Rolling bearing construction

Most rolling bearings consist of rings with raceway (inner ring and outer ring), rolling elements (either balls or rollers) and cage. The cage separates the rolling elements at regular intervals, holds them in place within the inner and outer raceways, and allows them to rotate freely.

Classification of rolling bearings

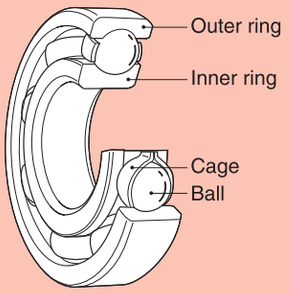
Rolling bearings divide into two main classifications: ball bearings and roller bearings. Ball bearings are classified according to their bearing ring configurations: deep groove type and angular contact type. Roller bearings on the other hand are classified according to the shape of the rollers: cylindrical, needle, tapered and spherical. Rolling bearings can be further classified according to the direction in which the load is applied; radial bearings carry radial loads and thrust bearings carry axial loads.

Other classifications

1) Number of rolling rows (single, double, or 4-row),
2) Separable and non-separable, in which either the inner ring or the outer ring can be detached.
3) There are also bearings designed for special purposes, such as Automotive and other applications

Deep groove ball bearings

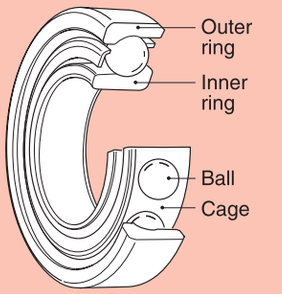
The most common type of bearing, deep groove ball bearings are widely used in a variety of fields. Deep groove ball bearings include shield bearings and sealed bearings with grease enabling easier usage. Deep groove ball bearings also include bearings with a locating snap-ring to facilitate positioning when mounting the outer ring. These type of bearings supports radial load on both directions. Deep groove ball bearings are also classified into Thin series, Light series, Medium series and Heavy series ball bearings.



Deep groove ball bearing

Angular contact ball bearings

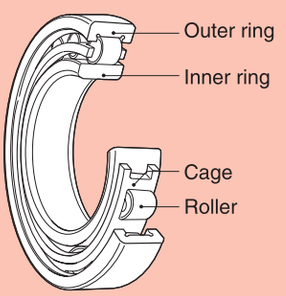
Angular contact ball bearings unite point of contact of the inner ring, ball and the outer ring runs at a certain angle (contact angle) in the radial direction. Bearings are generally designed with three contact angles. Angular contact ball bearings can support an axial load, but cannot be used as single bearing because of the contact angle. They must instead be used in pairs or in combinations. Angular contact ball bearings include double row angular contact ball bearings for which the inner and outer rings are combined as a single unit. The contact angle of double row angular contact ball bearings is 25°. These type support certain amount of combined loads.



Angular contact ball bearing

Cylindrical roller bearings

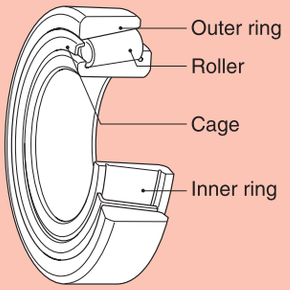
Cylindrical roller bearings use rollers for rolling elements, and therefore has a high load capacity. The rollers are guided by the ribs of the inner or outer ring. The inner and outer rings can be separated to facilitate assembly, and both can be fitted with shaft or housing tightly. If there are no ribs, either the inner or the outer ring can move freely in the axial direction. Cylindrical roller bearings are of different types, like N, NU, NJ, NUP, NF depending upon the construction of inner and outer rings. Cylindrical roller bearings are designed with multiple row rollers and full compliment rollers without cage depending on the applications. These bearings are suitable for heavy radial and impact loading and are appropriate for high speed applications.



