MinebeaMitsumi Inc.

NMB

Ball Bearing Products

Miniature & Small Ball Bearings


NMB Ball Bearing Products

Introduction

Thank you for your patronage of MinebeaMitsumi and our products. Since our founding in 1951 as the first specialist miniature ball bearing manufacturer in Japan, we have expanded product sizes to include miniature, instrument, and small-diameter rolling ball bearings. We now conduct production at twelve plants in Japan, the US, Singapore, Thailand, China, Germany, the Czech Republic, and Cambodia.

Rolling ball bearings are composed of parts including outer rings, inner rings, balls, retainers, and shields. MinebeaMitsumi produces these parts in-house, with an integrated production system from machining to assembly. The mothership plant in Japan coordinates with the other factories, enabling the stable production of high-quality rolling ball bearings at every plant.


THAILAND
NMB
SINGAPORE
NMB

NMB

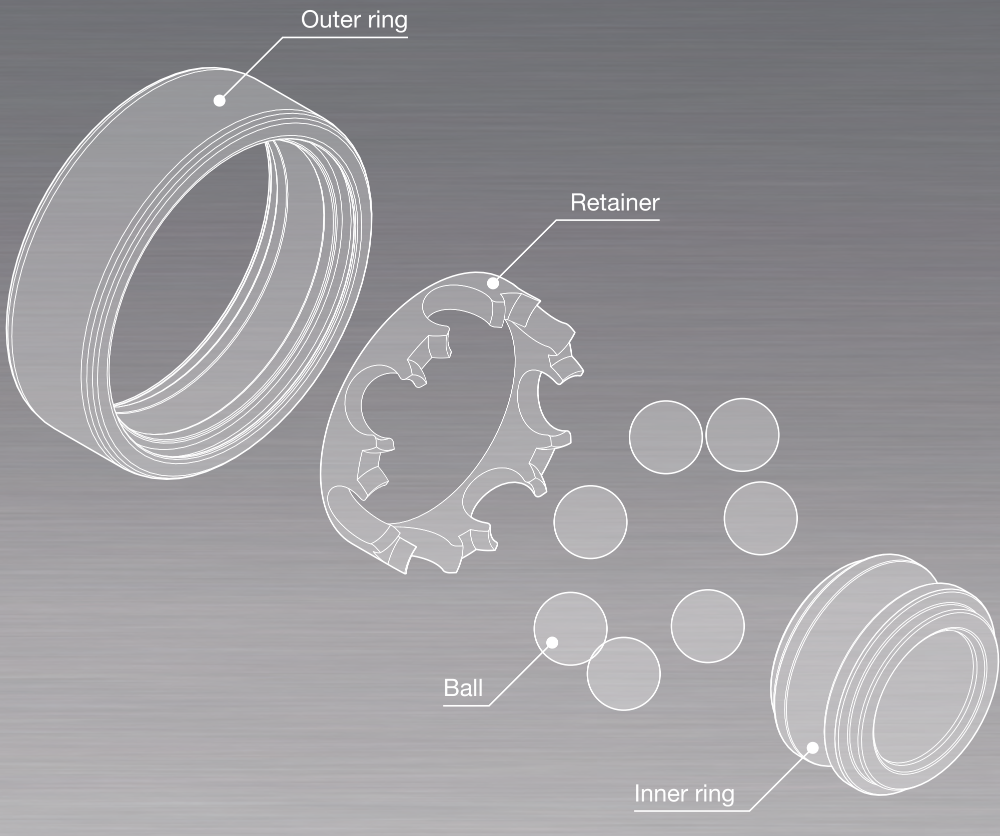
Notes upon Publication

In July 2021, MinebeaMitsumi celebrated the 70th anniversary of our founding and the 60th anniversary as a listed company.
We are grateful for the support of our customers which has enabled us to reach these milestones.
In July 1951, the company was founded as the first specialist miniature ball bearing manufacturer in Japan. During our seventy years of history, we have developed into an "integrated"* precision parts manufacturer with a globally unique product portfolio comprising everything from rolling ball bearings to motors, sensors, access parts, and semiconductors.
In particular, rolling ball bearings are an important mechanical element used in various products, growing more advanced and diverse in order to support smaller sizes, higher speed, lower noise, longer life, and special environments.
Elsewhere, in the carbon-neutral era, we believe in the importance of reducing CO_2 emissions through our products used by the assembly manufacturers who are our clients.
With an eye to this trend, we have begun an initiative in which the quality of miniature & small ball bearings will improve dramatically, as a new product strategy.
We are working toward product creation in which the use of our rolling ball bearings will lead to major reductions in CO_2 emissions.
It is hoped that this catalog will be useful in the selection of miniature & small ball bearings.

*Integration: We choose to spell the Japanese version of this word with the characters for "coming together mutually," referring to the melded use of our technologies as eight evolving strings to our bow, further integrating the products thus evolved to create new products in various fields.

Tireless pursuit of accuracy

Rolling ball bearing

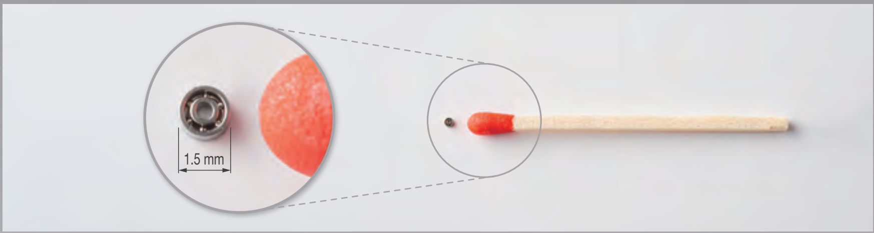


The key to performance improvement for rolling ball bearings is thoroughgoing enhancement of the accuracy of every part, including outer rings, inner rings, balls, retainers and so on.
MinebeaMitsumi manufactures every component within its Group, showing accuracy improvement in our products throughout over seventy years of rolling ball bearing manufacturing and product machining. The development of our in-house machine tools and maintenance technology pursues accuracy in all our products.

Ultra-precision machining technology realizes smaller, higher-efficiency products

Ultra-precision ▶ Outer diameter 1.5 mm

Successfully commercialized mass production of ultra-small steel ball bearings with an outer diameter of 1.5 mm (nominal size) *1. This achievement contributes to the further downsizing of products while demonstrating MinebeaMitsumi's advanced processing technology.



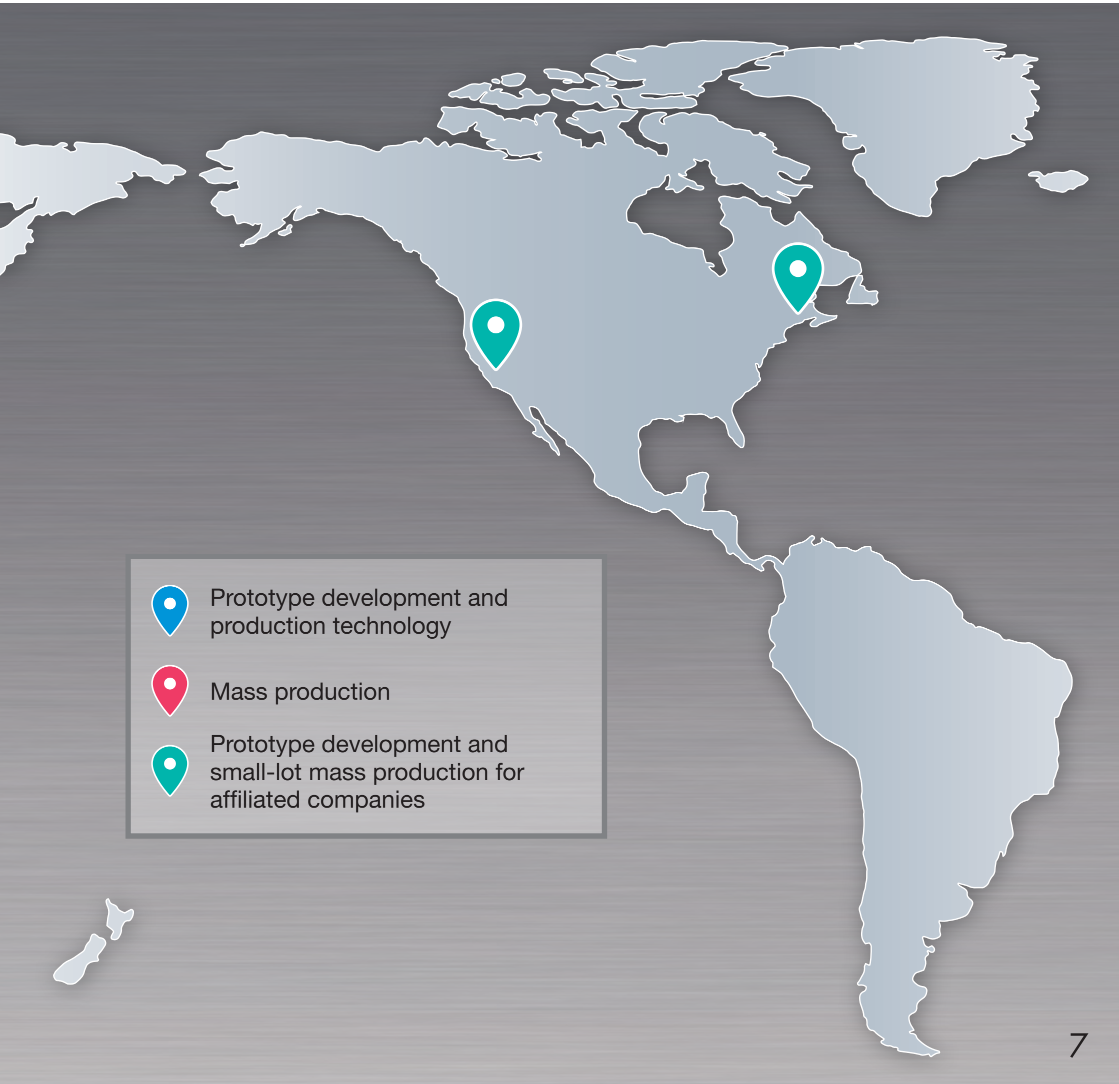
High efficiency ▶ Proven rotation time of over 24 minutes

Measured a rotation time of
24 minutes and 46.34 seconds
using a hand spinner equipped with specialized ball bearings, which apply our low-power consumption technology *2.

*1：As of August 2015. Based on in-house research of mass-produced steel ball bearings commercially available on the market.
*2：As of December 11, 2017. Verification results obtained under our in-house testing environment.

Toward the realization of stable supply

Some 99% of all production takes place at our overseas plants around the globe; every factory has an integrated production system established from parts machining to rolling ball bearing assembly, all done in-house.
This enables us to construct a large-scale mass production system based on quality control across all bases, realizing stable supply of rolling ball bearings.



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Warnings and Precautions

⚠ Warnings

■ No compensation will be provided for damage caused by products used for applications not to be predicted by MinebeaMitsumi.

■ When rolling ball bearings are modified or machined beyond MinebeaMitsumi's knowledge after manufacture, no compensation will be provided for damage caused by these rolling ball bearings or the products in which they are embedded.

■ No compensation will be provided for damage caused by changed usage conditions or device specifications without confirmation with Minebea Mitsumi after rolling ball bearing selection.

■ The products in this catalog are not manufactured for use with nuclear power-related devices. No compensation will be provided for damage caused by use for nuclear power-related applications.

⚠ Precautions

Bearing Selection

Consult MinebeaMitsumi in the following situations.

- Usage in environments involving high-speed rotation, high precision, high or low temperatures, high or low humidity, or high load.
- Usage in aircraft, space-related devices, public equipment related to electric power or gas, automobile/automotive-related products, shipping and distribution devices, vertical parking systems, lifts, medical devices, playground devices, or critical safety parts such as tools.
- Usage of resin in the rolling ball bearing's surrounding parts.

  *Depending on the type of resin, grease or oil may cause damage or deterioration to the resin parts.
- Electrical conduction through the rolling ball bearing.
- Usage in environments corrosive to metal (corrosive gases, steam, liquids).

Bearing Storage

Observe the following precautions with regard to storage, as the performance of rolling ball bearings will decline, leading to failures and damage, due to the adhesion or ingress of contamination, rust, or deteriorated grease.

- Avoid high-temperature, high-humidity environments. Even when packaged, do not place directly on concrete floors; in order to maintain ventilation, place on pallets or similar.
- Avoid environments corrosive to metal (corrosive gases, steam, liquids).
- Do not open the package carelessly. After unpackaging, repackage and store any unused parts. When unpackaging, wear rubber gloves or similar in order not to touch the product with bare hands.

Installing into Devices

Observe the following precautions when installing into devices, as scratches, indentation, or contamination in the bearing interior will lead to noise or shortened life.

- Do not apply excessive load when installing.
- Maintain a clean environment when installing.

Operation Testing

- After assembling the rolling ball bearing, conduct an operation test to make sure it rotates normally. During operation testing, gradually increase the rotation speed.
- If an abnormality is found during operation testing, immediately cease operation and inspect the product. Do not reuse rolling ball bearings in which an abnormality has been found.

Storage and Transport of Devices

Vibration applied to devices in which rolling ball bearings have been embedded will generate wear marks due to fine movement (fretting corrosion) in the bearing interior, leading to noise and shortened life. Impact load will also generate scratches or indentation in the bearing interior, leading to deterioration of the rolling ball bearing or shortened life. Therefore, observe the following precautions.

- Package devices with embedded rolling ball bearings so that vibration and impact from the exterior will be softened. Package rotating parts such as impellers so that they will not move.
- During transport, do not apply vibration or impact to the device.

Other

- As some shield type and seal type rolling ball bearings can only be lubricated with oil, confirm the lubricant type before purchase and usage.
- Some rolling ball bearings are applicable as export-restricted cargo under the Foreign Exchange and Foreign Trade Act of Japan. When exporting these restricted items, export permission from the Japanese Minister of Economy, Trade and Industry is required.
- The purchaser is asked to confirm whether the products in this catalog fall under this category or not.
- The Harmonized System code (HS code) for rolling ball bearings is 8482.10.
- Kindly note that while every effort has been made to attain accuracy within this catalog, MinebeaMitsumi bears no responsibility in the case of errata or omissions. The contents of this catalog may be changed without notice.

1 Technical Notes

1-1 Bearing Models

Bearing Models

The bearings manufactured by MinebeaMitsumi are mainly single-row deep groove ball bearings (below, bearings).
MinebeaMitsumi's bearings include, in addition to the open type, the shielded and sealed types, which suppress contamination ingress and grease leakage.
We also offer flanged deep groove ball bearings and deep groove ball bearings with locating snap ring, for easier mounting to housings as well as ultra-thin ball bearings, thrust ball bearings, special bearings and so on.

Deep groove ball bearings

Characteristics	The typical ball bearing. Receives axial load from both directions as well as radial load
Model	Open type, shielded, sealed
Dimensions	Metric design, inch design

Flanged deep groove ball bearings

Characteristics	Deep groove ball bearings with a flange on one side of the outer ring Positioning in the axial direction is easy when mounting to housings
Model	Open type, shielded, sealed
Dimensions	Metric design, inch design

*Standard bearing material is stainless steel

Deep groove ball bearings with locating snap ring

Characteristics	Deep groove ball bearings with a locating snap ring on one side of the outer ring Positioning in the axial direction is easy when mounting to housings
Model	Open type, shielded
Dimensions	Metric design *Standard bearing material is high-carbon chromium bearing steel

Ultra-thin ball bearings

Characteristics	Types with inner diameter larger than normal deep groove ball bearings compared to the outer diameter
Model	Open type, shielded
Dimensions	Metric design *Standard bearing material is stainless steel

Thrust ball bearings

Characteristics	Types receiving axial load
Model	With and without raceway groove
Dimensions	Metric design *Standard bearing material is stainless steel

1-1 Bearing Models

Bearing Models

Special bearings

MinebeaMitsumi also produces bearings with various shapes and functions in addition to those on the preceding pages.

- Bearings with O-ring

Characteristics	Types with rubber O-rings on the outer ring periphery

- Bearings with groove

Characteristics	Types with grooves on the outer ring periphery Shapes and dimensions such as U- and V-shapes can also be manufactured

- Eccentric bearings

Characteristics	Types with the inner ring inner diameter shifted away from the center, creating a cam effect

- Elastic bearings

Characteristics	Elastically deformed into oval shapes for use, through ultra-thin inner and outer rings Mainly used in strain wave reduction gear

- Cross roller bearings

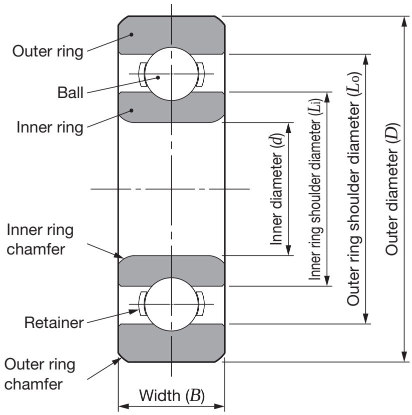
Characteristics	Bearings whose structure arranges adjacent cylindrical rollers orthogonally

Bearing Components and Names

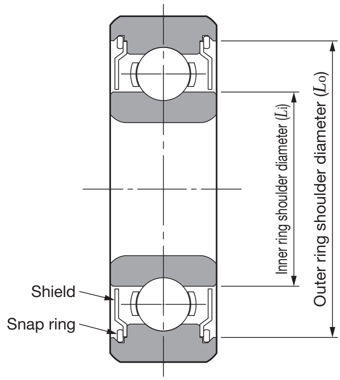
Bearings are composed of outer rings and inner ring (raceway rings), balls (rolling elements), and retainers.

The basic types include open bearings and shielded bearings, while other types include flanged bearings and bearings with locating snap rings.

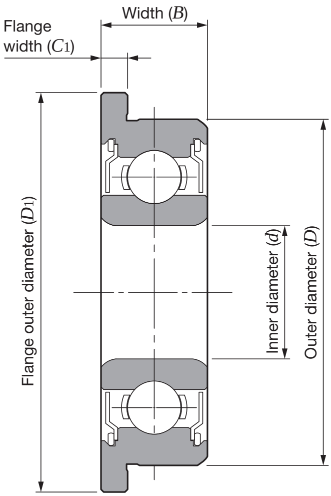
Part Names



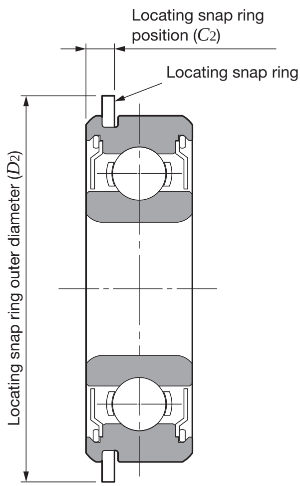
Basic type (open bearing)



Basic type (shielded bearing)



Flanged bearing



Bearing with locating snap ring

1-3 Part Numbers

Part numbers are composed of the model name and the specification name.
NMB part numbers are unique to MinebeaMitsumi. JIS part numbers refer to the nominal usage regulated by JIS B 1513.

NMB Part Numbers

Model name

Basic symbols

Material symbols		Series symbols		Dimension symbols	
Display example	DD	R-		1560	
No symbol	SUJ2 or equivalent bearing steel	Radial ball bearing (metric)		Metric design	
DD	Martensitic stainless steel	R- (RF-)	Thick type (flanged)	1560	Outer diameter 15 mm Inner diameter 6 mm
CE	Outer / Inner ring: SUJ2 or equivalent bearing steel Ball: Ceramic	L- (LF-)	Thin type (flanged)		
		A-	Ultra-thin type	Inch design	
		RNR-	Thick type with locating snap ring	418	Outer diameter 4/16" Inner diameter 1/8"
		LNR-	Thin type with locating snap ring		
		Radial ball bearing (inch)		Symbol	
		RI-	Inch type overall	X	Internal design symbols
		(R-)	*Used for some inch types		
		RIF-	Flanged type		
		Thrust ball bearings			
		T-	With/without raceway groove		
		Special types			
		AS-	Special shape type		

See p.30 for details

The outer and inner diameter dimensions are displayed.
When there are internal design differences within the basic number, they will be displayed at the end of the basic number.
Ex.: 1560X2
Outer diameter 15 mm
Inner diameter 6 mm
Internal design X2 type

Specification name

Class symbol		Clearance symbol		Lubricant symbol		Grease amount symbol	
Display example	P0	P25		LY121		L	
Metric dimension series		Radial clearance		Lubricant type		No symbol	25% ~ 35% (standard)
P0	JIS Class 0	P13	2.5 μm ~ 7.5 μm	LO	Oil	X	5% ~ 10%
P5	JIS Class 5	P24	5.0 μm ~ 10.0 μm	LG	Grease	L	10% ~ 15%
Inch dimension series		P25	5.0 μm ~ 12.5 μm	LY	Grease or oil	T	15% ~ 20%
A1	ABEC 1	P58	12.5 μm ~ 20.0 μm	LD	No lubricant	H	40% ~ 50%
A3	ABEC 3P					J	50% ~ 60%
A5	ABEC 5P						

See p.40 for details
See p.52 for details
See p.73 for details
See p.74 for details

Display method
The radial direction lower and upper limit dimensions are converted to inch figures for display.
Ex.: For radial clearance 5.0 μm ~ 12.5 μm,
conversion into inches yields
→ 0.0002" ~ 0.0005"
These figures are displayed as "P25".

Note 1: Grease amounts are shown as percentages of the interior volume.
Note 2: Grease amounts may be corrected for some miniature bearings.

Supplementary symbols					
Shield/seal symbols		Noise/special symbols		Retainer symbols	
ZZ		MT		R	
No symbol	Open type	MT	Low-noise motor specifications	R	Ribbon retainer (steel plate)
Steel plate shield		SD	Special design specifications	H	Crown retainer (steel plate)
Z	Steel plate shield (snap ring fixed)	W	Wider than standard type	MN	Resin retainer (polyamide/reinforced)
		Y	Narrower than standard type		
H	Steel plate shield				
K	Steel plate shield				
Rubber seal					
S	Rubber seal (non-contact type)				
D	Rubber seal (contact type)				

See p.32 for details

See p.33 for details

Indicated twice when mounting on both sides.
Ex.: ZZ, DD, etc.

Other resin materials are also available for resin retainers.

1-3 Part Numbers

JIS Part Numbers

Model name

Basic symbols					
Material symbols		Series symbols		Inner diameter symbols	
Display example	No symbol	60		8	
No symbol	SUJ2 or equivalent bearing steel	67	Single-row deep groove ball bearing	5	Inner diameter 5 mm
CE	Outer / Inner ring: SUJ2 or equivalent bearing steel Ball: Ceramic	68		6	Inner diameter 6 mm
		69		00	Inner diameter 10 mm
		60		01	Inner diameter 12 mm
		62		02	Inner diameter 15 mm
		63		03	Inner diameter 17 mm
		64		Symbol	
				X	Internal design symbols

See p.30 for details

When there are internal design differences within the basic number, they will be displayed at the end of the basic number.

Specification name

Clearance symbol		Noise symbol		Class symbol		Lubricant symbol	
Display example	M3	MT		P5		LY121	
Radial clearance		MT	Low-noise motor specifications	No symbol	JIS Class 0	Lubricant type	
M2	3 µm ~ 8 µm	SM	General specifications	P5	JIS Class 5	LO	Oil
M3	5 µm ~ 10 µm					LG	Grease
M4	8 µm ~ 13 µm					LY	Grease or oil
M5	13 µm ~ 20 µm					LD	No lubricant
M6	20 µm ~ 28 µm						
M9	27 µm ~ 32 µm						

See p.52 for details

See p.40 for details

See p.73 for details

	Supplementary symbols		
	Retainer symbols	Shield/seal symbols	Special symbols
	No symbol	**ZZ**	**NR**

No symbol	Ribbon retainer
MN	Resin retainer (polyamide/reinforced)

See p.33 for details

Other resin materials are also available for resin retainers.

No symbol	Open type
Steel plate shield	
Z	Steel plate shield
Rubber seal	
S	Rubber seal (non-contact type)
D	Rubber seal (contact type)

See p.32 for details

Indicated twice when mounting on both sides. Ex.: ZZ, DD, etc.

SD	Special design specifications
NR	Type with locating snap ring

	Grease amount symbol
	L

No symbol	25% ~ 35% (standard)
X	5% ~ 10%
L	10% ~ 15%
T	15% ~ 20%
H	40% ~ 50%
J	50% ~ 60%

See p.74 for details

1-3 Part Numbers

Arrays

Display examples are below.

NMB part number display example 1

R	-	8	30	X10	ZZ	SD10	MT	R	P5	P24	LO1
(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)

(1) Series symbol: Thick type
(2) Outer diameter: 8 mm
(3) Inner diameter: 3 mm
(4) Internal design X10 type
(5) Steel plate shield
(6) Special design specifications
(7) Low-noise motor use
(8) Ribbon retainer
(9) JIS Class 5
(10) Radial clearance: 5.0 μm ~ 10.0 μm
(11) Lubricant: LO1 (oil)

*Material: No symbol (SUJ2 or equivalent bearing steel)

NMB part number display example 2

DD	L	-	16	80	DD	MN	P5	P58	LY551
(1)	(2)		(3)	(4)	(5)	(6)	(7)	(8)	(9)

(1) Material: Stainless steel
(2) Series symbol: Thin type
(3) Outer diameter: 16 mm
(4) Inner diameter: 8 mm
(5) Rubber seal contact type
(6) Resin retainer
(7) JIS Class 5
(8) Radial clearance: 12.5 μm ~ 20.0 μm
(9) Lubricant: LY551 (grease)

*Grease amount symbol: No symbol (25% ~ 35%)

JIS part number display example

60	8	X10	MN	ZZ	M5	MT	LY121	H
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

(1) Series symbol
(2) Inner diameter: 8 mm
(3) Internal design X10 type
(4) Resin retainer
(5) Steel plate shield

(6) Radial clearance: 13 μm ~ 20 μm
(7) Low-noise motor specifications
(8) Lubricant: LY121 (grease)
(9) Grease amount symbol: H amount (40% ~ 50%)

*Material: No symbol (SUJ2 or equivalent bearing steel)
*Class: No symbol (JIS Class 0)

1-4 Bearing Selection

(1) Selection process

In order to select bearing models and specifications, it is essential to confirm the structure and dimensions of the device for embedding along with the operating environment and conditions and to clarify the required performance.
Below is an overview of the process of bearing examination and selection.

Operating conditions/ environment/ required performance

↓

Model selection

↓

Tolerance and class

↓

Performance examination

↓

Lubricant selection

Operating conditions/environment/required performance (p.28)

- Device structure and function
- Operating environment (temperature, humidity, vibration, powder, etc.)
- Load
- Shaft/housing dimensions and material
- Rotation speed, rotation precision, rotating ring
- Torque
- Noise
- Life
- Regulated substances
- Other special environments

Model selection

- Bearing material (p.30)
- Bearing dimensions (see dimension tables from p.85 on)
- Shield/seal structure (p.32)
- Retainer
- Rating load and life

Tolerance and class

- Tolerance and tolerance values
- Measurement methods

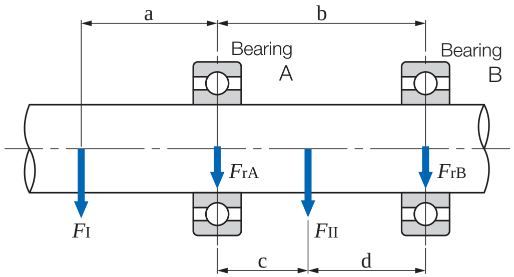
Performance examination

- Internal clearance
- Fits
- Shaft and housing design
- Preload
- Displacement
- Torque
- Vibration due to forced rotation
- Noise
- Combination with resin parts

Lubricants

Condition table: Use as reference when deciding on bearing models and specifications.

Ball Bearings operating condition table		
Application		
	Please check the appropriate box below if your application matches any of the following.	
	☐ Automotive ☐ Automotive (Safety-critical components) ☐ Aerospace ☐ Defense-related equipment ☐ Spacecraft / Space equipment	
	☐ Medical devices *For medical devices, please also check the boxes below.*	
	■ Medical Device Class: ☐ JP(PMDA Ⅰ, Ⅱ, Ⅲ, Ⅳ) ☐ US(FDA Ⅰ, Ⅱ, Ⅲ) ☐ EU(MDR Ⅰ, Ⅱa, Ⅱb, Ⅲ) ☐ CN(NMPA Ⅰ, Ⅱ, Ⅲ)	
	■ Category: ☐ Implant ☐ Surgical/Procedure ☐ Diagnostics ☐ Unknown	
Fit	Shaft	Inner diameter(for hollow shaft) Nominal dimension [mm]
		Outer diameter Nominal dimension [mm] Tolerance [mm]
		Material name
	Housing	Inner diameter Nominal dimension [mm] Tolerance [mm]
		Outer diameter Nominal dimension [mm]
		Material name
Material Properties	Shaft Material	Young's modulus [MPa] Poisson's ratio Coefficient of linear thermal expansion X10-6[1/℃]
	Housing Material	Young's modulus [MPa] Poisson's ratio Coefficient of linear thermal expansion X10-6[1/℃]
Operating Conditions for Evaluation	Radial load acting per bearing	[N] Axial load acting per bearing [N]
	Rotational speed	[min-1] Oscillation angle (for oscillatory motion) [deg.]
	Temperature environment	~ [deg. C]
	Required lifespan	[h]
	Other conditions	
Operating Conditions in Actual Use	Preload Method	☐ Constant pressure ☐ Constant position Preload Direction ☐ Face-to-face ☐ Back-to-back
	Rotational speed	[min-1] Oscillation angle (for oscillatory motion) [deg.]
	Rotating Ring	☐ Inner ring rotation ☐ Outer ring rotation
	Temperature environment	~ [deg. C]
	Resin material near the bearing	☐ Yes ☐ No *If "Yes", please specify the material name.*
	Other conditions	



FI	N (kgf)
FII	N (kgf)
a	mm
b	mm
c	mm
d	mm

(2) Structure of products in use / Functions required of bearings and

Among the bearings which are MinebeaMitsumi's main products are many series with standardized dimensions.
Select the optimal dimensions in order to fit the product to be used into the space allowable.
As well, select bearings with specifications suited to the functions required and the operating environment.

Structure of products in use / Functions required of bearings

• Structure and function of products in use

Work out based on the structure and function of the product in use the space usable for bearings, and decide on the bearing inner and outer diameters and width.

• Load

Decide on the bearing dimensions based on the size of the load applied and its position and direction.
If the size of the load applied to the bearing is too large, the product structure must be reconsidered (using a larger bearing, reducing the load, etc.).

• Shaft/housing dimensions and material

Decide on the inner and outer diameter and width of the bearing, and on its tolerance, based on the shaft and housing dimensions and material.
Take into account changes in the bearing internal clearance due to temperature change caused by differences in the linear expansion coefficients of the shaft and housing material and the bearing material.

• Rotation speed, rotation precision, rotating ring

Decide on the bearing dimensional tolerance, retainer, clearance, preload, lubricant, etc. based on the rotation speed, rotation conditions (continuous/intermittent/return rotation, inner ring rotation/outer ring rotation), and rotation precision.

• Torque

Torque, which includes starting torque and rotating torque, influences the motor current value required for bearing rotation.
In particular, when requirements include low power consumption, etc., the type and amount of lubricant require consideration.

• Noise

When the rotation noise of the bearing must be minimized, the noise properties of the bearing and lubricant require consideration. As well, attention must be paid to conditions around the bearing such as preload, unbalanced rotors, or resonance during bearing use.

usage environments

• Life

While the definition of life includes the rating life officially indicated in JIS B 1518, nothing else is universally determined, and it may be defined in various ways according to the usage application or individually required performance (degree of deterioration with regard to noise, torque, runout, etc.). Note that life in general may refer to rating life (material fatigue life), modified rating life, functional life (performance concerning noise, torque, vibration, etc.), lubrication life etc.

