UUM**	22.7	19.2	12.7	23.0	29.5	12.5	5 100	7 200	32	0.159
CR24M	**CR24UUM**	25.7	23.2	21.5	27.8	39.3	15.6	4 400	6 200	62	0.240
CR26M	**CR26UUM**	25.7	23.2	21.5	27.8	39.3	16.9	4 400	6 200	62	0.272
CR28M	**CR28UUM**	28.8	29.2	32.9	35.0	55.3	21.2	3 900	5 500	110	0.381
CR30M	**CR30UUM**	28.8	29.2	32.9	35.0	55.3	22.7	3 900	5 500	110	0.431
CR32M	**CR32UUM**	31.8	35.5	42.8	42.6	74.0	29.4	3 500	4 900	170	0.617

4) Track capacity is described in Table 8 on page 161.
The values listed in the table are the capacities of cylindrical track rollers.
5) Limiting speeds are applicable to without seals type.
6) Tightening torque apply when threaded portion is dry; if thread is wet with oil or other fluid, torque is half these values.

CR (inch series, full complement type)

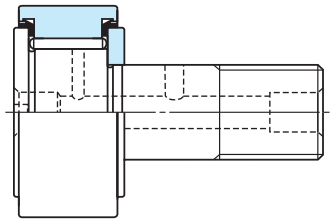
D 57.150 mm

Without seals



CR...M

With seals

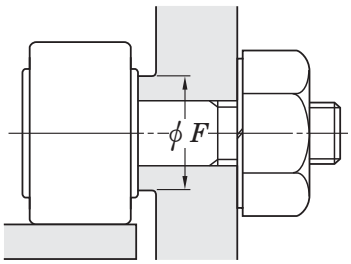


CR...UUM

Boundary dimensions (mm)

Outer ring				Stud						Thread		Lubrication hole			
D mm	1/25.4	C	r min.	d mm	1/25.4	L	B_1	B_2	E	G	S	B_3	H	p	
57.150	2 1/4	31.750	2.4	22.225	7/8	83.344	32.544	50.800	35.5	7/8 ×14	25.400	12.7	3.2	4.8	

[Notes] 1) Stud type track rollers with no lubrication hole on the stud threaded end.
2) To calculate track roller rated service life, use these track roller load rating values (C_t).
Numerical values P_{max} refer to maximum load track roller can accommodate. If track roller is fixed in housing as with regular type bearings, JIS basic static load rating values (C_{0r}) may apply.
3) If track roller is fixed in housing, as with regular type bearings, rated service life can be calculated using JIS basic dynamic load rating values (C_r).



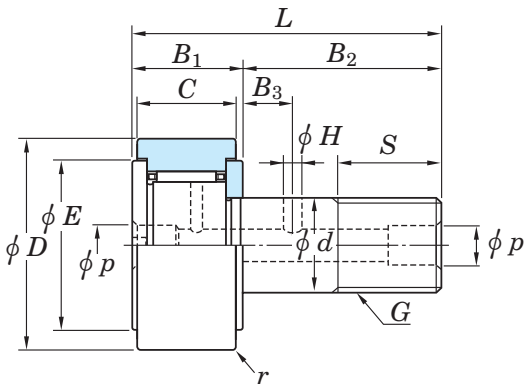
Bearing No.		Clamping dia.	Track roller load ratings [2]		JIS Basic load ratings [3]		Track capacity [4]	Limiting speeds [5] (min^{-1})		Tightening torque [6]	(Refer.) Mass
Without seals	With seals	F (mm)	C_t (kN)	P_{max} (kN)	C_r (kN)	C_{0r} (kN)	(kN)	Grease lub.	Oil lub.	(N·m) max.	(CR...M type) (kg)
CR36M	**CR36UUM**	31.8	35.5	42.8	42.6	74.0	33.1	3 500	4 900	170	0.748

4) Track capacity is described in Table 8 on page 161.
The values listed in the table are the capacities of cylindrical track rollers.
5) Limiting speeds are applicable to without seals type.
6) Tightening torque apply when threaded portion is dry; if thread is wet with oil or other fluid, torque is half these values.

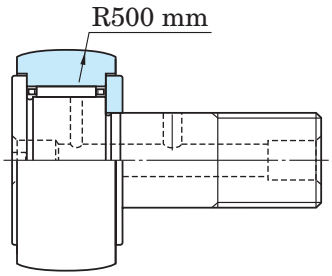
KM (metric series, caged type)

D 13 ~ 90 mm

Without seals



KM...M

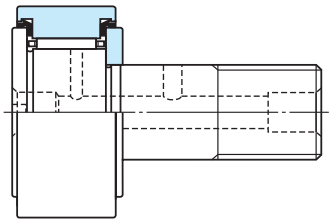


KM...RM

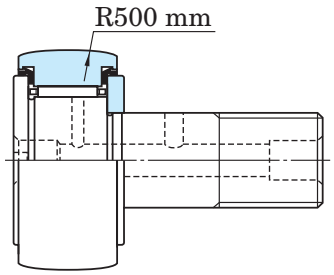
Boundary dimensions (mm)												Bearing No. Without seals	
Outer ring			Stud					Thread		Lubrication hole			
D	C	r min.	d	L	B_1	B_2	E	G	S	B_3	H	p	Cylindrical outer ring	Crowned outer ring
13	9	0.3	5	23	10	13	10	M5×0.8	7.5	—	—	3 [1]	**KM5M**	**KM5RM**
16	11	0.3	6	28	12	16	12	M6×1	9	—	—	4 [1]	**KM6M**	**KM6RM**
19	11	0.3	8	32	12	20	15	M8×1.25	11	—	—	4 [1]	**KM8M**	**KM8RM**
22	12	0.5	10	36	13	23	17	M10×1.25	13	—	—	4	**KM10M**	**KM10RM**
26	12	0.5	10	36	13	23	17	M10×1.25	13	—	—	4	**KM10-1M**	**KM10-1RM**
30	14	1	12	40	15	25	22	M12×1.5	14	6	3	6	**KM12M**	**KM12RM**
32	14	1	12	40	15	25	22	M12×1.5	14	6	3	6	**KM12-1M**	**KM12-1RM**
35	18	1	16	52	19.5	32.5	27	M16×1.5	18	8	3	6	**KM16M**	**KM16RM**
40	20	1.5	18	58	21.5	36.5	32	M18×1.5	20	8	3	6	**KM18M**	**KM18RM**
47	24	1.5	20	66	25.5	40.5	36	M20×1.5	22	9	4	8	**KM20M**	**KM20RM**
52	24	1.5	20	66	25.5	40.5	36	M20×1.5	22	9	4	8	**KM20-1M**	**KM20-1RM**
62	29	1.5	24	80	30.5	49.5	44	M24×1.5	25	11	4	8	**KM24M**	**KM24RM**
72	29	2	24	80	30.5	49.5	44	M24×1.5	25	11	4	8	**KM24-1M**	**KM24-1RM**
80	35	2	30	100	37	63	58	M30×1.5	32	15	4	8	**KM30M**	**KM30RM**
85	35	2	30	100	37	63	58	M30×1.5	32	15	4	8	**KM30-1M**	**KM30-1RM**
90	35	2	30	100	37	63	58	M30×1.5	32	15	4	8	**KM30-2M**	**KM30-2RM**

[Notes] 1) Stud type track rollers with no lubrication hole on the stud threaded end.
2) To calculate track roller rated service life, use these track roller load rating values (C_t).
Numerical values P_{max} refer to maximum load track roller can accommodate. If track roller is fixed in housing as with regular type bearings, JIS basic static load rating values (C_{0r}) may apply.
3) If track roller is fixed in housing, as with regular type bearings, rated service life can be calculated using JIS basic dynamic load rating values (C_r).

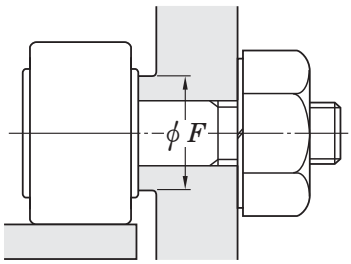
With seals



KM...UUM



KM...UURM



With seals		Clamping dia.	Track roller load ratings [2]		JIS Basic load ratings [3]		Track capacity [4]	Limiting speeds [5] (min^{-1})		Tightening torque [6]	(Refer.) Mass
Cylindrical outer ring	Crowned outer ring	F (mm)	C_t (kN)	P_{max} (kN)	C_r (kN)	C_{0r} (kN)	(kN)	Grease lub.	Oil lub.	(N·m) max.	(KM...M type) (kg)
KM5UUM	**KM5UURM**	9.0	2.20	1.60	2.65	2.45	2.35	16 000	22 000	1.8	0.010
KM6UUM	**KM6UURM**	10.5	3.40	2.25	4.10	4.05	3.55	15 000	20 000	3.0	0.018
KM8UUM	**KM8UURM**	12.5	3.80	4.10	4.55	4.90	4.25	13 000	18 000	7.3	0.028
KM10UUM	**KM10UURM**	15	5.20	6.05	6.25	7.25	5.20	11 000	16 000	15	0.043
KM10-1UUM	**KM10-1UURM**	15	5.20	6.05	6.25	7.25	6.15	11 000	16 000	15	0.055
KM12UUM	**KM12UURM**	19	6.80	8.00	8.20	9.60	7.75	9 500	13 000	26	0.087
KM12-1UUM	**KM12-1UURM**	19	6.80	8.00	8.20	9.60	8.25	9 500	13 000	26	0.096
KM16UUM	**KM16UURM**	24	10.8	15.8	13.0	18.9	12.0	7 400	10 000	64	0.166
KM18UUM	**KM18UURM**	27	13.3	19.6	15.9	23.5	14.6	6 500	8 900	92	0.245
KM20UUM	**KM20UURM**	30.5	17.7	29.5	21.3	35.4	21.2	5 700	7 900	130	0.387
KM20-1UUM	**KM20-1UURM**	30.5	17.7	29.5	21.3	35.4	23.5	5 700	7 900	130	0.453
KM24UUM	**KM24UURM**	37.5	26.3	46.1	31.6	55.3	34.6	4 600	6 400	220	0.801
KM24-1UUM	**KM24-1UURM**	37.5	26.3	46.1	31.6	55.3	38.7	4 600	6 400	220	1.04
KM30UUM	**KM30UURM**	51	46.5	86.9	55.8	104	53.3	3 400	4 700	440	1.62
KM30-1UUM	**KM30-1UURM**	51	46.5	86.9	55.8	104	56.6	3 400	4 700	440	1.79
KM30-2UUM	**KM30-2UURM**	51	46.5	86.9	55.8	104	60.0	3 400	4 700	440	1.98

4) Track capacity is described in Table 8 on page 161.
The values listed in the table are the capacities of cylindrical track rollers.
5) Limiting speeds are applicable to without seals type.
6) Tightening torque apply when threaded portion is dry; if thread is wet with oil or other fluid, torque is half these values.

Yoke type track rollers (roller followers)

The Koyo yoke type track rollers are non-separable bearings with needle rollers built into a thick section outer ring.

Many types such as full complement, with cage and with seal can be used according to various needs.

■ The full complement type is suited for low speed, heavy load and impact load, while the caged type is generally used for medium speed and heavy load.

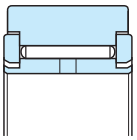
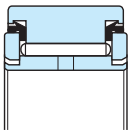
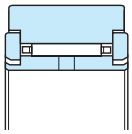
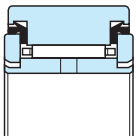
1 Bearing number

(Ex.)

CXM 25 UU R M

- M Series
- Outer ring outside diameter shape code (R = crowned outer ring; no mark = cylindrical outer ring)
- Seal code (Both sides sealed)
- Bore diameter (25 mm)
- Bearing type code (refer to **Table 1**)

Table 1 Type code of yoke type track rollers (roller followers)

Type	Full complement type		Caged type	
	Without seals	With seals	Without seals	With seals
				
Cylindrical outer ring	CYM...M	CYM...UUM	CXM...M	CXM...UUM
Crowned outer ring	CYM...RM	CYM...UURM	CXM...RM	CXM...UURM

2 Tolerances

The Koyo yoke type track rollers are manufactured according to the tolerances shown in **Table 2**.

Table 2 Tolerances for metric series = JIS B 1536-5 =

(1) Inner ring

Unit : μm

Nominal bore diameter d (mm)		Single plane mean bore diameter deviation Δ_{dmp}		Single inner ring width deviation Δ_{Bs}	
over	up to	upper	lower	upper	lower
2.5	**10**	0	– 8	0	*–180*
10	**18**	0	– 8	0	*–210*
18	**30**	0	–10	0	*–210*
30	**50**	0	–12	0	*–250*

[Remark] Values in Italics are prescribed in JTEKT standards.

(2) Outer ring

Unit : μm

Nominal outside diameter D (mm)		Single plane mean outside diameter deviation Δ_{Dmp}				Single outer ring width deviation Δ_{Cs}		Radial runout of assembled bearing outer ring K_{ea}
		Cylindrical outside surface		Crowning outside surface				
over	up to	upper	lower	upper	lower	upper	lower	max.
10	**18**	0	*– 8*	0	–50	0	–120	15
18	**30**	0	*– 9*	0	–50	0	–120	15
30	**50**	0	*–11*	0	–50	0	–120	20
50	**80**	0	*–13*	0	–50	0	–120	25
80	**120**	0	*–15*	0	–50	0	–120	35

[Remark] Values in Italics are prescribed in JTEKT standards.

3 Fits

Because Koyo yoke type track rollers (roller followers) are generally used with the outer ring rotation, they should be attached to the shaft by transition fitting or clearance fitting. If the application involves heavy loading, the shaft should be hardened and the track roller should be attached by interference fitting. The tolerance for the shaft is shown in **Table 3**.

Table 3 Shaft tolerance

Degree of loading	Shaft tolerance class
Light or medium load	g6 or h6
Heavy load	k6

Mounting Instruction

1) When the Koyo yoke type track roller is used under heavy loading, the lubrication hole should be located in the no-load zone.
2) In order to prevent axial movement of the bearing, the inner ring should be clamped end wise.
   To support the end plate securely, it is preferable to make the shoulder size larger than "E" shown in the specification table.

4 Lubrication

1) The Koyo yoke type track roller with seal filled with grease. It is high quality lithium soap base grease which can be used in a temperature range of −10 ℃ to +100 ℃.
2) The Koyo yoke type track roller without seal is not filled with grease, so it is necessary to supply grease or lubricating oil when in use.
3) Either grease and oil can be used as a lubricant. Generally, oil is used for high speed operation.

5 Track capacity

Track capacity is the maximum load receivable without deformation or indentation of track surfaces contacted by the outer rings of track rollers to allow the track to be used continuously. The values in the specification table are track capacities obtained using track rollers with cylindrical outside surfaces made of HRC 40 steel.