Cylindrical roller bearing

Tapered roller bearings

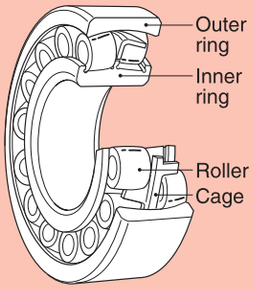
Tapper roller bearings are designed such that the outer ring, inner ring and the rollers have tapered surfaces whose apexes converge at a common point on the bearing axis. Tapper rollers are available in metric as well as inch dimensions most commonly called as metric series and inch series . Tapper rollers are available in Single, Double and four row, these type of bearings are suitable for Heavy and Impact load application and can take both radial and axial load simultaneously.



Tapered roller bearing

Spherical roller bearings

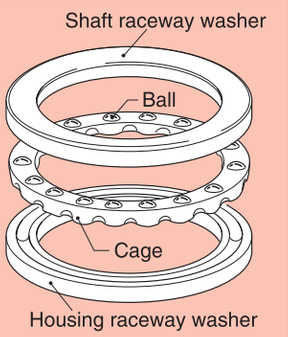
Spherical roller bearings are equipped with an outer ring with a spherical raceway surface and an inner ring which holds two rows of barrel shaped rolling elements, spherical roller bearings are able to adjust center alignment to handle inclination of the axle or shaft. There are varieties of bearing types that differ according to internal design. Spherical roller bearings include as type equipped with an inner ring with a tapered bore. The bearing can easily be mounted on a shaft by means of an adapter or withdrawal sleeve. The bearing is capable of supporting heavy loads, and is therefore often used in industrial machinery. Gages for these bearings are of both steel and brass depending on the applications.



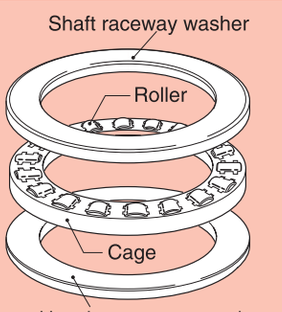
Spherical roller bearing

Thrust bearings

Thrust bearings are classified in accordance to the rolling elements they contain and generally the allowable rotational speed is very low.
Thrust ball bearing with single row is called as single direction Thrust ball bearings and can take axial load in one direction, whereas Thrust ball bearing with double row is called as double direction Thrust ball bearings and can take axial load from both directions. Thrust bearings with rollers as rolling element can accommodate a certain amount of radial load along with axial loads.



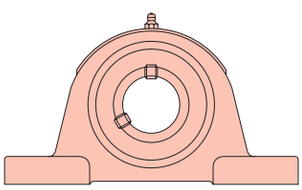
Thrust ball bearing

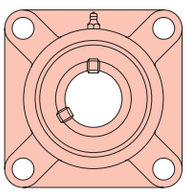


Thrust roller bearing

Ball Bearing unit

A ball bearing unit is comprised of a ball bearing inserted into various types of housings. The housing can be bolted onto machinery and the inner ring can be easily mounted on the shaft with a set screw. This means the bearing unit can support rotating equipment without special design to allow for mounting. A variety of standardized housing shapes is available, including pillow and flange types. The outer diameter of the bearing is spherical just like the inner diameter of the housing, so it capable of aligning itself on the shaft. For lubrication, grease is sealed inside the bearing, and particle penetration is prevented by a double seal with 3 lip