Operating environment

• Temperature, humidity, powder, external vibration, etc.

Decide on the bearing material, retainer, lubricant, etc. based on the expected upper and lower limit values of the operating environment temperature and humidity.
Decide on whether to select a shield or seal structure based on the presence of powder, and consider preload as well as lubricant type and amount based on external vibration conditions.

• Other special environments

For special operating environments, such as those with exposure to specific chemicals or gases or to salt water, those where bearings must not produce powder, or those where electricity is to be conducted within the bearing, consult MinebeaMitsumi.

(3) Materials

The inner ring, outer ring, and ball materials are important elements of the bearing, and their selection significantly affects bearing performance.

Ultra-high pressure of roughly 1,000 MPa or more is repeatedly applied to the bearing inner ring/outer ring and ball contact parts.
Because long life is required even under this repeated stress, the material type, cleanness, hardness, and so on are extremely important elements.
MinebeaMitsumi mainly uses high-carbon chromium bearing steel and highly corrosion-resistant martensitic stainless steel as raceway ring and ball materials.
For high-carbon chromium bearing steel, high-quality vacuum degassed high-carbon chromium bearing steel (JIS G 4805 SUJ2, SUJ2MD, AISI/SAE 52100) and its equivalents are used; quenching hardness enables excellent load resistance, life, and noise properties.
For stainless steel, MinebeaMitsumi's original DD400 is used. DD400 has higher quenching hardness than SUS440C, with excellent noise properties and load resistance; with regard to corrosion resistance, tests based on ASTM-A380 have shown results equivalent to those of SUS440C.
As well, we have developed the Giga Protection® Series for applications requiring extreme corrosion resistance, such as exposure to seawater or chemical liquids; compared to DD400, extremely high corrosion resistance is available.
Consult MinebeaMitsumi with questions about the Giga Protection® Series.

In order to respond to demands of recent years for long life and low noise, MinebeaMitsumi provides bearings using ceramic (silicon nitride). While using the conventional high-carbon chromium bearing steel or stainless steel for the raceway ring, the use of ceramic for the ball enables a balance of good noise performance and long life. As well, the almost total non-conductivity peculiar to silicon nitride is also effective as a measure against electric corrosion generated by conduction within the bearing.

Material properties

High-carbon chromium bearing steel

Standard	Symbol	Chemical composition (wt%)						
		C	Si	Mn	P	S	Cr	Mo
JIS G 4805	SUJ 2	0.95 ~ 1.10	0.15 ~ 0.35	0.50 or below	0.025 or below	0.025 or below	1.30 ~ 1.60	-
-	SUJ 2 MD	0.75 ~ 0.85	0.35 or below	0.50 or below	0.025 or below	0.025 or below	1.30 ~ 1.60	-
AISI/SAE	52100	0.98 ~ 1.05	0.15 ~ 0.35	0.25 ~ 0.45	0.025 or below	0.025 or below	1.35 ~ 1.60	-

Stainless steel

Standard	Symbol	Chemical composition (wt%)						
		C	Si	Mn	P	S	Cr	Mo
-	DD400	0.60 ~ 0.75	1.00 or below	1.00 or below	0.03 or below	0.02 or below	11.50 ~ 13.50	0.30 or below

1-4 Bearing Selection

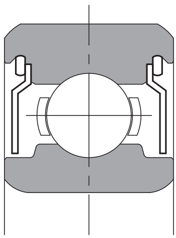
(4) Shields/seals

Compared to open bearings, shielded and sealed bearings suppress contamination ingress into the bearing and grease leakage.

Steel plate shield

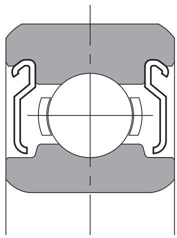
NMB part number: ZZ (snap ring fixed)

Structure with a steel plate shield fixed to the outer ring with a snap ring
No contact between the shield inner periphery and the inner ring outer periphery



NMB part number: KK or HH (outer ring fixed)
JIS part number: ZZ (outer ring fixed)

Structure with a steel plate shield directly fixed to the outer ring
No contact between the shield inner periphery and the inner ring outer periphery

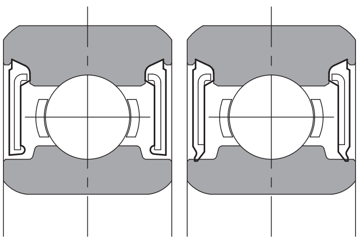


Rubber seal

NMB/JIS part number: SS and DD

Structure with a rubber seal directly fixed to the outer ring
Select no contact (SS) or contact (DD) between the seal and inner ring outer periphery
DD is airtight but has higher torque

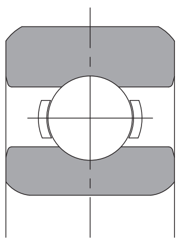
SS DD



Open type (open bearing)

NMB/JIS part number: No symbol

Structure without steel plate shield or rubber seal mounted
For miniature sizes, the shielded bearing may have different width dimensions



(5) Retainer

The role of the retainer is to keep the balls inside the bearing at even intervals.
Each model has a standard retainer type, but in some cases selection is possible in accordance with the required performance.

Ribbon retainer

NMB part number: R
JIS part number: No symbol

Composed of two parts made of press-molded steel plates.
At assembly, the balls are arranged as if clamped between two parts, with the claw on one part folded onto the other part; fixing with rivets is also possible.
General method frequently used

Crown retainer

NMB part number: H

Component made of a press-molded steel plate.
The difference between the retainer's inner and outer diameter can be decreased, for use in ultra-thin type ball bearings or miniature ball bearings.

Resin retainer

NMB/JIS part number: MN

Component molded and cut from resin.
Resins used include polyamides and polyacetal among others
Used for high-speed rotation and low-noise applications

(6) Rating load and life

Modern high-quality bearings, manufactured with high-quality bearing steel, have a rating life which can be calculated based on ISO281:2007 and JIS B 1518:2013.

Bearing life

The life required of bearings varies significantly depending on the device purpose and required content. This is because device usage is highly diverse, and the measurement scale for "life" varies widely. Therefore, a suitable life must be set with consideration for the purpose and required content.
Even when bearings are used under normal conditions, repetitive compression stress is generated on the raceway surface of the outer and inner rings and on the rolling surface of the rolling elements, leading to flaking* due to material fatigue and thus failure to meet specifications.
Bearing rating life is defined as the total number of rotations until flaking is generated, expressed as a predicted value based on the basic dynamic radial load rating.
As well as rating life, other definitions of life include noise life, lubrication life, and functional life.
Noise life refers to the time until the noise level required for the application or product is exceeded, lubrication life to the time until the lubricant deteriorates enough to fail to perform its function, and functional life to the time until functions such as rotation speed and runout exceed their settings and no longer meet requirements. In the bearings manufactured by MinebeaMitsumi, these definitions of life are sometimes even more important than the rating life.

This section provides an overview of the "basic rating life" and "modified rating life" of "radial ball bearings" as regulated in JIS B 1518:2013 and ISO281:2007, on which the JIS definition is based.

*Peeling or damage due to metal fatigue. See p.83 for photographs.

Basic dynamic radial load rating C_r

Defined as "a given stationary radial load which the bearing can theoretically withstand at the basic rating life of 1 million rotations." The calculation method is provided in JIS B 1518:2013. The basic dynamic radial load rating is indicated in the dimension tables.

Dynamic equivalent radial load P_r

Defined as "a given stationary radial load on the bearing at which life equivalent to the bearing life reached under actual load conditions can be achieved." The total radial and axial loads can be converted into stationary radial load with the formula and table below.

$$P_r = XF_r + YF_a$$

X, Y : Found in the table below.
F_r : Radial load (N)
F_a : Axial load (N)

Axial load ratio $\frac{F_a}{ZD_w^2}$ (N)	e	$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
		X	Y	X	Y
0.172	0.19	1	0	0.56	2.3
0.345	0.22				1.99
0.689	0.26				1.71
1.03	0.28				1.55
1.38	0.3				1.45
2.07	0.34				1.31
3.45	0.38				1.15
5.17	0.42				1.04
6.89	0.44				1

Z : Number of balls
D_w : Ball diameter (mm)

Note 1: Values for X, Y, and e which are not shown can be calculated with linear interpolation.
Note 2: This equation is for single-row bearings, so the double-row variable has been removed from the formula for axial load ratio regulated in JIS.

(6) Rating load and life

Basic rating life L_{10}

Defined as "rating life when reliability is 90% under normal operating conditions." This means the "total number of rotations possible without material peeling for 90% of a group of the same bearings operated under the same conditions."

Based on JIS B 1518:2013, it is calculated with the following formula.

$$L_{10} = \left(\frac{C_r}{P_r} \right)^3$$

L_{10} : Basic rating life (10^6 rotations)
C_r : Basic dynamic radial load rating (N)
P_r : Dynamic equivalent radial load (N)

The given number of rotations is normally expressed as time. Basic rating life and life time have the following relationship.

$$L_{10} = \left(\frac{10^6}{60 \cdot n} \right) \times \left(\frac{C_r}{P_r} \right)^3$$

L_{10} : Time (h)
n : Number of rotations (min^{-1})

Modified rating life L_{nm}

Basic rating life L_{10} has been used as the evaluation standard for bearing performance over many years; in recent years, however, in addition to life calculation at various reliability levels, there has been an increasing demand for life calculation reflecting actual status to some extent, taking into consideration lubrication performance, contamination status, etc.
Modern high-quality bearings are known to achieve extremely long lives compared to the basic rating life when in good operating status not exceeding certain conditions; on the other hand, poor operating conditions are known to shorten life. ISO281:2007 and JIS B 1518:2013 define life calculation for modified rating life taking into account the fluctuations and mutual effects of the factors that influence bearing life. The modified rating life damage probability n% is expressed with the following formula.

$$L_{nm} = \alpha_1 \alpha_{iso} L_{10}$$

α_1 : Reliability coefficient
α_{iso} : Modified life coefficient
L_{10} : Basic rating life

Reliability coefficient α_1

Reliability coefficients cover a range from 90% to 99.95%.
They are shown in the table at right.

Reliability (%)	L_{nm}	α_1
90	L_{10m}	1
95	L_{5m}	0.64
96	L_{4m}	0.55
97	L_{3m}	0.47
98	L_{2m}	0.37
99	L_{1m}	0.25
99.2	$L_{0.8m}$	0.22
99.4	$L_{0.6m}$	0.19
99.6	$L_{0.4m}$	0.16
99.8	$L_{0.2m}$	0.12
99.9	$L_{0.1m}$	0.093
99.92	$L_{0.08m}$	0.087
99.94	$L_{0.06m}$	0.080
99.95	$L_{0.05m}$	0.077

Life modification coefficient α_{iso}

This coefficient is derived from fatigue limit load, contamination coefficient, viscosity ratio, etc.
Modern high-quality bearing steel, with good lubrication, cleanliness, and other operating conditions, can achieve extremely long rating life under a given load. With the high-quality bearings generally in use, the contact stress on the rolling elements and raceway surface reaches fatigue limit stress at 1500 MPa, enabling the rating life to be achieved.
The following influences are considered as factors.

- Bearing model, fatigue limit load and bearing equivalent load
- Lubrication status (lubricant type, viscosity, bearing speed, bearing size, etc.)
- Operating environment (pollution class, seal)
- Contaminating particles during operation (bearing size, lubrication method, hardness, size, amount)
- Mounting (contamination cleanliness during assembly)

Expressed by $\alpha_{iso} = f\left(\dfrac{e_C\, C_u}{P}, \kappa\right)$.

(6) Rating load and life

• Fatigue limit load C_u

This means the load on the bearing which leads to fatigue limit stress at the maximum load contact part of the raceway. It depends on the bearing model, internal specifications, quality, and material strength; for generally used high-quality bearings, we recommend 1500 MPa as contact stress equivalent to C_u. (Fatigue limit stress: The maximum stress at which fatigue does not occur in the bearing material)

• Contamination coefficient e_c

If the lubricant is contaminated with solid particles, which enter between the raceway and the rolling elements, the raceway may be dented. This indentation leads to localized stress increase, shortening the rolling bearing life. This coefficient allows for this shortened life.

As an indicator, the following is excerpted from the regulations in JIS B 1518:2013.

Contamination coefficient e_c indicators

Contamination level	e_c
Extremely high cleanliness	1
High cleanliness	0.8 ~ 0.6
Standard cleanliness	0.6 ~ 0.5
Light contamination	0.5 ~ 0.3
Normal contamination	0.3 ~ 0.1
Serious contamination	0.1 ~ 0
Extreme contamination	0

• Viscosity ratio κ

Expresses the separation status of the lubricant from the rolling contact surface, as a ratio of the oil viscosity at actual operating temperatures to the reference viscosity.

Note: When calculating modified rating life, various restrictions apply; in addition, the calculation may not be entirely applicable to miniature bearings. Because of the complex conditions which must be confirmed, involving numerous factors including device design, usage application, operating environment and so on, the calculation results must be handled with sufficient foresight and verification.

Bearing basic static radial load rating and static equivalent radial load are regulated in JIS B 1519 "Static load ratings for rolling ball bearings."

Basic static radial load rating C_{0r}

Defined as "the static load at which the calculated contact stress is 4200 MPa at the contact center of a ball and raceway at maximum load." The total permanent deformation of the ball and raceway under this contact stress is roughly 0.0001 of the ball diameter. The basic static radial load rating is indicated in the dimension tables.

Static equivalent radial load P_{0r}

Static equivalent radial load is defined as "the static radial load which generates contact stress equal to the contact stress generated under actual load conditions at the contact center of the ball and raceway under maximum load."

The larger value calculated with the following formula is used.

$$P_{0r} = X_0 F_r + Y_0 F_a$$
$$P_{0r} = F_r$$

X_0, Y_0: from JIS B 1519

Deep groove ball bearing coefficient $X_0 = 0.6$, $Y_0 = 0.5$

F_r : Radial load (N)
F_a: Axial load (N)

Load distribution to bearings

Considering the shaft system as static tension supported by bearings, distribute the load acting on it among the bearings.
For example, in Fig. 6-1, the radial load on bearings A and B can be simply expressed by formulas (1) and (2).

(1) $$F_{rA} = \frac{a+b}{b} \times F_{I} + \frac{d}{c+d} F_{II}$$

(1) $$F_{rB} = -\frac{a}{b} \times F_{I} + \frac{c}{c+d} F_{II}$$

F_{rA} : Radial load (N) on bearing A
F_{rB} : Radial load (N) on bearing B
F_{I}, F_{II} : Radial load (N) on the shaft system

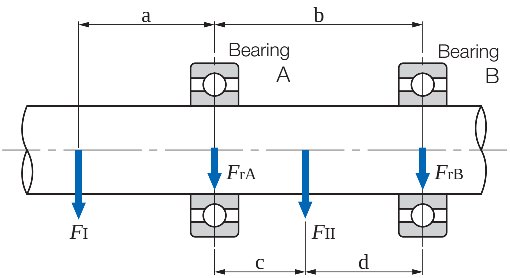


Fig. 6-1

(7) Tolerance and class

Bearings belong to classes, for which the tolerances and tolerance values are regulated by JIS and ABMA.
MinebeaMitsumi uses the regulations in JIS B 1514-1 and -3 and ABMA 12.2 and 20.
The main symbols used in the standards are as below.

Tolerance and tolerance values

*Symbols regulated in JIS B 0124

Quantifiers concerning bearing, raceway ring, and starting plate dimensions and dimensional deviations

Nominal dimension symbol*	Property symbol*	Description
d Nominal inner diameter	$t_{\Delta dmp}$	Dimensional deviation between the inner diameter intermediate size (obtained via two-point measurement) and the nominal dimension in an arbitrary lateral cross-section
	$t_{\Delta ds}$	Dimensional deviation of the two-point distance of a cylindrical hole and the nominal dimension
	t_{Vdsp}	Difference between maximum and minimum values of the two-point distance of the inner diameter in an arbitrary lateral cross-section of a cylindrical hole (range size)
	t_{Vdmp}	Difference between maximum and minimum values of the inner diameter intermediate size (obtained via two-point measurement) in multiple arbitrary lateral cross-sections of a cylindrical hole (range size)
B Nominal inner ring width	$t_{\Delta Bs}$	Dimensional deviation of the two-point distance of the inner ring width and the nominal dimension
	t_{VBs}	Difference between maximum and minimum values of the two-point distance of the inner ring width (range size)
D Nominal outer diameter	$t_{\Delta Dmp}$	Dimensional deviation between the outer diameter intermediate size (obtained via two-point measurement) and the nominal dimension in arbitrary lateral cross-sections
	$t_{\Delta Ds}$	Dimensional deviation of the two-point distance of the outer diameter and the nominal dimension
	t_{VDsp}	Difference between maximum and minimum values of the two-point distance of the outer diameter in an arbitrary lateral cross-section (range size)
	t_{VDmp}	Difference between maximum and minimum values of the outer diameter intermediate size (obtained via two-point measurement) in multiple arbitrary lateral cross-sections (range size)
D_1 Nominal outer diameter of the outer ring flange	$t_{\Delta D1s}$	Dimensional deviation of the two-point distance of the outer ring flange outer diameter and the nominal dimension

Nominal dimension symbol*	Property symbol*	Description
C Nominal outer ring width	$t_{\Delta Cs}$	Dimensional deviation of the two-point distance of the outer ring width and the nominal dimension
	t_{VCs}	Difference between maximum and minimum values of the two-point distance of the outer ring width (range size)
$C1$ Outer ring nominal flange width	$t_{\Delta C1s}$	Dimensional deviation of the two-point distance of the outer ring flange width and the nominal dimension
	t_{VC1s}	Difference between maximum and minimum values of the two-point distance of the outer ring flange width (range size)
r_s Actual measured chamfer dimensions of inner ring and outer ring	$r_{s\,min}$	r_s minimum value
	$r_{s\,max}$	r_s maximum value

Quantifiers concerning bearing, raceway ring, and starting plate peripheral runout

Property symbol*	Description
t_{Sd}	Inner ring side axial peripheral runout against the datum axis line derived from the inner ring inner diameter
t_{SD}	Outer ring outer diameter center line perpendicularity against the datum plane derived from the outer ring side
t_{Sea}	Bearing assembly part outer ring side axial peripheral runout against the datum axis line derived from the inner ring inner diameter
t_{Sea1}	Bearing assembly part outer ring flange back axial peripheral runout against the datum axis line derived from the inner ring inner diameter
t_{Sia}	Bearing assembly part inner ring side axial peripheral runout against the datum axis line derived from the outer ring outer diameter
t_{Kea}	Bearing assembly part outer ring outer diameter radial peripheral runout against the datum axis line derived from the inner ring inner diameter
t_{Kia}	Bearing assembly part inner ring inner diameter radial peripheral runout against the datum axis line derived from the outer ring outer diameter

Note: "Intermediate size" refers to the average of the maximum and minimum values obtained from multiple measurements between two points.

(7) Tolerance and class

Excerpted from JIS B 1514-1

Tolerances and tolerance values for class 0 radial bearing inner rings

(Unit: μm)

d (mm) Over	d (mm) Up to	$t_{\Delta dmp}$ U	$t_{\Delta dmp}$ L	t_{Vdsp} Diameter series 9	t_{Vdsp} Diameter series 0, 1	t_{Vdsp} Diameter series 2, 3, 4	t_{Vdmp}	t_{Kia}	$t_{\Delta Bs}$ Single-row bearing U	$t_{\Delta Bs}$ Single-row bearing L	t_{VBs}
-	0.6	0	- 8	10	8	6	6	10	0	- 40	12
0.6	2.5	0	- 8	10	8	6	6	10	0	- 40	12
2.5	10	0	- 8	10	8	6	6	10	0	-120	15
10	18	0	- 8	10	8	6	6	10	0	-120	20
18	30	0	-10	13	10	8	8	13	0	-120	20
30	50	0	-12	15	12	9	9	15	0	120	20
50	80	0	-15	19	19	11	11	20	0	-150	25

Tolerances and tolerance values for class 0 radial bearing outer rings

(Unit: μm)

D (mm) Over	D (mm) Up to	$t_{\Delta Dmp}$ U	$t_{\Delta Dmp}$ L	t_{VDsp}*1 Open bearing Diameter series 9	t_{VDsp}*1 Open bearing Diameter series 0, 1	t_{VDsp}*1 Open bearing Diameter series 2, 3, 4	t_{VDsp}*1 Sealed bearing / Shielded bearing Diameter series 2, 3, 4	t_{VDmp}*1	t_{Kea}	$t_{\Delta Cs}$ / $t_{\Delta C1s}$*2*3 U	$t_{\Delta Cs}$ / $t_{\Delta C1s}$*2*3 L	t_{VCs} / t_{VC1s}*2
-	2.5	0	- 8	10	8	6	10	6	15	0	- 40	12
2.5	6	0	- 8	10	8	6	10	6	15	0	- 40	12
6	18	0	- 8	10	8	6	10	6	15	0	-120	15
18	30	0	- 9	12	9	7	12	7	15	0	-120	20
30	50	0	-11	14	11	8	16	8	20	0	-120	20
50	80	0	-13	16	13	10	20	10	25	0	120	20

*1: Applicable when a locating snap ring is not mounted.
*2: Applicable to groove ball bearings such as deep groove ball bearings and angular ball bearings.
Tolerances for outer ring flange outer diameter D_1 are shown in a separate table.
*3: MinebeaMitsumi regulates the inner ring width $t_{\Delta Bs}$ and outer ring width $t_{\Delta Cs}$ based on the nominal inner diameter d.

Tolerances and tolerance values for class 5 radial bearing inner rings

(Unit: μm)

d (mm)		$t_{\Delta dmp}$		t_{Vdsp}			t_{Vdmp}	t_{Kia}	t_{Sd}	t_{Sia} *1	$t_{\Delta Bs}$		t_{VBs}
				Diameter series							Single-row bearing		
Over	Up to	U	L	9	0, 1	2, 3, 4					U	L	
-	0.6	0	-5	5	4	4	3	4	7	7	0	- 40	5
0.6	2.5	0	-5	5	4	4	3	4	7	7	0	- 40	5
2.5	10	0	-5	5	4	4	3	4	7	7	0	- 40	5
10	18	0	-5	5	4	4	3	4	7	7	0	- 80	5
18	30	0	-6	6	5	5	3	4	8	8	0	-120	5
30	50	0	-8	8	6	6	4	5	8	8	0	-120	5
50	80	0	-9	9	7	7	5	5	8	8	0	-150	6

*1: Applicable to groove ball bearings such as deep groove ball bearings and angular ball bearings.

Tolerances and tolerance values for class 5 radial bearing outer rings

(Unit: μm)

D (mm)		$t_{\Delta Dmp}$		t_{VDsp} *2*3			t_{VDmp} *3	t_{Kea}	t_{SD} *4*6 t_{SD1} *5*6	t_{Sea} *4*5	t_{Sea1} *5	$t_{\Delta Cs}$ $t_{\Delta C1s}$ *5*7		t_{VCs} t_{VC1s} *5
				Diameter series										
Over	Up to	U	L	9	0, 1	2, 3, 4						U	L	
-	2.5	0	-5	5	4	4	3	5	4	8	11	0	- 40	5
2.5	6	0	-5	5	4	4	3	5	4	8	11	0	- 40	5
6	18	0	-5	5	4	4	3	5	4	8	11	0	- 40	5
18	30	0	-6	6	5	5	3	6	4	8	11	0	- 80	5
30	50	0	-7	7	5	5	4	7	4	8	11	0	-120	5
50	80	0	-9	9	7	7	5	8	4	10	14	0	-120	6

*2: Not applicable to sealed or shielded bearings.
*3: Applicable when a locating snap ring is not mounted.
*4: Not applicable to flanged outer rings.
*5: Applicable to groove ball bearings such as deep groove ball bearings and angular ball bearings.
*6: SD and $SD1$ in this standard are regulated as the perpendicularity of the outer ring outer diameter center line against the datum plane based on the outer ring side or outer ring flange back: therefore, this tolerance value is half of the value in the old standard.
Tolerances for outer ring flange outer diameter D_1 are shown in a separate table.
*7: MinebeaMitsumi regulates the inner ring width $t_{\Delta Bs}$ and outer ring width $t_{\Delta Cs}$ based on the nominal inner diameter d.

(7) Tolerance and class

Tolerances and tolerance values for class 6 radial bearing inner rings

(Unit: μm)

d (mm)		$t_{\Delta dmp}$		t_{Vdsp}			t_{Vdmp}	t_{Kia}	$t_{\Delta Bs}$		t_{VBs}
				Diameter series					Single-row bearing		
Over	Up to	U	L	9	0, 1	2, 3, 4			U	L	
-	0.6	0	-7	9	7	5	5	5	0	- 40	12
0.6	2.5	0	-7	9	7	5	5	5	0	- 40	12
2.5	10	0	-7	9	7	5	5	6	0	-120	15
10	18	0	-7	9	7	5	5	7	0	-120	20
18	30	0	-8	10	8	6	6	8	0	-120	20
30	50	0	-10	13	10	8	8	10	0	-120	20
50	80	0	-12	15	15	9	9	10	0	-150	25

Tolerances and tolerance values for class 6 radial bearing outer rings

(Unit: μm)

D (mm)		$t_{\Delta Dmp}$		t_{VDsp} *1				t_{VDmp} *1	t_{Kea}	$t_{\Delta Cs}$ $t_{\Delta C1s}$ *2*3		t_{VCs} t_{VC1s} *2
				Open bearing			Sealed bearing / Shielded bearing					
				Diameter series								
Over	Up to	U	L	9	0, 1	2, 3, 4	2, 3, 4			U	L	
-	2.5	0	-7	9	7	5	9	5	8	0	- 40	12
2.5	6	0	-7	9	7	5	9	5	8	0	- 40	12
6	18	0	-7	9	7	5	9	5	8	0	-120	15
18	30	0	-8	10	8	6	10	6	9	0	-120	20
30	50	0	-9	11	9	7	13	7	10	0	-120	20
50	80	0	-11	14	11	8	16	8	13	0	-120	20

*1: Applicable when a locating snap ring is not mounted.
*2: Applicable to groove ball bearings such as deep groove ball bearings and angular ball bearings.
Tolerances for outer ring flange outer diameter D_1 are shown in a separate table.
*3: MinebeaMitsumi regulates the inner ring width $t_{\Delta Bs}$ and outer ring width $t_{\Delta Cs}$ based on the nominal inner diameter d.

Tolerances and tolerance values for class 4 radial bearing inner rings

(Unit: μm)

d (mm)		$t_{\Delta dmp}$ *1 $t_{\Delta ds}$ *2		t_{Vdsp} Diameter series			t_{Vdmp}	t_{Kia}	t_{Sd}	t_{Sia} *3	$t_{\Delta Bs}$ Single-row bearing		t_{VBs}
Over	Up to	U	L	9	0, 1	2, 3, 4					U	L	
-	0.6	0	-4	4	3	3	2	2.5	3	3	0	- 40	2.5
0.6	2.5	0	-4	4	3	3	2	2.5	3	3	0	- 40	2.5
2.5	10	0	-4	4	3	3	2	2.5	3	3	0	- 40	2.5
10	18	0	-4	4	3	3	2	2.5	3	3	0	- 80	2.5
18	30	0	-5	5	4	4	2.5	3	4	4	0	-120	2.5
30	50	0	-6	6	5	5	3	4	4	4	0	-120	3
50	80	0	-7	7	5	5	3.5	4	5	5	0	-150	4

*1: These tolerances are applicable to diameter series 7, 8, and 9.
*2: These tolerances are applicable to diameter series 0, 1, 2, 3, and 4.
*3: Applicable to groove ball bearings such as deep groove ball bearings and angular ball bearings.

Tolerances and tolerance values for class 4 radial bearing outer rings

(Unit: μm)

D (mm)		$t_{\Delta Dmp}$ *4 $t_{\Delta Ds}$ *5		t_{VDsp} *6*7 Diameter series			t_{VDmp} *7	t_{Kea}	t_{SD} *8*9 t_{SD1} *9*10	t_{Sea} *8*10	t_{Sea1} *10	$t_{\Delta Cs}$ $t_{\Delta C1s}$ *10*11		t_{VCs} t_{VC1s} *10
Over	Up to	U	L	9	0, 1	2, 3, 4						U	L	
-	2.5	0	-4	4	3	3	2	3	2	5	7	0	- 40	2.5
2.5	6	0	-4	4	3	3	2	3	2	5	7	0	- 40	2.5
6	18	0	-4	4	3	3	2	3	2	5	7	0	- 40	2.5
18	30	0	-5	5	4	4	2.5	4	2	5	7	0	- 80	2.5
30	50	0	-6	6	5	5	3	5	2	5	7	0	-120	2.5
50	80	0	-7	7	5	5	3.5	5	2	5	7	0	-120	3

*4: These tolerances are applicable to diameter series 7, 8, and 9.
*5: These tolerances are applicable to diameter series 0, 1, 2, 3, and 4.
*6: Not applicable to sealed or shielded bearings.
*7: Applicable when a locating snap ring is not mounted.
*8: Not applicable to flanged outer rings.
*9: SD and $SD1$ in this standard are regulated as the perpendicularity of the outer ring outer diameter center line against the datum plane based on the outer ring side or outer ring flange back: therefore, this tolerance value is half of the value in the old standard.
*10: Applicable to groove ball bearings such as deep groove ball bearings and angular ball bearings.
Tolerances for outer ring flange outer diameter D_1 are shown in a separate table.
*11: MinebeaMitsumi regulates the inner ring width $t_{\Delta Bs}$ and outer ring width $t_{\Delta Cs}$ based on the nominal inner diameter d.

1-4 Bearing Selection

(7) Tolerance and class

Tolerances and tolerance values for class 2 radial bearing inner rings

(Unit: μm)

d (mm)		$t_{\Delta dmp}$ *1 $t_{\Delta ds}$ *2		t_{Vdsp} *2	t_{Vdmp}	t_{Kia}	t_{Sd}	t_{Sia} *3	$t_{\Delta Bs}$ Single-row bearing		t_{VBs}
Over	Up to	U	L						U	L	
-	0.6	0	-2.5	2.5	1.5	1.5	1.5	1.5	0	- 40	1.5
0.6	2.5	0	-2.5	2.5	1.5	1.5	1.5	1.5	0	- 40	1.5
2.5	10	0	-2.5	2.5	1.5	1.5	1.5	1.5	0	- 40	1.5
10	18	0	-2.5	2.5	1.5	1.5	1.5	1.5	0	- 80	1.5
18	30	0	-2.5	2.5	1.5	2.5	1.5	2.5	0	-120	1.5
30	50	0	-2.5	2.5	1.5	2.5	1.5	2.5	0	-120	1.5
50	80	0	-4	4	2	2.5	1.5	2.5	0	-150	1.5

*1: These tolerances are applicable to diameter series 7, 8, and 9.
*2: These tolerances are applicable to diameter series 0, 1, 2, 3, and 4.
*3: Applicable to groove ball bearings such as deep groove ball bearings and angular ball bearings.