Track capacity of the type track rollers with spherical outside surface is 80 % of the values listed in the specification table.

To obtain track capacity for hardness out of standard, multiply the track capacities by track capacity coefficient listed in the table at right.

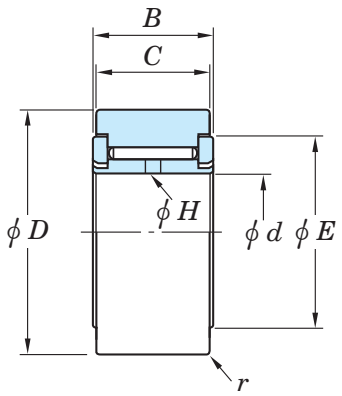
Table 4 Track capacity

Hardness (HRC)	Track capacity coefficient
26	0.48
32	0.64
36	0.79
40	1
44	1.31
47	1.59
50	1.99
53	2.43
56	2.90
58	3.23

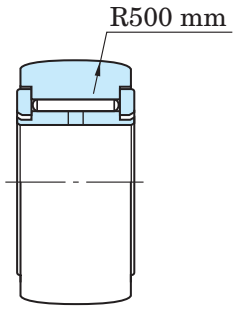
CYM (full complement type)

d 5 ~ 50 mm

Without seals



CYM...M

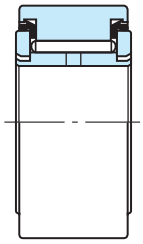


CYM...RM

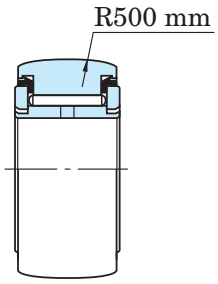
Boundary dimensions (mm)							Bearing No.			
							Without seals		With seals	
d	D	B	C	r min.	E	H 1)	Cylindrical outer ring	Crowned outer ring	Cylindrical outer ring	Crowned outer ring
5	16	12	11	0.3	12	2	**CYM5M**	**CYM5RM**	**CYM5UUM**	**CYM5UURM**
6	19	12	11	0.3	15	2	**CYM6M**	**CYM6RM**	**CYM6UUM**	**CYM6UURM**
8	24	15	14	0.5	18	2	**CYM8M**	**CYM8RM**	**CYM8UUM**	**CYM8UURM**
10	30	15	14	1	22	2	**CYM10M**	**CYM10RM**	**CYM10UUM**	**CYM10UURM**
12	32	15	14	1	24	2	**CYM12M**	**CYM12RM**	**CYM12UUM**	**CYM12UURM**
15	35	19	18	1	27	2	**CYM15M**	**CYM15RM**	**CYM15UUM**	**CYM15UURM**
17	40	21	20	1.5	32	2.4	**CYM17M**	**CYM17RM**	**CYM17UUM**	**CYM17UURM**
20	47	25	24	1.5	36	2.4	**CYM20M**	**CYM20RM**	**CYM20UUM**	**CYM20UURM**
25	52	25	24	1.5	41	2.4	**CYM25M**	**CYM25RM**	**CYM25UUM**	**CYM25UURM**
30	62	29	28	1.5	51	3.2	**CYM30M**	**CYM30RM**	**CYM30UUM**	**CYM30UURM**
35	72	29	28	2	58	3.2	**CYM35M**	**CYM35RM**	**CYM35UUM**	**CYM35UURM**
40	80	32	30	2	63	3.2	**CYM40M**	**CYM40RM**	**CYM40UUM**	**CYM40UURM**
45	85	32	30	2	69	3.2	**CYM45M**	**CYM45RM**	**CYM45UUM**	**CYM45UURM**
50	90	32	30	2	75	3.2	**CYM50M**	**CYM50RM**	**CYM50UUM**	**CYM50UURM**

[Notes] 1) Lubrication hole is provided on inner ring internal surface.
2) To calculate track roller rated service life, use these track roller load rating values (C_t).
Numerical values P_{max} refer to maximum load track roller can accommodate. If track roller is fixed in housing as with regular type bearings, JIS basic static load rating values (C_{0r}) may apply.
3) If track roller is fixed in housing, as with regular type bearings, rated service life can be calculated using JIS basic dynamic load rating values (C_r).

With seals



CYM...UUM



CYM...UURM

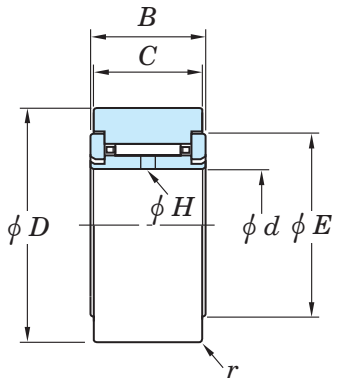
	Track roller load ratings [2]		JIS Basic load ratings [3]		Track capacity [4]	Limiting speeds [5] (min^{-1})		(Refer.) Mass
	C_t (kN)	P_{max} (kN)	C_r (kN)	C_{0r} (kN)	(kN)	Grease lub.	Oil lub.	(CYM...M type) (kg)
	5.85	6.85	7.00	8.25	3.55	9 200	13 000	0.014
	6.70	8.70	8.05	10.4	4.25	8 200	12 000	0.021
	9.55	12.6	11.5	15.1	6.70	6 800	9 500	0.043
	11.1	15.1	13.3	18.1	7.75	5 900	8 300	0.062
	11.9	17.3	14.3	20.7	8.25	5 300	7 400	0.069
	16.8	28.2	20.2	33.9	12.0	4 600	6 400	0.105
	19.2	31.8	23.1	38.2	14.6	4 000	5 700	0.153
	25.6	47.7	30.7	57.3	21.2	3 600	5 000	0.255
	28.4	58.2	34.1	69.8	23.5	3 000	4 200	0.284
	41.5	88.8	49.8	107	33.3	2 400	3 400	0.476
	47.4	99.4	56.9	119	37.1	2 100	2 900	0.649
	58.3	122	70.0	147	44.7	1 900	2 600	0.845
	61.4	135	73.7	162	47.5	1 700	2 400	0.924
	64.2	148	77.0	177	50.3	1 600	2 200	0.984

4) Track capacity is described in Table 4 on page 171.
The values listed in the above table are the capacities of cylindrical track rollers.
The track capacities of crowned track rollers are 80 % of these values.
5) Limiting speeds are as measured with no seals.

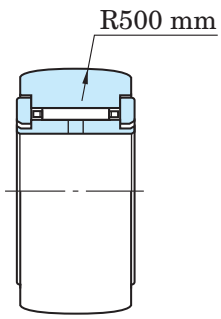
CXM (caged type)

d 5 ~ 50 mm

Without seals



CXM...M

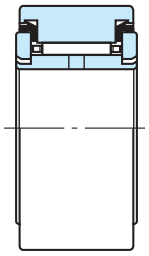


CXM...RM

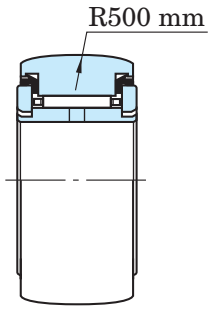
Boundary dimensions (mm)							Bearing No.			
							Without seals		With seals	
d	D	B	C	r min.	E	H 1)	Cylindrical outer ring	Crowned outer ring	Cylindrical outer ring	Crowned outer ring
5	16	12	11	0.3	12	2	**CXM5M**	**CXM5RM**	**CXM5UUM**	**CXM5UURM**
6	19	12	11	0.3	15	2	**CXM6M**	**CXM6RM**	**CXM6UUM**	**CXM6UURM**
8	24	15	14	0.5	18	2	**CXM8M**	**CXM8RM**	**CXM8UUM**	**CXM8UURM**
10	30	15	14	1	22	2	**CXM10M**	**CXM10RM**	**CXM10UUM**	**CXM10UURM**
12	32	15	14	1	24	2	**CXM12M**	**CXM12RM**	**CXM12UUM**	**CXM12UURM**
15	35	19	18	1	27	2	**CXM15M**	**CXM15RM**	**CXM15UUM**	**CXM15UURM**
17	40	21	20	1.5	32	2.4	**CXM17M**	**CXM17RM**	**CXM17UUM**	**CXM17UURM**
20	47	25	24	1.5	36	2.4	**CXM20M**	**CXM20RM**	**CXM20UUM**	**CXM20UURM**
25	52	25	24	1.5	41	2.4	**CXM25M**	**CXM25RM**	**CXM25UUM**	**CXM25UURM**
30	62	29	28	1.5	51	3.2	**CXM30M**	**CXM30RM**	**CXM30UUM**	**CXM30UURM**
35	72	29	28	2	58	3.2	**CXM35M**	**CXM35RM**	**CXM35UUM**	**CXM35UURM**
40	80	32	30	2	63	3.2	**CXM40M**	**CXM40RM**	**CXM40UUM**	**CXM40UURM**
45	85	32	30	2	69	3.2	**CXM45M**	**CXM45RM**	**CXM45UUM**	**CXM45UURM**
50	90	32	30	2	75	3.2	**CXM50M**	**CXM50RM**	**CXM50UUM**	**CXM50UURM**

[Notes] 1) Lubrication hole is provided on inner ring internal surface.
2) To calculate track roller rated service life, use these track roller load rating values (C_t).
Numerical values P_{max} refer to maximum load track roller can accommodate. If track roller is fixed in housing as with regular type bearings, JIS basic static load rating values (C_{0r}) may apply.
3) If track roller is fixed in housing, as with regular type bearings, rated service life can be calculated using JIS basic dynamic load rating values (C_r).

With seals



CXM...UUM



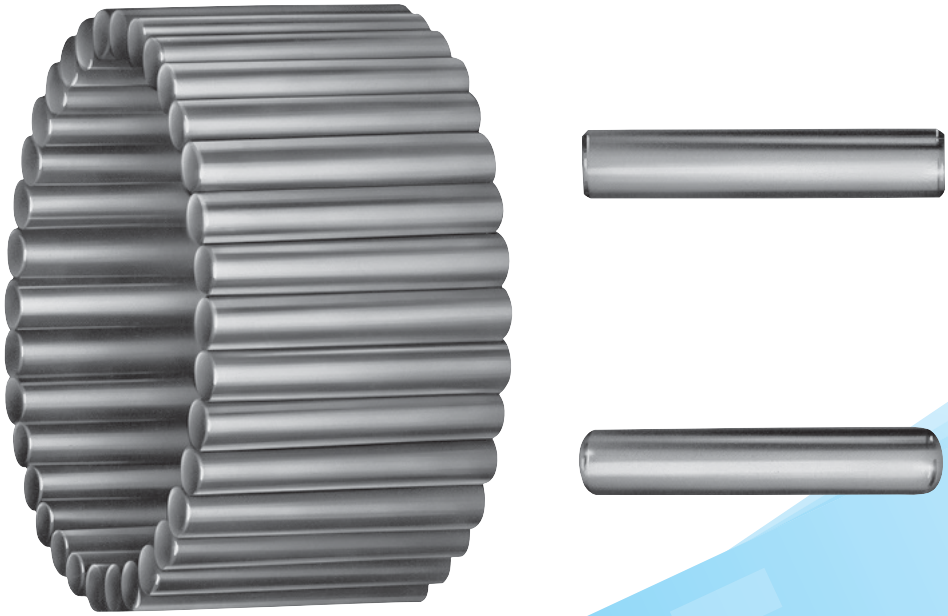
CXM...UURM

	Track roller load ratings [2]		JIS Basic load ratings [3]		Track capacity [4]	Limiting speeds [5] (min^{-1})		(Refer.) Mass
	C_t (kN)	P_{max} (kN)	C_r (kN)	C_{0r} (kN)	(kN)	Grease lub.	Oil lub.	(CXM...M type) (kg)
	3.40	3.40	4.10	4.05	3.55	15 000	20 000	0.011
	3.80	4.10	4.55	4.90	4.25	13 000	18 000	0.018
	5.70	6.40	6.85	7.65	6.70	11 000	15 000	0.040
	6.80	8.00	8.20	9.60	7.75	9 500	13 000	0.060
	7.25	9.05	8.70	10.8	8.25	8 400	12 000	0.067
	10.8	15.8	13.0	18.9	12.0	7 400	10 000	0.102
	13.3	19.6	15.9	23.5	14.6	6 500	8 900	0.150
	17.7	29.5	21.3	35.4	21.2	5 700	7 900	0.252
	19.2	34.6	23.0	41.5	23.5	4 800	6 600	0.278
	28.4	53.9	34.0	64.7	33.3	3 900	5 300	0.465
	32.4	60.3	38.9	72.4	37.1	3 300	4 600	0.636
	41.4	78.1	49.7	93.7	44.7	3 000	4 100	0.825
	42.7	83.6	51.2	100	47.5	2 700	3 700	0.901
	45.5	93.9	54.6	113	50.3	2 500	3 400	0.960

4) Track capacity is described in Table 4 on page 171.
The values listed in the above table are the capacities of cylindrical track rollers.
The track capacities of crowned track rollers are 80 % of these values.
5) Limiting speeds are as measured with no seals.

Koyo®

Needle rollers



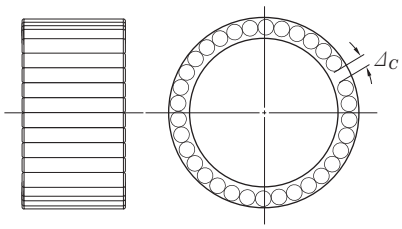
NEEDLE ROLLER BEARINGS

Needle rollers

Koyo needle rollers with proper end faces can be selected depending on varied operating conditions.

They are made of bearing steel, their hardness ranges from 60 to 66 HRC, and tolerances of class 3 conforming to JIS B 1506 roller for roller bearing are applied as the standard item.

When using the roller as full complements type, the circumferential clearance (Δ_C) must be 0.1 mm (minimum) under normal rotating condition.



1 Roller number

(Ex.)

LF 2 × 9.8 H

- H — Tolerance class code (refer to **Table1**)
- 9.8 — Roller length (9.8 mm)
- 2 — Roller outside diameter (2 mm)
- LF — Roller type code (refer to **Table 2**)

Table 1 Tolerance class code

Code	Description
No mark	Class 5
H	Class 3
P	Class 2

Table 2 Type code of rollers

End face	Name	Code		Remarks
		JIS	JTEKT	
	Flat end[1)]	F	LF	Obtains maximum effective contact length.
	Spherical end	A	LA	

[Note] 1) Roller end face center with grinding undercut is included.

2 Tolerances

The tolerances of Koyo needle roller are as specified in JIS B 1506.