UCP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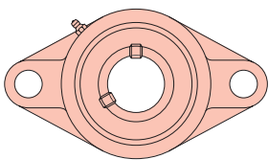
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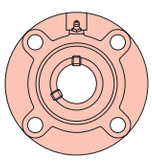
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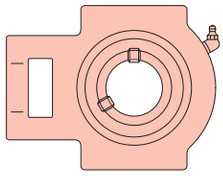
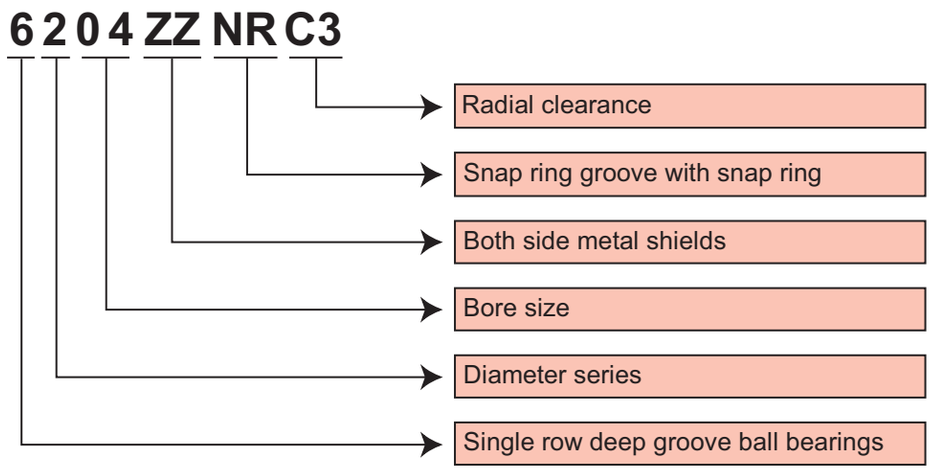

UCT

Bearing Designation, prefix and suffix

Rolling bearing part numbers indicate bearing type, dimensions, tolerances, internal construction, and other related specifications. Bearing numbers are comprised of a “basic number” followed by “supplementary codes.” The basic number indicates general information about a bearing, such as its fundamental type, boundary dimensions, series number, bore diameter code and contact angle. The supplementary codes derive from prefixes and suffixes which indicate a bearing’s tolerance, internal clearance, and related specifications.

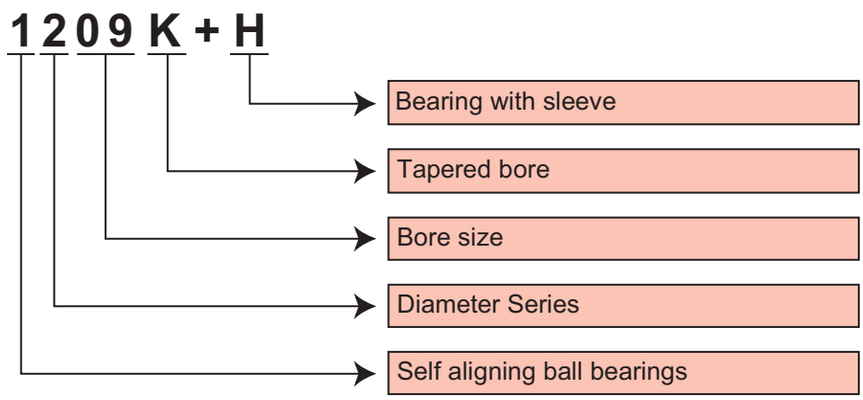
Ball bearings



Bearing type	Bearing series	Diameter series
Single row ball bearings	68,69,160,60,62,63,64,622,623	8,9,0,0,2,3,4,2,3
Double row ball bearings	42,43	2,3

Prefix	Description	Suffix	Description
F	Flanged outer ring	CM	Electric motor clearance
RLS	Inch type ball bearing	C2	Radial clearance lesser than normal
RMS	Inch type ball bearing	C3	Radial clearance higher than normal
		C4	Radial clearance higher than C3
		DDU	Bearings with non contact type rubber seals
		LLU	Bearings with contact type rubber seals
		M	Machined brass cage
		N	With snap ring groove
		NR	Snap ring groove with snap ring
		P6	Precision class 6
		Z	With one side metal shield
		ZZ	With both side metal shield
		ZNR	With one side metal shield and snap ring groove with snap ring