Tolerances and tolerance values for class 2 radial bearing outer rings

(Unit: μm)

D (mm)		$t_{\Delta Dmp}$ *4 $t_{\Delta Ds}$ *5		t_{VDsp} *5*6*7	t_{VDmp} *7	t_{Kea}	t_{SD} *8*9 t_{SD1} *9*10	t_{Sea} *8*10	t_{Sea1} *10	$t_{\Delta Cs}$ $t_{\Delta C1s}$ *10*11		t_{VCs} t_{VC1s} *10
Over	Up to	U	L							U	L	
-	2.5	0	-2.5	2.5	1.5	1.5	0.75	1.5	3	0	- 40	1.5
2.5	6	0	-2.5	2.5	1.5	1.5	0.75	1.5	3	0	- 40	1.5
6	18	0	-2.5	2.5	1.5	1.5	0.75	1.5	3	0	- 40	1.5
18	30	0	-4	4	2	2.5	0.75	2.5	4	0	- 80	1.5
30	50	0	-4	4	2	2.5	0.75	2.5	4	0	-120	1.5
50	80	0	-4	4	2	4	0.75	4	6	0	-120	1.5

*4: These tolerances are applicable to diameter series 7, 8, and 9.
*5: These tolerances are applicable to diameter series 0, 1, 2, 3, and 4.
*6: Not applicable to sealed or shielded bearings.
*7: Applicable when a locating snap ring is not mounted.
*8: Not applicable to flanged outer rings.
*9: SD and $SD1$ in this standard are regulated as the perpendicularity of the outer ring outer diameter center line against the datum plane based on the outer ring side or outer ring flange back: therefore, this tolerance value is half of the value in the old standard.
*10: Applicable to groove ball bearings such as deep groove ball bearings and angular ball bearings.
Tolerances for outer ring flange outer diameter D_1 are shown in a separate table.
*11: MinebeaMitsumi regulates the inner ring width $t_{\Delta Bs}$ and outer ring width $t_{\Delta Cs}$ based on the nominal inner diameter d.

Note: Bearings manufactured in this grade are cargo subject to export control under the Foreign Exchange and Foreign Trade Act of Japan. When exporting or re-exporting, please comply with relevant laws and regulations and obtain necessary licenses. For details, please check the website of the Ministry of Economy, Trade and Industry (METI) of Japan or contact our Export Control Department

Flange outer diameter tolerance

(Unit: μm)

D_1 (mm)		$t_{\Delta D1s}$			
		Positioning flange		Non-positioning flange	
Over	Up to	U	L	U	L
-	6	0	-36	220	-36
6	10	0	-36	220	-36
10	18	0	-43	270	-43
18	30	0	-52	330	-52
30	50	0	-62	390	-62
50	80	0	-74	460	-74
80	120	0	-87	540	-87

Excerpted from JIS B 1514-3

Chamfering

(Unit: mm)

$r_{s\,min}$	d		$r_{s\,max}$ *1	
	Over	Up to	Radial direction	Axial direction
0.05	-	-	0.1	0.2
0.08	-	-	0.16	0.3
0.1	-	-	0.2	0.4
0.15	-	-	0.3	0.6
0.2	-	-	0.5	0.8
0.3	-	40	0.6	1
	40	-	0.8	1
0.6	-	40	1	2
	40	-	1.3	2
1	-	50	1.5	3
	50	-	1.9	3
1.1	-	120	2	3.5
	120	-	2.5	4

*1: The value $r_{s\,max}$ in the axial direction of bearings with nominal raceway ring width of 2 mm or below is the same as the value in the radial direction.
Note: These chamfer dimensions are not regulated in JIS B 1512.

Remarks: The accurate shape of the chamfer dimensions is not regulated, but its outline in the axial dimension must not go beyond the virtual arc with radius $r_{s\,min}$ contacting the inner ring side and bearing inner diameter surface, or the outer ring side and bearing outer diameter surface (refer to fig. 7-1).

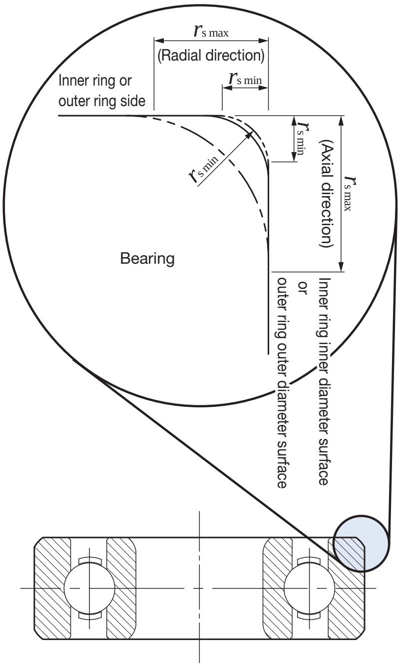


Fig. 7-1

(7) Tolerance and class

Excerpted from ABMA 20

Inner ring tolerance and tolerance values

(Unit: μm)

Class ABEC	d (mm)		$t_{\Delta dmp}$		t_{Kia}	t_{Sia}	$t_{\Delta Bs}$		t_{VBs}
	Over	Up to	Upper limit	Lower limit	Maximum	Maximum	Upper limit	Lower limit	Maximum
1	-	18	0	-8	10	15*1 20	0 0	-40*1 -120	12*1 15*2 20

*1: Applies when inner diameter is between 0.6 mm and 2.5 mm.
*2: Applies when inner diameter is 10 mm or below.
Note 1: MinebeaMitsumi treats ABEC-1 as JIS Class 0.

Outer ring tolerance and tolerance values

(Unit: μm)

Class ABEC	D (mm)		$t_{\Delta Dmp}$		t_{Kea}	t_{Sea}	$t_{\Delta Cs}$ $t_{\Delta C1s}$		t_{VCs} t_{VC1s}
	Over	Up to	Upper limit	Lower limit	Maximum	Maximum	Upper limit	Lower limit	Maximum
1	-	30	0	-8*3 -9	15	15*4 20*3 25	0	-40*5 -120	12*5 15*6 20

*3: Applies when outer diameter is 18 mm or below.
*4: Applies when outer diameter is 6 mm or below.
*5: Applies when inner diameter is 2.5 mm or below.
*6: Applies when inner diameter is 10 mm or below.
Note 2: MinebeaMitsumi treats ABEC-1 as JIS Class 0.

Excerpted from ABMA 12.2

Inner ring tolerance and tolerance values

(Unit: μm)

Class ABEC	d (mm)		$t_{\Delta dmp}$ *1		$t_{\Delta ds}$		t_{Ki}	t_{Sdi}	t_{Si}	$t_{\Delta Bs}$		t_{VBs}
	Over	Up to	Upper limit	Lower limit	Upper limit	Lower limit	Maximum	Maximum	Maximum	Upper limit	Lower limit	Maximum
3P	-	18	0	-5.1	+2.5	-7.6	5.1*2 7.6	-	-	0	-127	-
5P	-	18	0	-5.1	0	-5.1	3.8	7.6	7.6	0	- 25.4	5.1
7P	-	18	0	-5.1	0	-5.1	2.5	2.5	2.5	0	- 25.4	2.5
9P	-	18	0	-2.5	0	-2.5	1.3	1.3	1.3	0	- 25.4	1.3

*1: Class 3P is normally regulated with Δ_{dm}.
*2: Applies when inner diameter is 10 mm or below.

Outer ring tolerance and tolerance values

(Unit: μm)

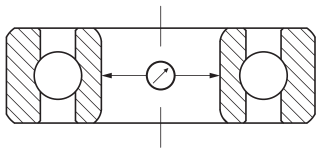
Class ABEC	D (mm)		$t_{\Delta Dmp}$ *3		$t_{\Delta Ds}$ Open bearing		$t_{\Delta Ds}$ Sealed bearing / Shielded bearing		t_{Ke}	t_{SD}	t_{Se}	$t_{\Delta Cs}$		t_{VCs}
	Over	Up to	Upper limit	Lower limit	Upper limit	Lower limit	Upper limit	Lower limit	Maximum	Maximum	Maximum	Upper limit	Lower limit	Maximum
3P	-	30	0	-7.6	+2.5	-10.2	+5.1	-12.7	10.2	-	-	0	-127	-
5P	-	30	0	-5.1	0	- 5.1	+1	- 6.1	5.1	7.6	7.6	0	- 25.4	5.1
7P	-	30	0	-5.1	0	- 5.1	+1	- 6.1	3.8	3.8	5.1	0	- 25.4	2.5
9P	-	30	0	-2.5*4 -3.8	0	- 2.5*4 - 3.8	-	-	1.3*4 2.5	1.3	1.3*4 2.5	0	- 25.4	1.3

*3: Class 3P is normally regulated with Δ_{dm}.
*4: Applies when outer diameter is 18 mm or below.

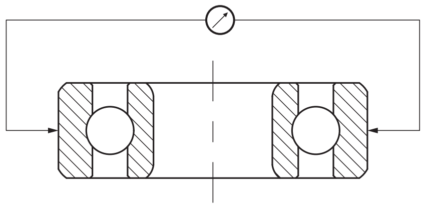
(8) Measurement methods

The general principles of verification for bearing dimensions and runout are regulated in JIS B 1515-2.
An overview of measurement methods for the actual measured dimensions and runout is below.

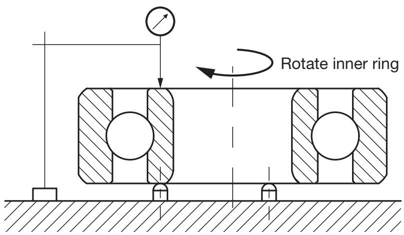
Dimensions



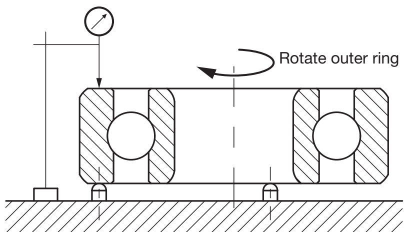
Measure within the radial plane, changing the angle.
Fig. 8-1 Actual measured inner diameter (d_s)



Measure within the radial plane, changing the angle.
Fig. 8-2 Actual measured outer diameter (D_s)

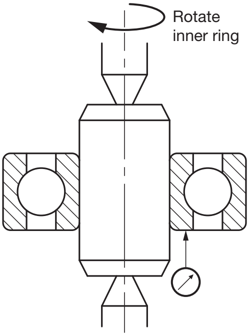


Rotate the inner ring once and measure.
Fig. 8-3 Actual measured inner ring width (B_s)



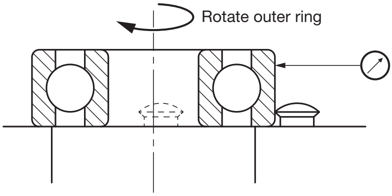
Rotate the outer ring once and measure.
Fig. 8-4 Actual measured outer ring width (C_s)

Runout



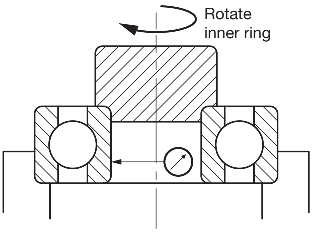
Read the indicator while rotating the inner ring once.

Fig. 8-5 Perpendicularity of the inner ring side against the inner diameter axis (S_d)



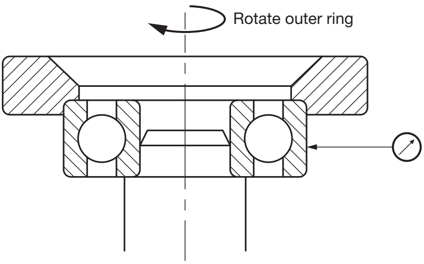
Read the indicator while rotating the outer ring once.

Fig. 8-6 Perpendicularity of the outer ring outer diameter side against the side (S_D)



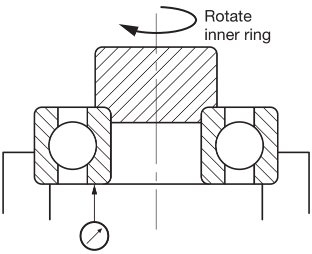
Apply load to the inner ring and read the indicator while rotating once.

Fig. 8-7 Inner ring radial runout (K_{ia})



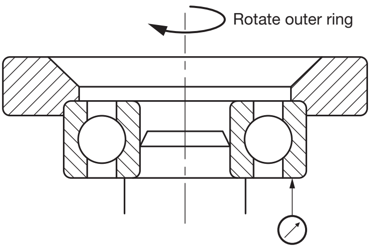
Apply load to the outer ring and read the indicator while rotating once.

Fig. 8-8 Outer ring radial runout (K_{ea})



Apply load to the inner ring and read the indicator while rotating once.

Fig. 8-9 Inner ring axial runout (S_{ia})



Apply load to the outer ring and read the indicator while rotating once.

Fig. 8-10 Outer ring axial runout (S_{ea})

(9) Internal clearance

Bearing internal clearance is significantly affected by performance including life, vibration, noise, heat generation, etc.
It is important to select internal clearance appropriately suited to the application.

Internal clearance

Types of internal clearance include radial internal clearance, axial internal clearance, and inclination angular clearance.

- **Radial internal clearance (*Gr*)**
  Travel amount when the outer ring is alternately moved in the radial direction, with the inner ring fixed (Fig. 9-1)
- **Axial internal clearance (*Ga*)**
  Travel amount when the inner ring is alternately moved in the axial direction, with the outer ring fixed (Fig. 9-2)
- **Inclination angular clearance (θ)**
  Travel amount of the angular direction when the inner ring is tilted in the axial direction, with the outer ring fixed (Fig. 9-3)

Normally, the radial internal clearance is set at the value in the standards.
This value is set in the tables below, under the NMB and JIS part numbers.
When the bearing is interference fitted, leaving interference with the shaft or housing, the internal clearance decreases.
As the internal clearance changes depending on the fit conditions and temperature environment, consider the operating conditions and environment when selecting the internal clearance.

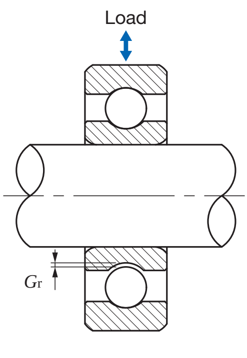


Fig. 9-1
Radial internal clearance (G_r)

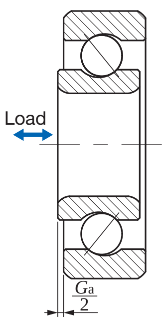


Fig. 9-2
Axial internal clearance (G_a)

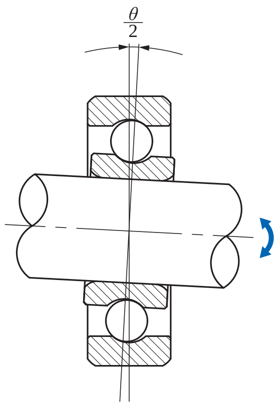


Fig. 9-3
Inclination angular clearance (θ)

NMB part number radial internal clearance

Internal clearance symbol	P13	P24	P25 (standard)	P58
Internal clearance amount (μm)	2.5 ~ 7.5	5.0 ~ 10.0	5.0 ~ 12.5	12.5 ~ 20.0

JIS part number radial internal clearance

Internal clearance symbol	M2	M3 (standard)	M4	M5	M6	M9
Internal clearance amount (μm)	3 ~ 8	5 ~ 10	8 ~ 13	13 ~ 20	20 ~ 28	27 ~ 32

(10) Fits

Bearings are never used on their own; rather, they are fitted into shafts or housings.
The fit refers to the mutual dimensions between the inner ring and shaft and between the outer ring and housing; generally, it is divided into clearance fits, intermediate fits, and interference fits.

Fits

The purpose of fits is to suppress vibration during rotation and to fix the bearing inner ring and shaft and the outer ring and housing, preventing creep. Creep refers to slipping on the fit surface; it can lead to the generation of abnormal heat and wear powder.
Abnormal heat generation causes rapid deterioration of the grease inside the bearing, while if wear powder enters the bearing it will increase vibration and noise and lead to shortened bearing life.
In the case of interference fits, the interference changes the bearing's internal clearance. The amount of change due to interference in the bearing's radial clearance is calculated as below. (Based on Timoshenko)

Internal clearance decrease due to interference fits

- **Shaft and inner ring interference fits**

Fig. 10-1 is a simple diagram showing before (dotted line) and after (solid line) fitting.
When the inner ring groove diameter d_2 is press-fit with interference i, δ increases.
That is, δ is the amount the radial clearance decreases due to the fit.

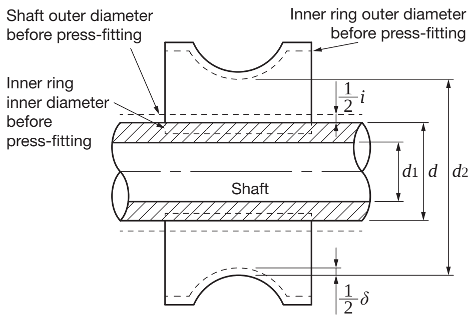


Fig. 10-1

$$\delta = \frac{2i\left(\frac{d_2}{d}\right)}{\left\{(d_2/d)^2-1\right\}\left[\left\{\frac{\left(\frac{d_2}{d}\right)^2+1}{\left(\frac{d_2}{d}\right)^2-1}+\frac{1}{m_b}\right\}+\frac{E_b}{E_s}\left\{\frac{\left(\frac{d}{d_1}\right)^2+1}{\left(\frac{d}{d_1}\right)^2-1}-\frac{1}{m_s}\right\}\right]}$$

d : Nominal inner ring inner diameter, nominal shaft outer diameter

d_1 : Shaft inner diameter

For solid shaft, $\frac{(d/d_1)^2+1}{(d/d_1)^2-1}=1$

d_2 : Inner ring groove diameter

i : Interference (i/2 in radial direction)

E_b : Young's modulus of inner ring

E_s : Young's modulus of shaft

m_b : Poisson's number of inner ring

m_s : Poisson's number of shaft

(10) Fits

- **Outer ring and housing interference fits**

Fig. 10-2 is a simple diagram showing before (dotted line) and after (solid line) fitting.

When the outer ring groove diameter D_1 is press-fit with interference I, Δ decreases.

That is, Δ is the amount the radial clearance decreases due to the fit.

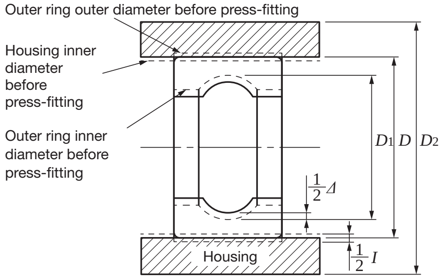


Fig. 10-2

$$\Delta = \frac{2I\left(\dfrac{D}{D_1}\right)}{\left\{\left(\dfrac{D}{D_1}\right)^2 - 1\right\}\left[\left\{\dfrac{\left(\dfrac{D}{D_1}\right)^2+1}{\left(\dfrac{D}{D_1}\right)^2-1} - \dfrac{1}{mb}\right\} + \dfrac{Eb}{Eh}\left\{\dfrac{\left(\dfrac{D_2}{D}\right)^2+1}{\left(\dfrac{D_2}{D}\right)^2-1} + \dfrac{1}{mh}\right\}\right]}$$

D : Nominal outer ring outer diameter, nominal housing inner diameter (mm)
D_1 : Outer ring groove diameter (mm)
D_2 : Housing outer diameter (mm)
I : Interference (I/2 in radial direction) (mm)
Eb : Young's modulus of outer ring (MPa)
Eh : Young's modulus of housing (MPa)
mb : Poisson's number of outer ring
mh : Poisson's number of housing

Calculating press-fit force and removal force

The press-fit force when mounting the bearing to the shaft or housing with interference is calculated through thick cylinder fit theory.
Press-fit force (or removal force) is determined by the surface area and surface pressure of the fit surface and the friction coefficient.
Press-fit force (or removal force) K is expressed with the following formula.

$$K = \mu P_m \pi d B \text{ (N)}$$

μ : Fit surface friction coefficient
$\mu = 0.12$ (when press-fitting the inner ring into the cylindrical shaft and the outer ring into the housing)
$\mu = 0.18$ (when removing the inner ring from the cylindrical shaft and the outer ring from the housing)

P_m : Surface pressure (MPa)

$$P_m = \frac{E}{2} \times \frac{\Delta d}{d} \times \frac{(1-k^2)(1-k_0^2)}{1-k^2 \times k_0^2}$$

d : Shaft diameter (mm)

B : Nominal bearing width (mm)
Δd : Effective interference (mm)
E : Longitudinal modulus of steel (MPa)
$E = 208000$ MPa
k : Inner ring thickness ratio
$k = d/d_i$
k_0 : Hollow shaft thickness ratio
$k_0 = d_0/d$ For solid shaft, $k_0 = 0$
d_0 : Hollow shaft inner diameter (mm)
For solid shaft, $d_0 = 0$

The actual press-fit force and removal force may be larger than the calculated values if the raceway ring has been mounted to the shaft or housing at a tilt, or if the force applied is not equal over the raceway ring periphery. Therefore, consider the calculated press-fit force and removal force to be guidelines, and confirm with the actual device.

Correlation between load properties and fits

The selection of fits is determined by the direction of load on the bearing and the rotation status of the inner and outer rings; it generally follows the table below.

Load conditions	Bearing rotation		Fits	
	Inner ring	Outer ring	Inner ring	Outer ring
Inner ring rotating load Outer ring static load	Rotating	Static	Interference fit	Clearance fit
	Static	Rotating		
Outer ring rotating load Inner ring static load	Static	Rotating	Clearance fit	Interference fit
	Rotating	Static		
Indeterminate direction load	Rotating or static	Rotating or static	Interference fit	Interference fit

Fixing clearance fits with adhesive

When fixing bearings to the shaft or housing with adhesive, etc., without interference, select a clearance suited to the adhesive strength. In addition, the appropriate clearance varies by the type of adhesive, so inquire with the adhesive manufacturer.
As well, note that curing stress due to adhesive hardening may adversely affect the raceway ring roundness.

Introducing Precision Mechanical Component (PMC)

In response to diverse customer needs, MinebeaMitsumi provides custom-made machined parts, or Precision Mechanical Assembly (PMC).
Various assemblies of our bearings with complex machined parts are supported.
One-stop manufacturing of various materials and shapes is possible. For details, see p.120 of this catalog.
Consult MinebeaMitsumi for any problems with fits.

(10) Fits

Excerpted from JIS B 0401-2

Commonly used fitting hole dimensional tolerances

(Unit: μm)

Dimension category (mm)		G	H			JS			K			M			N		P
Over	Up to	G7	H5	H6	H7	JS5	JS6	JS7	K5	K6	K7	M5	M6	M7	N6	N7	P7
-	3	+12	+4	+6	+10	±2	±3	±5	0	0	0	-2	-2	-2	-4	-4	-6
		+2	0	0	0				-4	-6	-10	-6	-8	-12	-10	-14	-16
3	6	+16	+5	+8	+12	±2.5	±4	±6	0	+2	+3	-3	-1	0	-5	-4	-8
		+4	0	0	0				-5	-6	-9	-8	-9	-12	-13	-16	-20
6	10	+20	+6	+9	+15	±3	±4.5	±7.5	+1	+2	+5	-4	-3	0	-7	-4	-9
		+5	0	0	0				-5	-7	-10	-10	-12	-15	-16	-19	-24
10	18	+24	+8	+11	+18	±4	±5.5	±9	+2	+2	+6	-4	-4	0	-9	-5	-11
		+6	0	0	0				-6	-9	-12	-12	-15	-18	-20	-23	-29
18	30	+28	+9	+13	+21	±4.5	±6.5	±10.5	+1	+2	+6	-5	-4	0	-11	-7	-14
		+7	0	0	0				-8	-11	-15	-14	-17	-21	-24	-28	-35
30	50	+34	+11	+16	+25	±5.5	±8	±12.5	+2	+3	+7	-5	-4	0	-12	-8	-17
		+9	0	0	0				-9	-13	-18	-16	-20	-25	-28	-33	-42

Commonly used fitting shaft dimensional tolerances

(Unit: μm)

Dimension category (mm)		f	g		h			js			k			m		n	p	r
Over	Up to	f6	g5	g6	h4	h5	h6	js4	js5	js6	k4	k5	k6	m5	m6	n6	p6	r6
-	3	-6	-2	-2	0	0	0	±1.5	±2	±3	+3	+4	+6	+6	+8	+10	+12	+16
		-12	-6	-8	-3	-4	-6				0	0	0	+2	+2	+4	+6	+10
3	6	-10	-4	-4	0	0	0	±2	±2.5	±4	+5	+6	+9	+9	+12	+16	+20	+23
		-18	-9	-12	-4	-5	-8				+1	+1	+1	+4	+4	+8	+12	+15
6	10	-13	-5	-5	0	0	0	±2	±3	±4.5	+5	+7	+10	+12	+15	+19	+24	+28
		-22	-11	-14	-4	-6	-9				+1	+1	+1	+6	+6	+10	+15	+19
10	18	-16	-6	-6	0	0	0	±2.5	±4	±5.5	+6	+9	+12	+15	+18	+23	+29	+34
		-27	-14	-17	-5	-8	-11				+1	+1	+1	+7	+7	+12	+18	+23
18	30	-20	-7	-7	0	0	0	±3	±4.5	±6.5	+8	+11	+15	+17	+21	+28	+35	+37
		-33	-16	-20	-6	-9	-13				+2	+2	+2	+8	+8	+15	+22	+28

Excerpted from JIS B 1566

Fit against radial bearing inner ring*1

<table>
<tr><th rowspan="2">Bearing class</th><th colspan="7">Inner ring rotating load or indeterminate direction load</th><th colspan="3">Inner ring static load</th></tr>
<tr><th colspan="10">Bearing tolerance zone class*2</th></tr>
<tr><td>Class 0, Class 6</td><td>r6</td><td>p6</td><td>n6</td><td>m6
m5</td><td>k6
k5</td><td>js6
js5</td><td>h5</td><td>h6
h5</td><td>g6
g5</td><td>f6</td></tr>
<tr><td>Class 5</td><td>-</td><td>-</td><td>-</td><td>m5</td><td>k4</td><td>js4</td><td>h4</td><td>h5</td><td>-</td><td>-</td></tr>
<tr><td>Fit</td><td colspan="5">Interference fit</td><td colspan="4">Intermediate fit</td><td>Clearance fit or intermediate fit</td></tr>
</table>

Fit against radial bearing outer ring*3

<table>
<tr><th rowspan="2">Bearing class</th><th colspan="4">Outer ring static load</th><th colspan="5">Indeterminate direction load or outer ring rotating load</th></tr>
<tr><th colspan="9">Hole tolerance zone class*2</th></tr>
<tr><td>Class 0, Class 6</td><td>G7</td><td>H7
H6</td><td>JS7
JS6</td><td>-</td><td>JS7
JS6</td><td>K7
K6</td><td>M7
M6</td><td>N7
N6</td><td>P7</td></tr>
<tr><td>Class 5</td><td>-</td><td>H5</td><td>JS5</td><td>K5</td><td>-</td><td>K5</td><td>M5</td><td>-</td><td>-</td></tr>
<tr><td>Fit</td><td colspan="2">Clearance fit</td><td colspan="5">Intermediate fit</td><td colspan="2">Interference fit or intermediate fit</td></tr>
</table>

*1: Bearing inner diameter tolerance is based on JIS B 1514-1.
*2: Tolerance zone class notation is based on JIS B 0401-1 and JIS B 0401-2.
*3: Bearing outer diameter tolerance is based on JIS B 1514-1.

(11) Shaft and housing design

In the device where the bearing is to be embedded, attention is required to the dimensions and accuracy design of the shaft and housing mounting parts in order to realize the full performance of the bearing.

Shaft and housing

- **Shaft and housing finish accuracy**

If the shaft and housing to be combined with the bearing are insufficient in terms of accuracy and surface roughness, it will affect the fit and the bearing's roundness after assembly.
Affected roundness leads to noise and shortened life, preventing full performance.
The finish accuracy such as roundness of the shaft and housing can be calculated as general content through the radius method; reference is possible to the basic tolerance IT classes corresponding to the bearing basic dimensions.
For the IT values, see the table below.
In addition, when mounting the bearing outer ring with interference with the housing, mounting thin ball bearing inner and outer rings, etc., the housing accuracy has greater influence on the bearing roundness, so further improved accuracy is required.

Excerpted from JIS B 0401-1

Reference dimension category (mm)		Tolerance class (IT)																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Over	Up to	Basic tolerance values (μm)											Basic tolerance values (mm)						
-	3	0.8	1.2	2	3	4	6	10	14	25	40	60	0.1	0.14	0.25	0.4	0.6	1	1.4
3	6	1	1.5	2.5	4	5	8	12	18	30	48	75	0.12	0.18	0.3	0.48	0.75	1.2	1.8
6	10	1	1.5	2.5	4	6	9	15	22	36	58	90	0.15	0.22	0.36	0.58	0.9	1.5	2.2
10	18	1.2	2	3	5	8	11	18	27	43	70	110	0.18	0.27	0.43	0.7	1.1	1.8	2.7
18	30	1.5	2.5	4	6	9	13	21	33	52	84	130	0.21	0.33	0.52	0.84	1.3	2.1	3.3
30	50	1.5	2.5	4	7	11	16	25	39	62	100	160	0.25	0.39	0.62	1	1.6	2.5	3.9

Remark 1: Tolerances IT1 ~ 4 are mainly used for gauges,
IT5 ~ IT10 mainly for fit, and
IT11 ~ IT18 for non-fit parts.
Remark 2: Tolerance classes IT14 ~ IT18 are not used for reference dimensions of 1 mm or below.

• Shaft and housing corner roundness radius

The shaft and housing ends (the surfaces in contact with the bearing ends) are orthogonal to the shaft center and fit surface. As well, the maximum allowable radius ($r_{as\ max}$) for corner roundness is smaller than the bearing minimum allowable chamfer dimension.

• Shoulder height

The shaft and housing shoulder height (h) should be larger than the bearing minimum allowable chamfer dimension, enabling firm contact with the ends of the outer and inner rings.

The minimum shoulder height (h) should be roughly 4x the bearing minimum allowable chamfer dimension, and the maximum should be smaller than the outer ring shoulder diameter (L_o) for the bearing outer diameter limit dimensions and larger than the inner ring shoulder diameter (L_i) for the housing inner diameter limit dimensions.

For the dimensional relationships, see the table below and the dimension tables.

Excerpted from JIS B 1566

(Unit: mm)

Inner ring or outer ring chamfer dimension	Shaft or housing		
	Corner roundness radius	In general cases[*1]	In special cases[*2]
$r_{s\ min}$	$r_{s\ max}$	h (minimum)	
0.05[*3]	0.05	0.2	0.2
0.08[*3]	0.08	0.3	0.3
0.1	0.1	0.4	0.4
0.15	0.15	0.6	0.6
0.2	0.2	0.8	0.8
0.3	0.3	1.25	1
0.6	0.6	2.25	2

*1: Under large axial load, shoulder height larger than these values will be required.
*2: Used when the axial load is small.
*3: Not regulated in JIS B 1566.

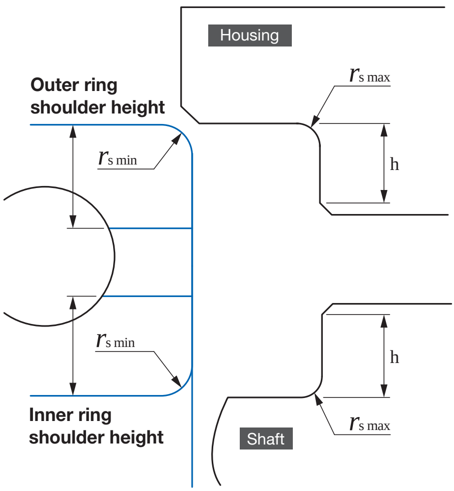


Fig. 11-1

(12) Preload and load

If the preload amount and method are not suitably selected, the preload applied to the bearing will cause its performance to deteriorate (in terms of life, vibration, noise, heat generation, etc.); therefore, it is important to select a preload amount and method suited to the usage application.

Preload purpose

When using the bearing in a motor, etc., internal clearance will lead to larger ball play and reduce the bearing rigidity, increasing the bearing rotation vibration. As shown in Fig. 12-1, axial direction load (F_a) is applied in advance to make the internal clearance negative. The load applied in advance in the axial direction is called “preload.” By applying preload, the contact angle between the inner and outer rings and the ball can be maintained at a constant angle, which is expected to improve vibration and acoustics.
Preload involves a suitable preload amount for the required bearing performance.
If the preload amount is too large, the rigidity will increase, but it will also lead to increased noise and vibration and shortened life.
If the preload amount is too small, the rigidity will be too low, failing to suppress vibration and leading to damage such as fretting corrosion. Therefore, when using bearings, the preload amount setting is an extremely important element.