Table 3 Tolerance grades and recommended gauge of needle rollers

Unit : μm

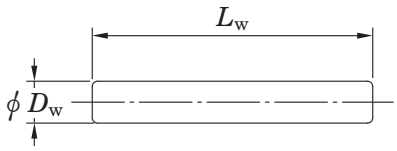
class	Single plane diameter variation[1)] V_{Dwp} (max.)	Deviation from circular form[1)] Δ_{Rw} (max.)	Gauge lot diameter variation[1)] V_{DwL} (max.)	Actual length deviation[2)] Δ_{Lws}	Recommended gauge S
2	1	1	2	h13	0/–2, –1/–3, 2/–4, –3/–5, –4/–6, –5/–7, –6/–8, –7/–9, –8/–10
3	1.5	1.5	3		0/–3, –1.5/–4.5, –3/–6, –4.5/–7.5, –6/–9, –7/–10
5	2	2.5	5		0/–5, –3/–8, –5/–10

[Notes] 1) Values apply only at middle of roller length.
2) Applied tolerance differs according to L_W division.

[Remark] Along the entire length of the roller, all the actually measured diameters should not exceed the actual maximum diameter at the middle of the entire length of the roller by the lengths shown below.
a) class 2 : 0.5 μm b) class 3 : 0.8 μm c) class 5 : 1 μm

D_w 1.500 ～ (3.000) mm

D_w (3.000) ～ (4.000) mm



LF

Dimensions (mm) D_w	Dimensions (mm) L_w	Roller No.	Mass (per 1 000 pcs.) (kg)
1.500	5.8	**1.5×5.8**	0.076
1.500	6.8	**1.5×6.8**	0.090
1.500	7.8	**1.5×7.8**	0.102
1.500	9.8	**1.5×9.8**	0.131
1.500	11.8	**1.5×11.8**	0.157
1.500	13.8	**1.5×13.8**	0.185
2.000	6.8	**2×6.8**	0.158
2.000	7.8	**2×7.8**	0.183
2.000	9.8	**2×9.8**	0.231
2.000	11.8	**2×11.8**	0.280
2.000	13.8	**2×13.8**	0.329
2.000	15.8	**2×15.8**	0.378
2.000	17.8	**2×17.8**	0.420
2.000	19.8	**2×19.8**	0.475
2.500	7.8	**2.5×7.8**	0.283
2.500	9.8	**2.5×9.8**	0.359
2.500	11.8	**2.5×11.8**	0.435
2.500	13.8	**2.5×13.8**	0.511
2.500	15.8	**2.5×15.8**	0.587
2.500	17.8	**2.5×17.8**	0.663
2.500	19.8	**2.5×19.8**	0.739
2.500	21.8	**2.5×21.8**	0.815
2.500	23.8	**2.5×23.8**	0.891
3.000	9.8	**3×9.8**	0.513
3.000	11.8	**3×11.8**	0.622
3.000	13.8	**3×13.8**	0.732
3.000	15.8	**3×15.8**	0.841
3.000	17.8	**3×17.8**	0.951
3.000	19.8	**3×19.8**	1.06

Dimensions (mm) D_w	Dimensions (mm) L_w	Roller No.	Mass (per 1 000 pcs.) (kg)
3.000	21.8	**3×21.8**	1.17
3.000	23.8	**3×23.8**	1.28
3.000	25.8	**3×25.8**	1.38
3.000	27.8	**3×27.8**	1.50
3.000	29.8	**3×29.8**	1.61
3.500	11.8	**3.5×11.8**	0.841
3.500	13.8	**3.5×13.8**	0.991
3.500	15.8	**3.5×15.8**	1.14
3.500	17.8	**3.5×17.8**	1.29
3.500	19.8	**3.5×19.8**	1.44
3.500	21.8	**3.5×21.8**	1.56
3.500	23.8	**3.5×23.8**	1.74
3.500	25.8	**3.5×25.8**	1.86
3.500	27.8	**3.5×27.8**	2.01
3.500	29.8	**3.5×29.8**	2.18
3.500	31.8	**3.5×31.8**	2.31
3.500	34.8	**3.5×34.8**	2.53
4.000	11.8	**4×11.8**	1.15
4.000	13.8	**4×13.8**	1.29
4.000	15.8	**4×15.8**	1.48
4.000	17.8	**4×17.8**	1.68
4.000	19.8	**4×19.8**	1.87
4.000	21.8	**4×21.8**	2.07
4.000	23.8	**4×23.8**	2.26
4.000	25.8	**4×25.8**	2.42
4.000	27.8	**4×27.8**	2.65
4.000	29.8	**4×29.8**	2.85
4.000	31.8	**4×31.8**	3.04
4.000	34.8	**4×34.8**	3.30

D_w (4.000) ~ (6.000) mm

Dimensions (mm) D_w	L_w	Roller No.	Mass (per 1 000 pcs.) (kg)
4.000	37.8	**4×37.8**	3.59
4.000	39.8	**4×39.8**	3.79
4.500	17.8	**4.5×17.8**	2.07
4.500	19.8	**4.5×19.8**	2.31
4.500	21.8	**4.5×21.8**	2.56
4.500	23.8	**4.5×23.8**	2.81
4.500	25.8	**4.5×25.8**	3.05
4.500	29.8	**4.5×29.8**	3.55
4.500	31.8	**4.5×31.8**	3.76
4.500	34.8	**4.5×34.8**	4.21
4.500	37.8	**4.5×37.8**	4.53
4.500	39.8	**4.5×39.8**	4.78
4.500	44.8	**4.5×44.8**	5.40
5.000	15.8	**5×15.8**	2.32
5.000	17.8	**5×17.8**	2.70
5.000	19.8	**5×19.8**	2.84
5.000	21.8	**5×21.8**	3.14
5.000	23.8	**5×23.8**	3.45
5.000	25.8	**5×25.8**	3.75
5.000	27.8	**5×27.8**	4.06
5.000	29.8	**5×29.8**	4.36
5.000	31.8	**5×31.8**	4.67
5.000	34.8	**5×34.8**	5.12
5.000	37.8	**5×37.8**	5.58
5.000	39.8	**5×39.8**	5.88
5.000	49.8	**5×49.8**	7.40
6.000	17.8	**6×17.8**	3.90
6.000	19.8	**6×19.8**	4.33

D_w (6.000) mm

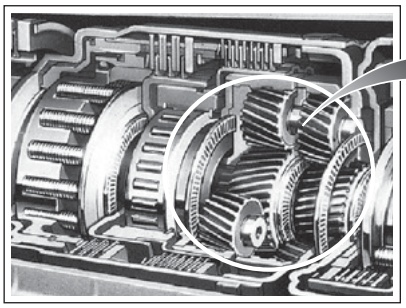
Dimensions (mm) D_w	L_w	Roller No.	Mass (per 1 000 pcs.) (kg)
6.000	21.8	**6×21.8**	4.77
6.000	23.8	**6×23.8**	5.21
6.000	25.8	**6×25.8**	5.65
6.000	27.8	**6×27.8**	6.08
6.000	29.8	**6×29.8**	6.52
6.000	34.8	**6×34.8**	7.62
6.000	39.8	**6×39.8**	8.71
6.000	49.8	**6×49.8**	10.90
6.000	59.8	**6×59.8**	13.09

Other products · Example of use

Needle roller and cage assemblies for high-rotation speed planetary gears

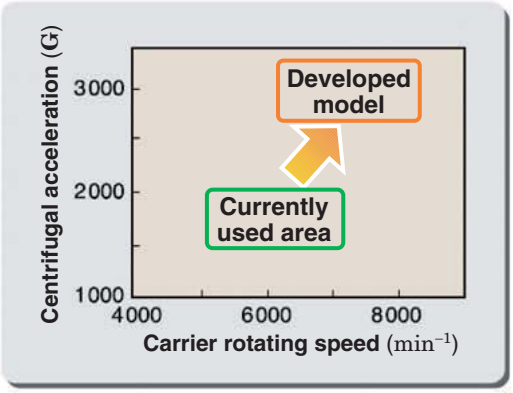
Structure and characteristics

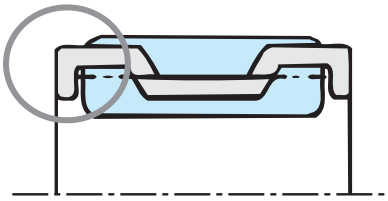
- M-shape cross section provides lightweight and high rigidity
- Bearing load capacity is increased by extended entire length of roller



Automotive automatic transmission
(planetary gear unit)

Needle roller and cage assemblies





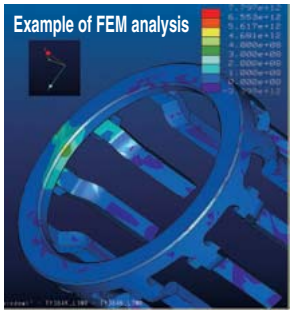
Sectional drawing

Advantages obtained by M-shape sectional

Lightweight and high rigidity

Cage weight	**Decreased by 12%**
Cage strength (FEM analysis)	**Increased by 60%**
Load capacity	**Increased by 10%**

Compared to current model

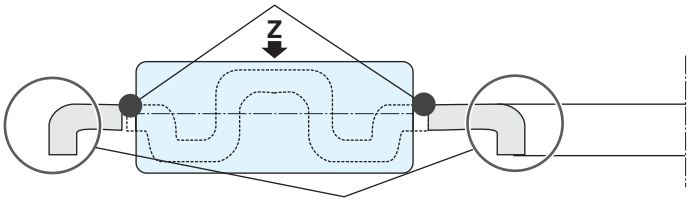


Low torque needle roller and cage thrust assemblies

Structure and characteristics

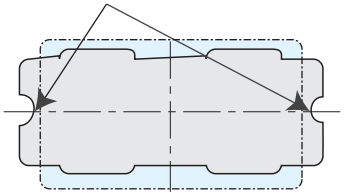
- Low torque (decreased by 50 % in every load area)
  Used in automatic transmission or continuously variable transmission of automobiles or reduction gears of battery vehicles to contribute to improvement in fuel consumption

Contact point of roller end face and cage (contact near center of roller)



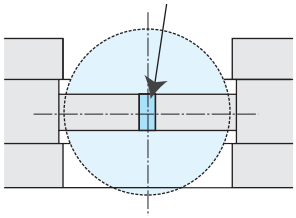
Increased rigidity for stability of contact of roller end face with cage

Contact point of roller end face and cage



Cage pocket (view Z)

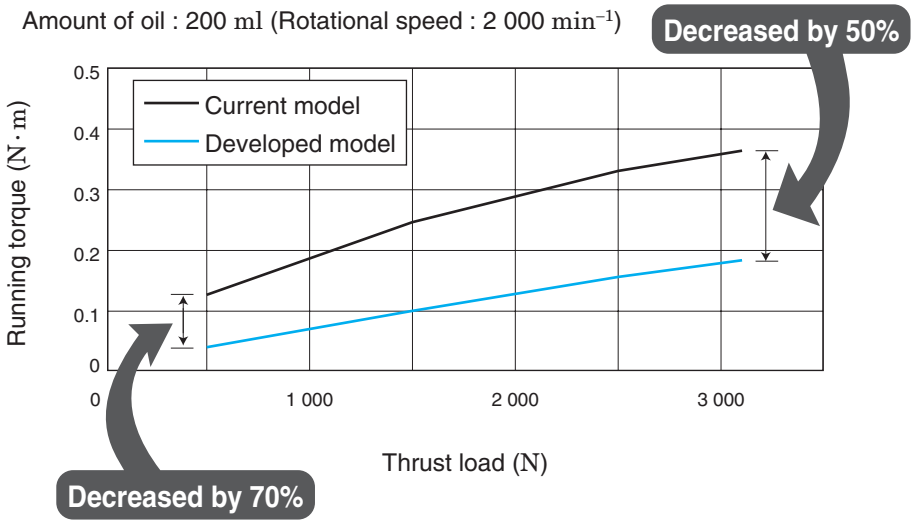
Contact point of roller end face and cage



Cross section of pocket

Torque reduction

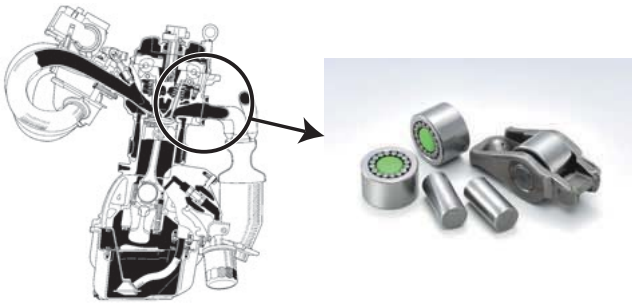
Amount of oil : 200 ml (Rotational speed : 2 000 min^{-1})

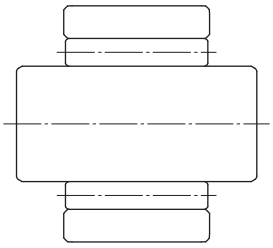


Rocker Roller (bearing for roller rocker arm)

Structure and characteristics

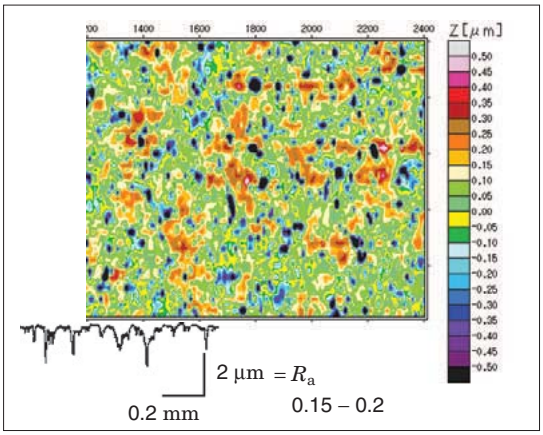
- Prevents wear and damage to cam (equivalent to conventional model for peeling resistance)
- Low cost
- Low torque





Cross section

Current model

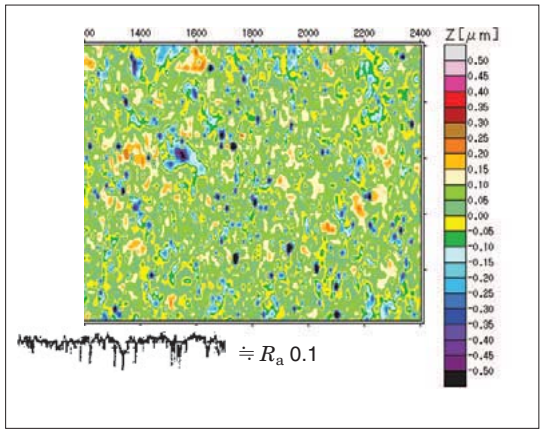


Shot blast and barrelling

Shot blast ⇒ Countermeasure against surface distress similar to the peeling made of micro-spalls : improved surface distress strength