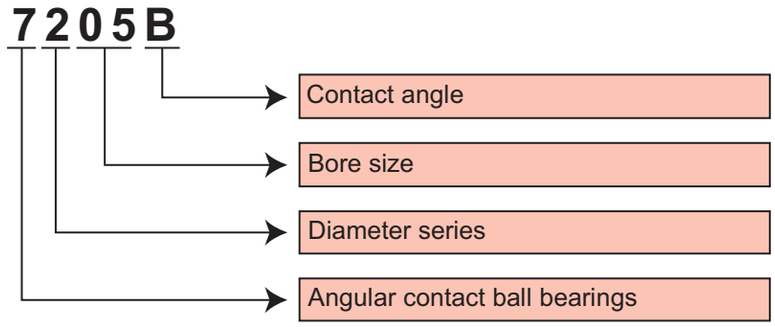
Self Aligning ball bearings



Bearing type	Bearing Series	Diameter series
Self aligning ball bearings	12,22,13,23	2,2,3,3

Prefix	Description	Suffix	Description
		K	With tapered bore
		+H	With adapter sleeve

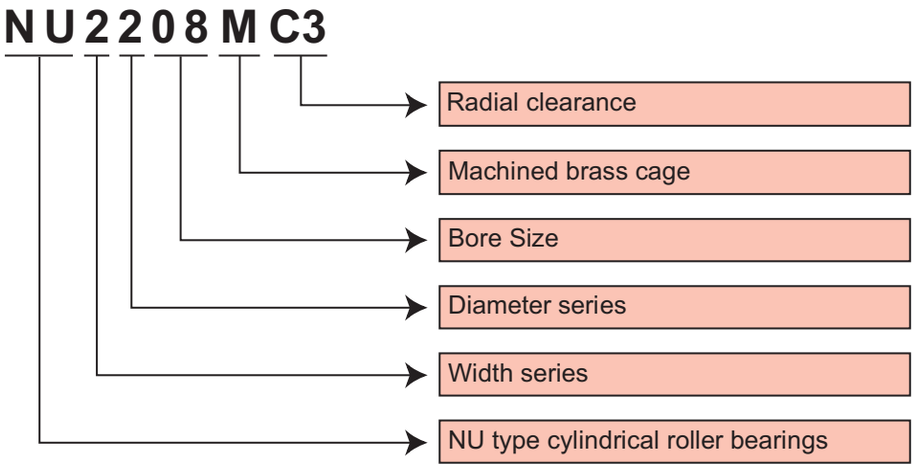
Angular Contact ball bearings



Bearing type	Bearing Series	Diameter series
Angular contact ball bearings	72.73	2,3
Double row angular contact ball bearing with filling slot (maximum capacity)	32,33	2,3
Double row angular contact ball bearing without filling slot	52,53	2,3

Prefix	Description	Suffix	Description
		A	30 degree contact angle
		B	40 degree contact angle
		TVP	With reinforced polyamide cage
		C	15 degree contact angle
		M	Brass cage

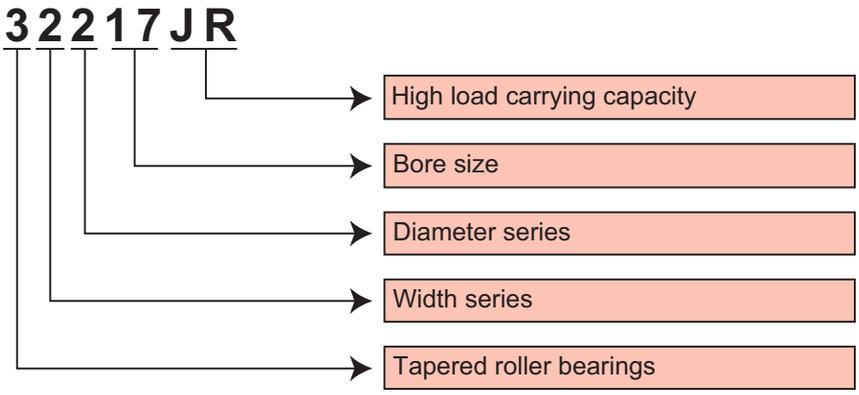
Cylindrical roller bearings



Bearing type	Bearing series	Diameter series
Cylindrical roller bearing	2,22,3,32	2,2,3,3