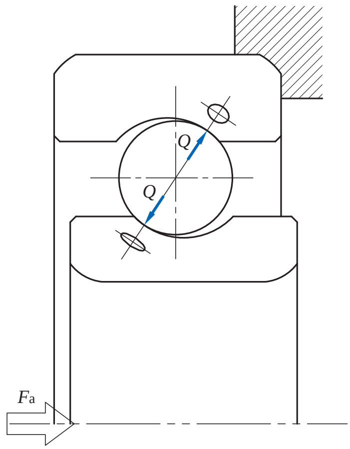


Fig. 12-1

MinebeaMitsumi provides various unit products (PMC products) with suitable preload applied in advance to the bearings.

For PMC products ▶

Suitable preload amount for a focus on noise performance

MinebeaMitsumi recommends that when the load on the bearings is predominantly preload, the suitable preload setting for life emphasizing noise performance should be calculated through average surface pressure.

When preload (F_a) is applied to the bearing, the ball and raceway groove contact parts undergo elastic deformation, creating an elliptical contact surface.
The value per ball of the vertical component of force generated at the contact parts of the ball and raceway groove (rolling element load: Q) divided by the contact ellipse surface area (S) is called average surface pressure.
Fig. 12-1 shows that when the ratio of the circumference is π, the major axis radius is a, and the minor axis radius is b, the contact ellipse (S) generated in the contact parts of the ball and raceway groove is $S = \pi ab$ (mm^2).
As well, when the average surface pressure is P, $P = Q/S$ (MPa).
The preload amount when focusing on noise life must be minimized; the calculation method and sample applications using simple calculation from the dynamic rating load C_r as a guideline are shown below.

Noise life guideline	Simple calculation method based on dynamic rating load C_r	Sample applications
10,000 hours up	0.005C_r ~ 0.010C_r	Fan motors, air conditioners, ventilation fans, etc.
5000 ~ 10,000 hours	0.010C_r ~ 0.015C_r	

Concept of load

Setting for preload and load at or below average surface pressure 1000 MPa (maximum surface pressure 1500 MPa) adopts the region in which fatigue will not be generated in the bearing material regulated by the fatigue limit load C_u used in the modified rating life L_{nm} regulated by ISO281:2007 and JIS B 1518:2013.
As well, for high-carbon chromium bearing steel, average surface pressure exceeding 2700 MPa will enter the plastic deformation area.
However, the bearing life is more significantly affected by elements such as rotation speed, operating environment, lubricant status and so on in comparison to load conditions; therefore, consult MinebeaMitsumi for details on the suitable preload amount and load in consideration of these conditions.

(12) Preload and load

Preload methods and preload directions

The bearing preload methods are shown in Fig. 12-2 "Fixed position preload" and Fig. 12-3 "Constant pressure preload."
As well, the preload directions are shown in Fig. 12-4 "Duplex face to face (DF)" and Fig. 12-5 "Duplex back to back (DB)."

- **Preload methods**

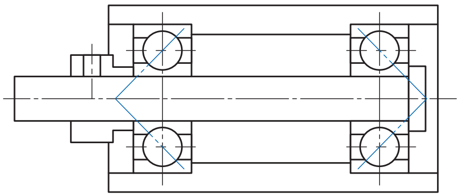


Fig. 12-2 Fixed position preload

Preload method	Fixed position preload
Advantages	Bearings are fixed with regard to one another, effectively enhancing rigidity
Disadvantages	Temperature changes lead to changing preload amounts due to expansion and contraction of bearings and surrounding parts

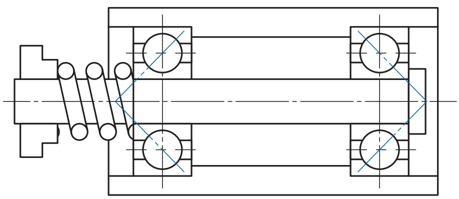


Fig. 12-3 Constant pressure preload

Preload method	Constant pressure preload
Advantages	The use of a spring for preload keeps the preload amount relatively stable even when the temperature changes
Disadvantages	Load on the shaft or housing from the axial direction changes the preload amount

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• **Preload direction**

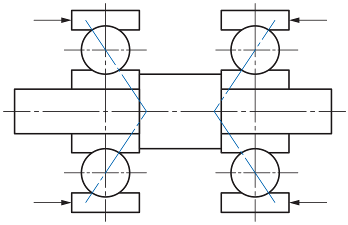


Fig. 12-4 Duplex face to face (DF)

Preload direction	Duplex face to face (DF)
Advantages	Because the mutual contact angles (intersection position dimensions) at the shaft center are small, mounting error tolerance is relatively large
Disadvantages	Rigidity is relatively low

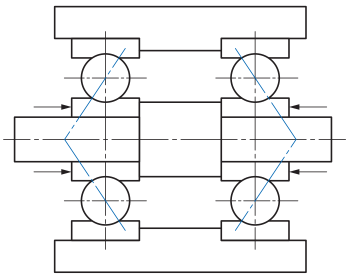


Fig. 12-5 Duplex back to back (DB)

Preload direction	Duplex back to back (DB)
Advantages	Because the mutual contact angles (intersection position dimensions) at the shaft center are large, rigidity is relatively high
Disadvantages	Mounting error tolerance is relatively small

(13) Displacement

When external load is applied to the bearing, deformation (displacement) occurs at the contact point of the balls and the raceway groove.

Radial displacement

When radial load (F_r) is applied as in Fig. 13-1, the maximum load (Q) on the balls is

$$Q = \frac{5}{Z} F_r \ .$$

Z : Number of balls

The radial displacement (δ) at the ball and raceway groove contact point is

Expressed by $\delta = e_\delta \sqrt{(\Sigma\rho) Q^2}$.

e_δ : Coefficient determined by the relationship of the balls and raceway groove

$\Sigma\rho$: Sum of contact point principal curvature

Because the balls are in contact with the inner and outer rings, the total displacement amount is the sum of each one's displacement amount.

δ_r : Total radial displacement amount

δ_i : Radial displacement amount between balls and inner ring raceway groove

δ_e : Radial displacement amount between balls and outer ring raceway groove

Thus, the total displacement amount (δ_r) is shown with the formula below.

$$\delta_r = \delta_i + \delta_e$$

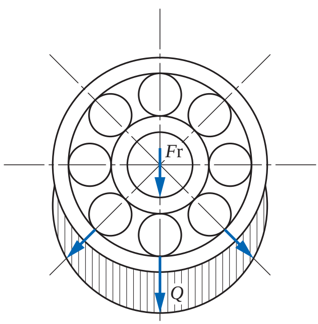


Fig. 13-1

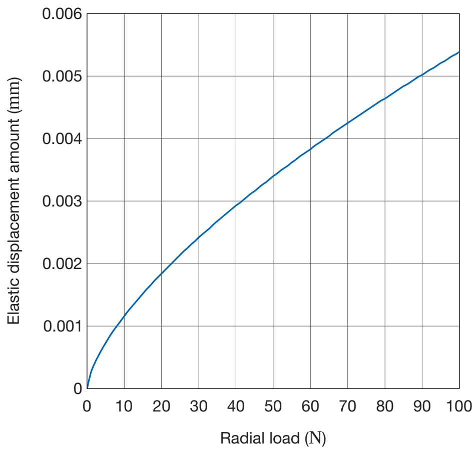


Fig. 13-2 Calculation example of elastic displacement amount for 608ZZ due to radial load

Axial displacement

The axial displacement amount (δ_a) when axial load (F_a) is applied is calculated as below.

$$\delta_a = (r_i + r_e - D_w)(\sin\alpha - \sin\alpha_0) + c\left(\frac{F_a}{Z}\right)^{\frac{2}{3}}\left(\frac{\sin\alpha}{D_w}\right)^{\frac{1}{3}}$$

C : Contact modulus

• Relationship of the initial contact angle (α_0) and contact angle (α)

When one raceway ring is moved in the axial direction until the clearance disappears, the initial contact angle (α_0) as shown in Fig. 13-3 is calculated as below.

$$\alpha_0 = \cos^{-1}\left\{1 - \frac{G_r}{2(r_i + r_e - D_w)}\right\}$$

G_r : Radial clearance
r_i : Inner ring groove curvature radius
r_e : Outer ring groove curvature radius
D_w : Ball diameter

As shown in Fig. 13-3, when load (F_a) is applied in the axial direction from the initial contact angle, the formula showing the relationship of the contact angle (α) and initial contact angle (α_0) is as below.

$$\frac{\cos\alpha_0}{\cos\alpha} = 1 + \frac{c \cdot D_w}{(r_i + r_e - D_w)}\left(\frac{F_a}{Z \cdot D_w^2 \cdot \sin\alpha}\right)^{\frac{2}{3}}$$

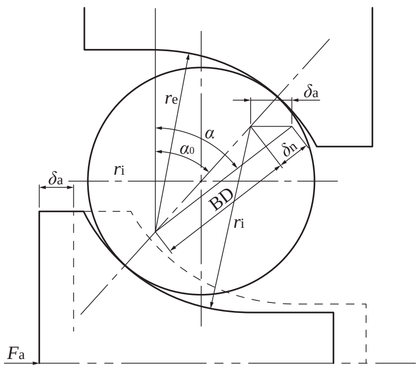


Fig. 13-3

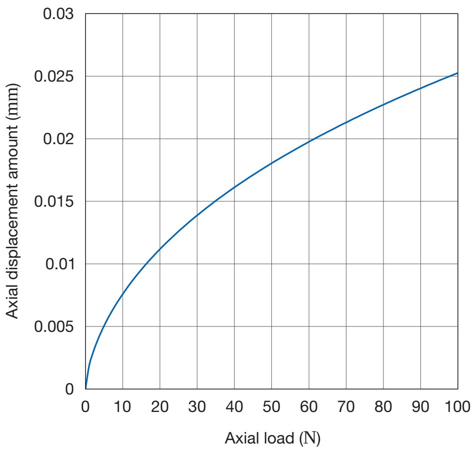


Fig. 13-4 Calculation example of axial displacement amount for 608ZZ due to axial load

Consult MinebeaMitsumi for calculation of the displacement amount for each model.

(14) Torque

Torque refers to the force required to make an object rotate.

Torque

Generally, ball bearings are known for their low torque in comparison to sliding bearings. At rotation start in particular, rolling ball bearing, which have rolling elements (balls), have much lower starting torque than sliding bearings.
Elements majorly influencing ball bearing torque include rolling element rolling resistance as well as retainer sliding friction, lubricant viscous resistance, and so on.
For miniature and small-diameter rolling ball bearings in particular, the output from the motive power source, i.e. the motor, is often low, so the elements affecting torque must be examined.

Ball bearing torque includes starting torque and rotating torque.

(1) Starting torque

This is the starting/initial torque which makes non-rotating ball bearings rotate. When preload or other load is applied to non-rotating ball bearings, they are stopped as contact elastic deformation is generated in the starting groove (surface) in contact with the balls. Making them rotate requires enough force to overcome the elastic deformation and the lubricant on the balls and raceway groove, so a force larger than rotating torque is required.

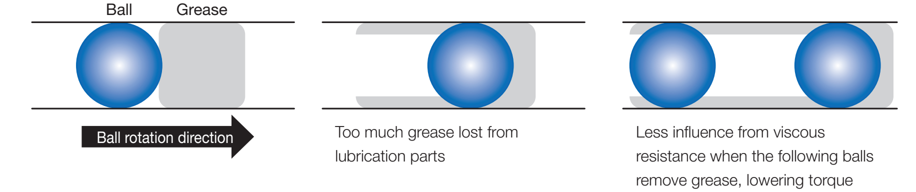
(2) Rotating torque

The viscous resistance when lubricant is mixed by the balls, raceway groove, and retainer during rotation is a property of rotating torque, as are other forms of resistance including the sliding friction between the balls and the retainer and the rolling friction between the balls and the raceway groove.
Rotating torque in ball bearings is related to phenomena such as heat generation and, in motor types, startup current value, rated current value, rated rotation speed, current value fluctuation, and rotation irregularity.

(3) Lubricant properties and phenomena related to torque

For miniature and small-diameter rolling ball bearings, the output from the motive power source, i.e. the motor, is often low, so attention paid to lubricant properties is often considered important.
For lubricants in general and grease in particular, most of the grease in the lubrication of the balls and raceway groove disappears over time, reducing torque to the rated value. Grease especially prone to this phenomenon is called channeling grease.
Elsewhere, grease which clings to the lubrication parts or continues to return there is called churning grease.
The rated value and time to reach this value vary depending on the grease type and amount and on the rotation speed, requiring measurement of the torque with the ball bearing single unit and examination of the current value, etc. when assembled into the device.

Channeling grease behavior pattern



Churning grease behavior pattern

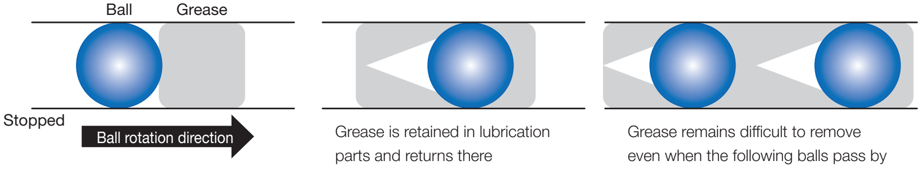


Fig. 14-1

(4) Causes and countermeasures of major torque-related issues

Issue	Cause	Countermeasure
Rated rotation is not achieved Startup current value is too high	Too much grease Use of churning grease Fit is too tight Load amount is too high	Reduce the grease amount Use channeling grease Reexamine the fit Reexamine the load amount
Rotation irregularity	Too much grease Use of grease (also consider rotation speed, temperature, required life, etc.)	Reduce the grease amount Use channeling grease (also consider rotation speed, temperature, required life, etc.)
Grease amount and rotating torque	Too much grease	Reduce the grease amount (also consider required life, etc.)
Temperature and rotating torque	Grease base oil viscosity increases	Insert grease with low base oil viscosity (also consider required life, etc.)

As the countermeasures listed here with regard to torque-related phenomena are closely involved with other aspects of required performance, consult MinebeaMitsumi for details.

(15) Vibration due to forced rotation

Bearings basically perform their function by rotating, but their rotation also generates vibration.
Vibration which changes frequency depending on the rotation speed is called vibration due to forced rotation.

Calculation of vibration due to forced rotation in rolling ball bearings

Vibration is generated in three directions: axial, radial, and rotation. These forms of vibration seriously affect performance, depending on the product in which the bearing is used.
As well, these forms of vibration, as vibration energy, may also excite inherent vibration in the components around the shaft.
Understand the product properties when selecting the bearing type and deciding on its specifications.

D_w : Ball diameter (mm)
D_{pw} : Pitch circle diameter (mm)
α_0 : Nominal contact angle (°)
Z : Number of balls
n : Integer number
f_r : Inner ring rotation speed (Hz)
F_r : Outer ring rotation speed (Hz)

As a simplified calculation, $\cos \alpha_0 = 1$ is also acceptable.

• Formula for inner ring rotation

Ball orbital vibration (f_a)	$\frac{1}{2}\left(1 - \frac{D_w}{D_{pw}} \cos \alpha_0\right) f_r$
Retainer rotation vibration (f_b)	Same as f_a
Ball rotation vibration (f_c)	$\frac{1}{2}\left(\frac{D_{pw}}{D_w} - \frac{D_w}{D_{pw}} \cos^2 \alpha_0\right) f_r$
Ball passage vibration (f_d)	Zf_a
	$Z (f_r - f_a)$

Vibration due to inner ring raceway groove wave motion (f_e)	
Axial direction vibration (f_{et})	$nZ (f_r - f_a)$
Radial direction vibration (f_{er})	$f_{et} \pm f_r$
Vibration due to outer ring raceway groove wave motion (f_f)	nZf_a
Vibration due to ball surface wave motion (f_g)	
Axial direction vibration (f_{gt})	$2nf_c$
Radial direction vibration (f_{gr})	$f_{gt} \pm f_a$

- **Formula for outer ring rotation**

Ball orbital vibration (F_a)	$\frac{1}{2}\left(1+\frac{D_w}{D_{pw}}\cos\alpha_0\right)F_r$
Retainer rotation vibration (F_b)	Same as F_a
Ball rotation vibration (F_c)	$\frac{1}{2}\left(\frac{D_{pw}}{D_w}-\frac{D_w}{D_{pw}}\cos^2\alpha_0\right)F_r$
Ball passage vibration (F_d)	ZF_a $Z(F_r - F_a)$

Vibration due to inner ring raceway groove wave motion (F_e)	nZF_a
Vibration due to outer ring raceway groove wave motion (F_f)	
Axial direction vibration (F_{ft})	$nZ(F_r - F_a)$
Radial direction vibration (F_{fr})	$F_{ft} \pm F_r$
Vibration due to ball surface wave motion (F_g)	
Axial direction vibration (F_{gt})	$2nF_c$
Radial direction vibration (F_{gr})	$F_{gt} \pm F_a$

- **Examples of analysis via formula**

Example 1:

For R-1560X13KK, the above formula when the ball orbital vibration rotates the inner ring at 1800 min^{-1} is

$$f_a = \frac{1}{2}\left(1-\frac{2.778}{10.5}\times 1\right)\times 30 = 11\ \text{Hz}$$

When the ball mutual error increases, the rotation direction vibration increases compared to normal status. (Figs. 15-1, 15-2)

Example 2:

For R-1560X13KK, when the outer ring raceway groove deformation and inner ring raceway groove shape become hexagonal, heptagonal, or octagonal, the amplitude at the vibration position found with the above formula is seen to increase.
(Figs. 15-3, 15-4, 15-5, 15-6)

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(15) Vibration due to forced rotation

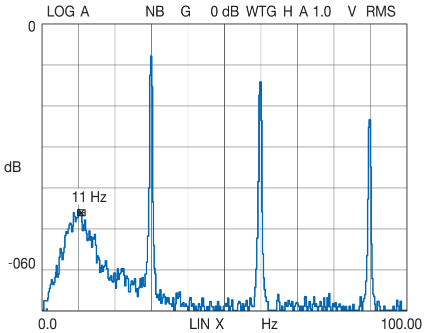


Fig. 15-1 Normal rotation direction vibration

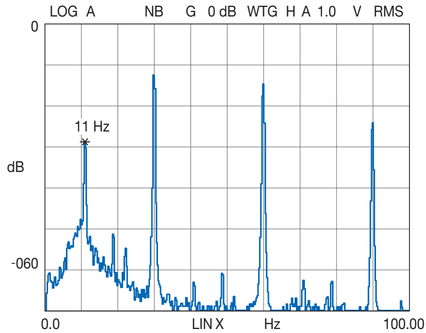


Fig. 15-2 Rotation direction vibration when ball wave motion mutual error is large

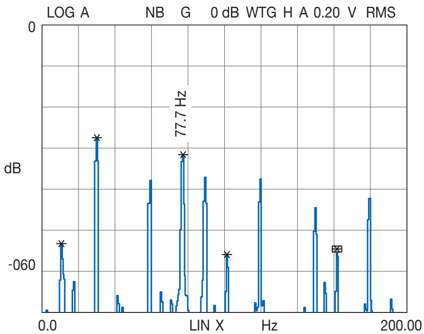


Fig. 15-3 Outer ring raceway groove deformation (triangle)

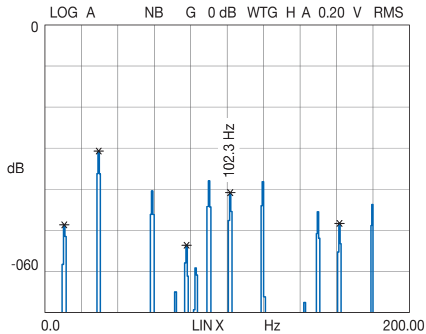


Fig. 15-4 Inner ring raceway groove hexagon $f_{er} = f_{et} \pm f_r$

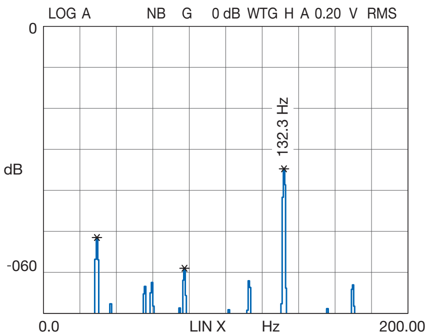


Fig. 15-5 Inner ring raceway groove heptagon $f_{et} = nZ\,(f_r - f_a)$

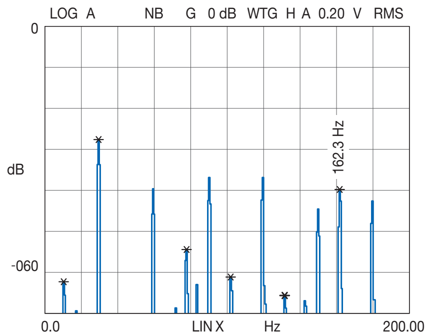


Fig. 15-6 Inner ring raceway groove octagon $f_{er} = f_{et} \pm f_r$

Vibration due to forced rotation and MinebeaMitsumi's approach

Rolling ball bearings have multiple balls and their retainer as rolling elements; they also contain the grease which lubricates these parts.
Because the ball movement involves spin and slip, runout appearing inconstantly (NRRO, non-repeatable runout) is theoretically unavoidable; however, MinebeaMitsumi has used the know-how accumulated since its founding to develop bearings which minimize this almost entirely.
That is, the mutual error of ball sphericity and ball dimensions has been reduced almost to zero, enabling the inner and outer ring groove roundness and curvature to be maintained according to the ideal design.

In the 1980s, the demand for hard disk drives (HDDs) began to increase as VTRs and personal computers came into widespread use.
In VTRs, the rotation precision of the bearings used in the motor significantly affects the image quality: bearings are so central to HDDs that the rotation precision of the spindle motor which rotates the disk determines performance such as memory capacity and processing speed.
These bearings are called on for higher-precision roundness, sphericity, and cylindricity as well as reduced NRRO, with more advanced demands yearly for precision in MinebeaMitsumi bearings.

HDD spindle motors switched in the 2000s from bearings to fluid dynamic bearings, but the technologies developed therein have been applied to the increasingly miniaturized and higher-speed server cooling fan motors, vacuum cleaner motors, dental handpieces, etc., with astonishing rotation speeds of tens of thousand rotations a minute embedded in the products that support our lifestyle.

In the development of products using bearings, the control of vibration frequency due to product inherent vibration is a major concern for its influence on requisite performance. MinebeaMitsumi has various proposals available based on its decades of accumulated technology and experience.
Consult MinebeaMitsumi for any problems with vibration.

1-4 Bearing Selection

(16) Noise

Confirmation of bearing noise performance is done with an anderon meter.
Below is an overview of anderon meters.
*Anderon: A unit used to express the vibration unique to bearings

Anderon meter

An anderon meter is a device which rotates bearings as a complete product to measure their vibration properties.

The bearing inner ring is mounted on the anderon meter spindle and rotated at 1800 min^{-1}; preload is applied to the stationary outer ring, a speed sensor is touched to the outer ring periphery, and the mechanical vibration transmitted to the outer ring is extracted as electrical signals for evaluation.
By rotating the inner ring on a high-precision spindle and detecting vibration directly from the outer ring, external influences can be eliminated and weak vibration can be detected.
The vibration detected is divided into L (low band), M (medium band), and H (high band), and confirmed and evaluated in each frequency band.
As well, headphones can be connected to the anderon meter to confirm noise performance.

The miniature and small-diameter rolling ball bearings manufactured by MinebeaMitsumi focus on lower noise during rotation, as well as the vibration issues addressed above.
Approaches to lower noise have become more and more important in recent years as demands for energy saving appear in every field; by detecting scratches and detritus in bearing components and improving bearing quality, we support lower noise in automobiles, industrial products, and household items like air conditioners and ventilation fans.

Band	Frequency band (Hz)
L : Low band	50 ~ 300
M : Medium band	300 ~ 1800
H : High band	1800 ~ 10000

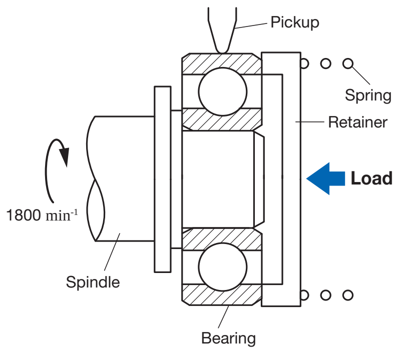


Fig. 16-1 Simple diagram of detection part

(17) Lubricants

Bearing lubrication normally uses grease or oil. For miniature and small-diameter rolling ball bearings, the initially inserted lubricant can almost always be used throughout the device life without replacement. Therefore, lubricants must be selected upon sufficient consideration of life, torque, rotation performance, noise performance, and so on.

Oil

Oils can be roughly divided into mineral oil, synthetic oil, and mixed oil combining the two. As it is fluid and not used in large quantities, it enables reduced torque but also requires consideration with regard to life. It is also used as the base oil of grease.

Grease

A solid or semi-solid formed by diffusing thickener in base oil. Composed of base oil, thickener, and additive, its properties are determined by their combination.

- **Base oil**
  Base oils can be roughly divided into mineral oil, synthetic oil, and mixed oil combining the two.
- **Thickener**
  Thickener is added in order to diffuse in the base oil and form semi-solids (in grease). This substance is important in determining the properties and performance of grease. Thickeners can be divided into soap-based types which use metal soaps (lithium, etc.) and non-soap-based types which do not (urea, etc.).
- **Additives**
  Additives are added to improve the physical and chemical performance of the grease. Types of additives include antioxidants, rust-proofing agents, corrosion inhibitors, extreme-pressure additives, and so on.

Types of grease

Grease is divided into various types by thickener, as shown on the following page in Table 17-1 "Lubricant types." The representative characteristics of grease are below.

- **Lithium soap grease**
  Lithium soap grease has excellent low-noise properties and durability, and is the most widely used as a universal grease in general industry, automobiles, and household appliances. It is comparatively inexpensive.
- **Urea grease**
  Urea grease has excellent heat resistance, high speed, and water resistance, and is frequently used in automotive electrical products, vacuum cleaner motors, and ventilation fans. As well, in combination with synthetic oil, other greases have excellent environmental stress cracking (ESC) resistance.
- **Fluorine grease**
  Fluorine grease has excellent chemical stability and is used in high-temperature environments around automobile engines. It is also used in vacuum environments. This grease is extremely expensive.
- **Conductive grease**
  Conductive grease has conductivity and enables conduction of electricity within the bearing, for use in devices such as copiers where electrical discharge must be avoided.

1-4 Bearing Selection

(17) Lubricants

Grease amount

The standard grease amount for miniature and small-diameter ball bearings is 30%. Inserted amounts suited to the application are shown in the table at right.

Inserted amount symbol	X	L	T	No symbol (standard)	H	J
Inserted amount	5 ~ 10%	10 ~ 15%	15 ~ 20%	25 ~ 35%	40 ~ 50%	50 ~ 60%

Caution

In recent years, as devices become more compact and lighter, resin materials are more frequently used near bearings. Some resin materials react badly in scientific terms to some types of oil and grease, leading to deterioration or damage. When selecting lubricants, consider the operating environment carefully and take care to avoid these problems.

Table 17-1 Lubricant types

Type	Application	Required spec	Code	Base oil
Grease	General	Silency	LY121	Ester
		Wide temperature, humid resistance	LY551	Synthetic hydrocarbon
	Automotive	High temperature	LY500	Fluorinated oil
		High temperature, high speed	LY704	Fluorinated oil, Ester
		Wide temperature	LY586	Fluorinated oil
		Low temperature Wide temperature	LY754	PFPE / Ester / Synthetic hydrocarbon oil
		Fretting resistance	LY773	Synthetic hydrocarbon
	Fan motor	High temperature	LY706	Ester
		High temperature, high speed	LY740	Synthetic hydrocarbon
	Home appliance Office equipment	High temperature	LY706	Ester
		High speed	LY773	Synthetic hydrocarbon
		Electrical corrosion resistance	LY764	Synthetic hydrocarbon
		Electrical corrosion resistance, high temperature	LY768	Fluorinated oil
	Industrial machine	Low temperature	LY72	Synthetic hydrocarbon, Ester
		Low particulate, (high temperature)	LY740	Synthetic hydrocarbon
		Silency	LY552	Ester, Ether
		High speed	LY755	Synthetic hydrocarbon, Ester
		Low heat generating High speed	LY112	Ester / Mineral
	Food machinery	FDA NSF H1 Conform	LY737	Synthetic hydrocarbon, Ester
	Medical equipment	ISO10993-5 Conform	LY788	Synthetic hydrocarbon
Oil	General	-	LO1	Ester
		Environmental stress cracking(ESC) resistance	LY650	Synthetic hydrocarbon
	Medical equipment	ISO10993-5 Conform	LO116	Fluorinated oil

*NMB can suggest various grease other than above table, please contact us.

Base oil kinematic viscosity

Base oil kinematic viscosity refers to the viscosity of the base oil, as the value measuring the size of the base oil internal resistance. The larger the base oil kinematic viscosity value, the higher the viscosity of the base oil, and vice versa.
For lubricant oil, it is expressed in SI units with mm^2/s (40°C) = cSt.

Worked penetration

Worked penetration expresses grease hardness. The larger the penetration value, the softer the grease, and vice versa. This is the penetration just after 60 times working the grease kept in a regulated mixer at 25°C.

Thickener	Base oil viscosity mm^2/s (40°C)	Worked penetration (60W)	Need to consider
Li soap	24	250	High temperature, High humidity, Environmental stress cracking(ESC)
Urea	48	235	High temperature and long time use
PTFE	190	280	Low temperature, silency
PTFE, Urea	150	280	Low temperature, silency
PTFE	85	280	High speed, silency
PTFE / polyurea	67	285	High speed
Urea	48	233	High temperature
Urea	100	263	Mechanical loss (Torque)
Urea	95	194	Low temperature
Urea	100	263	Mechanical loss (Torque)
Urea	48	233	High temperature
Carbon black, Li soap	120	260	Silency
Carbon black	390	260	Silency
Li soap	16	275	High temperature
Urea	95	194	Low temperature
Li soap	53	263	High temperature
Urea	22	250	High temperature
Li soap	15.1	280	Prolonged usage, Thermal stability
Al-complex soap	144	327	High temperature
Urea	43	280	High temperature
-	12	-	Environmental stress cracking(ESC)
-	32	-	Lubricity
-	500	-	Mechanical loss (Torque)

1-5 Handling Bearings

When assembling the bearing on the shaft or housing, unsuitable assembly will generate noise, vibration, heat, etc., leading to rapid deterioration. Caution is also required during transport and storage.

Precautions for Storage

For bearings, check the noise, appearance, etc., and store clean.
Be sure to keep them clean throughout the storage and handling before use.

Bearings handle dust poorly

Dust entering bearings will catch between the balls and raceway, leading to worsened noise and durability performance.
Dust includes not only minute fibers, sand, and paper dust, but also metal powder.

- **Open at the right timing**
  Open the package just before use.
- **Repackage any unused parts (leftover parts) after opening**
  Do not leave unused parts out; return them to airtight packaging.
- **Caution is required for dust during use as well**
  Dustproof the device during use with a regularly applied cover or similar, to prevent dust adhesion.

Bearings rust easily

Most bearings use high-carbon chromium bearing steel.
This material is inclined to rust easily.

- **Avoid locations with sharply fluctuating temperature and humidity**
  Store indoors, avoiding locations where temperature and humidity are prone to fluctuations, such as those exposed to atmosphere or to direct sunlight.
- **Do not place the package directly on the floor**
  Do not place directly on the floor (ground, concrete, etc.).
  Place on a pallet or a shelf.
- **Do not touch with bare hands**
  Use clean rubber gloves, finger protectors, or tweezers to avoid direct contact with bare hands. Skin oils can cause rust, so particular caution is required.