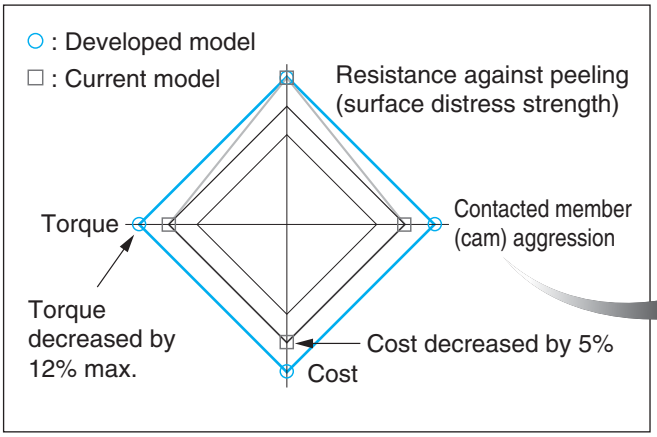
Barrelling ⇒ Improved surface roughness

Developed model

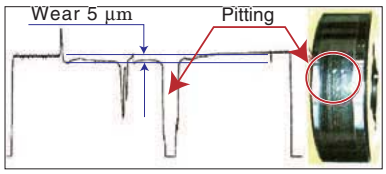


Tetratekt (special barrelling)

Optimization of barrelling conditions
⇒ Compatibility of omission of processes and improvement in surface layer fatigue strength and surface roughness

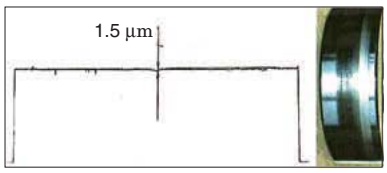


Evaluation of single low hardness cam (40 HRC)



Current model

Contacted cam after test



Developed model

Contacted cam after test

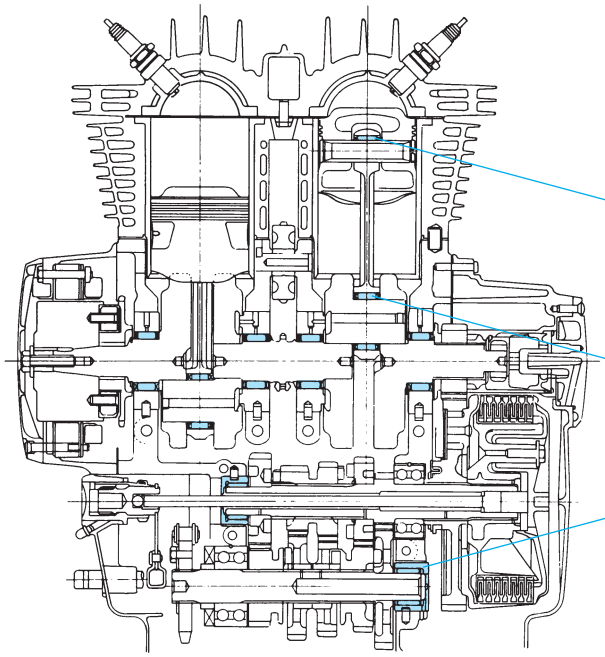
Developed model

- **Wear of contacted cam is limited to half or less**
- **Pitting of contacted cam is prevented**

Example of use

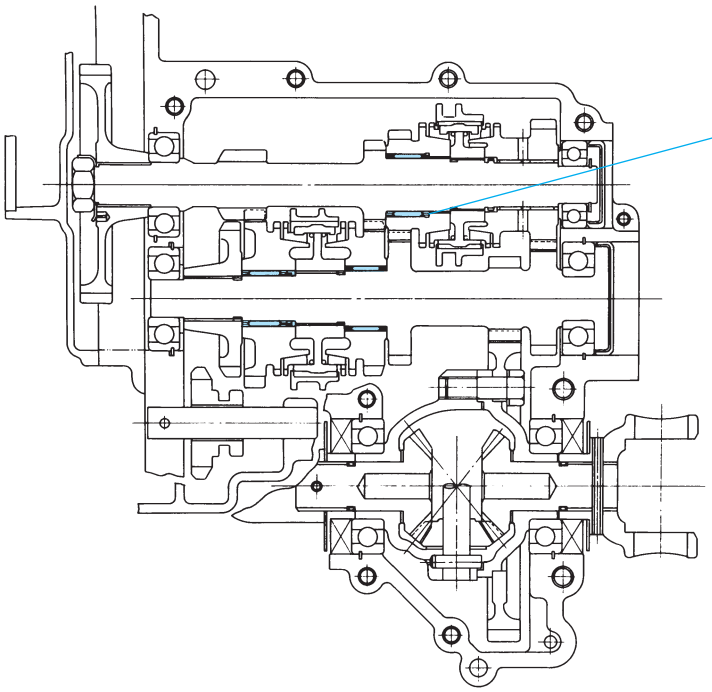
• Motorcycle, Engine

Special needle roller and cage assemblies are used for the large and small ends of connecting rods, and ordinary needle roller and cage assemblies are used for support of crankshafts. For support of shafts, machined ring needle roller bearings are used, and turning of the housings and outer rings are blocked by pins.



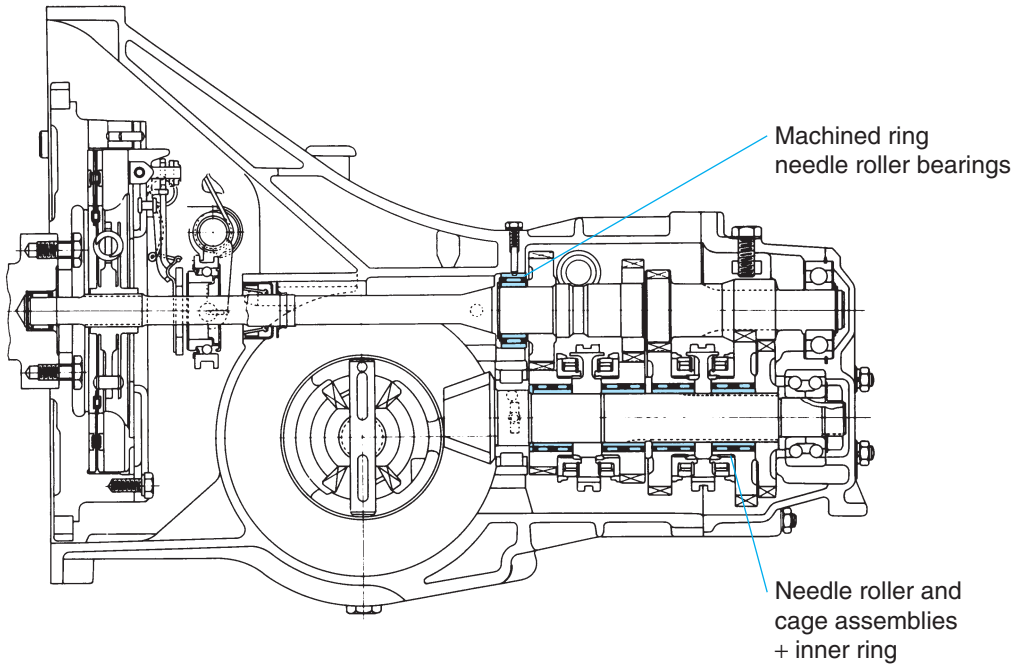
• Front Wheel Drive Mini-Vehicles, Transmission

Needle roller and cage assemblies are used for the main shafts and countershaft inner gears of transmissions.



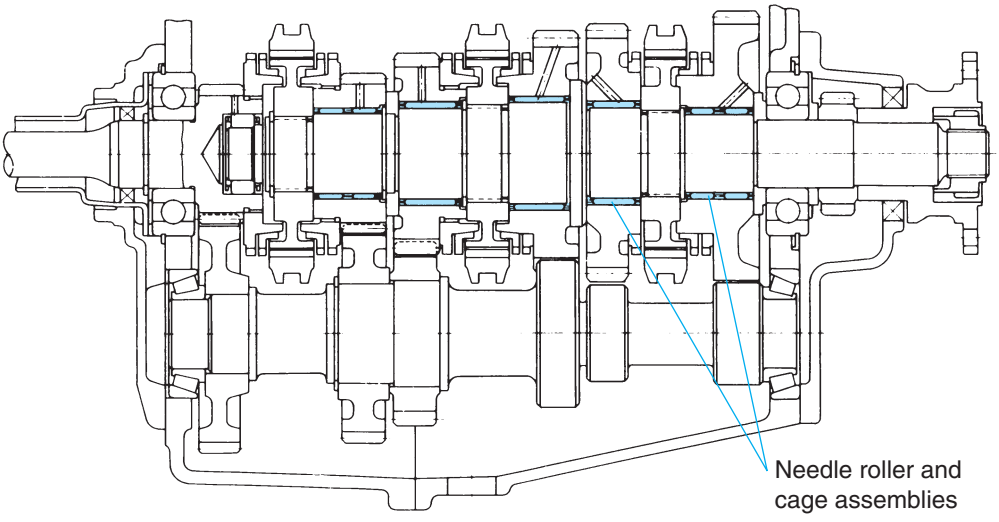
• Front Wheel Drive Passenger Car, Transmission

Needle roller and cage assemblies are used for the main shafts and countershaft inner gears of transmissions. For support of shafts, machined ring needle roller bearings are used.



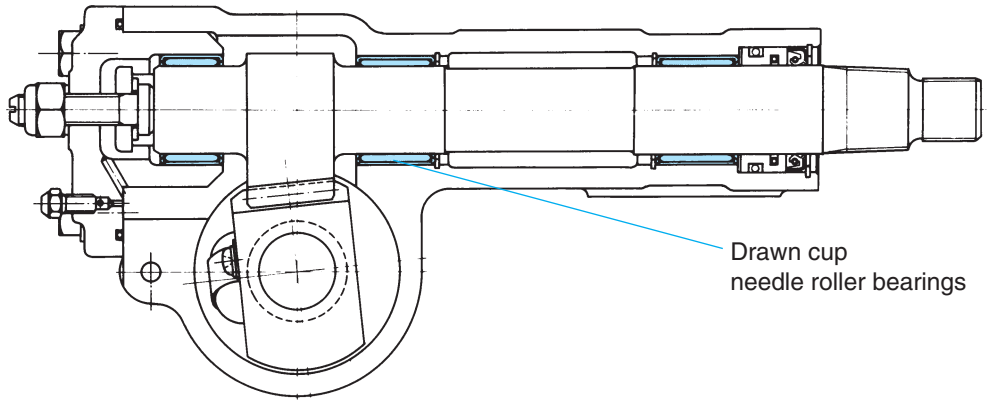
• Rear Wheel Drive Passenger Car, Transmission

Needle roller and cage assemblies are used for the inner gears of transmissions.



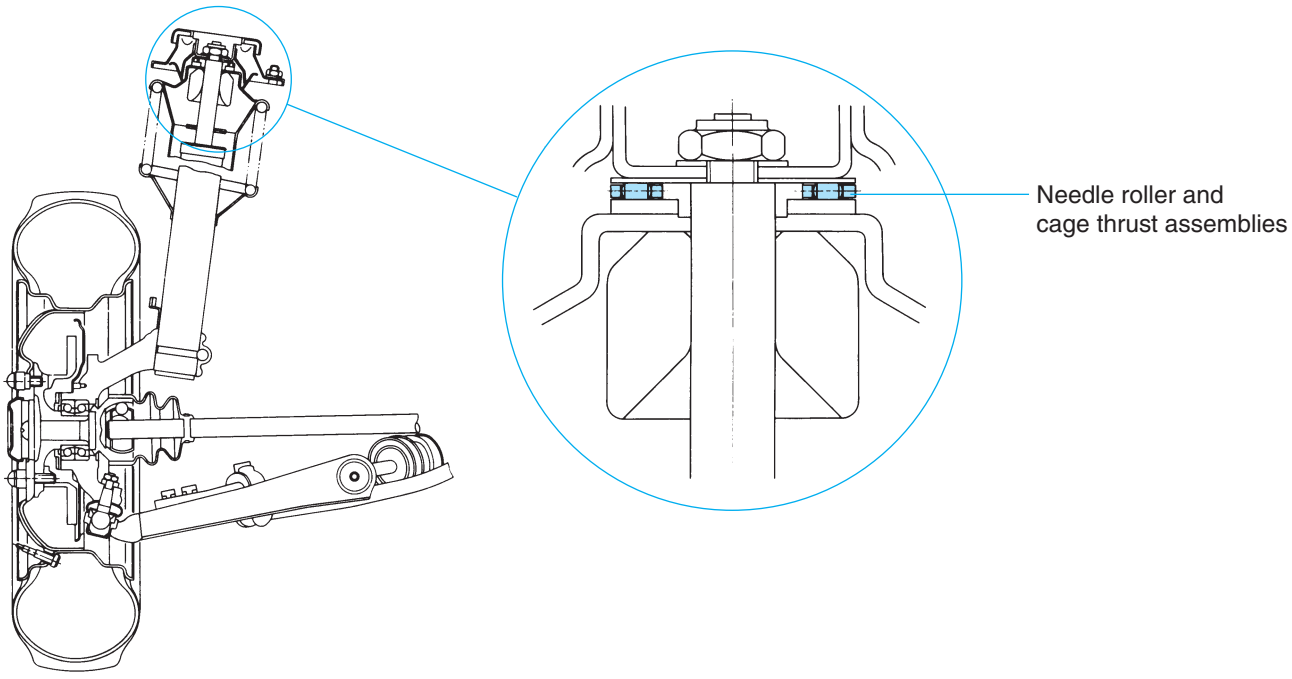
• Passenger Car, Steering Gear (Sector Shaft)

Although machined ring needle roller bearings have been used for support of sector shafts previously, use of drawn cup needle roller bearings has been recently spread for reduction of cost.



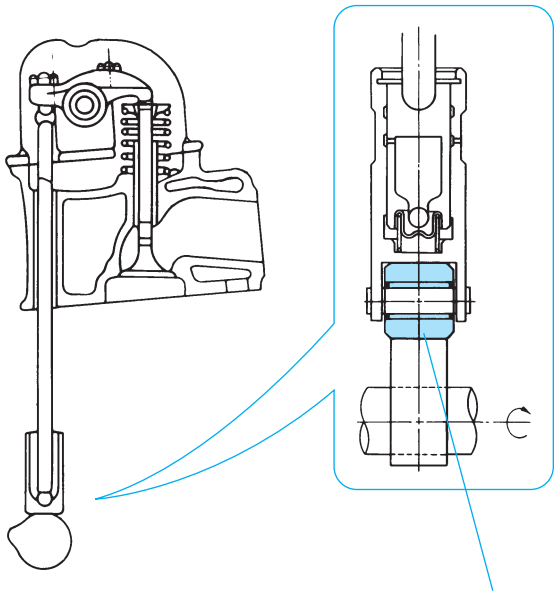
• Passenger Car, Front Suspension (Shock Absorver)

This is the example of a use of needle roller and cage thrust assemblies for a front suspension and shock absorber.