Prefix	Description	Suffix	Description
N	Bearings with both side sliding outer ring	N	With snap ring groove
NJ	Bearings with one side sliding inner ring	NR	Snap ring groove and snap ring
NU	Bearings with both side sliding inner ring	V	Full compliment bearings
NUP	Bearing with fixed inner and outer ring		

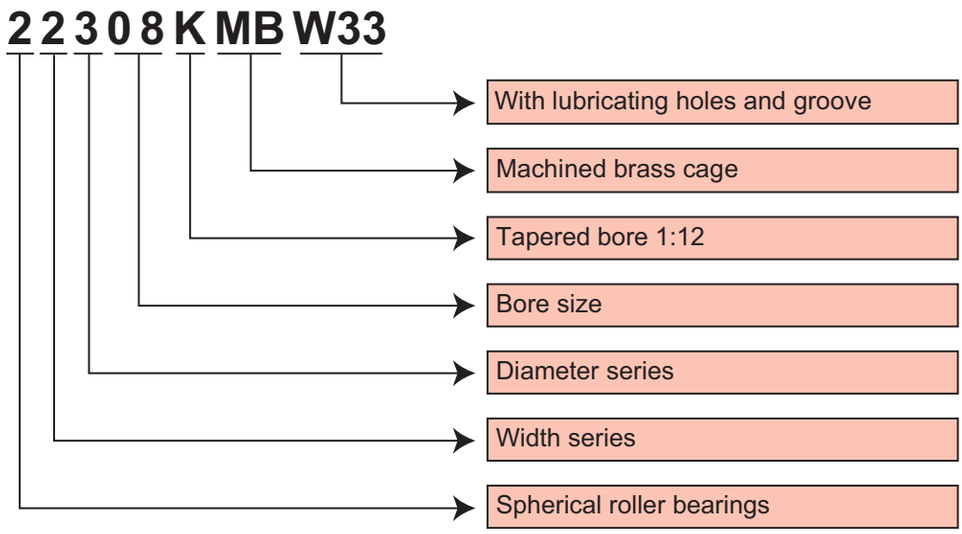
Tapered Roller bearings



Bearing type	Bearing Series	Diameter series
Taper roller bearing	320,330,331,302,322,332,303,313,323	0,0,1,2,2,2,3,3,3

Prefix	Description	Suffix	Description
HC	Hi-cap	D	Steep contact angel (24°~32°) metric series
HM	Heavy medium duty inch series	JR	High load carrying capacity
JL	J series tapper roller bearings		
JLM	J series light medium duty inch series		
L	Light duty inch series		
LM	Light medium duty inch series		
M	Medium duty inch series		

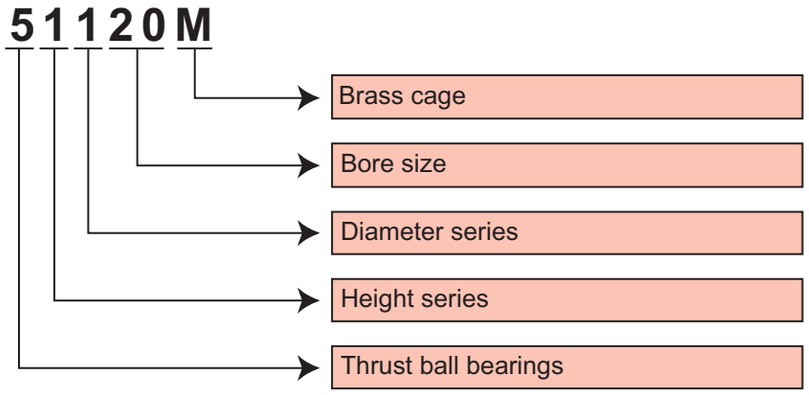
Spherical Roller bearings



Bearing type	Bearing Series	Diameter series
Spherical roller bearings	239,230,240,231,241,222,232,213,223,	9,0,0,1,1,2,2,3,3