Bearings are vulnerable to impact

Bearings will suffer from brinelling under impact loads.

- **Handle with care**

  Do not drop from high places or throw, even when packaged.
  As well, do not handle bearings roughly when transferring into a container or during storage.
  Otherwise, brinelling and shield plate indentation will result.

- **Do not use fallen parts**

  Do not use bearings that have fallen or been dropped.
  Brinelling due to fall impact will lead to abnormal noise.

Precautions for Use and Assembly

Unsuitable bearing use or assembly will generate abnormal noise, vibration, runout, or rotation defects.
Keep the work environment clean and be careful with parts and work management as well.

Do not modify

Use bearings in the state in which they were delivered.

- **Disassembly and reassembly**

  Do not disassemble or reassemble the bearings.
  Abnormal noise and rotation defects will result from dust ingress and scratches.

Cleanliness

Be careful to keep bearings and mating parts clean.

- **Parts cleaning (Fig. 18-1)**

  Keep the parts such as shaft and housing, where the bearing will be assembled, clean.
  Contamination on the shaft or housing will generate abnormal noise and misalignment (assembly precision defects).

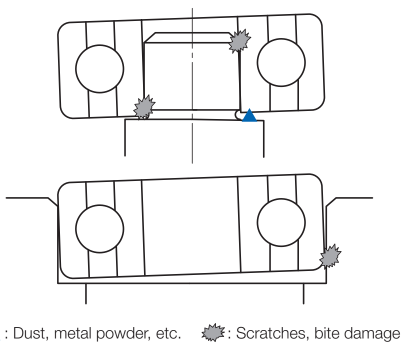


Fig. 18-1 Misalignment due to contamination/ scratches

1-5 Handling Bearings

Precautions for Use and Assembly

Oil wiping

It may be necessary to wipe off the rust-proofing oil applied to the bearing outer and inner diameter before installing; solvents, etc., will enter the bearing and cause abnormal noise and rotation defects.

- **Use a clean dust-proof cloth, etc.**
  Keep the product clean with consideration for the usage frequency.
- **Minimize the use of solvents**
  While it is normal to apply solvents such as alcohol to the cloth before wiping clean, keep the use of solvents to a minimum.
  Solvents used in excess will carry dust into the bearing, generating noise.

Fits

Unsuitable fit will lead to creep (sliding wear), rotation defects (high torque, vibration, heat generation), brinelling, etc.

- **Shaft and housing roundness**
  Be careful with the shaft and housing roundness.
  The shaft and housing shape will be transferred to the inner and outer ring rolling contact groove, worsening the roundness and generating vibration, abnormal noise, and runout.
- **Shaft and housing dimensions**
  Check that the shaft and housing dimensions are correct.
  Excess press-fitting on the fit side due to dimensional defects will lead to rotation defects (torque, vibration, heat generation), brinelling, etc.
- **Shaft and housing shape (design precautions)**
  Be careful with the shaft and housing shape.
  Discontinuity in the shaft outer perimeter or screws on the housing end may worsen the inner and outer ring roundness.
- **Shaft and housing chamfering**
  Be careful with the size and shape of the chamfered shaft and housing parts that hit the bearing ends.
  If the chamfering interferes, assembly in the correct position will not be possible, leading to misalignment (assembly precision defects).
- **Shaft and housing burrs and scratches**
  Check that there are no burrs or scratches on the shaft and housing.
  If burrs interfere with the bearing contact surface, misalignment (assembly precision defects) may be generated; scratches on the fit surface may lead to worsened inner and outer ring rolling contact groove roundness.

MinebeaMitsumi provides various unit products (PMC products) combining shafts and housings with bearings.

For PMC products ▶

Load/vibration

If bearings are incorrectly inserted into the shaft and housing, brinelling will result.
Fretting corrosion may also result from vibration on assembly lines, etc.
Rough handling when moving from one container to another can lead bearings to impact one another, denting their shield plates.

- **When press-fitting into the shaft, push the inner ring (Fig. 18-2)**

  When press-fitting the bearing into the shaft, push the inner ring end.
  If the outer ring end is pushed, brinelling will result.

- **When press-fitting into the housing, push the outer ring (Fig. 18-2)**

  When press-fitting the bearing into the housing, push the outer ring end.
  If the inner ring end is pushed, brinelling will result.

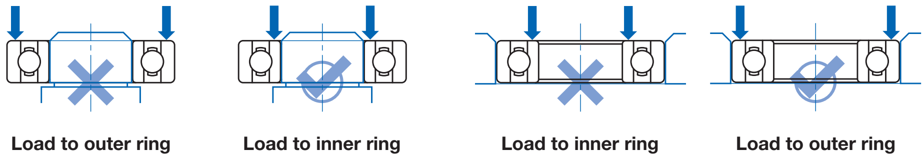


Fig. 18-2 Load position when press-fitting

- **Insert straight (Fig. 18-3)**

  Use a suitable jig to insert straight.
  If inserted diagonally, seizing scratches may result on the shaft and housing, leading to worsened roundness due to misalignment (assembly precision defects) or scratches caused by the interference of metal powder.

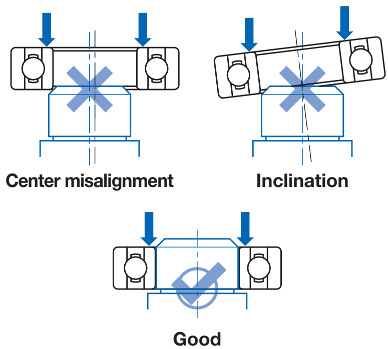


Fig. 18-3. Handling during insertion

- **Vibration (belt conveyor vibration, etc.)**

  When using a belt conveyor to transport bearings, etc., reduce the vibration transmitted to the bearings.
  Slight vibration transmitted to non-rotating bearings will result in fretting corrosion.
  For details, see p.82 of this catalog.

Precautions for Use and Assembly

Adhesive

When using adhesive to fix the bearing, be careful that it does not enter the bearing or cause uneven thickness. Abnormal noise and rotation defects will result.

- **Adhesive ingress prevention (Fig. 18-4)**
  Consider machining adhesive gutter grooves into the shaft and housing.
  Apply to the shaft end, the bearing chamfered part, etc.
- **Application quantity management**
  Manage the quantity with a dispenser, etc., and minimize the necessary amount.
- **No variations in adhesive application**
  Variations in thickness may worsen the bearing roundness.
  Apply adhesive evenly.

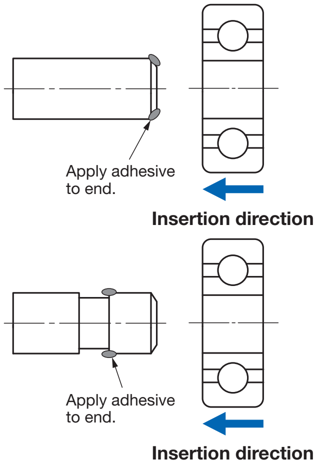


Fig 18-4 Adhesive application (example)

Air blow

Compressed air may be used in order to remove dust, etc. The blowing method may generate abnormal noise or rotation defects.

Applying grease to housing

Grease may be applied to the housing in order to reduce noise and vibration. Be careful with the grease used.
For details and a property sheet for the grease inside the bearings, contact MinebeaMitsumi.

- **Do not use grease with different properties**
  Mixing grease with different properties with the grease in the bearings may affect bearing performance.
- **Use clean grease**
  The use of dirty grease will cause contamination to enter the bearings and lead to abnormal noise.

Varnish gas

When applying varnish to the motor coil, the gas emitted while drying will generate rust. Abnormal noise may also occur.

Environmental stress cracking (ESC)

When the bearing assembly part is resin, the oil type may lead to environmental stress cracking (ESC).

- **Confirming resin materials**
  The likelihood of environmental stress cracking (ESC) varies according to the resin material type.
- **Confirming fit tolerance**
  High strain is more likely to lead to environmental stress cracking (ESC).

Effects of magnetization

Do not magnetize the bearings. Magnetization will gather iron-based contamination and generate abnormal noise and misalignment (assembly precision defects).

1-6 Malfunction Symptoms, Causes, and Countermeasures

In the case of abnormalities in the device with the bearing mounted, or damage to the bearing, the symptoms can be a guide to the cause. Below are some typical abnormalities and their countermeasures.

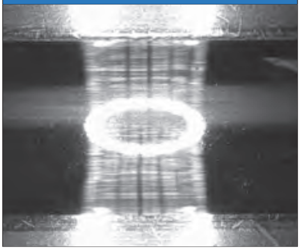
Abnormality symptoms/status

<table>
<tr><th colspan="2">Symptoms/status</th><th>Bearing damage status/suspected causes, etc.</th><th>Damage examples</th><th>Countermeasure</th></tr>
<tr><td rowspan="9">Abnormal noise</td><td rowspan="6">Continuous noise</td><td>Brinelling on raceway groove</td><td>3</td><td>Review of bearing handling, assembly work, device transport work
(possible overload or impact load)</td></tr>
<tr><td>Roughness/wear</td><td>1</td><td>Review of lubricant, bearing size, preload, seal</td></tr>
<tr><td>Scratches (indentation) due to raceway groove contamination</td><td>2</td><td>Review of bearing sealing, work environment</td></tr>
<tr><td>Fretting corrosion</td><td>4</td><td>Review of vibration prevention, packaging/conveyance</td></tr>
<tr><td>Electric corrosion</td><td>6</td><td>Insulation measures: Use ceramic balls</td></tr>
<tr><td>Resonance of components</td><td></td><td>Review of component dimensions (thickness)/materials</td></tr>
<tr><td rowspan="3">Intermittent noise</td><td>Scratches on balls</td><td></td><td>Review of work environment and process
(possible contamination or overload)</td></tr>
<tr><td>Contamination bite damage</td><td></td><td>Review of bearing sealing, work environment</td></tr>
<tr><td>Insufficient preload</td><td></td><td>Review of preload amount based on load/rotation conditions, etc.</td></tr>
<tr><td rowspan="9">Rotation defects</td><td rowspan="6">No rotation or sluggish rotation</td><td>Effects of lubricant (grease) (amount, type)</td><td></td><td>Review of grease, improvement (increased drive power, etc.) of drive parts (motor parts, etc.)</td></tr>
<tr><td>Contamination or adhesive ingress</td><td></td><td>Review of work environment and methods</td></tr>
<tr><td>Large interference</td><td></td><td>Review of fit</td></tr>
<tr><td>Lubrication runs dry</td><td></td><td>Review of lubricant, increased grease amount
Review of grease type/amount</td></tr>
<tr><td>Flaking</td><td>7</td><td>Confirmation of load/rotation conditions
Selection of larger bearing</td></tr>
<tr><td>Part contact</td><td></td><td>Review of work and design</td></tr>
<tr><td rowspan="2">Heat generation</td><td>Unsuitable type and amount of grease</td><td></td><td>Review of grease</td></tr>
<tr><td>Overload</td><td></td><td>Review of load resistance and fit</td></tr>
<tr><td>Short life</td><td>Unsuitable environment/operating conditions, etc.</td><td></td><td>Review of environment/operating conditions</td></tr>
<tr><td colspan="2" rowspan="5">Large vibration/runout</td><td>Misalignment</td><td></td><td>Review of part dimensions/tolerances, cleanliness, work</td></tr>
<tr><td>Raceway surface deformation</td><td></td><td>Review of bearing or housing machined accuracy (roundness), review of adhesive and adhesive application work</td></tr>
<tr><td>Unsuitable preload
Fallen preload</td><td></td><td>Review of preload amount based on load/ rotation conditions, etc.</td></tr>
<tr><td>Large internal clearance</td><td></td><td>Reduced bearing internal clearance</td></tr>
<tr><td>Creep</td><td>5</td><td>Review of fit</td></tr>
<tr><td colspan="2" rowspan="2">Grease leak</td><td>Unsuitable type and amount of grease</td><td></td><td>Review of grease</td></tr>
<tr><td>Unsuitable selection of shield/seal</td><td></td><td>Review of shield/seal</td></tr>
<tr><td colspan="2" rowspan="3">Resin material damage (split)</td><td>Environmental stress cracking (ESC)</td><td></td><td>Review of lubricant, stress mitigation, reselection of resin</td></tr>
<tr><td>Excess interference</td><td></td><td>Review of fit</td></tr>
<tr><td>Weld lines</td><td></td><td>Review of molding conditions, gate position</td></tr>
</table>

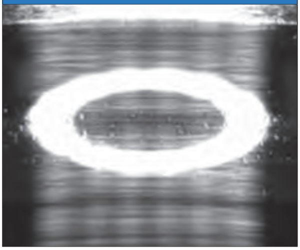
Note: Damage examples are numbered in order of frequency

Damage examples

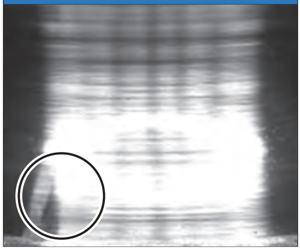
1. Roughness



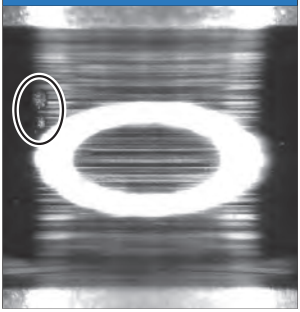
2. Scratches due to contamination



3. Brinelling

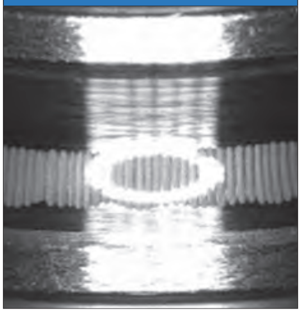


4. Fretting corrosion

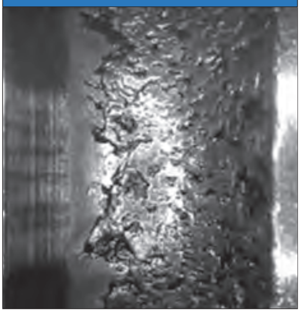


5. Creep

6. Electric corrosion



7. Flaking (peeling due to metal fatigue)



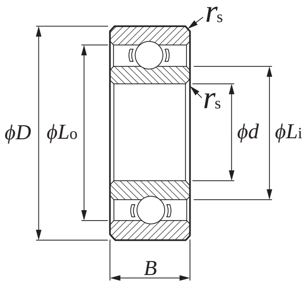
2 Dimension Tables

Some of the models listed require a preparation period for production.

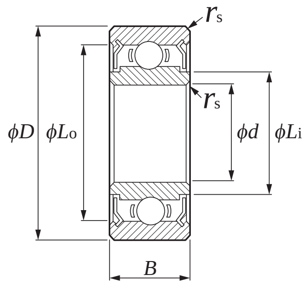
2-1 Metric Design Deep Groove Ball Bearings

Basic type (bearing steel)

R-Series
L-Series
JIS-Series
Inner diameter: 1 mm to 5 mm



Open bearing
Radial Open Ball Bearing



Shielded bearing
Radial Shielded Ball Bearing

(Unit: mm)

Part Numbers	Inner diameter d	Outer diameter D	Width B	Chamfer r_s min.	Shoulder diameter		Basic rating load (N)		Reference
					Outer ring L_o	Inner ring L_i	Dynamic load C_r	Static load C_{or}	JIS nominal
L-310	1	3	1	0.05	2.41	1.60	80	23	681
L-415	1.5	4	1.2	0.05	3.25	2.26	125	38	68/1.5
L-415X5ZZ	1.5	4	2	0.05	3.42	2.15	113	34	68/1.5
L-520	2	5	1.5	0.08	4.00	2.90	187	59	682
L-520ZZ	2	5	2.3	0.08	4.28	2.90	187	59	-
L-520W52	2	5	2.5	0.08	4.00	2.90	187	59	-
L-520ZZW52	2	5	2.5	0.08	4.28	2.90	187	59	-
L-520X9ZZW52	2	5	2.5	0.08	4.27	2.72	186	58	-
R-620ZZ	2	6	3	0.15	5.23	3.10	330	99	-
R-620W52	2	6	2.5	0.15	4.93	3.10	330	99	-
R-620ZZY52	2	6	2.5	0.15	5.23	3.10	330	99	-
R-720ZZ	2	7	3.5	0.15	5.93	3.80	380	126	-
L-625ZZ	2.5	6	2.6	0.08	5.23	3.80	206	73	-
R-725ZZ	2.5	7	3.5	0.15	5.93	3.80	380	126	-
R-825ZZ	2.5	8	4	0.15	7.19	4.10	553	176	-
L-630	3	6	2	0.08	4.93	3.80	206	73	673

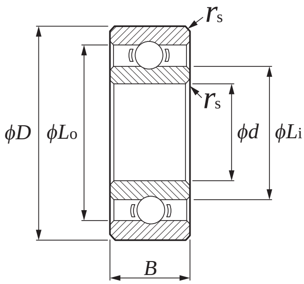
(Unit: mm)

Part Numbers	Inner diameter d	Outer diameter D	Width B	Chamfer r_s min.	Shoulder diameter Outer ring L_o	Shoulder diameter Inner ring L_i	Basic rating load (N) Dynamic load C_r	Basic rating load (N) Static load C_{0r}	Reference JIS nominal
L-630ZZ	3	6	2.5	0.08	5.23	3.80	206	73	-
L-730	3	7	2	0.1	5.83	4.10	384	129	683
L-730ZZ	3	7	3	0.1	6.13	4.10	384	129	-
R-830	3	8	3	0.15	6.53	4.10	553	176	693
R-830ZZ	3	8	4	0.15	7.19	4.10	553	176	-
R-830X10ZZ	3	8	4	0.15	7.19	4.18	553	176	-
R-930ZZY04	3	9	4	0.15	7.64	4.80	634	219	-
R-1030	3	10	4	0.15	8.20	5.08	641	226	623
R-1030ZZ	3	10	4	0.15	8.20	5.08	641	226	623ZZ
L-740ZZ	4	7	2.5	0.08	6.33	4.80	252	106	674
L-840ZZ	4	8	3	0.1	7.24	5.20	391	140	-
L-940	4	9	2.5	0.1	7.48	5.20	641	226	684
L-940ZZ	4	9	4	0.1	7.93	5.20	641	226	-
L-1040X2	4	10	3	0.15	7.96	5.80	708	266	-
L-1040X2ZZ	4	10	4	0.15	8.50	5.46	708	266	-
R-1140	4	11	4	0.15	9.54	6.40	714	276	694
R-1140ZZ	4	11	4	0.15	9.54	6.40	714	276	694ZZ
R-1240	4	12	4	0.2	9.99	5.62	959	347	604
R-1240KK1	4	12	4	0.2	9.68	5.62	959	347	604ZZ
R-1340	4	13	5	0.2	11.22	5.97	1306	487	624
R-1340HH	4	13	5	0.2	11.22	5.97	1306	487	624ZZ
R-1340DD	4	13	5	0.2	11.22	5.97	1306	487	624DD
R-1640	4	16	5	0.3	13.41	7.80	1735	671	634
R-1640HH	4	16	5	0.3	13.41	7.80	1735	671	634ZZ
R-1640DD	4	16	5	0.3	13.41	7.80	1735	671	634DD
L-850	5	8	2	0.08	6.95	5.80	274	130	675
L-850ZZ	5	8	2.5	0.08	7.26	5.80	274	130	-
L-950ZZ	5	9	3	0.1	8.04	6.00	495	207	-

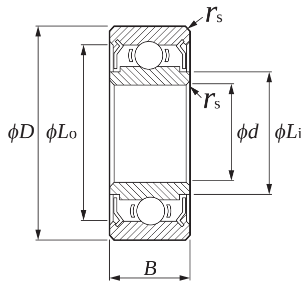
Basic type (bearing steel)

R-Series
L-Series
JIS-Series

Inner diameter: 5 mm to 7 mm



Open bearing
Radial Open Ball Bearing



Shielded bearing
Radial Shielded Ball Bearing

(Unit: mm)

Part Numbers	Inner diameter d	Outer diameter D	Width B	Chamfer r_s min.	Shoulder diameter		Basic rating load (N)		Reference
					Outer ring L_o	Inner ring L_i	Dynamic load C_r	Static load C_{0r}	JIS nominal
L-1050	5	10	3	0.1	8.63	6.40	714	276	-
L-1050ZZ	5	10	4	0.1	8.94	6.40	714	276	-
L-1050SS	5	10	4	0.1	8.94	6.40	714	276	-
L-1150	5	11	3	0.15	8.63	6.40	714	276	685
L-1150ZZ	5	11	5	0.15	9.54	6.40	714	276	-
L-1150ZZY04	5	11	4	0.15	9.54	6.40	714	276	-
R-1350	5	13	4	0.2	11.14	6.66	1074	422	695
R-1350ZZ	5	13	4	0.2	11.14	6.66	1074	422	695ZZ
R-1350DD	5	13	4	0.2	11.14	6.66	1074	422	695DD
R-1450	5	14	5	0.2	12.14	6.88	1329	508	605
R-1450ZZ	5	14	5	0.2	12.14	6.88	1329	508	605ZZ
R-1650	5	16	5	0.3	13.41	7.80	1735	671	625
R-1650HH	5	16	5	0.3	13.41	7.80	1735	671	625ZZ
R-1650DD	5	16	5	0.3	13.41	7.80	1735	671	625DD
R-1650SS	5	16	5	0.3	13.41	7.80	1735	671	625SS
635	5	19	6	0.3	16.68	9.20	2614	1053	635

(Unit: mm)

Part Numbers	Inner diameter d	Outer diameter D	Width B	Chamfer r_s min.	Shoulder diameter: Outer ring L_o	Shoulder diameter: Inner ring L_i	Basic rating load (N): Dynamic load C_r	Basic rating load (N): Static load C_{0r}	Reference: JIS nominal
635ZZ	5	19	6	0.3	16.68	9.20	2614	1053	635ZZ
L-1060	6	10	2.5	0.1	8.73	6.95	457	194	676
L-1060ZZ	6	10	3	0.1	9.04	6.95	457	194	-
L-1060DD	6	10	3	0.1	9.04	6.95	457	194	-
L-1060SS	6	10	3	0.1	9.04	6.95	457	194	-
L-1260	6	12	3	0.15	9.94	7.70	831	363	-
L-1260ZZ	6	12	4	0.15	10.48	7.70	831	363	-
L-1260X2DD	6	12	4	0.15	10.80	7.70	831	363	-
L-1360	6	13	3.5	0.15	10.98	8.00	1083	438	686
L-1360ZZ	6	13	5	0.15	11.44	7.33	1083	438	-
L-1360DD	6	13	5	0.15	11.44	7.33	1083	438	-
R-1560X13KK	6	15	5	0.2	13.20	7.80	1735	671	696ZZ
R-1560X13DD	6	15	5	0.2	13.20	7.80	1735	671	696DD
R-1660HH	6	16	5	0.3*	13.41	7.80	1735	671	-
R-1660DD	6	16	5	0.3*	13.41	7.80	1735	671	-
R-1760X2	6	17	6	0.3	14.70	8.22	2265	839	606
R-1760X2KK	6	17	6	0.3	14.70	8.22	2265	839	606ZZ
R-1760X2DD	6	17	6	0.3	14.70	8.22	2265	839	606DD
626	6	19	6	0.3	16.68	9.20	2614	1053	626
626ZZ	6	19	6	0.3	16.68	9.20	2614	1053	626ZZ
626DD	6	19	6	0.3	16.68	9.20	2614	1053	626DD
626SS	6	19	6	0.3	16.68	9.20	2614	1053	626SS
L-1370ZZ	7	13	4	0.15	11.54	8.43	880	414	-
L-1470	7	14	3.5	0.15	12.03	9.00	1175	511	687
L-1470KK	7	14	5	0.15	12.88	9.00	1175	511	-
607	7	19	6	0.3	16.68	9.20	2614	1053	607
607ZZ	7	19	6	0.3	16.68	9.20	2614	1053	607ZZ
607DD	7	19	6	0.3	16.68	9.20	2614	1053	607DD

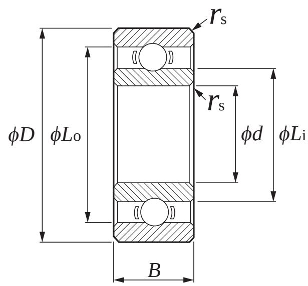
*Inner ring chamfer is 0.2 min

2-1 Metric Design Deep Groove Ball Bearings

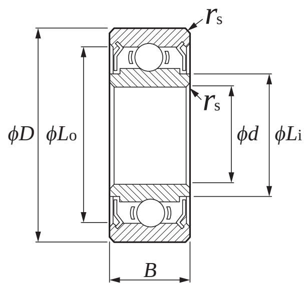
Basic type (bearing steel)

R-Series
L-Series
JIS-Series

Inner diameter: 7 mm to 10 mm



Open bearing
Radial Open Ball Bearing



Shielded bearing
Radial Shielded Ball Bearing

(Unit: mm)

Part Numbers	Inner diameter d	Outer diameter D	Width B	Chamfer r_s min.	Shoulder diameter		Basic rating load (N)		Reference
					Outer ring L_o	Inner ring L_i	Dynamic load C_r	Static load C_{or}	JIS nominal
607SS	7	19	6	0.3	16.68	9.20	2614	1053	607SS
627	7	22	7	0.3	19.10	10.80	3297	1368	627
627ZZ	7	22	7	0.3	19.10	10.80	3297	1368	627ZZ
627DD	7	22	7	0.3	19.10	10.80	3297	1368	627DD
627SS	7	22	7	0.3	19.10	10.80	3297	1368	627SS
637ZZ	7	26	9	0.3	22.83	13.75	4578	1970	637ZZ
L-1280ZZ	8	12	3.5	0.1	11.24	9.10	506	249	-
L-1280DD	8	12	3.5	0.1	11.24	9.10	506	249	-
L-1480ZZ	8	14	4	0.15	12.55	9.90	819	386	-
L-1480DD	8	14	4	0.15	12.70	9.90	819	386	-
L-1680	8	16	4	0.2	13.40	10.30	1606	712	688
L-1680KK	8	16	5	0.2	14.18	9.68	1606	712	-
L-1680DD	8	16	5	0.2	14.18	9.68	1606	712	-
R-1980	8	19	6	0.3	16.68	10.60	2463	1059	698
R-1980KK	8	19	6	0.3	16.68	10.60	2463	1059	698ZZ
R-1980DD	8	19	6	0.3	16.68	10.60	2463	1059	698DD

(Unit: mm)

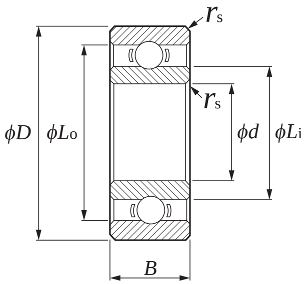
Part Numbers	Inner diameter d	Outer diameter D	Width B	Chamfer r_s min.	Shoulder diameter		Basic rating load (N)		Reference
					Outer ring Lo	Inner ring Li	Dynamic load Cr	Static load C_{0r}	JIS nominal
R-1980SS	8	19	6	0.3	16.68	10.60	2463	1059	698SS
608	8	22	7	0.3	19.10	10.80	3297	1368	608
608ZZ	8	22	7	0.3	19.10	10.80	3297	1368	608ZZ
608DD	8	22	7	0.3	19.10	10.80	3297	1368	608DD
608SS	8	22	7	0.3	19.10	10.80	3297	1368	608SS
R-2480	8	24	8	0.3	19.10	11.80	3297	1368	628
R-2480KK	8	24	8	0.3	19.10	11.80	3297	1368	628ZZ
L-1790	9	17	4	0.2	14.84	11.20	1724	813	689
L-1790ZZ	9	17	5	0.2	15.34	11.20	1724	813	-
L-1790DD	9	17	5	0.2	15.34	11.20	1724	813	-
L-2090	9	20	6	0.3	16.71	12.32	2123	985	699
L-2090KK	9	20	6	0.3	17.44	12.32	2123	985	699ZZ
609	9	24	7	0.3	19.10	12.40	3297	1368	609
609ZZ	9	24	7	0.3	19.10	12.40	3297	1368	609ZZ
609DD	9	24	7	0.3	19.10	12.40	3297	1368	609DD
609SS	9	24	7	0.3	19.10	12.40	3297	1368	609SS
629ZZSD61	9	26	8	(0.6)	22.80	12.88	4578	1970	629ZZ
629DDSD61	9	26	8	(0.6)	22.80	12.88	4578	1970	629DD
629SSSD61	9	26	8	(0.6)	22.80	12.88	4578	1970	629SS
L-1910	10	19	5	0.3	16.71	12.32	2123	985	6800
L-1910DD	10	19	7	0.3	17.44	12.32	2123	985	-
L-1910KKY05	10	19	5	0.3	17.44	12.32	2123	985	6800ZZ
L-1910DDY05	10	19	5	0.3	17.44	12.32	2123	985	6800DD
R-2210X3KK	10	22	6	0.3	19.40	13.40	2697	1273	6900ZZ
R-2210X3DD	10	22	6	0.3	19.40	13.40	2697	1273	6900DD
R-2210X3SS	10	22	6	0.3	19.40	13.40	2697	1273	6900SS
6000	10	26	8	0.3	22.80	13.75	4578	1970	6000
6000ZZ	10	26	8	0.3	22.80	13.75	4578	1970	6000ZZ

Figures in parentheses do not meet JIS standards.