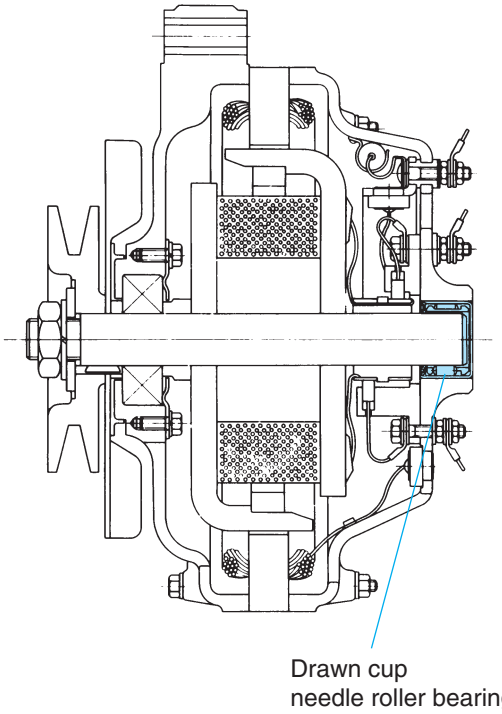
• Passenger Car, Valve Lifter

The roller followers, used for the valve lifters in the engines of automobiles, contribute to smooth rotation and reduction of running torque.



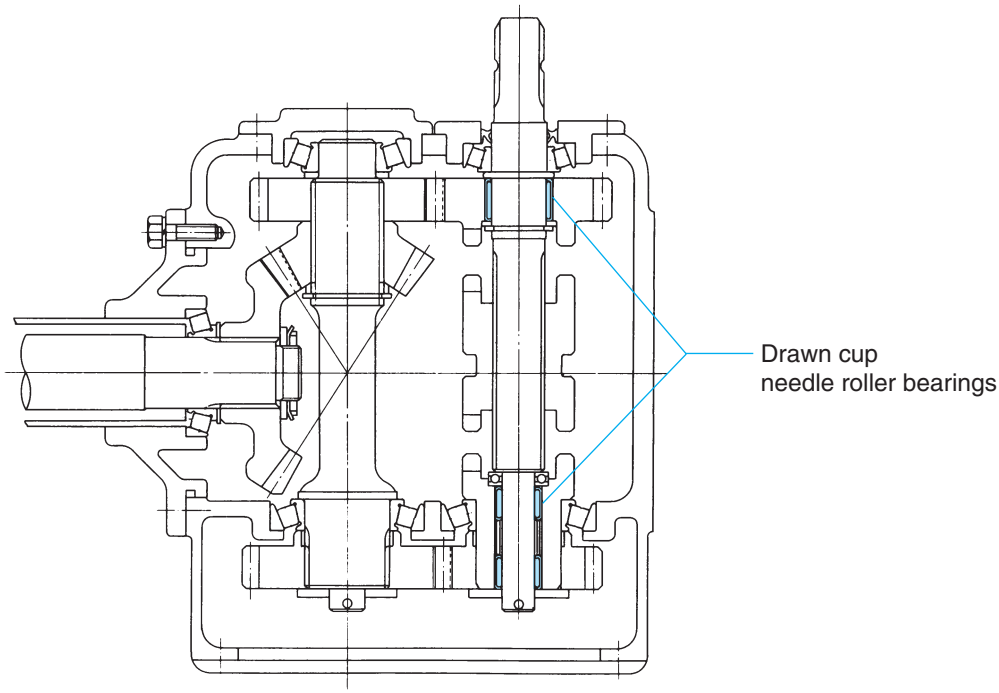
• Alternator

The closed end type drawn cup needle roller bearings are used for the other side of the pulleys in alternators.



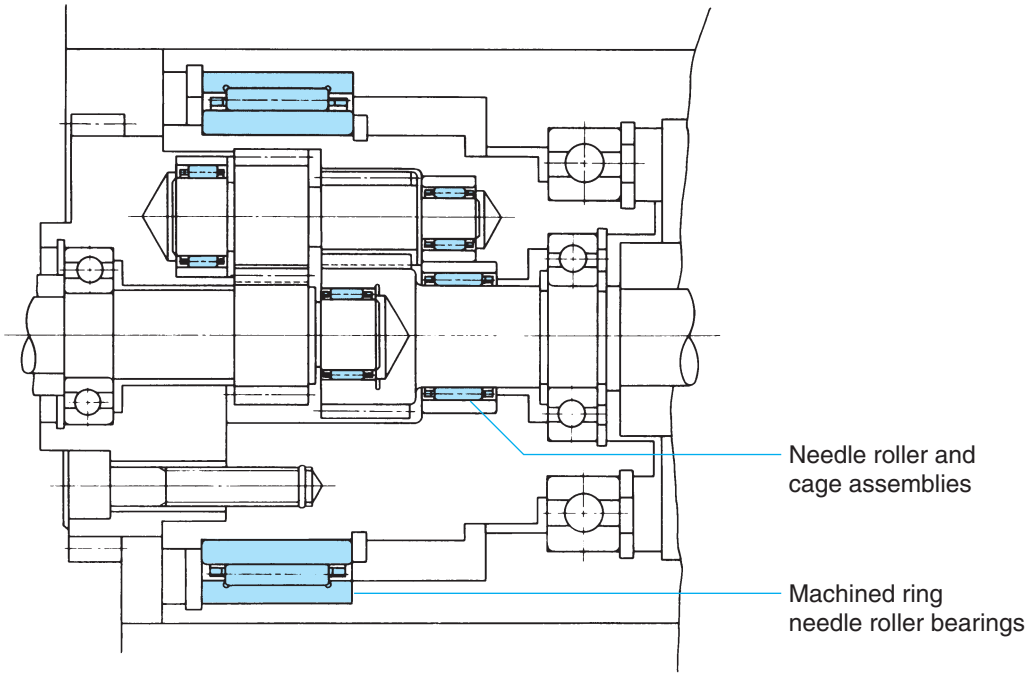
• Cultivator, Transmisson

This is the example of a use of drawn cup needle roller bearings in inner gears.



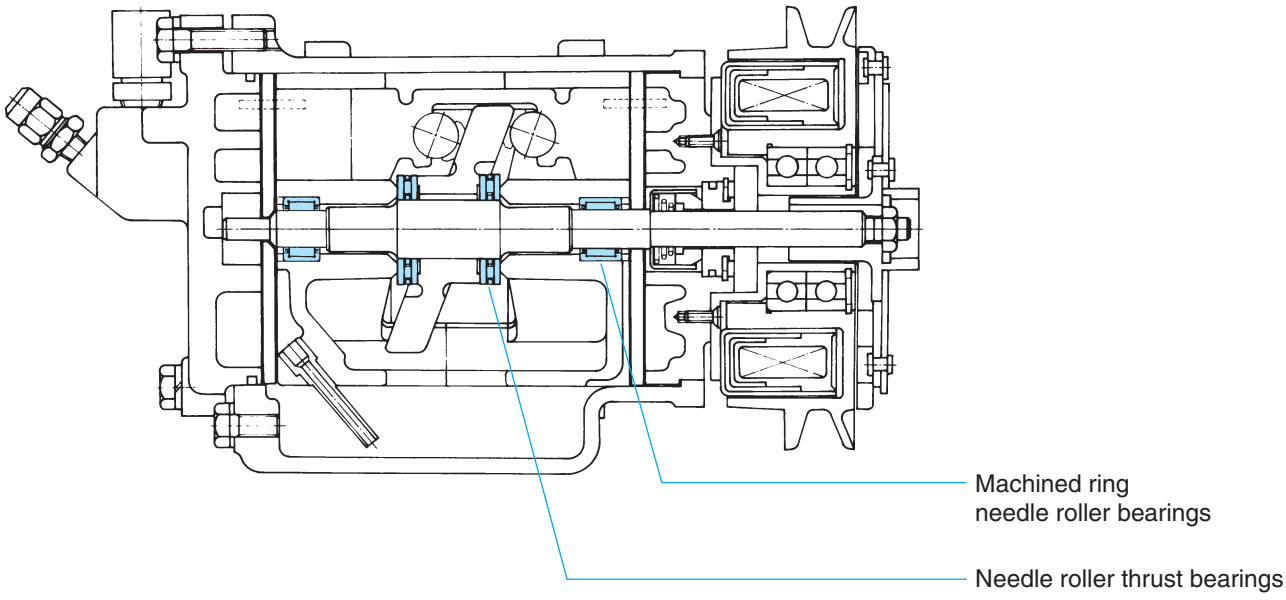
• Planetary Gear Reducer

In this example, machined ring needle roller bearings are used for support of the entire planetary gear unit, and needle roller and cage assemblies are used for the inner gears.



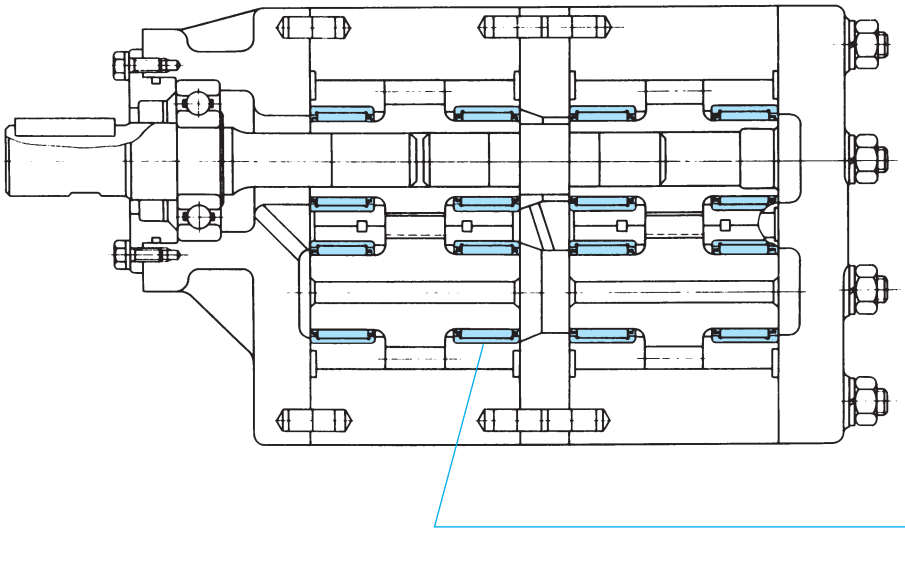
• Swash Plate Pump

In swash plate type pumps, machined ring needle roller bearings are used for support of main shafts, and needle roller thrust bearings are used for the swash plates.



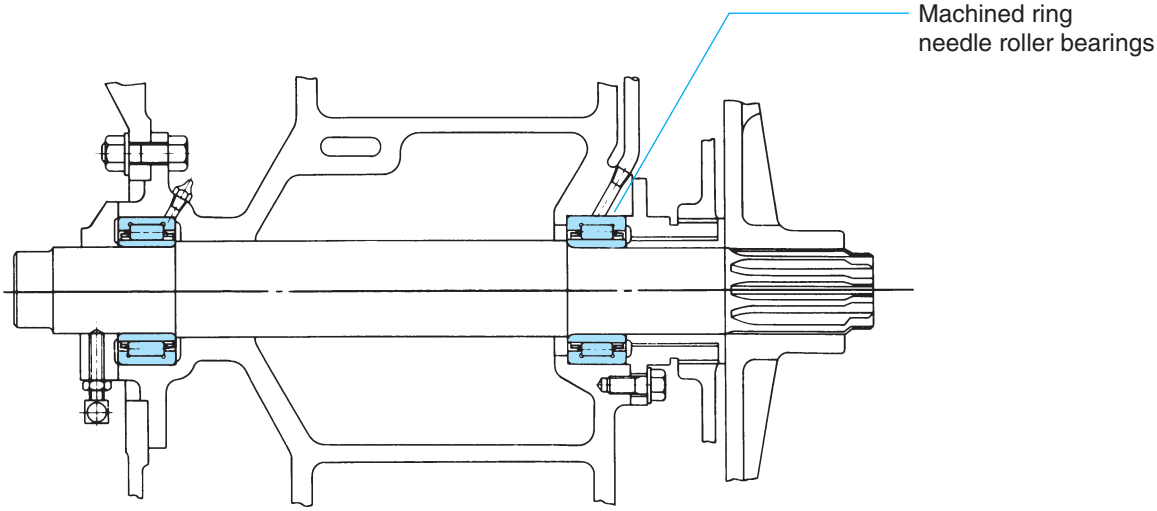
• Gear Pump

This is the example of a use of machined ring needle roller bearings in a gear pump.

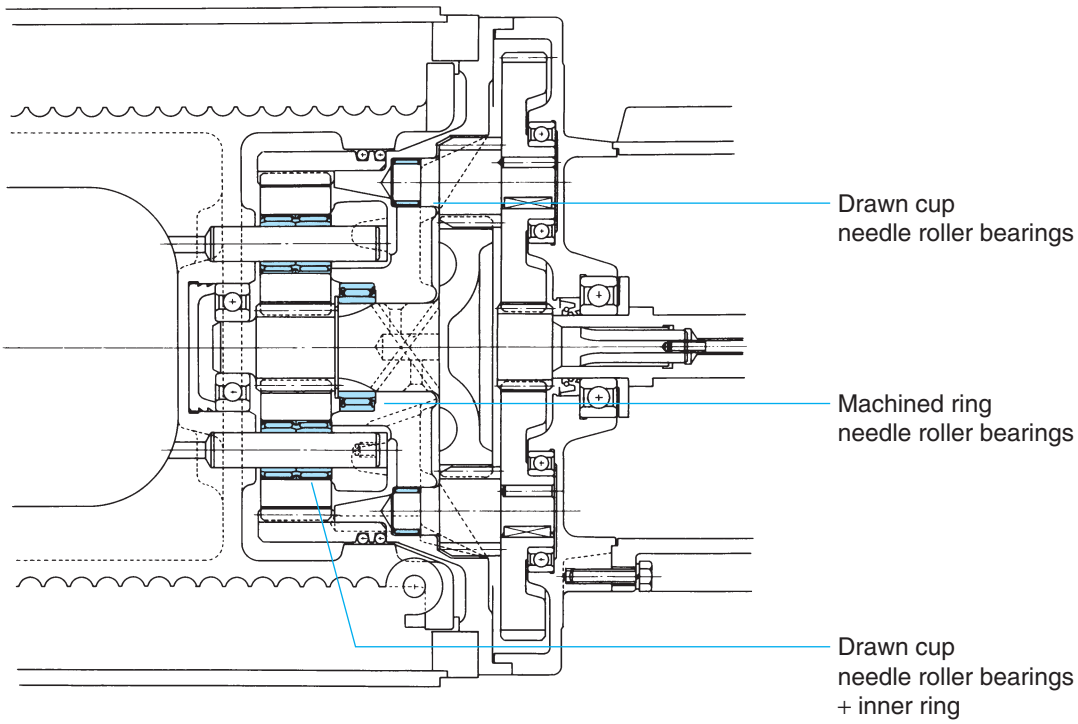


• Power Shovel, Wheel Drum

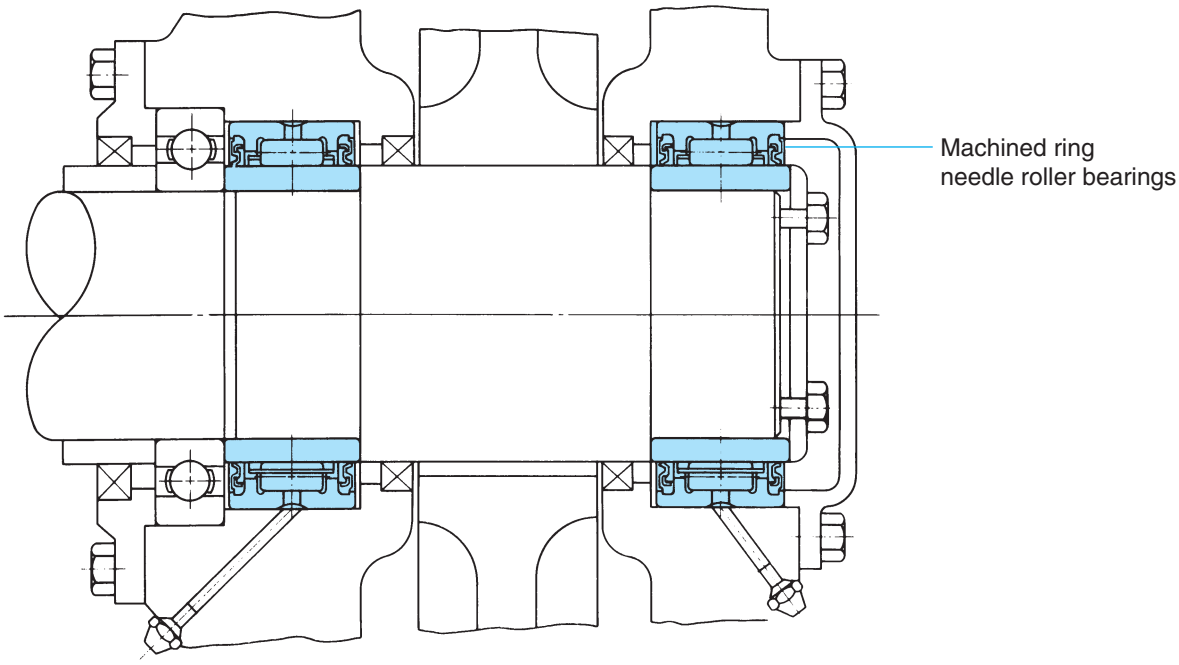
In this example, two machined ring needle roller bearings are used for support of a shaft.



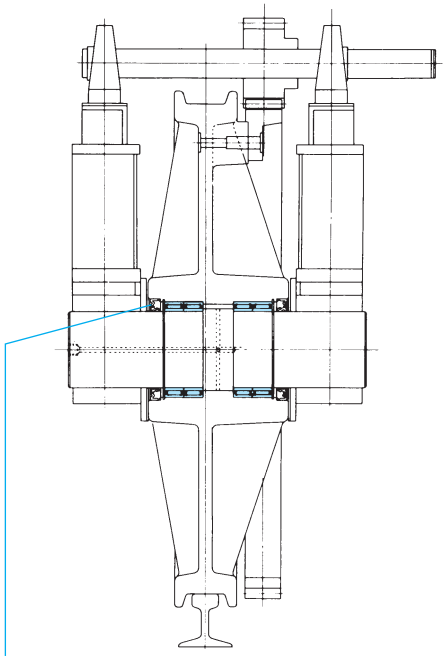
• Hoist



• Overhead Crane (1)



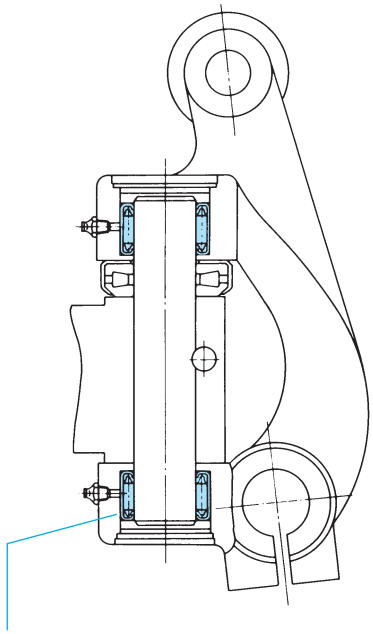
• Overhead Crane (2)



Machined ring
needle roller bearings

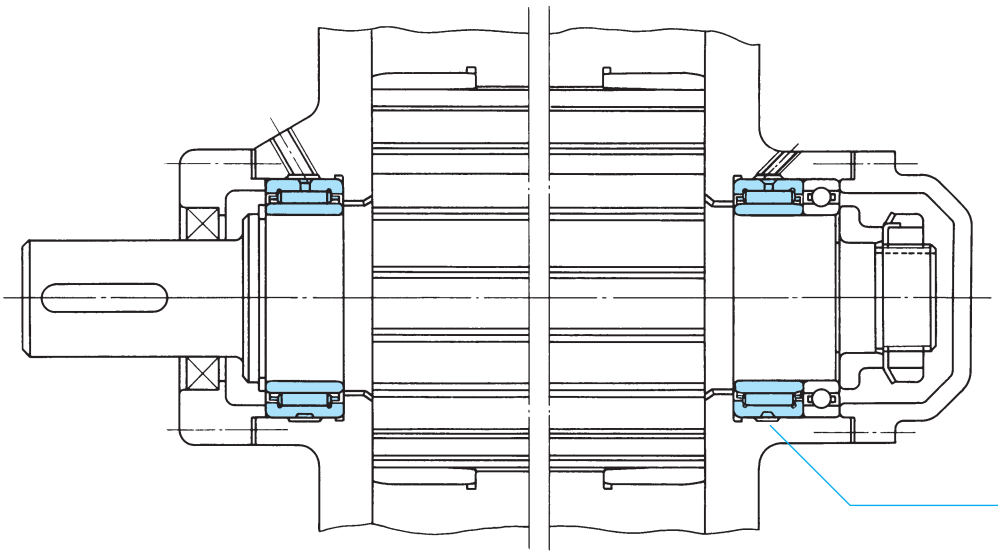
• Forklift Truck, King Pin

In this example, two drawn cup needle roller bearings are used for support of a king pin.



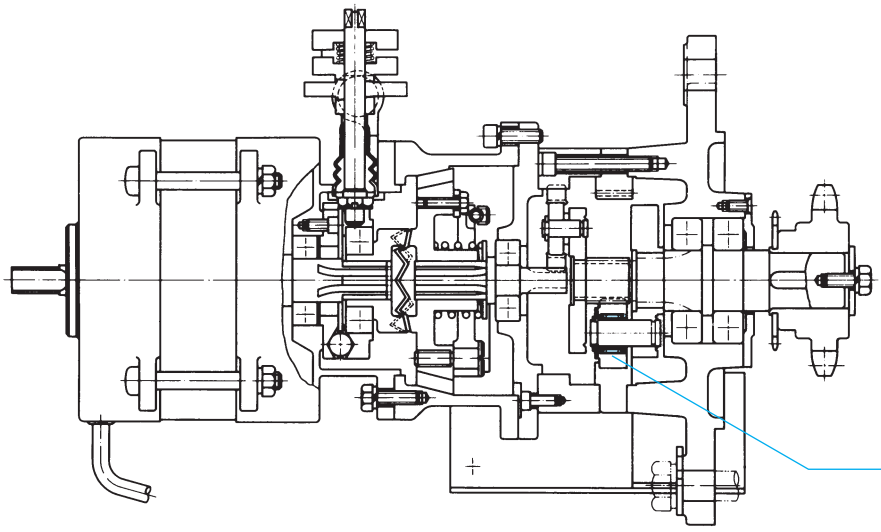
Drawn cup
needle roller bearings

• Multivane Rotary Compressor

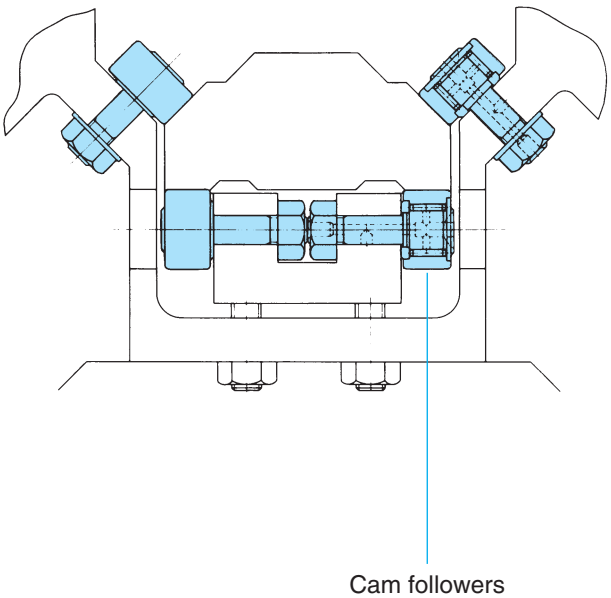


Machined ring
needle roller bearings

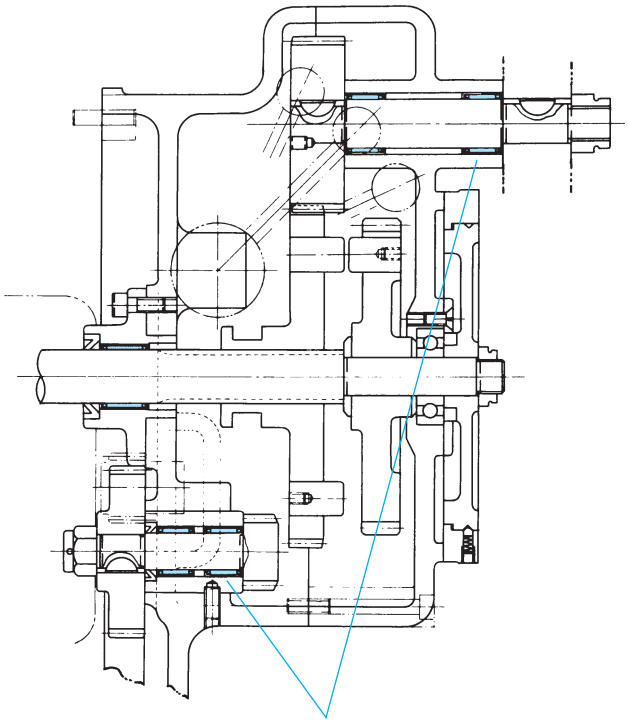
• Shutter Driving Gear



• Machine Tool, Bed

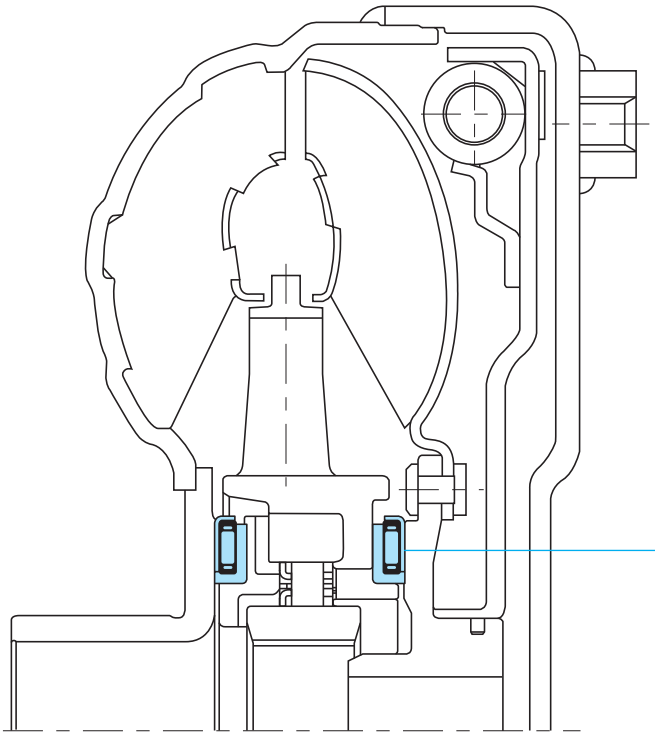


• Grinder Hoist



• Torque converter

In this example, needle roller thrust bearings are used in a torque converter.



Supplementary tables

Supplementary table 1 Shaft tolerances (deviation from nominal dimensions)

Nominal shaft dia. (mm)		Deviation classes of shaft dia.															
over	up to	c 12	d 6	e 6	e 7	e 12	f 5	f 6	g 5	g 6	h 5	h 6	h 7	h 8	h 9	h 10	h 11	h 12
3	6	− 70 − 190	− 30 − 38	− 20 − 28	− 20 − 32	− 20 −140	−10 −15	− 10 − 18	− 4 − 9	− 4 −12	0 − 5	0 − 8	0 −12	0 −18	0 − 30	0 − 48	0 − 75	0 −120
6	10	− 80 − 230	− 40 − 49	− 25 − 34	− 25 − 40	− 25 −175	−13 −19	− 13 − 22	− 5 −11	− 5 −14	0 − 6	0 − 9	0 −15	0 −22	0 − 36	0 − 58	0 − 90	0 −150
10	18	− 95 − 275	− 50 − 61	− 32 − 43	− 32 − 50	− 32 −212	−16 −24	− 16 − 27	− 6 −14	− 6 −17	0 − 8	0 −11	0 −18	0 −27	0 − 43	0 − 70	0 −110	0 −180
18	30	− 110 − 320	− 65 − 78	− 40 − 53	− 40 − 61	− 40 −250	−20 −29	− 20 − 33	− 7 −16	− 7 −20	0 − 9	0 −13	0 −21	0 −33	0 − 52	0 − 84	0 −130	0 −210
30	40	− 120 − 370	− 80 − 96	− 50 − 66	− 50 − 75	− 50 −300	−25 −36	− 25 − 41	− 9 −20	− 9 −25	0 −11	0 −16	0 −25	0 −39	0 − 62	0 −100	0 −160	0 −250
40	50	− 130 − 380																
50	65	− 140 − 440	−100 −119	− 60 − 79	− 60 − 90	− 60 −360	−30 −43	− 30 − 49	−10 −23	−10 −29	0 −13	0 −19	0 −30	0 −46	0 − 74	0 −120	0 −190	0 −300
65	80	− 150 − 450																
80	100	− 170 − 520	−120 −142	− 72 − 94	− 72 −107	− 72 −422	−36 −51	− 36 − 58	−12 −27	−12 −34	0 −15	0 −22	0 −35	0 −54	0 − 87	0 −140	0 −220	0 −350
100	120	− 180 − 530																
120	140	− 200 − 600	−145 −170	− 85 −110	− 85 −125	− 85 −485	−43 −61	− 43 − 68	−14 −32	−14 −39	0 −18	0 −25	0 −40	0 −63	0 −100	0 −160	0 −250	0 −400
140	160	− 210 − 610																
160	180	− 230 − 630																
180	200	− 240 − 700	−170 −199	−100 −129	−100 −146	−100 −560	−50 −70	− 50 − 79	−15 −35	−15 −44	0 −20	0 −29	0 −46	0 −72	0 −115	0 −185	0 −290	0 −460
200	225	− 260 − 720																
225	250	− 280 − 740																
250	280	− 300 − 820	−190 −222	−110 −142	−110 −162	−110 −630	−56 −79	− 56 − 88	−17 −40	−17 −49	0 −23	0 −32	0 −52	0 −81	0 −130	0 −210	0 −320	0 −520
280	315	− 330 − 850																
315	355	− 360 − 930	−210 −246	−125 −161	−125 −182	−125 −695	−62 −87	− 62 − 98	−18 −43	−18 −54	0 −25	0 −36	0 −57	0 −89	0 −140	0 −230	0 −360	0 −570
355	400	− 400 − 970																
400	450	− 440 −1 070	−230 −270	−135 −175	−135 −198	−135 −765	−68 −95	− 68 −108	−20 −47	−20 −60	0 −27	0 −40	0 −63	0 −97	0 −155	0 −250	0 −400	0 −630
450	500	− 480 −1 110																