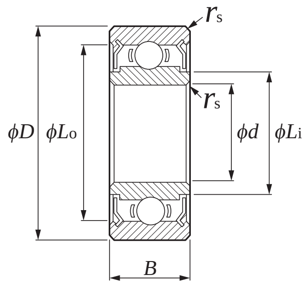
2-1 Metric Design Deep Groove Ball Bearings

Basic type (bearing steel)

R-Series
L-Series
JIS-Series
Inner diameter: 10 mm to 20 mm



Open bearing
Radial Open Ball Bearing



Shielded bearing
Radial Shielded Ball Bearing

(Unit: mm)

Part Numbers	Inner diameter *d*	Outer diameter *D*	Width *B*	Chamfer *rs* min.	Shoulder diameter Outer ring *Lo*	Shoulder diameter Inner ring *Li*	Basic rating load (N) Dynamic load *Cr*	Basic rating load (N) Static load *Cor*	Reference JIS nominal
6000DD	10	26	8	0.3	22.80	13.75	4578	1970	6000DD
6000SS	10	26	8	0.3	22.80	13.75	4578	1970	6000SS
6200	10	30	9	0.6	25.05	15.69	5098	2366	6200
6200ZZ	10	30	9	0.6	25.05	15.69	5098	2366	6200ZZ
L-2112	12	21	5	0.3	19.22	14.40	1917	1042	6801
L-2112KK	12	21	5	0.3	19.22	14.40	1917	1042	6801ZZ
L-2112DD	12	21	5	0.3	19.22	14.40	1917	1042	6801DD
L-2112SS	12	21	5	0.3	19.22	14.40	1917	1042	6801SS
R-2412X3	12	24	6	0.3	21.69	14.28	3082	1433	6901
R-2412X3KK	12	24	6	0.3	21.69	14.28	3082	1433	6901ZZ
R-2412X3DD	12	24	6	0.3	21.69	14.28	3082	1433	6901DD
6001X3	12	28	8	0.3	25.05	15.69	5098	2366	6001
6001X3ZZ	12	28	8	0.3	25.05	15.69	5098	2366	6001ZZ
6201	12	32	10	0.6	27.55	16.93	6805	3049	6201
6201ZZ	12	32	10	0.6	27.55	16.93	6805	3049	6201ZZ
L-2415	15	24	5	0.3	22.00	17.70	2076	1258	6802

(Unit: mm)

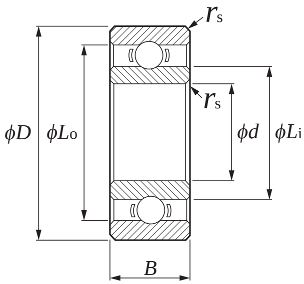
Part Numbers	Inner diameter *d*	Outer diameter *D*	Width *B*	Chamfer r_s min.	Shoulder diameter		Basic rating load (N)		Reference
					Outer ring *Lo*	Inner ring *Li*	Dynamic load *Cr*	Static load *Cor*	JIS nominal
L-2415KK	15	24	5	0.3	22.23	17.70	2076	1258	6802ZZ
R-2815X	15	28	7	0.3	25.38	17.66	4325	2254	6902
R-2815XDD	15	28	7	0.3	25.38	17.66	4325	2254	6902DD
R-2815XSS	15	28	7	0.3	25.38	18.10	4325	2254	6902SS
6002X	15	32	9	0.3	28.55	19.20	5591	2842	6002
6002XZZ	15	32	9	0.3	28.55	19.20	5591	2842	6002ZZ
6202	15	35	11	0.6	30.71	19.56	7746	3579	6202
6202ZZ	15	35	11	0.6	30.71	19.56	7746	3579	6202ZZ
6803	17	26	5	0.3	24.22	19.70	2137	1368	6803
6803ZZ	17	26	5	0.3	24.22	19.70	2137	1368	6803ZZ
6903	17	30	7	0.3	27.85	20.05	4593	2558	6903
6903ZZ	17	30	7	0.3	27.85	20.05	4593	2558	6903ZZ
6003	17	35	10	0.3	31.21	21.21	6805	3366	6003
6003ZZ	17	35	10	0.3	31.21	21.21	6805	3366	6003ZZ
6804	20	32	7	0.3	29.15	23.72	3483	2235	6804
6804ZZ	20	32	7	0.3	29.15	23.72	3483	2235	6804ZZ
6005*	25	47	12	0.6	41.77	29.79	10068	5826	6005
6005ZZ*	25	47	12	0.6	41.77	29.79	10068	5826	6005ZZ
6705*	25	32	4	0.2	30.44	27.17	1095	838	6705
6705DD*	25	32	4	0.2	30.44	27.17	1095	838	6705DD
6705SS*	25	32	4	0.2	30.44	27.17	1095	838	6705SS
6805*	25	37	7	0.3	34.15	28.01	3683	2634	6805
6805ZZ*	25	37	7	0.3	34.15	28.01	3683	2634	6805ZZ
6805SS*	25	37	7	0.3	34.15	28.01	3683	2634	6805SS
6006*	30	55	13	1	49.51	36.16	13231	8283	6006
6006SS*	30	55	13	1	49.51	36.16	13231	8283	6006SS
6206*	30	62	16	1	55.97	41.58	15975	10274	6206
6206SS*	30	62	16	1	55.97	41.58	15975	10274	6206SS

Consult MinebeaMitsumi for models marked with *.

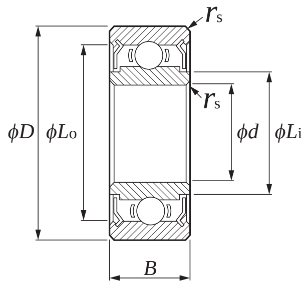
2-1 Metric Design Deep Groove Ball Bearings

Basic type (bearing steel)

R-Series
L-Series
JIS-Series
Inner diameter: 10 mm to 20 mm



Open bearing
Radial Open Ball Bearing



Shielded bearing
Radial Shielded Ball Bearing

(Unit: mm)

Part Numbers	Inner diameter *d*	Outer diameter *D*	Width *B*	Chamfer r_s min.	Shoulder diameter		Basic rating load (N)		Reference
					Outer ring *Lo*	Inner ring *Li*	Dynamic load *Cr*	Static load *Cor*	JIS nominal
6706*	30	37	4	0.2	35.41	32.05	1176	987	6706
6706ZZ*	30	37	4	0.2	35.41	32.05	1176	987	6706ZZ
6806*	30	42	7	0.3	39.44	32.69	4002	3154	6806
6806ZZ*	30	42	7	0.3	39.44	32.69	4002	3154	6806ZZ
6806SS*	30	42	7	0.3	39.44	32.69	4002	3154	6806SS
6906*	30	47	9	0.3	42.80	34.11	7241	5014	6906
6906ZZ*	30	47	9	0.3	42.80	34.11	7241	5014	6906ZZ
6007*	35	62	14	1	55.97	41.58	15975	10274	6007
6007ZZ*	35	62	14	1	55.97	41.58	15975	10274	6007ZZ
6007SS*	35	62	14	1	55.97	41.58	15975	10274	6007SS
6207*	35	72	17	1.1	62.96	45.02	20886	13119	6207
6207SS*	35	72	17	1.1	62.96	45.02	20886	13119	6207SS
6008*	40	68	15	1	61.76	47.00	16780	11538	6008
6008ZZ*	40	68	15	1	61.76	47.00	16780	11538	6008ZZ
6008SS*	40	68	15	1	61.76	47.00	16780	11538	6008SS
6208*	40	80	18	1.1	70.15	51.10	24234	16243	6208

Consult MinebeaMitsumi for models marked with *.

(Unit: mm)

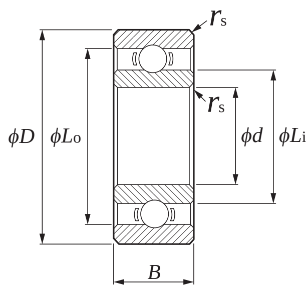
Part Numbers	Inner diameter d	Outer diameter D	Width B	Chamfer r_s min.	Shoulder diameter		Basic rating load (N)		Reference
					Outer ring L_o	Inner ring L_i	Dynamic load C_r	Static load C_{0r}	JIS nominal
6208ZZ*	40	80	18	1.1	70.15	51.10	24234	16243	6208ZZ
6808*	40	52	7	0.3	49.13	42.70	4405	3891	6808
6808ZZ*	40	52	7	0.3	49.13	42.70	4405	3891	6808ZZ
6808SS*	40	52	7	0.3	49.13	42.70	4405	3891	6808SS
6809*	45	58	7	0.3	54.81	49.28	4629	4337	6809
6809ZZ*	45	58	7	0.3	54.81	49.28	4629	4337	6809ZZ
6809SS*	45	58	7	0.3	54.81	49.28	4629	4337	6809SS
6909*	45	68	12	0.6	63.45	50.00	14114	10865	6909
6909ZZ*	45	68	12	0.6	63.45	50.00	14114	10865	6909ZZ
6909SS*	45	68	12	0.6	63.45	50.00	14114	10865	6909SS

Consult MinebeaMitsumi for models marked with *.

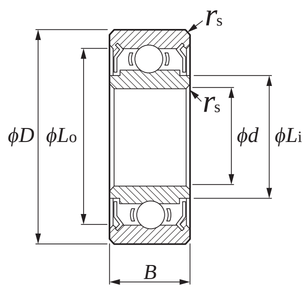
2-1 Metric Design Deep Groove Ball Bearings

Basic type (stainless steel)

R-Series
L-Series
A-Series
Inner diameter: 1 mm to 4 mm



Open bearing
Radial Open Ball Bearing



Shielded bearing
Radial Shielded Ball Bearing

(Unit: mm)

Part Numbers	Inner diameter d	Outer diameter D	Width B	Chamfer r_s min.	Shoulder diameter		Basic rating load (N)		Reference
					Outer ring L_o	Inner ring L_i	Dynamic load C_r	Static load C_{or}	JIS nominal
DDL-310	1	3	1	0.05*	2.41	1.60	80	23	681
DDR-410	1	4	1.6	0.1	3.16	2.05	158	44	691
DDR-410XZZ	1	4	2	(0.05)	3.49	2.26	125	38	-
DDR-412	1.2	4	1.8	0.1	3.16	2.05	158	44	-
DDL-415	1.5	4	1.2	0.05	3.25	2.26	125	38	68/1.5
DDL-415ZZ	1.5	4	2	0.05	3.49	2.26	125	38	-
DDR-515	1.5	5	2	0.15	3.73	2.60	184	57	69/1.5
DDR-515ZZ	1.5	5	2.6	0.15	4.03	2.60	184	57	-
DDR-615	1.5	6	2.5	0.15	4.73	2.90	324	97	60/1.5
DDR-615ZZ	1.5	6	3	0.15	5.06	2.90	324	97	-
DDL-420	2	4	1.2	0.05	3.44	2.57	125	41	672
DDL-520	2	5	1.5	0.08	4.00	2.90	187	59	682
DDL-520ZZ	2	5	2.3	0.08	4.28	2.90	187	59	-
DDL-520W52	2	5	2.5	0.08	4.28	2.90	187	59	-
DDL-520ZZW52	2	5	2.5	0.08	4.28	2.90	187	59	-
DDR-620	2	6	2.3	0.15	4.78	3.16	279	89	692

*Maximum chamfer dimension values do not conform to JIS. Consult MinebeaMitsumi for dimensions.
Figures in parentheses do not meet JIS standards.

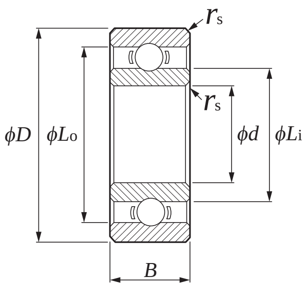
(Unit: mm)

Part Numbers	Inner diameter d	Outer diameter D	Width B	Chamfer r_s min.	Shoulder diameter Outer ring Lo	Shoulder diameter Inner ring Li	Basic rating load (N) Dynamic load Cr	Basic rating load (N) Static load C_{0r}	Reference JIS nominal
DDR-620ZZY32	2	6	2.3	0.15	5.23	3.16	279	89	692ZZ
DDR-620W52	2	6	2.5	0.15	4.93	3.10	330	99	-
DDR-620ZZY52	2	6	2.5	0.15	5.23	3.10	330	99	-
DDR-620ZZ	2	6	3	0.15	5.23	3.10	330	99	-
DDR-720	2	7	2.8	0.15	5.52	3.80	380	126	602
DDR-720ZZ	2	7	3.5	0.15	5.93	3.80	380	126	-
DDR-720ZZY03	2	7	3	0.15	5.93	3.80	380	126	-
DDL-625	2.5	6	1.8	0.08	4.93	3.80	206	73	68/2.5
DDL-625ZZ	2.5	6	2.6	0.08	5.23	3.80	206	73	-
DDR-725	2.5	7	2.5	0.15	5.52	3.80	380	126	69/2.5
DDR-725ZZ	2.5	7	3.5	0.15	5.93	3.80	380	126	-
DDR-825	2.5	8	2.8	0.15	6.53	4.10	553	176	60/2.5
DDR-825ZZ	2.5	8	4	0.15	7.19	4.10	553	176	-
DDL-630	3	6	2	0.08	4.93	3.80	206	73	673
DDL-630ZZ	3	6	2.5	0.08	5.23	3.80	206	73	-
DDL-730	3	7	2	0.1	5.83	4.10	384	129	683
DDL-730ZZ	3	7	3	0.1	6.13	4.10	384	129	-
DDR-830	3	8	3	0.15	6.53	4.10	553	176	693
DDR-830ZZ	3	8	4	0.15	7.19	4.10	553	176	-
DDR-930	3	9	3	0.15	7.23	4.80	634	219	603
DDR-930ZZ	3	9	5	0.15	7.64	4.80	634	219	-
DDR-930ZZY04	3	9	4	0.15	7.64	4.80	634	219	-
DDR-1030	3	10	4	0.15	7.65	5.08	641	226	623
DDR-1030ZZ	3	10	4	0.15	8.20	5.08	641	226	623ZZ
DDL-740	4	7	2	0.08	5.93	4.80	252	106	674
DDL-740ZZ	4	7	2.5	0.08	6.33	4.80	252	106	-
DDL-840	4	8	2	0.1	6.93	5.20	391	140	-
DDL-840ZZ	4	8	3	0.1	7.24	5.20	391	140	-

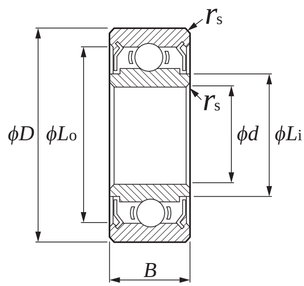
2-1 Metric Design Deep Groove Ball Bearings

Basic type (stainless steel)

R-Series
L-Series
A-Series
Inner diameter: 4 mm to 6 mm



Open bearing
Radial Open Ball Bearing



Shielded bearing
Radial Shielded Ball Bearing

(Unit: mm)

Part Numbers	Inner diameter *d*	Outer diameter *D*	Width *B*	Chamfer *r*s min.	Shoulder diameter: Outer ring *L*o	Shoulder diameter: Inner ring *L*i	Basic rating load (N): Dynamic load *C*r	Basic rating load (N): Static load *C*0r	Reference: JIS nominal
DDL-940	4	9	2.5	0.1	7.48	5.20	641	226	684
DDL-940ZZ	4	9	4	0.1	7.93	5.20	641	226	-
DDL-1040	4	10	3	0.15	7.96	5.80	708	266	-
DDL-1040ZZ	4	10	4	0.15	8.50	5.46	708	266	-
DDR-1140	4	11	4	0.15	8.63	6.40	714	276	694
DDR-1140ZZ	4	11	4	0.15	9.54	6.40	714	276	694ZZ
DDR-1240	4	12	4	0.2	8.95	5.62	959	347	604
DDR-1240ZZ	4	12	4	0.2	9.99	5.62	959	347	604ZZ
DDR-1340	4	13	5	0.2	10.49	7.00	1306	487	624
DDR-1340ZZ	4	13	5	0.2	11.04	7.00	1306	487	624ZZ
DDR-1340DD	4	13	5	0.2	11.04	7.00	1306	487	624DD
DDR-1640	4	16	5	0.3	12.50	7.80	1735	671	634
DDR-1640HH	4	16	5	0.3	13.41	7.80	1735	671	634ZZ
DDL-850	5	8	2	0.08	6.95	5.80	274	130	675
DDL-850ZZ	5	8	2.5	0.08	7.26	5.80	274	130	-
DDL-950	5	9	2.5	0.1	7.73	6.00	495	207	-

(Unit: mm)

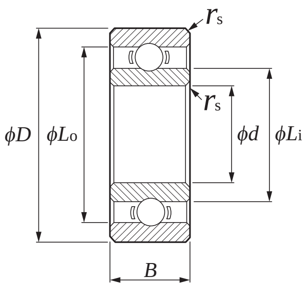
Part Numbers	Inner diameter d	Outer diameter D	Width B	Chamfer r_s min.	Shoulder diameter		Basic rating load (N)		Reference
					Outer ring L_o	Inner ring L_i	Dynamic load C_r	Static load C_{0r}	JIS nominal
DDL-950ZZ	5	9	3	0.1	8.04	6.00	495	207	-
DDL-1050	5	10	3	0.1	8.63	6.40	714	276	-
DDL-1050ZZ	5	10	4	0.1	8.94	6.40	714	276	-
DDL-1050SS	5	10	4	0.1	8.94	6.40	714	276	-
DDL-1150	5	11	3	0.15	8.63	6.40	714	276	685
DDL-1150ZZ	5	11	5	0.15	9.54	6.40	714	276	-
DDL-1150W04	5	11	4	0.15	9.54	6.40	714	276	-
DDL-1150ZZY04	5	11	4	0.15	9.54	6.40	714	276	-
DDR-1350	5	13	4	0.2	10.49	7.00	1306	487	695
DDR-1350ZZ	5	13	4	0.2	11.14	6.66	1074	422	695ZZ
DDR-1450	5	14	5	0.2	12.14	6.88	1329	508	605
DDR-1450ZZ	5	14	5	0.2	12.14	6.88	1329	508	605ZZ
DDR-1650	5	16	5	0.3	12.50	7.80	1735	671	625
DDR-1650HH	5	16	5	0.3	13.41	7.80	1735	671	625ZZ
DDR-1650DD	5	16	5	0.3	13.41	7.80	1735	671	625DD
DDR-1950	5	19	6	0.3	15.63	8.67	2805	1060	635
DDR-1950ZZ	5	19	6	0.3	16.26	8.67	2805	1060	635ZZ
DDL-1060	6	10	2.5	0.1	8.73	6.95	457	194	676
DDL-1060ZZ	6	10	3	0.1	9.04	6.95	457	194	-
DDL-1060DD	6	10	3	0.1	9.04	6.95	457	194	-
DDL-1260	6	12	3	0.15	9.94	7.70	831	363	-
DDL-1260ZZ	6	12	4	0.15	10.48	7.70	831	363	-
DDL-1260X2DD	6	12	4	0.15	10.80	7.70	831	363	-
DDL-1360	6	13	3.5	0.15	10.98	8.00	1083	438	686
DDL-1360ZZ	6	13	5	0.15	11.44	7.33	1083	438	-
DDL-1360DD	6	13	5	0.15	11.44	7.33	1083	438	-
DDR-1560	6	15	5	0.2	13.20	7.80	1735	671	696
DDR-1560ZZ	6	15	5	0.2	13.20	7.80	1735	671	696ZZ

2-1 Metric Design Deep Groove Ball Bearings

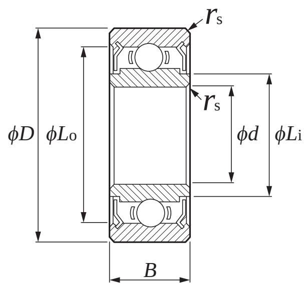
Basic type (stainless steel)

R-Series
L-Series
A-Series

Inner diameter: 6 mm to 10 mm



Open bearing
Radial Open Ball Bearing



Shielded bearing
Radial Shielded Ball Bearing

(Unit: mm)

Part Numbers	Inner diameter *d*	Outer diameter *D*	Width *B*	Chamfer r_s min.	Shoulder diameter		Basic rating load (N)		Reference
					Outer ring *Lo*	Inner ring *Li*	Dynamic load *Cr*	Static load *Cor*	JIS nominal
DDR-1560DD	6	15	5	0.2	13.20	7.80	1735	671	696DD
DDR-1660HH	6	16	5	0.3*	13.41	7.80	1735	671	-
DDR-1760X2	6	17	6	0.3	14.70	8.22	2265	839	606
DDR-1760X2ZZ	6	17	6	0.3	14.70	8.22	2265	839	606ZZ
DDR-1760X2DD	6	17	6	0.3	14.70	8.22	2265	839	606DD
DDR-1960	6	19	6	0.3	15.63	8.67	2805	1060	626
DDR-1960ZZ	6	19	6	0.3	16.26	8.67	2805	1060	626ZZ
DDR-1960DD	6	19	6	0.3	16.29	8.70	2805	1060	626DD
DDL-1170	7	11	2.5	0.1	9.83	8.10	449	199	677
DDL-1170ZZ	7	11	3	0.1	10.14	8.10	449	199	-
DDL-1170DD	7	11	3	0.1	10.14	8.10	449	199	-
DDL-1370	7	13	3	0.15	11.13	8.90	880	414	-
DDL-1370ZZ	7	13	4	0.15	11.54	8.43	880	414	-
DDL-1470	7	14	3.5	0.15	12.03	9.00	1175	511	687
DDL-1470ZZ	7	14	5	0.15	12.45	9.00	1175	511	-
DDR-1970	7	19	6	0.3	16.24	9.55	2240	912	607

*Inner ring chamfer is 0.2 min

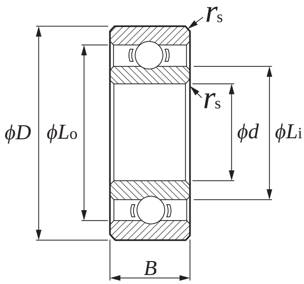
(Unit: mm)

Part Numbers	Inner diameter d	Outer diameter D	Width B	Chamfer r_s min.	Shoulder diameter		Basic rating load (N)		Reference
					Outer ring L_o	Inner ring L_i	Dynamic load C_r	Static load C_{0r}	JIS nominal
DDR-1970ZZ	7	19	6	0.3	16.24	9.55	2240	912	607ZZ
DDR-2270	7	22	7	0.3	19.07	10.80	3297	1368	627
DDR-2270HH	7	22	7	0.3	19.07	10.80	3297	1368	627ZZ
DDL-1280	8	12	2.5	0.1	10.93	9.10	506	249	678
DDL-1280ZZ	8	12	3.5	0.1	11.24	9.10	506	249	-
DDL-1480	8	14	3.5	0.15	12.13	9.90	819	386	-
DDL-1480ZZ	8	14	4	0.15	12.55	9.90	819	386	-
DDL-1680	8	16	4	0.2	13.40	10.30	1606	712	688
DDL-1680HH	8	16	5	0.2	14.23	9.68	1606	712	-
DDL-1680DD	8	16	5	0.2	14.23	9.68	1606	712	-
DDR-1980	8	19	6	0.3	16.24	9.55	2240	912	698
DDR-1980ZZ	8	19	6	0.3	16.24	9.55	2240	912	698ZZ
DDR-1980DD	8	19	6	0.3	16.68	10.60	2463	1059	698DD
DDR-2280	8	22	7	0.3	19.07	10.80	3297	1368	608
DDR-2280HH	8	22	7	0.3	19.07	10.80	3297	1368	608ZZ
DDR-2280DD	8	22	7	0.3	19.10	10.80	3297	1368	608DD
DDL-1790	9	17	4	0.2	14.84	11.20	1724	813	689
DDL-1790ZZ	9	17	5	0.2	15.34	11.20	1724	813	-
DDL-1790DD	9	17	5	0.2	15.34	11.20	1724	813	-
DDL-2090	9	20	6	0.3	16.71	12.32	2123	985	699
DDL-2090ZZ	9	20	6	0.3	17.44	12.32	2123	985	699ZZ
DDA-1510	10	15	3	0.1	13.63	11.25	857	435	6700
DDA-1510ZZ	10	15	4	0.1	14.04	11.25	857	435	-
DDL-1910	10	19	5	0.3	16.71	12.32	2123	985	6800
DDL-1910ZZ	10	19	7	0.3	17.44	12.32	2123	985	-
DDL-1910DD	10	19	7	0.3	17.44	12.32	2123	985	-
DDL-1910ZZY05	10	19	5	0.3	17.44	12.32	2123	985	6800ZZ
DDL-1910DDY05	10	19	5	0.3	17.44	12.32	2123	985	6800DD

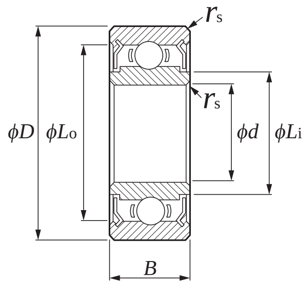
2-1 Metric Design Deep Groove Ball Bearings

Basic type (stainless steel)

R-Series
L-Series
A-Series
Inner diameter: 10 mm to 20 mm



Open bearing
Radial Open Ball Bearing



Shielded bearing
Radial Shielded Ball Bearing

(Unit: mm)

Part Numbers	Inner diameter d	Outer diameter D	Width B	Chamfer r_s min.	Shoulder diameter		Basic rating load (N)		Reference
					Outer ring L_o	Inner ring L_i	Dynamic load C_r	Static load C_{0r}	JIS nominal
DDR-2210X2	10	22	6	0.3	19.08	12.40	2697	1273	6900
DDR-2210X2HH	10	22	6	0.3	19.08	12.40	2697	1273	6900ZZ
DDR-2610	10	26	8	0.3	21.25	13.76	4578	1970	6000
DDR-2610ZZ	10	26	8	0.3	22.69	13.76	4578	1970	6000ZZ
DDA-1812	12	18	4	0.2	16.48	13.52	1386	746	6701
DDL-2112	12	21	5	0.3	19.22	14.40	1917	1042	6801
DDL-2112DD	12	21	5	0.3	19.22	14.40	1917	1042	6801DD
DDL-2112SS	12	21	5	0.3	19.22	14.40	1917	1042	6801SS
DDR-2412X3ZZ	12	24	6	0.3	21.69	14.28	3082	1433	6901ZZ
DDR-2412X3DD	12	24	6	0.3	21.69	14.28	3082	1433	6901DD
DDA-2015	15	20	3.5	0.15	18.43	16.40	944	582	-
DDA-2015ZZ	15	20	4.5	0.15	18.76	16.40	944	582	-
DDA-2115	15	21	3.5	0.15	18.93	16.80	938	581	-
DDA-2115DD	15	21	4	0.15	19.72	16.80	938	581	-
DDL-2415DD	15	24	5	0.3	22.00	17.70	2076	1258	6802DD
DDL-2415SS	15	24	5	0.3	22.00	17.70	2076	1258	6802SS

(Unit: mm)

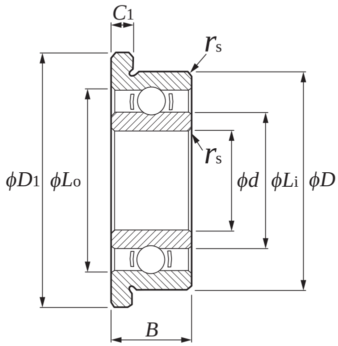
Part Numbers	Inner diameter d	Outer diameter D	Width B	Chamfer r_s min.	Shoulder diameter		Basic rating load (N)		Reference
					Outer ring L_o	Inner ring L_i	Dynamic load C_r	Static load C_{0r}	JIS nominal
DDA-2216	16	22	4	0.15	19.93	17.80	969	619	-
DDA-2216ZZ	16	22	4	0.15	20.72	17.80	969	619	-
DDA-2418	18	24	4	0.15	21.93	19.75	988	654	-
DDA-2520	20	25	4	0.15	23.43	21.35	1012	691	-

2-1 Metric Design Deep Groove Ball Bearings

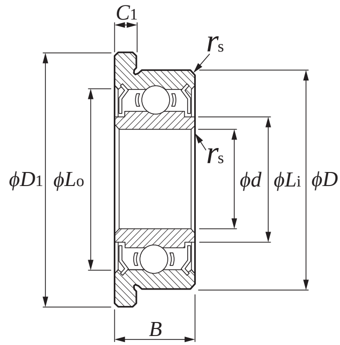
Flanged (bearing steel, stainless steel)

RF-Series LF-Series

Inner diameter: 1 mm to 5 mm



Open bearing
Radial Flanged Open Ball Bearing



Shielded bearing
Radial Flanged Shielded Ball Bearing

(Unit: mm)

Part Numbers	Inner diameter d	Outer diameter D	Width B	Chamfer r_s min.	Flange		Shoulder diameter		Basic rating load (N)		Reference
					Outer diameter D_1	Width C_1	Outer ring L_o	Inner ring L_i	Dynamic load C_r	Static load C_{0r}	JIS nominal
DDLF-310	1	3	1	0.05	3.8	0.3	2.41	1.60	80	23	F681
DDLF-415	1.5	4	1.2	0.05	5.0	0.4	3.25	2.26	125	38	F68/1.5
DDLF-415ZZ	1.5	4	2	0.05	5.0	0.6	3.49	2.26	125	38	-
DDRF-515	1.5	5	2	0.15	6.5	0.6	3.73	2.60	184	57	F69/1.5
DDRF-515ZZ	1.5	5	2.6	0.15	6.5	0.8	4.03	2.60	184	57	-
DDRF-615ZZ	1.5	6	3	0.15	7.5	0.8	5.06	2.90	324	97	-
DDLF-520	2	5	1.5	0.08	6.1	0.5	4.00	2.90	187	59	F682
DDLF-520ZZ	2	5	2.3	0.08	6.1	0.6	4.28	2.90	187	59	-
DDRF-620	2	6	2.3	0.15	7.5	0.6	4.78	3.16	279	89	F692
DDRF-620ZZ	2	6	3	0.15	7.5	0.8	5.23	3.10	330	99	-
DDRF-720ZZ	2	7	3.5	0.15	8.5	0.9	5.93	3.80	380	126	-
DDLF-625ZZ	2.5	6	2.6	0.08	7.1	0.8	5.23	3.80	206	73	-
DDRF-725ZZ	2.5	7	3.5	0.15	8.5	0.9	5.93	3.80	380	126	-
DDRF-825ZZ	2.5	8	4	0.15	9.5	0.9	7.19	4.10	553	176	-
DDLF-630	3	6	2	0.08	7.2	0.6	4.93	3.80	206	73	F673
DDLF-630ZZ	3	6	2.5	0.08	7.2	0.6	5.23	3.80	206	73	-

(Unit: mm)

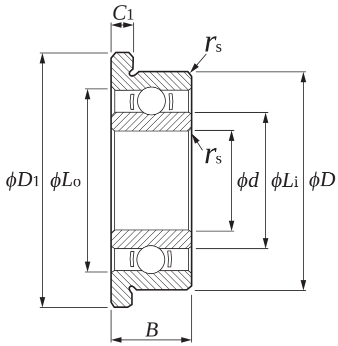
Part Numbers (Note)	Inner diameter d	Outer diameter D	Width B	Chamfer r_s min.	Flange: Outer diameter D_1	Flange: Width C_1	Shoulder diameter: Outer ring L_o	Shoulder diameter: Inner ring L_i	Basic rating load (N): Dynamic load C_r	Basic rating load (N): Static load C_{0r}	Reference: JIS nominal
DDLF-730	3	7	2	0.1	8.1	0.5	5.83	4.10	384	129	F683
DDLF-730ZZ	3	7	3	0.1	8.1	0.8	6.13	4.10	384	129	-
DDRF-830	3	8	3	0.15	9.5	0.7	6.53	4.10	553	176	F693
DDRF-830ZZ	3	8	4	0.15	9.5	0.9	7.19	4.10	553	176	-
DDRF-930ZZ	3	9	5	0.15	10.5	1.0	7.64	4.80	634	219	-
DDRF-1030ZZ	3	10	4	0.15	11.5	1.0	8.20	5.08	641	226	F623ZZ
DDLF-740	4	7	2	0.08	8.2	0.6	5.93	4.80	252	106	F674
DDLF-740ZZ	4	7	2.5	0.08	8.2	0.6	6.33	4.80	252	106	-
DDLF-840	4	8	2	0.1	9.2	0.6	6.93	5.20	391	140	-
DDLF-840ZZ	4	8	3	0.1	9.2	0.6	7.24	5.20	391	140	-
DDLF-940	4	9	2.5	0.1	10.3	0.6	7.48	5.20	641	226	F684
DDLF-940ZZ	4	9	4	0.1	10.3	1.0	7.93	5.20	641	226	-
DDLF-1040	4	10	3	0.15	11.6	0.6	7.96	5.80	708	266	-
DDLF-1040ZZ	4	10	4	0.15	11.6	0.8	8.50	5.46	708	266	-
DDRF-1140ZZ	4	11	4	0.15	12.5	1.0	9.54	6.40	714	276	F694ZZ
DDRF-1240	4	12	4	0.2	13.5	1.0	9.99	5.62	959	347	F604
DDRF-1240ZZ	4	12	4	0.2	13.5	1.0	9.99	5.62	959	347	F604ZZ
DDRF-1340	4	13	5	0.2	15.0	1.0	11.04	7.00	1306	487	F624
DDRF-1340ZZ	4	13	5	0.2	15.0	1.0	11.04	7.00	1306	487	F624ZZ
DDRF-1640	4	16	5	0.3	18.0	1.0	13.20	7.80	1735	671	F634
DDRF-1640ZZ	4	16	5	0.3	18.0	1.0	13.20	7.80	1735	671	F634ZZ
DDLF-850	5	8	2	0.08	9.2	0.6	6.95	5.80	274	130	F675
DDLF-850ZZ	5	8	2.5	0.08	9.2	0.6	7.26	5.80	274	130	-
DDLF-950	5	9	2.5	0.1	10.2	0.6	7.73	6.00	495	207	-
DDLF-950ZZ	5	9	3	0.1	10.2	0.6	8.04	6.00	495	207	-
DDLF-1050	5	10	3	0.1	11.2	0.6	8.63	6.40	714	276	-
DDLF-1050ZZ	5	10	4	0.1	11.6	0.8	8.94	6.40	714	276	-
LF-1050ZZ	5	10	4	0.1	11.6	0.8	8.94	6.40	714	276	-

Note: Columns in white are bearing steel; those in blue are stainless steel.

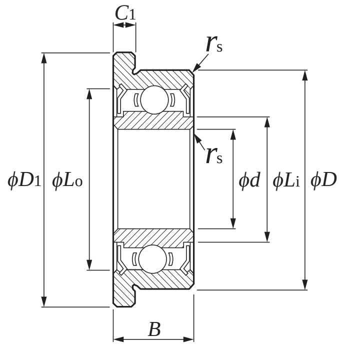
2-1 Metric Design Deep Groove Ball Bearings

Flanged (bearing steel, stainless steel)

RF-Series
LF-Series
Inner diameter: 5 mm to 8 mm



Open bearing
Radial Flanged Open Ball Bearing



Shielded bearing
Radial Flanged Shielded Ball Bearing

(Unit: mm)

Part Numbers (Note)	Inner diameter d	Outer diameter D	Width B	Chamfer r_s min.	Flange		Shoulder diameter		Basic rating load (N)		Reference
					Outer diameter D_1	Width C_1	Outer ring L_o	Inner ring L_i	Dynamic load C_r	Static load C_{or}	JIS nominal
DDLF-1150	5	11	3	0.15	12.5	0.8	8.63	6.40	714	276	F685
DDLF-1150ZZ	5	11	5	0.15	12.5	1.0	9.54	6.40	714	276	-
LF-1150ZZ	5	11	5	0.15	12.5	1.0	9.54	6.40	714	276	-
DDRF-1350	5	13	4	0.2	15.0	1.0	11.14	6.66	1074	422	F695
DDRF-1350ZZ	5	13	4	0.2	15.0	1.0	11.14	6.66	1074	422	F695ZZ
DDRF-1450	5	14	5	0.2	16.0	1.0	12.14	6.88	1329	508	F605
DDRF-1450ZZ	5	14	5	0.2	16.0	1.0	12.14	6.88	1329	508	F605ZZ
RF-1450ZZ	5	14	5	0.2	16.0	1.0	12.14	6.88	1329	508	F605ZZ
DDRF-1650	5	16	5	0.3	18.0	1.0	13.41	7.80	1735	671	F625
DDRF-1650HH	5	16	5	0.3	18.0	1.0	13.41	7.80	1735	671	F625ZZ
DDRF-1950	5	19	6	0.3	22.0	1.5	15.60	8.67	2805	1060	F635
DDRF-1950ZZ	5	19	6	0.3	22.0	1.5	16.26	8.67	2805	1060	F635ZZ
DDLF-1060	6	10	2.5	0.1	11.2	0.6	8.73	6.95	457	194	F676
DDLF-1060ZZ	6	10	3	0.1	11.2	0.6	9.04	6.95	457	194	-
LF-1060ZZ	6	10	3	0.1	11.2	0.6	9.04	6.95	457	194	-
DDLF-1260	6	12	3	0.15	13.2	0.6	9.94	7.70	831	363	-

Note: Columns in white are bearing steel; those in blue are stainless steel.

(Unit: mm)

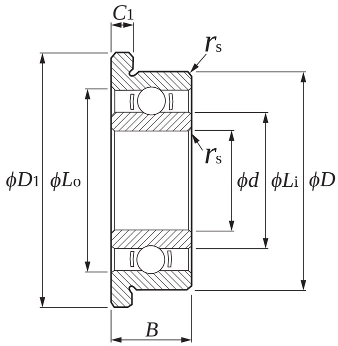
Part Numbers (Note)	Inner diameter d	Outer diameter D	Width B	Chamfer r_s min.	Flange: Outer diameter D_1	Flange: Width C_1	Shoulder diameter: Outer ring L_o	Shoulder diameter: Inner ring L_i	Basic rating load (N): Dynamic load C_r	Basic rating load (N): Static load C_{0r}	Reference: JIS nominal
DDLF-1260ZZ	6	12	4	0.15	13.6	0.8	10.48	7.70	831	363	-
LF-1260ZZ	6	12	4	0.15	13.6	0.8	10.48	7.70	831	363	-
DDLF-1360	6	13	3.5	0.15	15.0	1.0	10.98	8.00	1083	438	F686
DDLF-1360ZZ	6	13	5	0.15	15.0	1.1	11.44	7.33	1083	438	-
LF-1360ZZ	6	13	5	0.15	15.0	1.1	11.44	7.33	1083	438	-
DDRF-1560	6	15	5	0.2	17.0	1.2	13.20	7.80	1735	671	F696
DDRF-1560ZZ	6	15	5	0.2	17.0	1.2	13.20	7.80	1735	671	F696ZZ
DDRF-1760X2	6	17	6	0.3	19.0	1.2	14.70	8.22	2265	839	F606
DDRF-1760X2ZZ	6	17	6	0.3	19.0	1.2	14.70	8.22	2265	839	F606ZZ
RF-1760X2ZZ	6	17	6	0.3	19.0	1.2	14.70	8.22	2265	839	F606ZZ
DDRF-1960	6	19	6	0.3	22.0	1.5	16.26	8.67	2805	1060	F626
DDRF-1960ZZ	6	19	6	0.3	22.0	1.5	16.26	8.67	2805	1060	F626ZZ
RF-1960ZZ	6	19	6	0.3	22.0	1.5	16.26	8.67	2805	1060	F626ZZ
DDLF-1170	7	11	2.5	0.1	12.2	0.6	9.83	8.10	449	199	F677
DDLF-1170ZZ	7	11	3	0.1	12.2	0.6	10.14	8.10	449	199	-
DDLF-1370	7	13	3	0.15	14.2	0.6	11.13	8.90	880	414	-
DDLF-1370ZZ	7	13	4	0.15	14.6	0.8	11.54	8.43	880	414	-
DDLF-1470	7	14	3.5	0.15	16.0	1.0	12.03	9.00	1175	511	F687
DDLF-1470ZZ	7	14	5	0.15	16.0	1.1	12.45	9.00	1175	511	-
DDRF-1970ZZ	7	19	6	0.3	22.0	1.5	16.24	9.55	2240	912	F607ZZ
DDRF-1970DD	7	19	6	0.3	22.0	1.5	16.24	9.55	2240	912	F607DD
DDRF-2270	7	22	7	0.3	25.0	1.5	19.07	10.80	3297	1368	F627
DDRF-2270HH	7	22	7	0.3	25.0	1.5	19.07	10.80	3297	1368	F627ZZ
DDLF-1280	8	12	2.5	0.1	13.2	0.6	10.93	9.10	506	249	F678
DDLF-1280ZZ	8	12	3.5	0.1	13.6	0.8	11.24	9.10	506	249	-
DDLF-1280DD	8	12	3.5	0.1	13.6	0.8	11.24	9.10	506	249	-
DDLF-1480	8	14	3.5	0.15	15.6	0.8	12.13	9.90	819	386	-
DDLF-1480ZZ	8	14	4	0.15	15.6	0.8	12.55	9.90	819	386	-

Note: Columns in white are bearing steel; those in blue are stainless steel.

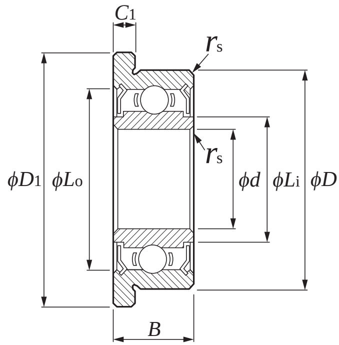
2-1 Metric Design Deep Groove Ball Bearings

Flanged (bearing steel, stainless steel)

RF-Series
LF-Series
Inner diameter: 8 mm to 10 mm



Open bearing
Radial Flanged Open Ball Bearing



Shielded bearing
Radial Flanged Shielded Ball Bearing

(Unit: mm)

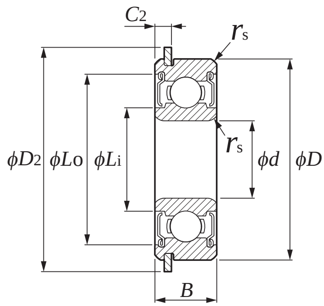
Part Numbers (Note)	Inner diameter d	Outer diameter D	Width B	Chamfer r_s min.	Flange		Shoulder diameter		Basic rating load (N)		Reference
					Outer diameter D_1	Width C_1	Outer ring L_o	Inner ring L_i	Dynamic load C_r	Static load C_{0r}	JIS nominal
LF-1480X3ZZ	8	14	4	0.15	15.6	0.8	11.77	9.20	878	419	-
LF-1480DD	8	14	4	0.15	15.6	0.8	12.70	9.90	819	386	-
DDLF-1680	8	16	4	0.2	18.0	1.0	13.40	10.30	1606	712	F688
DDLF-1680HH	8	16	5	0.2	18.0	1.1	14.23	9.68	1606	712	-
LF-1680HH	8	16	5	0.2	18.0	1.1	14.18	9.68	1606	712	-
DDRF-1980	8	19	6	0.3	22.0	1.5	16.24	9.55	2240	912	F698
DDRF-1980ZZ	8	19	6	0.3	22.0	1.5	16.24	9.55	2240	912	F698ZZ
DDRF-1980DD	8	19	6	0.3	22.0	1.5	16.68	10.60	2463	1059	F698DD
DDRF-2280	8	22	7	0.3	25.0	1.5	18.89	10.80	3297	1368	F608
DDRF-2280HH	8	22	7	0.3	25.0	1.5	19.07	10.80	3297	1368	F608ZZ
RF-2280	8	22	7	0.3	25.0	1.5	18.89	10.80	3297	1368	F608
RF-2280HH	8	22	7	0.3	25.0	1.5	19.07	10.80	3297	1368	F608ZZ
DDLF-1790	9	17	4	0.2	19.0	1.0	14.84	11.20	1724	813	F689
DDLF-1790ZZ	9	17	5	0.2	19.0	1.1	15.34	11.20	1724	813	-
DDLF-1910ZZ	10	19	7	0.3	22.0	1.5	17.44	12.32	2123	985	-
DDRF-2210X2HH	10	22	6	0.3	25.0	1.5	19.08	12.40	2697	1273	F6900ZZ

Note: Columns in white are bearing steel; those in blue are stainless steel.

With locating snap ring (bearing steel)

NR-Series

Inner diameter: 5 mm to 12 mm



Shielded bearing

Radial Shielded Ball Bearing with locating snap ring

(Unit: mm)

Part Numbers	Inner diameter	Outer diameter	Width	Chamfer	Locating snap ring		Shoulder diameter		Basic rating load (N)		Reference
					Outer diameter	Position	Shields/seals		Dynamic load	Static load	
	d	D	B	r_s min.	D_2	C_2	Outer ring Lo	Inner ring Li	Cr	C_{0r}	JIS nominal
RNR-1350ZZ	5	13	4	0.2	14.8	1.00	11.14	6.66	1074	422	695ZZNR
RNR-1350DD	5	13	4	0.2	14.8	1.00	11.14	6.66	1074	422	695DDNR
LNR-1360X3ZZ	6	13	5	0.15	14.5	1.10	10.48	7.70	831	363	686ZZNR
RNR-1560ZZ	6	15	5	0.2	17.2	1.50	13.20	7.80	1735	671	696ZZNR
RNR-1560DD	6	15	5	0.2	17.2	1.50	13.20	7.80	1735	671	696DDNR
RNR-1760X2KK	6	17	6	0.3	19.2	1.20	14.70	8.22	2265	839	606ZZNR
RNR-1760X2DD	6	17	6	0.3	19.2	1.20	14.70	8.22	2265	839	606DDNR
626ZZNR	6	19	6	0.3	22.1	1.50	16.68	9.20	2614	1053	626ZZNR
626DDNR	6	19	6	0.3	22.1	1.50	16.68	9.20	2614	1053	626DDNR
RNR-4KK	6.350	15.875	4.978	0.3	18.5	1.80	13.03	8.20	1470	599	-
LNR-1680KK	8	16	5	0.2	18.2	0.95	14.18	9.68	1606	712	-
LNR-1680DD	8	16	5	0.2	18.2	0.95	14.18	9.68	1606	712	-
608ZZNRSD06	8	22	7	0.3	25.1	2.30	19.10	10.80	3297	1368	608ZZNR
608DDNRSD06	8	22	7	0.3	25.1	2.30	19.10	10.80	3297	1368	608DDNR
RNR-2210X9KKSD21	10	22	6	0.3	24.7	1.62	19.40	13.40	2697	1273	6900ZZNR
RNR-2412X3KK	12	24	6	0.3	26.8	1.62	21.69	14.28	3082	1433	6901ZZNR

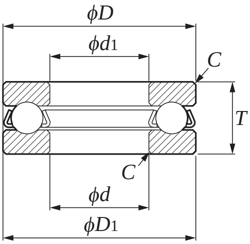
2-2 Metric Design Thrust Ball Bearings

Caution: Thrust ball bearing dimension tolerances do not conform to JIS.
Consult MinebeaMitsumi for dimension tolerances.

(Stainless steel) With groove

T-DSG Series

Inner diameter: 3 mm to 10 mm



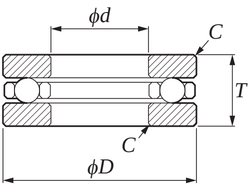
(Unit: mm)

Part Numbers	Main dimensions						Basic rating load (N)	
	Inner diameter d	Inner diameter d_1	Outer diameter D	Outer diameter D_1	Height T	Chamfer C	Dynamic load Ca	Static load C_{0a}
DDT-830DSG	3	3.1	8	8	3.5	0.2	1788	1725
DDT-1040DSG	4	4.1	10	10	4.5	0.2	1926	2218
DDT-1050DSG	5	5.1	10	10	4	0.2	1926	2218
DDT-1260DSG	6	6.2	12	12	4.5	0.2	1824	2218
DDT-1570DSG	7	7.2	15	15	5.5	0.3	2476	3144
DCT-1680X2DSG	8	8.2	16	16	5	0.3	3918	4990
DDT-1810DSG	10	10.2	18	18	5.5	0.3	5119	7452

(Stainless steel) Without groove

T-Series

Inner diameter: 3 mm to 10 mm



(Unit: mm)

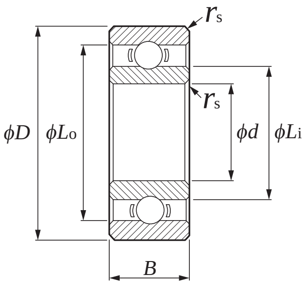
Part Numbers	Main dimensions			
	Inner diameter d	Outer diameter D	Height T	Chamfer C
DDT-830	3	8	3.5	0.2
DDT-940	4	9	4.0	0.2
DDT-1150	5	11	4.5	0.2
DDT-1260	6	12	4.5	0.2
DDT-1570	7	15	5.0	0.3
DDT-1680	8	16	5.0	0.3
DDT-1790	9	17	5.0	0.3
DDT-1810	10	18	5.5	0.3

NMB

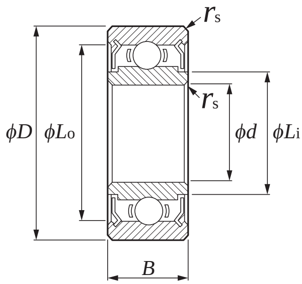
Basic type (bearing steel, stainless steel)

RI-Series (R-Series)

Inner diameter: 1.016 mm to 3.175 mm



Open bearing
Radial Open Ball Bearing



Shielded bearing
Radial Shielded Ball Bearing

(Unit: mm)

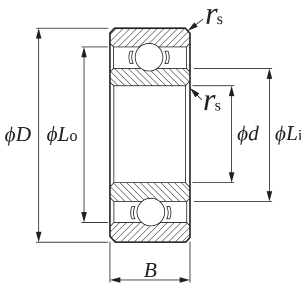
Part Numbers	Inner diameter d	Outer diameter D	Width B	Chamfer r_s min.	Shoulder diameter		Basic rating load (N)	
					Outer ring Lo	Inner ring Li	Dynamic load Cr	Static load C_{0r}
DDRI-2X2	1.016	3.175	1.191	0.08	2.56	1.64	106	28
DDRI-2 1/2	1.191	3.967	1.588	0.08	3.16	2.05	158	44
DDRI-2 1/2ZZ	1.191	3.967	2.380	0.08	3.43	2.05	158	44
DDRI-3	1.397	4.762	1.984	0.08	4.02	2.36	264	71
DDRI-3ZZ	1.397	4.762	2.779	0.08	4.29	2.36	264	71
DDRI-4	1.984	6.350	2.380	0.08	4.90	3.10	330	99
DDRI-4ZZ	1.984	6.350	3.571	0.08	5.23	3.10	330	99
DDRI-3332	2.380	4.762	1.588	0.08	4.13	3.00	187	59
DDRI-3332ZZ	2.380	4.762	2.380	0.08	4.28	3.00	187	59
DDRI-5	2.380	7.938	2.779	0.08	6.88	4.40	563	183
DDRI-5ZZ	2.380	7.938	3.571	0.08	7.19	4.40	563	183
DDRI-418	3.175	6.350	2.380	0.08	5.52	4.10	285	97
DDRI-418ZZ	3.175	6.350	2.779	0.08	5.85	4.10	285	97
DDRI-518	3.175	7.938	2.779	0.08	6.88	4.40	563	183
DDRI-518ZZ	3.175	7.938	3.571	0.08	7.19	4.40	563	183
DDR-2	3.175	9.525	3.967	0.3	7.65	5.08	641	226

2-3 Inch Design Deep Groove Ball Bearings

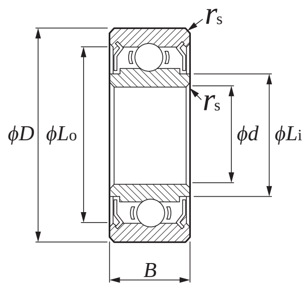
Basic type (bearing steel, stainless steel)

RI-Series (R-Series)

Inner diameter: 3.175 mm to 12.700 mm



Open bearing
Radial Open Ball Bearing



Shielded bearing
Radial Shielded Ball Bearing

(Unit: mm)

Part Numbers (Note)	Inner diameter d	Outer diameter D	Width B	Chamfer r_s min.	Shoulder diameter		Basic rating load (N)	
					Outer ring L_o	Inner ring L_i	Dynamic load C_r	Static load C_{0r}
DDR-2ZZ	3.175	9.525	3.967	0.3	8.19	5.08	641	226
R-2KK1	3.175	9.525	3.967	0.3	8.22	5.20	641	226
R-2DD	3.175	9.525	3.967	0.3	7.89	4.68	641	226
DDRI-618	3.175	9.525	2.779	0.13	6.88	4.40	563	183
DDRI-618ZZ	3.175	9.525	3.571	0.13	7.20	4.40	563	183
DDRI-5532	3.967	7.938	2.779	0.08	7.08	5.62	391	142
DDRI-5532ZZ	3.967	7.938	3.175	0.08	7.31	5.62	391	142
DDRI-5632	4.762	7.938	2.779	0.08	7.08	5.62	391	142
DDRI-5632ZZ	4.762	7.938	3.175	0.08	7.31	5.62	391	142
DDRI-6632	4.762	9.525	3.175	0.08	8.72	5.97	712	271
DDRI-6632ZZ	4.762	9.525	3.175	0.08	8.72	5.97	712	271
RI-6632ZZ	4.762	9.525	3.175	0.08	8.72	5.97	712	271
DDR-3	4.762	12.700	3.967	0.3	10.49	7.00	1306	487
DDR-3ZZ	4.762	12.700	4.978	0.3	11.00	7.00	1306	487
R-3HH	4.762	12.700	4.978	0.3	11.00	7.00	1306	487
R-3DD	4.762	12.700	4.978	0.3	11.00	7.00	1306	487

Note: Columns in white are bearing steel; those in blue are stainless steel.

(Unit: mm)

Part Numbers (Note)	Inner diameter d	Outer diameter D	Width B	Chamfer r_s min.	Shoulder diameter: Outer ring Lo	Shoulder diameter: Inner ring Li	Basic rating load (N): Dynamic load Cr	Basic rating load (N): Static load C_{0r}
DDRI-614	6.350	9.525	3.175	0.08	8.63	7.25	417	205
DDRI-614ZZ	6.350	9.525	3.175	0.08	8.88	7.25	417	205
DDRI-814	6.350	12.700	3.175	0.13	10.98	8.38	828	374
DDRI-814ZZ	6.350	12.700	4.762	0.13	11.55	8.38	828	374
RI-814ZZ	6.350	12.700	4.762	0.13	11.55	8.38	828	374
DDR-4	6.350	15.875	4.978	0.3	13.03	8.20	1470	599
DDR-4HH	6.350	15.875	4.978	0.3	13.03	8.20	1470	599
DDR-4SS	6.350	15.875	4.978	0.3	13.03	8.20	1470	599
R-4KK	6.350	15.875	4.978	0.3	13.03	8.20	1470	599
R-4DD	6.350	15.875	4.978	0.3	13.03	8.20	1470	599
R-4SS	6.350	15.875	4.978	0.3	13.03	8.20	1470	599
DDRI-1214	6.350	19.050	5.558	0.41	15.19	9.80	2411	912
DDRI-1214ZZ	6.350	19.050	7.142	0.41	16.28	8.63	2411	912
RI-1214ZZ	6.350	19.050	7.142	0.41	16.28	8.63	2411	912
DDRI-8516	7.938	12.700	3.967	0.13	11.44	9.20	878	419
DDRI-8516ZZ	7.938	12.700	3.967	0.13	11.77	9.20	878	419
DDRI-1038	9.525	15.875	3.967	0.25	13.78	11.63	906	477
DDRI-1038ZZ	9.525	15.875	3.967	0.25	14.16	11.63	906	477
DDRI-1438	9.525	22.225	5.558	0.41	18.83	13.22	3334	1413
DDRI-1438ZZ	9.525	22.225	7.142	0.41	19.89	12.05	3334	1413
RI-1438	9.525	22.225	5.558	0.41	18.00	12.40	3297	1368
RI-1438KK	9.525	22.225	7.142	0.41	19.10	12.40	3297	1368
RI-1438DD	9.525	22.225	7.142	0.41	19.10	12.40	3297	1368
RI-1438SS	9.525	22.225	7.142	0.41	19.10	12.40	3297	1368
DDRI-1212ZZ	12.700	19.050	3.967	0.25	17.49	14.90	1051	662
DDRI-1812	12.700	28.575	6.350	0.41	23.20	17.80	4033	2003
DDRI-1812ZZ	12.700	28.575	7.938	0.41	24.54	15.93	4033	2003
RI-1812KK	12.700	28.575	7.938	0.41	25.13	16.00	5113	2387

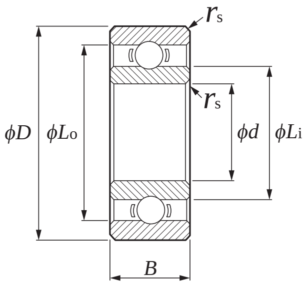
Note: Columns in white are bearing steel; those in blue are stainless steel.

2-3 Inch Design Deep Groove Ball Bearings

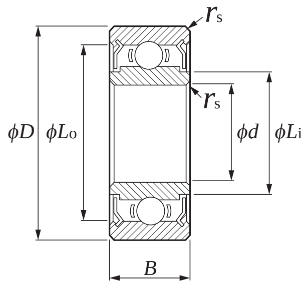
Basic type (bearing steel, stainless steel)

RI-Series (R-Series)

Inner diameter: 15.875 mm to 19.050 mm



Open bearing
Radial Open Ball Bearing



Shielded bearing
Radial Shielded Ball Bearing

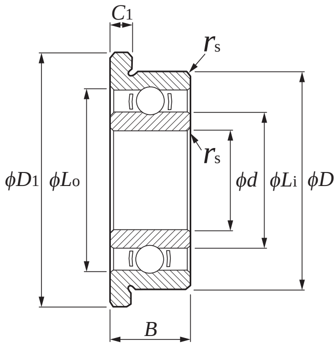
(Unit: mm)

Part Numbers	Inner diameter *d*	Outer diameter *D*	Width *B*	Chamfer r_s min.	Shoulder diameter		Basic rating load (N)	
					Outer ring L_o	Inner ring L_i	Dynamic load C_r	Static load C_{0r}
DDRI-1458ZZ	15.875	22.225	3.967	0.25	20.69	18.10	1093	742
DDRI-1634	19.050	25.400	3.967	0.25	23.84	21.25	1203	894
DDRI-1634ZZ	19.050	25.400	3.967	0.25	23.84	21.25	1203	894

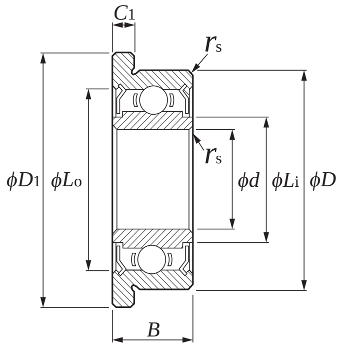
Flanged (bearing steel, stainless steel)

RIF-Series

Inner diameter: 1.016 mm to 3.175 mm



Open bearing
Radial Flanged Open Ball Bearing



Shielded bearing
Radial Flanged Shielded Ball Bearing

(Unit: mm)

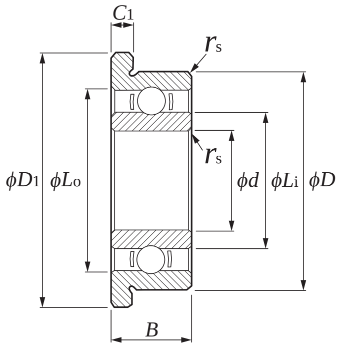
Part Numbers	Inner diameter d	Outer diameter D	Width B	Chamfer r_s min.	Flange		Shoulder diameter		Basic rating load (N)	
					Outer diameter D_1	Width C_1	Outer ring L_o	Inner ring L_i	Dynamic load C_r	Static load C_{0r}
DDRIF-2X2	1.016	3.175	1.191	0.08	4.343	0.33	2.56	1.64	106	28
DDRIF-2 1/2	1.191	3.967	1.588	0.08	5.156	0.33	3.16	2.05	158	44
DDRIF-2 1/2ZZ	1.191	3.967	2.380	0.08	5.156	0.79	3.43	2.05	158	44
DDRIF-3	1.397	4.762	1.984	0.08	5.944	0.58	4.02	2.36	264	71
DDRIF-4	1.984	6.350	2.380	0.08	7.518	0.58	4.90	3.10	330	99
DDRIF-4ZZ	1.984	6.350	3.571	0.08	7.518	0.79	5.23	3.10	330	99
DDRIF-3332	2.380	4.762	1.588	0.08	5.944	0.46	4.13	3.00	187	59
DDRIF-3332ZZ	2.380	4.762	2.380	0.08	5.944	0.79	4.28	3.00	187	59
DDRIF-5	2.380	7.938	2.779	0.08	9.119	0.58	6.88	4.40	563	183
DDRIF-5ZZ	2.380	7.938	3.571	0.08	9.119	0.79	7.19	4.40	563	183
DDRIF-418	3.175	6.350	2.380	0.08	7.518	0.58	5.52	4.10	285	97
DDRIF-418ZZ	3.175	6.350	2.779	0.08	7.518	0.79	5.85	4.10	285	97
DDRIF-518	3.175	7.938	2.779	0.08	9.119	0.58	6.88	4.40	563	183
DDRIF-518ZZ	3.175	7.938	3.571	0.08	9.119	0.79	7.19	4.40	563	183
DDRF-2	3.175	9.525	3.967	0.3	11.176	0.76	7.65	5.08	641	226
DDRF-2ZZ	3.175	9.525	3.967	0.3	11.176	0.76	8.19	5.08	641	226

2-3 Inch Design Deep Groove Ball Bearings

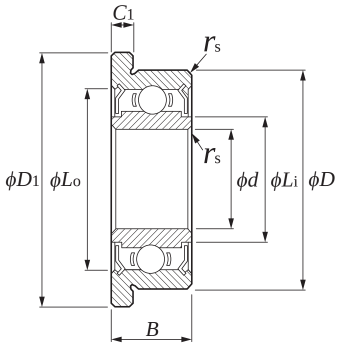
Flanged (bearing steel, stainless steel)

RIF-Series

Inner diameter: 3.175 mm to 9.525 mm



Open bearing
Radial Flanged Open Ball Bearing



Shielded bearing
Radial Flanged Shielded Ball Bearing

(Unit: mm)

Part Numbers (Note)	Inner diameter d	Outer diameter D	Width B	Chamfer r_s min.	Flange		Shoulder diameter		Basic rating load (N)	
					Outer diameter D_1	Width C_1	Outer ring L_o	Inner ring L_i	Dynamic load C_r	Static load C_{0r}
DDRIF-618	3.175	9.525	2.779	0.13	10.719	0.58	6.88	4.40	563	183
DDRIF-618ZZ	3.175	9.525	3.571	0.13	10.719	0.79	7.20	4.40	563	183
DDRIF-5532ZZ	3.967	7.938	3.175	0.08	9.119	0.91	7.31	5.62	391	142
DDRIF-5632	4.762	7.938	2.779	0.08	9.119	0.58	7.08	5.62	391	142
DDRIF-5632ZZ	4.762	7.938	3.175	0.08	9.119	0.91	7.31	5.62	391	142
DDRIF-6632	4.762	9.525	3.175	0.08	10.719	0.58	8.25	5.97	712	271
DDRIF-6632ZZ	4.762	9.525	3.175	0.08	10.719	0.79	8.72	5.97	712	271
DDRF-3	4.762	12.700	3.967	0.3	14.351	1.07	10.49	7.00	1306	487
DDRF-3ZZ	4.762	12.700	4.978	0.3	14.351	1.07	11.00	7.00	1306	487
DDRIF-614	6.350	9.525	3.175	0.08	10.719	0.58	8.63	7.25	417	205
DDRIF-614ZZ	6.350	9.525	3.175	0.08	10.719	0.91	8.88	7.25	417	205
DDRIF-814	6.350	12.700	3.175	0.13	13.894	0.58	10.98	8.38	828	374
DDRIF-814ZZ	6.350	12.700	4.762	0.13	13.894	1.14	11.55	8.38	828	374
DDRF-4HH	6.350	15.875	4.978	0.3	17.526	1.07	13.03	8.20	1470	599
RF-4HH	6.350	15.875	4.978	0.3	17.526	1.07	13.03	8.20	1470	599
DDRIF-8516	7.938	12.700	3.967	0.13	13.894	0.79	11.44	9.20	878	419

Note: Columns in white are bearing steel; those in blue are stainless steel.

(Unit: mm)

Part Numbers Note	Inner diameter d	Outer diameter D	Width B	Chamfer r_s min.	Flange Outer diameter D_1	Flange Width C_1	Shoulder diameter Outer ring L_o	Shoulder diameter Inner ring L_i	Basic rating load (N) Dynamic load C_r	Basic rating load (N) Static load C_{0r}
DDRIF-8516ZZ	7.938	12.700	3.967	0.13	13.894	0.79	11.77	9.20	878	419
DDRIF-1438ZZ	9.525	22.225	7.142	0.41	24.613	1.57	19.89	12.05	3334	1413
RIF-1438KK	9.525	22.225	7.142	0.41	24.613	1.58	19.10	12.40	3297	1368
RIF-1438DD	9.525	22.225	7.142	0.41	24.613	1.58	19.10	12.40	3297	1368

Note: Columns in white are bearing steel; those in blue are stainless steel.

3 Other Products

3-1 Other Products

Precision Mechanical Component (PMC)

These unit products use high-accuracy bearings made in-house by MinebeaMitsumi.
Higher accuracy and quality are achieved through the ultra-precision machining technology developed through manufacturing our bearings and the know-how required for assembly with other parts.