[Note] 1) Δ_{dmp} : single plane mean bore diameter deviation

Unit : μm

Nominal shaft dia. (mm) over	up to	js 5	js 6	j 5	j 6	k 5	k 6	m 5	m 6	n 5	n 6	p 5	p 6	r 6	r 7	(Refer.) Δ_{dmp} [1] of bearing (class 0)
3	6	± 2.5	± 4	+ 3 − 2	+ 6 − 2	+ 6 + 1	+ 9 + 1	+ 9 + 4	+12 + 4	+13 + 8	+16 + 8	+17 +12	+ 20 + 12	+ 23 + 15	+ 27 + 15	0 − 8
6	10	± 3	± 4.5	+ 4 − 2	+ 7 − 2	+ 7 + 1	+10 + 1	+12 + 6	+15 + 6	+16 +10	+19 +10	+21 +15	+ 24 + 15	+ 28 + 19	+ 34 + 19	0 − 8
10	18	± 4	± 5.5	+ 5 − 3	+ 8 − 3	+ 9 + 1	+12 + 1	+15 + 7	+18 + 7	+20 +12	+23 +12	+26 +18	+ 29 + 18	+ 34 + 23	+ 41 + 23	0 − 8
18	30	± 4.5	± 6.5	+ 5 − 4	+ 9 − 4	+11 + 2	+15 + 2	+17 + 8	+21 + 8	+24 +15	+28 +15	+31 +22	+ 35 + 22	+ 41 + 28	+ 49 + 28	0 −10
30	50	± 5.5	± 8	+ 6 − 5	+11 − 5	+13 + 2	+18 + 2	+20 + 9	+25 + 9	+28 +17	+33 +17	+37 +26	+ 42 + 26	+ 50 + 34	+ 59 + 34	0 −12
50	65	± 6.5	± 9.5	+ 6 − 7	+12 − 7	+15 + 2	+21 + 2	+24 +11	+30 +11	+33 +20	+39 +20	+45 +32	+ 51 + 32	+ 60 + 41	+ 71 + 41	0 −15
65	80													+ 62 + 43	+ 73 + 43	
80	100	± 7.5	±11	+ 6 − 9	+13 − 9	+18 + 3	+25 + 3	+28 +13	+35 +13	+38 +23	+45 +23	+52 +37	+ 59 + 37	+ 73 + 51	+ 86 + 51	0 −20
100	120													+ 76 + 54	+ 89 + 54	
120	140	± 9	±12.5	+ 7 −11	+14 −11	+21 + 3	+28 + 3	+33 +15	+40 +15	+45 +27	+52 +27	+61 +43	+ 68 + 43	+ 88 + 63	+103 + 63	0 −25
140	160													+ 90 + 65	+105 + 65	
160	180													+ 93 + 68	+108 + 68	
180	200	±10	±14.5	+ 7 −13	+16 −13	+24 + 4	+33 + 4	+37 +17	+46 +17	+51 +31	+60 +31	+70 +50	+ 79 + 50	+106 + 77	+123 + 77	0 −30
200	225													+109 + 80	+126 + 80	
225	250													+113 + 84	+130 + 84	
250	280	±11.5	±16	+ 7 −16	±16	+27 + 4	+36 + 4	+43 +20	+52 +20	+57 +34	+66 +34	+79 +56	+ 88 + 56	+126 + 94	+146 + 94	0 −35
280	315													+130 + 98	+150 + 98	
315	355	±12.5	±18	+ 7 −18	±18	+29 + 4	+40 + 4	+46 +21	+57 +21	+62 +37	+73 +37	+87 +62	+ 98 + 62	+144 +108	+165 +108	0 −40
355	400													+150 +114	+171 +114	
400	450	±13.5	±20	+ 7 −20	±20	+32 + 5	+45 + 5	+50 +23	+63 +23	+67 +40	+80 +40	+95 +68	+108 + 68	+166 +126	+189 +126	0 −45
450	500													+172 +132	+195 +132	

Supplementary table 2 Housing bore tolerances (deviation from nominal dimensions)

Nominal Bore dia. (mm)		Deviation classes of housing bore															
over	up to	E 7	E 10	E 11	E 12	F 6	F 7	F 8	G 6	G 7	H 5	H 6	H 7	H 8	H 9	H 10	JS 6	JS 7
3	6	+ 32 + 20	+ 68 + 20	+ 95 + 20	+140 + 20	+ 18 + 10	+ 22 + 10	+ 28 + 10	+12 + 4	+16 + 4	+ 5 0	+ 8 0	+12 0	+18 0	+ 30 0	+ 48 0	± 4	± 6
6	10	+ 40 + 25	+ 83 + 25	+115 + 25	+175 + 25	+ 22 + 13	+ 28 + 13	+ 35 + 13	+14 + 5	+20 + 5	+ 6 0	+ 9 0	+15 0	+22 0	+ 36 0	+ 58 0	± 4.5	± 7.5
10	18	+ 50 + 32	+102 + 32	+142 + 32	+212 + 32	+ 27 + 16	+ 34 + 16	+ 43 + 16	+17 + 6	+24 + 6	+ 8 0	+11 0	+18 0	+27 0	+ 43 0	+ 70 0	± 5.5	± 9
18	30	+ 61 + 40	+124 + 40	+170 + 40	+250 + 40	+ 33 + 20	+ 41 + 20	+ 53 + 20	+20 + 7	+28 + 7	+ 9 0	+13 0	+21 0	+33 0	+ 52 0	+ 84 0	± 6.5	±10.5
30	50	+ 75 + 50	+150 + 50	+210 + 50	+300 + 50	+ 41 + 25	+ 50 + 25	+ 64 + 25	+25 + 9	+34 + 9	+11 0	+16 0	+25 0	+39 0	+ 62 0	+100 0	± 8	±12.5
50	80	+ 90 + 60	+180 + 60	+250 + 60	+360 + 60	+ 49 + 30	+ 60 + 30	+ 76 + 30	+29 +10	+40 +10	+13 0	+19 0	+30 0	+46 0	+ 74 0	+120 0	± 9.5	±15
80	120	+107 + 72	+212 + 72	+292 + 72	+422 + 72	+ 58 + 36	+ 71 + 36	+ 90 + 36	+34 +12	+47 +12	+15 0	+22 0	+35 0	+54 0	+ 87 0	+140 0	±11	±17.5
120	180	+125 + 85	+245 + 85	+335 + 85	+485 + 85	+ 68 + 43	+ 83 + 43	+106 + 43	+39 +14	+54 +14	+18 0	+25 0	+40 0	+63 0	+100 0	+160 0	±12.5	±20
180	250	+146 +100	+285 +100	+390 +100	+560 +100	+ 79 + 50	+ 96 + 50	+122 + 50	+44 +15	+61 +15	+20 0	+29 0	+46 0	+72 0	+115 0	+185 0	±14.5	±23
250	315	+162 +110	+320 +110	+430 +110	+630 +110	+ 88 + 56	+108 + 56	+137 + 56	+49 +17	+69 +17	+23 0	+32 0	+52 0	+81 0	+130 0	+210 0	±16	±26
315	400	+182 +125	+355 +125	+485 +125	+695 +125	+ 98 + 62	+119 + 62	+151 + 62	+54 +18	+75 +18	+25 0	+36 0	+57 0	+89 0	+140 0	+230 0	±18	±28.5
400	500	+198 +135	+385 +135	+535 +135	+765 +135	+108 + 68	+131 + 68	+165 + 68	+60 +20	+83 +20	+27 0	+40 0	+63 0	+97 0	+155 0	+250 0	±20	±31.5

[Note] 1) Δ_{Dmp} : single plane mean outside diameter deviation

Unit : μm

J6	J7	K6	K7	M6	M7	N6	N7	P6	P7	R6	R7	S7	Nominal Bore dia. (mm) over	up to	(Refer.) Δ_{Dmp}[1] of bearing (class 0)
+ 5 − 3	+ 6 − 6	+ 2 − 6	+ 3 − 9	− 1 − 9	0 −12	− 5 −13	− 4 −16	− 9 −17	− 8 − 20	− 12 − 20	− 11 − 23	− 15 − 27	3	6	0 − 8
+ 5 − 4	+ 8 − 7	+ 2 − 7	+ 5 −10	− 3 −12	0 −15	− 7 −16	− 4 −19	−12 −21	− 9 − 24	− 16 − 25	− 13 − 28	− 17 − 32	6	10	0 − 8
+ 6 − 5	+10 − 8	+ 2 − 9	+ 6 −12	− 4 −15	0 −18	− 9 −20	− 5 −23	−15 −26	− 11 − 29	− 20 − 31	− 16 − 34	− 21 − 39	10	18	0 − 8
+ 8 − 5	+12 − 9	+ 2 −11	+ 6 −15	− 4 −17	0 −21	−11 −24	− 7 −28	−18 −31	− 14 − 35	− 24 − 37	− 20 − 41	− 27 − 48	18	30	0 − 9
+10 − 6	+14 −11	+ 3 −13	+ 7 −18	− 4 −20	0 −25	−12 −28	− 8 −33	−21 −37	− 17 − 42	− 29 − 45	− 25 − 50	− 34 − 59	30	50	0 −11
+13 − 6	+18 −12	+ 4 −15	+ 9 −21	− 5 −24	0 −30	−14 −33	− 9 −39	−26 −45	− 21 − 51	− 35 − 54	− 30 − 60	− 42 − 72	50	65	0 −13
										− 37 − 56	− 32 − 62	− 48 − 78	65	80	
+16 − 6	+22 −13	+ 4 −18	+10 −25	− 6 −28	0 −35	−16 −38	−10 −45	−30 −52	− 24 − 59	− 44 − 66	− 38 − 73	− 58 − 93	80	100	0 −15
										− 47 − 69	− 41 − 76	− 66 −101	100	120	
+18 − 7	+26 −14	+ 4 −21	+12 −28	− 8 −33	0 −40	−20 −45	−12 −52	−36 −61	− 28 − 68	− 56 − 81	− 48 − 88	− 77 −117	120	140	(up to 150) 0 −18 (over to 150) 0 −25
										− 58 − 83	− 50 − 90	− 85 −125	140	160	
										− 61 − 86	− 53 − 93	− 93 −133	160	180	
+22 − 7	+30 −16	+ 5 −24	+13 −33	− 8 −37	0 −46	−22 −51	−14 −60	−41 −70	− 33 − 79	− 68 − 97	− 60 −106	−105 −151	180	200	0 −30
										− 71 −100	− 63 −109	−113 −159	200	225	
										− 75 −104	− 67 −113	−123 −169	225	250	
+25 − 7	+36 −16	+ 5 −27	+16 −36	− 9 −41	0 −52	−25 −57	−14 −66	−47 −79	− 36 − 88	− 85 −117	− 74 −126	−138 −190	250	280	0 −35
										− 89 −121	− 78 −130	−150 −202	280	315	
+29 − 7	+39 −18	+ 7 −29	+17 −40	−10 −46	0 −57	−26 −62	−16 −73	−51 −87	− 41 − 98	− 97 −133	− 87 −144	−169 −226	315	355	0 −40
										−103 −139	− 93 −150	−187 −244	355	400	
+33 − 7	+43 −20	+ 8 −32	+18 −45	−10 −50	0 −63	−27 −67	−17 −80	−55 −95	− 45 −108	−113 −153	−103 −166	−209 −272	400	450	0 −45
										−119 −159	−109 −172	−229 −292	450	500	

Supplementary table 3 (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)] floz (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 floz (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 floz 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 3 (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	$kg{\cdot}m/s$			
Moment of momentum, Angular momentum	$kg{\cdot}m^2/s$			
Moment of inertia	$kg{\cdot}m^2$			
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_2O, 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_2O = 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] $kgf{\cdot}s/m^2$	10^{-2} P = 1 cP = 1 mPa·s 1 $kgf{\cdot}s/m^2$ = 9.806 65 Pa·s	 1 Pa·s = 0.101 97 $kgf{\cdot}s/m^2$
Kinematic viscosity	m^2/s	St [stokes]	10^{-2} St = 1 cSt = 1 mm^2/s	
Surface tension	N/m			