Main specifications

Material	Stainless steel-based	SUS3xx, SUS4xx, SUS6xx, etc.
	Bearing steel/ferric materials	SUJ2, SUMxx, SCMxx, etc.
	Aluminum alloy	A5xxx, A6xxx, etc.
	Brass	C3604, C6801, etc.
	Resin	POM, PEEK, etc.
Size		Outer diameter 65 mm or below Length 440 mm or below
Heat treatment		Quenching, tempering
Machining		Cutting Grinding (centerless polishing, cylindrical grinding) Milling, etc.
Surface treatment		Electroless nickel plating Hard chromium plating Hard anodizing Nitriding DLC

*Support for other options may also be available; contact MinebeaMitsumi.

Ball bearing cartridges for turbo charger

The ball bearing cartridges for automobile turbo chargers have high heat resistance.

Bearings for special applications

These bearings, using the performance of ceramic and special metals, are ideal for use in extreme environments*. They are used mainly for applications in medicine, aerospace, plant facilities, and so on. Bearings for special applications are manufactured by myonic, a member of the MinebeaMitsumi Group.

*Refers to extreme environments such as vacuum, high temperatures, corrosion, high-speed rotation, drying lubricants, and so on.

3-1 Other Products

Ceramic bearings

Ceramic (Si_3N_4) bearings are widely applicable to various environments, available for various applications due to their corrosion resistance, heat resistance, insulation, and light weight. Ceramic bearings are manufactured by CEROBEAR and NHBB, which are members of the MinebeaMitsumi Group.

Bearings for machine tool bases

According to the arrangement of the load-bearing rolling elements, these bearings can be roughly divided into 3-roller bearings (also called axial-radial bearings), double-row angular roller bearings, and cross roller bearings.
Bearings for machine tool bases are manufactured by myonic, a member of the MinebeaMitsumi Group.

3-roller bearing

Double-row angular roller bearing

Cross roller bearing

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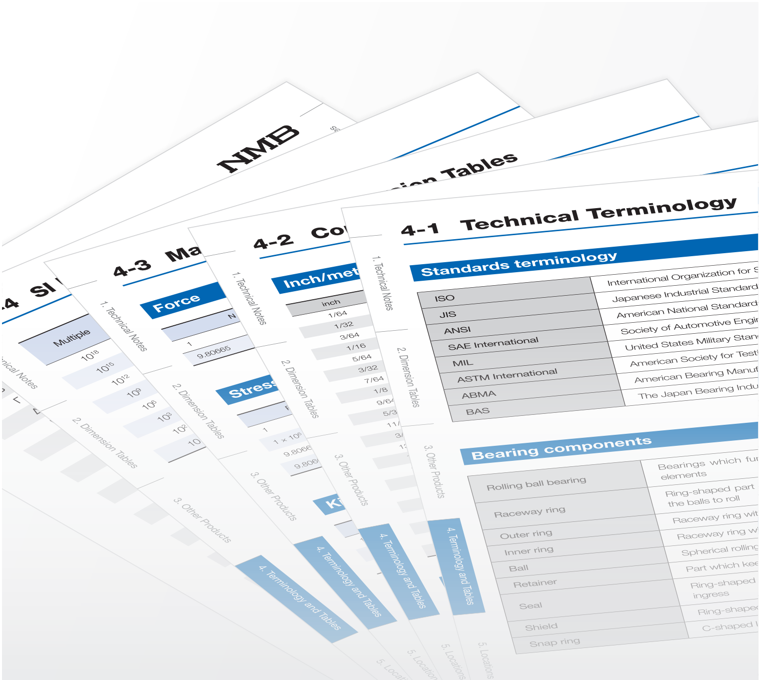


4 Terminology and Tables

4-1 Technical Terminology

Standards terminology

ISO	International Organization for Standardization
JIS	Japanese Industrial Standards
ANSI	American National Standards Institute
SAE International	Society of Automotive Engineers
MIL	United States Military Standard
ASTM International	American Society for Testing and Materials
ABMA	American Bearing Manufacturers Association
BAS	The Japan Bearing Industrial Association Standards

Bearing components

Rolling ball bearing	Bearings which function through rolling motion, using balls for rolling elements
Raceway ring	Ring-shaped part (inner and outer rings) with a path (raceway groove) for the balls to roll
Outer ring	Raceway ring with a path on the inside, usually inserted into housing
Inner ring	Raceway ring with a path on the outside, with shaft usually run through
Ball	Spherical rolling element
Retainer	Part which keeps balls equidistant on the orbital raceway
Seal	Ring-shaped rubber lid which prevents lubricant leakage or contamination ingress
Shield	Ring-shaped metal lid which prevents contamination ingress
Snap ring	C-shaped locating snap ring which fixes the shield

Dimensions and tolerances

Nominal outer diameter	Reference value against the outer ring outer diameter (bearing outer diameter)/actual outer diameter tolerance
Nominal inner diameter	Reference value against the inner ring inner diameter (bearing inner diameter)/actual inner diameter tolerance
Pitch circle diameter	Ball (rolling element) orbital raceway diameter
Radial runout	Raceway ring runout in the radial direction
Axial runout	Raceway ring runout in the axial direction
Inequality of width	Difference between the maximum and minimum width of one raceway ring

Lubricants

Grease	Semi-solid lubricant in which base oil is diffused by thickener
Viscosity	Measure of the viscousness of lubricant oil
Penetration	Measure of the hardness of grease
Thickener	Used to retain the base oil and keep the grease semi-solid
Drop point	Temperature at which the grease will melt and drip
Oil separation	Degree to which the base oil separates
Soap	One type of thickener
Base oil	Oil used as the base of lubricants
Oil film	The oil film formed between the balls and the raceway ring
Channeling type and churning type	When the bearing is rotated and the passage of the rolling elements shifts the grease, one type of grease is likely to accumulate there while the other tends to cling once again to the rolling element surfaces and raceway groove. The former type of grease is called the channeling type and the latter the churning type.

4-1 Technical Terminology

Applications and usage methods

Preload	The axial load applied in advance to bearings in order to enhance rigidity and suppress runout and impact
Radial load	Load applied in radial direction
Axial load	Load applied in axial direction
Life	Total number of rotations or time until the bearing is unable to perform its function
Fit	Combination of shaft and inner ring inner diameter or housing and outer ring outer diameter
dmn value	Product of pitch circle diameter and rotation speed
NRRO	Non-repetitive runout
Starting torque	Torque when the bearing starts rotation
Roating torque	Torque when the bearing is rotating
Rigidity	Degree to which displacement and deformation are unlikely to occur when force is applied to the component elements
Inherent vibration	In ball bearings, vibration with the balls acting as springs
Vibration frequency	The vibration unique to the bearing
Cogging	Resistance (catching) when the bearing is starting
Subside amount	Width dimension of the inner and outer ring overlapping part during preload
Surface pressure	Force per unit of surface area in the contact area of the balls and raceway surface
Total load	The composite of radial and axial loads
Misalignment	Embedding error of bearing into device

Damage

Rolling contact traces	Marks of the balls rolling in the raceway groove
Indentation	Marks of plastic deformation on the raceway groove
Brinelling	Marks of plastic deformation from the balls on the raceway groove
Fretting corrosion	Wear accompanying oxidation due to slight vibration (also called false indentation)
Flaking	Scaling of the raceway groove due to metal fatigue
Creep	Fit surface sliding
Pitching	Small holes on the raceway groove due to metal fatigue
Smearing	Partial seizing
Electric corrosion	Surface melting due to conduction (electrical discharge)
Roughness (satin)	Roughness of the raceway groove and ball surface (similar to the skin of a pear)
Temper color	Discoloration due to high temperature
Croaking	Retainer self-excitation vibration noise (similar to a frog croaking)
Raceway noise	Noise of the balls rolling in the raceway groove

Clearance

Radial clearance	Clearance in the radial direction within the bearing
Axial clearance	Clearance in the axial direction within the bearing
Inclination angular clearance	Inner ring tilt angle with the outer ring fixed
Residual clearance	Radial clearance after the bearing is assembled into the shaft or housing (Clearance after fit)
Effective clearance	Residual clearance with consideration of temperature
Operation clearance	Radial clearance during operation
Contact angle	Angle formed by the plane vertical to the bearing central axis and the line of action of the force moving between the raceway ring and balls
Nominal contact angle	Design contact angle

4-1 Technical Terminology

Other

Contact modulus	Coefficient determined by the ball diameter and curvature radius
Contact ellipse	Area and its shape where the ball and raceway surface are in contact
Groove radius	Curvature radius within the axial plane of the raceway groove
Groove curvature	Raceway groove curve shown as a ratio of the groove radius and ball radius

MEMO

4-2 Conversion Tables

Inch/metric dimension conversion table

inch	mm
1/64	0.3969
1/32	0.7938
3/64	1.1906
1/16	1.5875
5/64	1.9844
3/32	2.3813
7/64	2.7781
1/8	3.1750
9/64	3.5719
5/32	3.9688
11/64	4.3656
3/16	4.7625
13/64	5.1594
7/32	5.5563
15/64	5.9531
1/4	6.3500
17/64	6.7469
9/32	7.1438
19/64	7.5406
5/16	7.9375
21/64	8.3344
11/32	8.7313
23/64	9.1281
3/8	9.5250
25/64	9.9219
13/32	10.3188
27/64	10.7156
7/16	11.1125
29/64	11.5094
15/32	11.9063
31/64	12.3031
1/2	12.7000
33/64	13.0969
17/32	13.4938
35/64	13.8906
9/16	14.2875
37/64	14.6844
19/32	15.0813
39/64	15.4781
5/8	15.8750
41/64	16.2719
21/32	16.6688
43/64	17.0656
11/16	17.4625
45/64	17.8594
23/32	18.2563
47/64	18.6531
3/4	19.0500
49/64	19.4469
25/32	19.8438
51/64	20.2406
13/16	20.6375
53/64	21.0344
27/32	21.4313
55/64	21.8281
7/8	22.2250
57/64	22.6219
29/32	23.0188
59/64	23.4156
15/16	23.8125
61/64	24.2094
31/32	24.6063
63/64	25.0031
1	25.4000

Celsius/Fahrenheit temperature conversion table

°C	°F
-100	-148
- 90	-130
- 80	-112
- 70	- 94
- 60	- 76
- 50	- 58
- 40	- 40
- 30	- 22
- 20	- 4
- 10	14
-	-
0	32
10	50
20	68
30	86
40	104
50	122
60	140
70	158
80	176
90	194
100	212

Weight conversion table

Newton N	kilogram kgf	pound lb
1	0.1020	0.2248
2	0.2039	0.4496
3	0.3059	0.6744
4	0.4079	0.8992
5	0.5099	1.1240
6	0.6118	1.3489
7	0.7138	1.5737
8	0.8158	1.7985
9	0.9177	2.0233
10	1.0197	2.2481

Newton N	kilogram kgf	pound lb
20	2.0394	4.4962
30	3.0591	6.7443
40	4.0789	8.9924
50	5.0986	11.2404
60	6.1183	13.4885
70	7.1380	15.7366
80	8.1577	17.9847
90	9.1774	20.2328
100	10.1972	22.4809

Physical/mechanical properties of metal materials

Material name	Specific gravity	Linear expansion coefficient	Longitudinal modulus	Hardness
		0 ~ 100°C $\times 10^{-6}$	GPa	HBW
SUJ2	7.83	12.5	207	690
DD400	7.90	10.2	204	650
SUS440C	7.68	10.1	200	580
S25C	7.84	11.8	206	120
S45C	7.83	12.8	207	217
SUS303	8.03	17.3	193	180
SUS304	7.93	16.3	193	150
SUS416	7.75	9.9	200	-
SUS420J2	7.75	10.4	200	400
Brass	8.40	19.1	105	-
Copper	8.90	16.0	130	-
Aluminum	2.69	24.0	70	-
ADC10	2.74	22.0	71	-
FC200	7.30	10.4	105	217
SPCC	7.86	11.7	211	70
Ceramic	3.26	1.5	301	1,470 (HV)

Note 1: Physical property values in the table are reference values.
Note 2: SUJ2, DD400, and SUS440C are normally expressed with HRC, but they have been converted to HBW here for comparison.

Hardness conversion table

HRC	HV	HBW
68	940	-
67	900	-
66	865	-
65	832	(739)
64	800	(722)
63	772	(705)
62	746	(688)
61	720	(670)
60	697	(654)
59	674	(634)
58	653	615
57	633	595
56	613	577
55	595	560
54	577	543
53	560	525
52	544	512
51	528	496
50	513	481
49	498	469
48	484	455
47	471	443
46	458	432
45	446	421
44	434	409

4-3 Main SI Unit Conversion Tables

Force

N	kgf
1	1.01972×10^{-1}
9.80665	1

Stress

Pa or N/m^2	MPa or N/mm^2	kgf/mm^2	kgf/cm^2
1	1×10^{-6}	1.01972×10^{-7}	1.01972×10^{-5}
1×10^{6}	1	1.01972×10^{-1}	1.01972×10
9.80665×10^{6}	9.80665	1	1×10^{2}
9.80665×10^{4}	9.80665×10^{-2}	1×10^{-2}	1

Kinematic viscosity

m^2/s	mm^2/s	cSt	St
1	1×10^{6}	1×10^{6}	1×10^{4}
1×10^{-6}	1	1	1×10^{-2}
1×10^{-4}	1×10^{2}	1×10^{2}	1

Pressure

Pa	kPa	MPa
1	1×10^{-3}	1×10^{-6}
1×10^{3}	1	1×10^{-3}
1×10^{6}	1×10^{3}	1
1×10^{5}	1×10^{2}	1×10^{-1}
9.80665×10^{4}	9.80665×10	9.80665×10^{-2}
9.80665×10^{6}	9.80665×10^{3}	9.80665
9.80665	9.80665×10^{-3}	9.80665×10^{-6}
1.33322×10^{2}	1.33322×10^{-1}	1.33322×10^{-4}

bar	kgf/cm^2	kgf/mm^2	mmH_2O	mmHg or Torr
1×10^{-5}	1.01972×10^{-5}	1.01972×10^{-7}	1.01972×10^{-1}	7.50062×10^{-3}
1×10^{-2}	1.01972×10^{-2}	1.01972×10^{-4}	1.01972×10^{2}	7.50062
1×10	1.01972×10	1.01972×10^{-1}	1.01972×10^{5}	7.50062×10^{3}
1	1.01972	1.01972×10^{-2}	1.01972×10^{4}	7.50062×10^{2}
9.80665×10^{-1}	1	1×10^{-2}	1×10^{4}	7.35559×10^{2}
9.80665×10	1×10^{2}	1	1×10^{6}	7.35559×10^{4}
9.80665×10^{-5}	1×10^{-4}	1×10^{-6}	1	7.35559×10^{-2}
1.33322×10^{-3}	1.35951×10^{-3}	1.35951×10^{-5}	1.35951×10	1

Torque

N·m	mN·m	μN·m	kgf·cm	gf·cm
1	1×10^{3}	1×10^{6}	1.01972×10	1.01972×10^{4}
1×10^{-3}	1	1×10^{3}	1.01972×10^{-2}	1.01792×10
1×10^{-6}	1×10^{-3}	1	1.01972×10^{-5}	1.01972×10^{-2}
9.80665×10^{-2}	9.80665×10	9.80665×10^{4}	1	1×10^{3}
9.80665×10^{-5}	9.80665×10^{-2}	9.80665×10	1×10^{-3}	1

4-4 SI Unit Prefixes

Multiple	Prefix		Multiple	Prefix	
	Name	Symbol		Prefix	Symbol
10^{18}	Exa	E	10^{-1}	Deci	d
10^{15}	Peta	P	10^{-2}	Centi	c
10^{12}	Tera	T	10^{-3}	Milli	m
10^{9}	Giga	G	10^{-6}	Micro	μ
10^{6}	Mega	M	10^{-9}	Nano	n
10^{3}	Kilo	k	10^{-12}	Pico	p
10^{2}	Hecto	h	10^{-15}	Femto	f
10	Deca	da	10^{-18}	Atto	a

4-5 Greek Alphabet

NMB

Uppercase	Lowercase	English letter
Α	α	alpha
Β	β	beta
Γ	γ	gamma
Δ	δ	delta
Ε	ε	epsilon
Ζ	ζ	zeta
Η	η	eta
Θ	θ	theta
Ι	ι	iota
Κ	κ	kappa
Λ	λ	lambda
Μ	μ	mu
Ν	ν	nu
Ξ	ξ	xi
Ο	o	omicron
Π	π	pi
Ρ	ρ	rho
Σ	σ	sigma
Τ	τ	tau
Υ	υ	upsilon
Φ	ϕ	phi
Χ	χ	chi
Ψ	ψ	psi
Ω	ω	omega

5 Locations

5-1 Sales Bases

List of sales offices in Japan

MinebeaMitsumi Inc.

Tokyo Office

Customer Service Center, Tokyo Customer Group
1-9-3 Higashi-Shimbashi, Minato-ku, Tokyo 105-8317
Tel. +81-3-6758-6748
Fax +81-3-6758-6760

Sales Headquarters

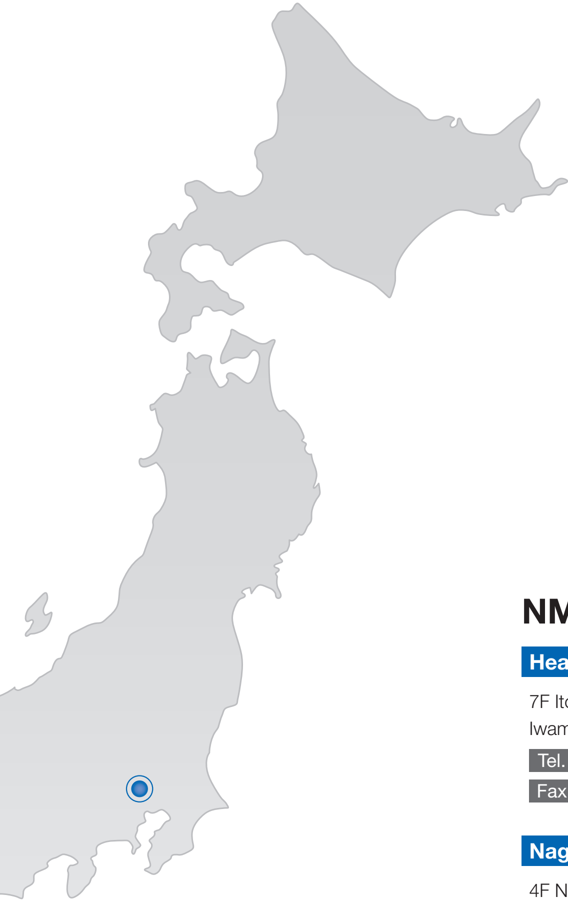
Marketing Department
1-9-3 Higashi-Shimbashi, Minato-ku, Tokyo 105-8317

Nagoya Office

Customer Service Center, Nagoya Customer Group
4F Nagoya Nishiki City Building, 1-6-5 Nishiki,
Naka-ku, Nagoya, Aichi 460-0003
Tel. +81-52-231-1181
Fax +81-52-231-1157

Osaka Office

Customer Service Center, Osaka Customer Group
11F PMO EX Shin-Osaka, 4-2-10 Miyahara,
Yodogawa-ku, Osaka 532-0003
Tel. +81-6-6150-1242
Fax +81-6-6152-7501



NMB Sales Co., Ltd.

Head Office

7F Itopia Iwamoto-cho 1-chome Building, 1-8-15
Iwamoto-cho, Chiyoda-ku, Tokyo 101-0032

Tel. +81-3-5835-0371
Fax +81-3-5835-0370

Nagoya Office

4F Nagoya Nishiki City Building, 1-6-5 Nishiki, Naka-ku,
Nagoya, Aichi 460-0003

Tel. +81-52-205-8841
Fax +81-52-231-1157

Osaka Office

11F PMO EX Shin-Osaka, 4-2-10 Miyahara, Yodogawa-ku,
Osaka 532-0003

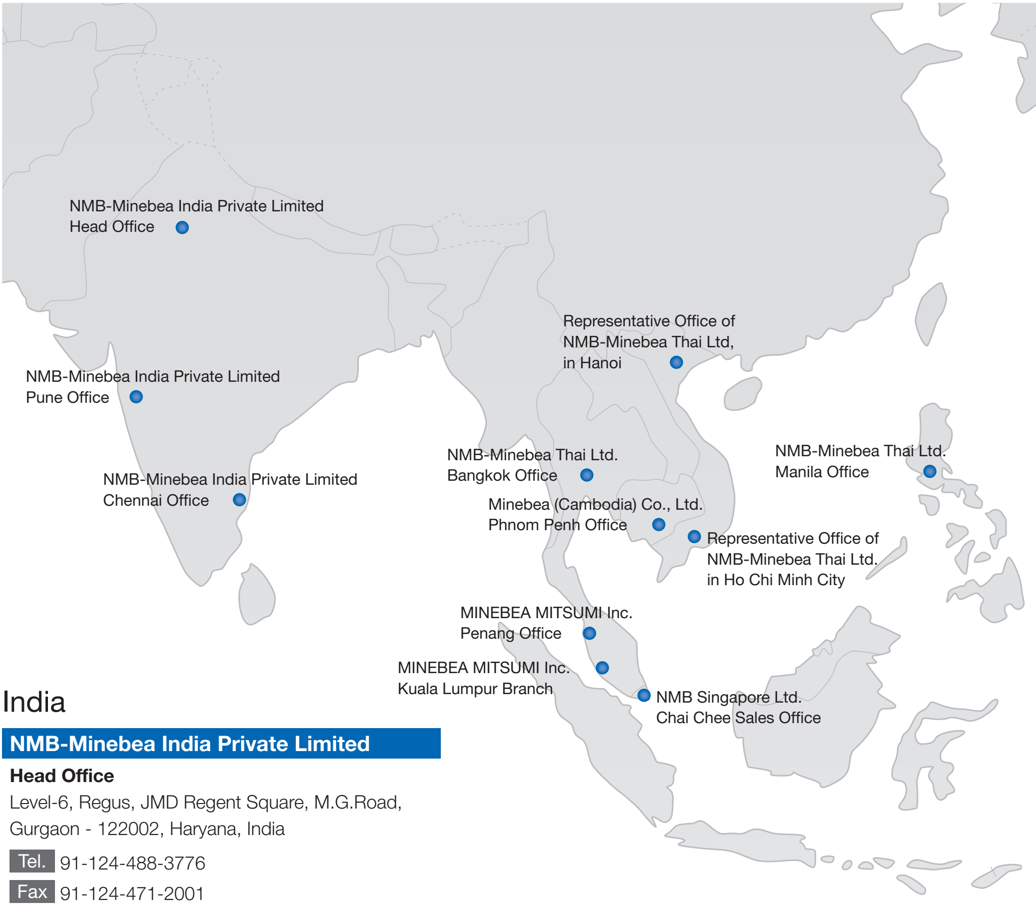
Tel. +81-3-5835-0371
Fax +81-3-5835-0370

*Please use the head office number above for inquiries.

5-1 Sales Bases

List of sales offices overseas

South and Southeast Asia



India

NMB-Minebea India Private Limited

Head Office

Level-6, Regus, JMD Regent Square, M.G.Road,
Gurgaon - 122002, Haryana, India

Tel. 91-124-488-3776
Fax 91-124-471-2001

Chennai Office

Level-2, Regus, ALTIUS Block, Olympia Technology Park
Guindy, Chennai - 600032, India

Tel. 91-44-4299-4215
Fax 91-44-4299-4300

Pune Office

Level IV, Regus, Prabhavee Tech Park, Baner,
Pune-411045 Maharashtra, India

Tel. 91-20-6723-5890
Fax 91-20-6723-6161

Thailand

NMB-Minebea Thai Ltd. Bangkok Office

19th Floor, Wave Place Building, 55 Wireless Road,
Lumpinee Pathumwan, Bangkok, 10330 Thailand

Tel. 66-2-253-4897
Fax 66-2-255-2875/66-2-253-4537

Malaysia

MINEBEA MITSUMI INC. Kuala Lumpur Branch

E407, 4th Floor, East Tower Wisma Consplant 1, No. 2 Jalan SS 16/4 47500 Subang Jaya Selangor Darul Ehsan, Malaysia

Tel. 60-3-5631-7849 ~ 52
Fax 60-3-5631-7844

Penang Office

Suite: 11-H Menara Northam 55, Jalan Sultan Ahmad Shah 10050 Penang, Malaysia

Tel. 60-4-2275681
Fax 60-4-2275820

Singapore

NMB Singapore Ltd. Chai Chee Sales Office

1, Chai Chee Avenue, Singapore 469059

Tel. 65-6278-8522
Fax 65-6278-8477

Philippines

NMB-Minebea Thai Ltd. Manila Office

Unit 908-909 Tower One, Ayala Triangle, Ayala Avenue, Makati City, Metro Manila, 1226 Philippines

Tel. 63-2-8856-1395
Fax 63-2-8813-2159

Vietnam

Representative Office of NMB-Minebea Thai Ltd.

in Hanoi

Room No.607, 6th Floor, Sun Red River Building, No.23 Phan Chu Trinh, Hoan Kiem District, Hanoi, 100000, Vietnam

Tel. 84-24-3974-4582
Fax 84-24-3974-4587

in Ho Chi Minh City

Unit 400 Saigon Riverside Office Center, 2A-4A Ton Duc Thang Street, Ben Nghe Ward, District 1, Ho Chi Minh City, Vietnam

Tel. 84-28-3535-9800
Fax 84-28-3535-9855

Cambodia

Minebea (Cambodia) Co., Ltd. Phnom Penh Office

Elysee Building 6th floor, B2-030, Koh Pich Street, Sangkat Tonle Bassac, Khan Chamkarmorn, Phnom Penh, Cambodia

Tel. 855-23-901-538

5-1 Sales Bases

List of sales offices overseas

Northeast Asia

South Korea

NMB Korea Co., Ltd.

12F, 29, Hwangsaeul-ro 258beon-gil, Bundang-gu, Seongnam-si, Gyeonggi-do, 13595, Korea

Tel. 82-2-557-4467
Fax 82-2-557-4478

China

Minebea Trading (Shanghai) Ltd.

Minebea Trading (Shanghai) Ltd.
Room 303, K.Wah Centre, 1010 Middle Huai Hai Road, Xuhui District, Shanghai 200031, China

Tel. 86-21-5405-0707

Minebea Trading (Shanghai) Ltd. Beijing Branch
Minebea Trading (Shanghai) Ltd. Dalian Branch
Minebea Trading (Shanghai) Ltd. Changzhou Branch
Minebea Trading (Shanghai) Ltd. Qingdao Office
Minebea Trading (Shanghai) Ltd. Hefei Office
Minebea Trading (Shanghai) Ltd. Hangzhou Office

Minebea (Shenzhen) Ltd.

Minebea (Shenzhen) Ltd.
23/F, Tower B, Kingkey 100, No.5016 Shennan Road East, Luohu District, Shenzhen 518001, China

Tel. 86-755-82668846

Minebea (Shenzhen) Ltd. Xiamen Branch
Minebea (Shenzhen) Ltd. Xi'an Office
Minebea (Shenzhen) Ltd. Chengdu Office
Minebea (Shenzhen) Ltd. Wuhan Office

Minebea Technologies Taiwan Co., Ltd.

Minebea Technologies Taiwan Co., Ltd.
Taipei Branch
8F, 28 Ching-Cheng Street, Taipei 105, Taiwan (Tong Tai Business Building)

Tel. 886-2-2718-2363
Fax 886-2-2718-4092

5-1 Sales Bases

List of sales offices overseas

Americas

USA

NMB Technologies Corporation

Novi Head Office

Building-1

39830 Grand River Ave., Suite B-1, Novi, Michigan 48375, U.S.A.

Tel. 1-248-919-2250

Building-2

40000 Grand River Avenue, NOVI Technology Center Suite 200 Novi, MI 48375, U.S.A.

Tel. 1-248-426-8448

Fax 1-248-426-8985

San Jose Office

2107 North First Street, Suite 220, San Jose, CA 95131 U.S.A.

Chatsworth Office

9730 Independence Ave., Chatsworth, California 91311, U.S.A.

Tel. 1-818-341-3355

Fax 1-818-341-8207

Brazil

NMB-Minebea do Brasil Importação e Comércio de Componentes de Precisão Ltda

Rua Coronel Oscar Porto, n´ 736, 5´ andar, sala 53, Bairro Paraíso, São Paulo, SP, CEP 04003-003, Brasil

Tel. 55-11-3939-0882

Europe

France

MinebeaMitsumi Sales France SARL

5, Avenue des Bosquets, Les Ponts de Baillet
95560, Baillet en France, France

Tel. 33-1-34083939
Fax 33-1-34083930

Germany

MinebeaMitsumi Sales Europe GmbH

Siemensstr. 5A, 63263 Neu-Isenburg, Germany

Tel. 49(0)-6102-775-70

Italy

MinebeaMitsumi Sales Italy S.r.l.

Via A, Grandi. 39-41, 20017 Mazzo Di Rho, Milan,
Italy

Tel. 39-02-939711
Fax 39-02-939-01154

5-2 Production Bases

List of production bases

Asia

China

Shanghai Plant
(Minebea Electronics & Hi-Tech Components (Shanghai) Ltd. Shanghai Plant)
No.8313, Hu Qing Ping Rd., Jinze Town, Qingpu District, Shanghai, 201721, China

Japan

Head Office/Karuizawa Plant
4106-73 Miyota, Miyota-machi, Kitasaku-gun, Nagano 389-0293
Tel.: +81-267-32-2200
Fax: +81-267-31-1350

Thailand

Ayutthaya Plant
(NMB-Minebea Thai Ltd.)
18 Moo 3, Asia Road, Km. 72, Tambol Thanoo, Amphoe Uthai, Ayutthaya Province, 13210 Thailand

Bang Pa-in Plant
(NMB-Minebea Thai Ltd.)
1 Moo 7, Phaholyothin Road, Km. 51, Tambol Chiang Rak-Noi, Amphoe Bang Pa-in, Ayutthaya Province, 13180 Thailand

Cambodia

Phnom Penh Plant
(Minebea (Cambodia) Co., Ltd.)
Phnom Penh Special Economic Zone, National Road 4, Sangkat Phleung Chhes Rotes, Khan Posenchey, Phnom Penh, Cambodia

Singapore

Jurong Plant
(NMB Singapore Ltd.)
28, Gul Way, Jurong Industrial Estate, Singapore 629198

Chai Chee Plant
(NMB Singapore Ltd.)
1 Chai Chee Avenue, Singapore 469059

North America

Peterborough Plant
(New Hampshire Ball Bearings, Inc.)
175 Jaffrey Road,
Peterborough, New Hampshire
03458-1709, U.S.A.

Chatsworth Plant
(New Hampshire Ball Bearings, Inc.)
9700 Independence Avenue,
Chatsworth, California 91311,
U.S.A.

Europe

Czech Republic

myonic
(myonic s.r.o.)
1 máje 2635, PO BOX 18,
75661 Rožnov pod Radhoštěm,
Czech Republic

Germany

CEROBEAR
(CEROBEAR GmbH)
Kaiserstrasse 100, 52134
Herzogenrath Germany

myonic
(myonic Holding GmbH / myonic GmbH)
Steinbeisstrasse 4, D-88299
Leutkirch, Germany

MEMO

MEMO

MEMO

MEMO

Head Office

4106-73 Miyota, Miyota-machi, Kitasaku-gun, Nagano 389-0293

For technical inquiries

Bearing Supervisory Department, Sales Technology Group
1-9-3 Higashi-Shimbashi, Minato-ku, Tokyo 105-8317
https://product.minebeamitsumi.com/en/contact/index.html

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https://www.minebeamitsumi.com/english/csr/

MinebeaMitsumi
Passion to Create Value through Difference

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