Supplementary table 3 (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)] *	1 eV = (1.602 189 2 ± 0.000 004 6) × 10^{-19} J	
		erg [erg(s)]	1 erg = 10^{-7} J	1 J = 10^{7} erg
		kgf·m	1 kgf·m = 9.806 65 J	1 J = 0.101 97 kgf·m
		lbf·ft	1 lbf·ft = 1.355 82 J	1 J = 0.737 56 lbf·ft
Power	W [watt(s)]	erg / s [ergs per second]	1 erg / s = 10^{-7} W	
		kgf·m / s	1 kgf·m / s = 9.806 65 W	1 W = 0.101 97 kgf·m / s
		PS [French horse-power]	1 PS = 75 kgf·m / s = 735.5 W	1 W = 0.001 36 PS
		HP [horse-power (British)]	1 HP = 550 lbf·ft / s = 745.7 W	1 W = 0.001 34 HP
		lbf·ft / s	1 lbf·ft / s = 1.355 82 W	
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)]	1 erg = 10^{-7} J	1 J = 10^{7} erg
		kgf·m		
		cal_{IT} [I. T. calories]	1 cal_{IT} = 4.186 8 J	1 J = 0.238 85 cal_{IT}
			1 $Mcal_{IT}$ = 1.163 kW·h	1 kW·h = 0.86 × 10^{6} cal_{IT}
Thermal conductivity	W / (m·K)	W / (m·°C)	1 W / (m·°C) = 1 W / (m·K)	
		cal / (s·m·°C)	1 cal / (s·m·°C) = 4.186 05 W / (m·K)	
Coefficient of heat transfer	W / (m^2·K)	W / (m^2·°C)	1 W / (m^2·°C) = 1 W/ (m^2·K)	
		cal / (s·m^2·°C)	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 3 (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 Oe = $\frac{10^3}{4\pi}$ A/m	1 A/m = $4\pi \times 10^{-3}$ Oe
Magnetic flux density	T [tesla(s)] {1 T = 1 N/(A·m) = 1 Wb/m^2 = 1 V·s/m^2}	Gs [gauss(es)] γ [gamma(s)]	1 Gs = 10^{-4} T 1 γ = 10^{-9} T	1 T = 10^4 Gs 1 T = 10^9 γ
Magnetic flux	Wb [weber(s)] {1 Wb = 1 V·s}	Mx [maxwell(s)]	1 Mx = 10^{-8} Wb	1 Wb = 10^8 Mx
Self inductance	H [henry (-ries)] {1 H = 1 Wb/A}			
Resistance (to direct current)	Ω [ohm(s)] {1 Ω = 1 V/A}			
Conductance (to direct current)	S [siemens] {1 S = 1 A/V}			
Active power	W {1 W = 1 J/s = 1 A·V}			

Supplementary table 4 Steel hardness conversion

Rockwell	Vicker's	Brinell		Rockwell		Shore
C-scale 1 471.0 N (150 kgf)		Standard ball	Tungsten carbide ball	A-scale 588.4 N (60 kgf)	B-scale 980.7 N (100 kgf)	
68	940			85.6		97
67	900			85.0		95
66	865			84.5		92
65	832		739	83.9		91
64	800		722	83.4		88
63	772		705	82.8		87
62	746		688	82.3		85
61	720		670	81.8		83
60	697		654	81.2		81
59	674		634	80.7		80
58	653		615	80.1		78
57	633		595	79.6		76
56	613		577	79.0		75
55	595	—	560	78.5		74
54	577	—	543	78.0		72
53	560	—	525	77.4		71
52	544	500	512	76.8		69
51	528	487	496	76.3		68
50	513	475	481	75.9		67
49	498	464	469	75.2		66
48	484	451	455	74.7		64
47	471	442	443	74.1		63
46	458	432	432	73.6		62
45	446	421		73.1		60
44	434	409		72.5		58
43	423	400		72.0		57
42	412	390		71.5		56
41	402	381		70.9		55
40	392	371		70.4	—	54
39	382	362		69.9	—	52
38	372	353		69.4	—	51
37	363	344		68.9	—	50
36	354	336		68.4	(109.0)	49
35	345	327		67.9	(108.5)	48
34	336	319		67.4	(108.0)	47
33	327	311		66.8	(107.5)	46
32	318	301		66.3	(107.0)	44
31	310	294		65.8	(106.0)	43
30	302	286		65.3	(105.5)	42
29	294	279		64.7	(104.5)	41
28	286	271		64.3	(104.0)	41
27	279	264		63.8	(103.0)	40
26	272	258		63.3	(102.5)	38
25	266	253		62.8	(101.5)	38
24	260	247		62.4	(101.0)	37
23	254	243		62.0	100.0	36
22	248	237		61.5	99.0	35
21	243	231		61.0	98.5	35
20	238	226		60.5	97.8	34
(18)	230	219		—	96.7	33
(16)	222	212		—	95.5	32
(14)	213	203		—	93.9	31
(12)	204	194		—	92.3	29
(10)	196	187			90.7	28
(8)	188	179			89.5	27
(6)	180	171			87.1	26
(4)	173	165			85.5	25
(2)	166	158			83.5	24
(0)	160	152			81.7	24

Supplementary table 5 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
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 mm^2/s = 1 cSt (centi stokes)

Supplementary table 6 ºC/ºF conversion

ºC		ºF	ºC		ºF	ºC		ºF	ºC		ºF
–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 eigher degrees Centigrade (ºC) or Fahrenheit (ºF) 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.

$$C = \frac{5}{9}(F - 32)$$

$$F = \frac{9}{5}(C + 32)$$

Supplementary table 7 Inch/millimeter conversion

Inch		Inches										
		0	1	2	3	4	5	6	7	8	9	10
		mm										
0	0	**0**	**25.4000**	**50.8000**	**76.2000**	**101.6000**	**127.0000**	**152.4000**	**177.8000**	**203.2000**	**228.6000**	**254.0000**
1/64	0.015625	0.3969	25.7969	51.1969	76.5969	101.9969	127.3969	152.7969	178.1969	203.5969	228.9969	254.3969
1/32	0.03125	0.7938	26.1938	51.5938	76.9938	102.3938	127.7938	153.1938	178.5938	203.9938	229.3938	254.7938
3/64	0.046875	1.1906	26.5906	51.9906	77.3906	102.7906	128.1906	153.5906	178.9906	204.3906	229.7906	255.1906
1/16	0.0625	1.5875	26.9875	52.3875	77.7875	103.1875	128.5875	153.9875	179.3875	204.7875	230.1875	255.5875
5/64	0.078125	1.9844	27.3844	52.7844	78.1844	103.5844	128.9844	154.3844	179.7844	205.1844	230.5844	255.9844
3/32	0.09375	2.3812	27.7812	53.1812	78.5812	103.9812	129.3812	154.7812	180.1812	205.5812	230.9812	256.3812
7/64	0.109375	2.7781	28.1781	53.5781	78.9781	104.3781	129.7781	155.1781	180.5781	205.9781	231.3781	256.7781
1/8	0.125	**3.1750**	**28.5750**	**53.9750**	**79.3750**	**104.7750**	**130.1750**	**155.5750**	**180.9750**	**206.3750**	**231.7750**	**257.1750**
9/64	0.140625	3.5719	28.9719	54.3719	79.7719	105.1719	130.5719	155.9719	181.3719	206.7719	232.1719	257.5719
5/32	0.15625	3.9688	29.3688	54.7688	80.1688	105.5688	130.9688	156.3688	181.7688	207.1688	232.5688	257.9688
11/64	0.171875	4.3656	29.7656	55.1656	80.5656	105.9656	131.3656	156.7656	182.1656	207.5656	232.9656	258.3656
3/16	0.1875	4.7625	30.1625	55.5625	80.9625	106.3625	131.7625	157.1625	182.5625	207.9625	233.3625	258.7625
13/64	0.203125	5.1594	30.5594	55.9594	81.3594	106.7594	132.1594	157.5594	182.9594	208.3594	233.7594	259.1594
7/32	0.21875	5.5562	30.9562	56.3562	81.7562	107.1562	132.5562	157.9562	183.3562	208.7562	234.1562	259.5562
15/64	0.234375	5.9531	31.3531	56.7531	82.1531	107.5531	132.9531	158.3531	183.7531	209.1531	234.5531	259.9531
1/4	0.25	**6.3500**	**31.7500**	**57.1500**	**82.5500**	**107.9500**	**133.3500**	**158.7500**	**184.1500**	**209.5500**	**234.9500**	**260.3500**
17/64	0.265625	6.7469	32.1469	57.5469	82.9469	108.3469	133.7469	159.1469	184.5469	209.9469	235.3469	260.7469
9/32	0.28125	7.1438	32.5438	57.9438	83.3438	108.7438	134.1438	159.5438	184.9438	210.3438	235.7438	261.1438
19/64	0.296875	7.5406	32.9406	58.3406	83.7406	109.1406	134.5406	159.9406	185.3406	210.7406	236.1406	261.5406
5/16	0.3125	7.9375	33.3375	58.7375	84.1375	109.5375	134.9375	160.3375	185.7375	211.1375	236.5375	261.9375
21/64	0.328125	8.3344	33.7344	59.1344	84.5344	109.9344	135.3344	160.7344	186.1344	211.5344	236.9344	262.3344
11/32	0.34375	8.7312	34.1312	59.5312	84.9312	110.3312	135.7312	161.1312	186.5312	211.9312	237.3312	262.7312
23/64	0.359375	9.1281	34.5281	59.9281	85.3281	110.7281	136.1281	161.5281	186.9281	212.3281	237.7281	263.1281
3/8	0.375	**9.5250**	**34.9250**	**60.3250**	**85.7250**	**111.1250**	**136.5250**	**161.9250**	**187.3250**	**212.7250**	**238.1250**	**263.5250**
25/64	0.390625	9.9219	35.3219	60.7219	86.1219	111.5219	136.9219	162.3219	187.7219	213.1219	238.5219	263.9219
13/32	0.40625	10.3188	35.7188	61.1188	86.5188	111.9188	137.3188	162.7188	188.1188	213.5188	238.9188	264.3188
27/64	0.421875	10.7156	36.1156	61.5156	86.9156	112.3156	137.7156	163.1156	188.5156	213.9156	239.3156	264.7156
7/16	0.4375	11.1125	36.5125	61.9125	87.3125	112.7125	138.1125	163.5125	188.9125	214.3125	239.7125	265.1125
29/64	0.453125	11.5094	36.9094	62.3094	87.7094	113.1094	138.5094	163.9094	189.3094	214.7094	240.1094	265.5094
15/32	0.46875	11.9062	37.3062	62.7062	88.1062	113.5062	138.9062	164.3062	189.7062	215.1062	240.5062	265.9062
31/64	0.484375	12.3031	37.7031	63.1031	88.5031	113.9031	139.3031	164.7031	190.1031	215.5031	240.9031	266.3031
1/2	0.5	**12.7000**	**38.1000**	**63.5000**	**88.9000**	**114.3000**	**139.7000**	**165.1000**	**190.5000**	**215.9000**	**241.3000**	**266.7000**
33/64	0.515625	13.0969	38.4969	63.8969	89.2969	114.6969	140.0969	165.4969	190.8969	216.2969	241.6969	267.0969
17/32	0.53125	13.4938	38.8938	64.2938	89.6938	115.0938	140.4938	165.8938	191.2938	216.6938	242.0938	267.4938
35/64	0.546875	13.8906	39.2906	64.6906	90.0906	115.4906	140.8906	166.2906	191.6906	217.0906	242.4906	267.8906
9/16	0.5625	14.2875	39.6875	65.0875	90.4875	115.8875	141.2875	166.6875	192.0875	217.4875	242.8875	268.2875
37/64	0.578125	14.6844	40.0844	65.4844	90.8844	116.2844	141.6844	167.0844	192.4844	217.8844	243.2844	268.6844
19/32	0.59375	15.0812	40.4812	65.8812	91.2812	116.6812	142.0812	167.4812	192.8812	218.2812	243.6812	269.0812
39/64	0.609375	15.4781	40.8781	66.2781	91.6781	117.0781	142.4781	167.8781	193.2781	218.6781	244.0781	269.4781
5/8	0.625	**15.8750**	**41.2750**	**66.6750**	**92.0750**	**117.4750**	**142.8750**	**168.2750**	**193.6750**	**219.0750**	**244.4750**	**269.8750**
41/64	0.640625	16.2719	41.6719	67.0719	92.4719	117.8719	143.2719	168.6719	194.0719	219.4719	244.8719	270.2719
21/32	0.65625	16.6688	42.0688	67.4688	92.8688	118.2688	143.6688	169.0688	194.4688	219.8688	245.2688	270.6688
43/64	0.671875	17.0656	42.4656	67.8656	93.2656	118.6656	144.0656	169.4656	194.8656	220.2656	245.6656	271.0656
11/16	0.6875	17.4625	42.8625	68.2625	93.6625	119.0625	144.4625	169.8625	195.2625	220.6625	246.0625	271.4625
45/64	0.703125	17.8594	43.2594	68.6594	94.0594	119.4594	144.8594	170.2594	195.6594	221.0594	246.4594	271.8594
23/32	0.71875	18.2562	43.6562	69.0562	94.4562	119.8562	145.2562	170.6562	196.0562	221.4562	246.8562	272.2562
47/64	0.734375	18.6531	44.0531	69.4531	94.8531	120.2531	145.6531	171.0531	196.4531	221.8531	247.2531	272.6531
3/4	0.75	**19.0500**	**44.4500**	**69.8500**	**95.2500**	**120.6500**	**146.0500**	**171.4500**	**196.8500**	**222.2500**	**247.6500**	**273.0500**
49/64	0.765625	19.4469	44.8469	70.2469	95.6469	121.0469	146.4469	171.8469	197.2469	222.6469	248.0469	273.4469
25/32	0.78125	19.8438	45.2438	70.6438	96.0438	121.4438	146.8438	172.2438	197.6438	223.0438	248.4438	273.8438
51/64	0.796875	20.2406	45.6406	71.0406	96.4406	121.8406	147.2406	172.6406	198.0406	223.4406	248.8406	274.2406
13/16	0.8125	20.6375	46.0375	71.4375	96.8375	122.2375	147.6375	173.0375	198.4375	223.8375	249.2375	274.6375
53/64	0.828125	21.0344	46.4344	71.8344	97.2344	122.6344	148.0344	173.4344	198.8344	224.2344	249.6344	275.0344
27/32	0.84375	21.4312	46.8312	72.2312	97.6312	123.0312	148.4312	173.8312	199.2312	224.6312	250.0312	275.4312
55/64	0.859375	21.8281	47.2281	72.6281	98.0281	123.4281	148.8281	174.2281	199.6281	225.0281	250.4281	275.8281
7/8	0.875	**22.2250**	**47.6250**	**73.0250**	**98.4250**	**123.8250**	**149.2250**	**174.6250**	**200.0250**	**225.4250**	**250.8250**	**276.2250**
57/64	0.890625	22.6219	48.0219	73.4219	98.8219	124.2219	149.6219	175.0219	200.4219	225.8219	251.2219	276.6219
29/32	0.90625	23.0188	48.4188	73.8188	99.2188	124.6188	150.0188	175.4188	200.8188	226.2188	251.6188	277.0188
59/64	0.921875	23.4156	48.8156	74.2156	99.6156	125.0156	150.4156	175.8156	201.2156	226.6156	252.0156	277.4156
15/16	0.9375	23.8125	49.2125	74.6125	100.0125	125.4125	150.8125	176.2125	201.6125	227.0125	252.4125	277.8125
61/64	0.953125	24.2094	49.6094	75.0094	100.4094	125.8094	151.2094	176.6094	202.0094	227.4094	252.8094	278.2094
31/32	0.96875	24.6062	50.0062	75.4062	100.8062	126.2062	151.6062	177.0062	202.4062	227.8062	253.2062	278.6062
63/64	0.984375	25.0031	50.4031	75.8031	101.2031	126.6031	152.0031	177.4031	202.8031	228.2031	253.6031	279.0031

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