Prefix	Description	Suffix	Description
		CC	Steel cage
		CA	Machined single brass cage
		K	Tapered bore 1:12
		K30	Tapered bore 1:30
		M	Machined brass cage
		MA	Machined brass cage outer ring guided
		MB	Machined brass cage inner ring guided
		W33	Lubricating holes and groove on outer ring

Thrust ball bearings



Bearing type	Bearing Series	Diameter series
Thrust ball bearing	511,512,513	1,2,3

Prefix	Description	Suffix	Description
		M	Machined brass cage

Tolerances for bearings

Bearing tolerances and permissible values for the boundary dimensions and running accuracy of bearings are specified. These values are prescribed in JIS B 1514 “tolerances for rolling bearings.” (These JIS standards are based on ISO standards.)
Bearing tolerances are standardized by classifying bearings into the following six classes (accuracy in tolerances becomes higher in the order described): 0, 6X, 6, 5, 4 and 2.

Dimensional accuracy

Dimensional accuracy constitutes the acceptable values for bore diameter, outer diameter, assembled bearing width, and bore diameter uniformity as seen in chamfer dimensions, allowable inner ring tapered bore deviation and shape error. Also included are, average bore diameter variation, outer diameter variation, average outer diameter unevenness, as well as raceway width and height variation (for thrust bearings).

Running accuracy

Running accuracy constitutes the acceptable values for inner and outer ring radial runout and axial runout, inner ring side runout, and outer ring outer diameter runout. Allowable rolling bearing tolerances have been established according to precision classes. Bearing precision is stipulated as JIS class 6, class 5, class 4, or class 2, with precision rising from ordinary precision indicated by class 0.

Bearing types and applicable tolerance

Bearing type		Applicable standard	Tolerance class					Tolerance table
Deep groove ball bearings		JIS B 1514 (ISO492)	class 0	class 6	class 5	class 4	class 2	Table a
Angular contact ball bearings			class 0	class 6	class 5	class 4	class 2	
Self-aligning ball bearings			class 0	—	—	—	—	
Cylindrical roller bearigns			class 0	class 6	class 5	class 4	class 2	
Spherical roller bearings			class 0	—	—	—	—	
Tapered roller bearings	metric	JIS B 1514	class 0,6X	class 6	class 5	class 4	—	Table b
	Inch	ANSI/ABMA Std.19	class 4	class 2	class 3	class 0	class 00	Table c
Thrust ball bearings		JIS B 1514 (ISO199)	class 0	class 6	class 5	class 4	—	Table d
Spherical roller thrust bearings			class 0	—	—	—	—	Table e

Comparison of tolerance classifications of national standards

Standard	Applicable standerd	Tolerance Class					Bearing Types
Japanese industrial standard (JIS)	JIS B 1514	Class 0,6X	Class 6	Class 5	Class 4	Class 2	All type
International Organization for Standardization (ISO)	ISO 492	Normal class Class 6X	Class 6	Class 5	Class 4	Class 2	Radial bearings
	ISO 199	Normal Class	Class 6	Class 5	Class 4	—	Thrust ball bearings
	ISO 578	Class 4	—	Class 3	Class 0	Class 00	Tapered roller bearings (Inch series)
	ISO 1224	—	—	Class 5A	Class 4A	—	Precision instrument bearings
Deutsches Institut fur Normung(DIN)	DIN 620	P0	P6	P5	P4	P2	All type
American National Standards Institute (ANSI)	ANSI/ABMA Std.20	ABEC-1 RBEC-1	ABEC-3 RBEC-3	ABEC-5 RBEC-5	ABEC-7	ABEC-9	Radial bearings (Except tapered roller bearings)
American Bearing Manufacturer's Association (ABMA)	ANSI/ABMA Std.19.1	Class K	Class N	Class C	Class B	Class A	Tapered roller bearings (Metric series)
	ANSI/ABMA Std.19	Class 4	Class 2	Class 3	Class 0	Class 00	Tapered roller bearings (Inch series)

Table a Tolerance of radial bearings (Except tapered roller bearings)

Table a.1 Inner rings

Nominal bore diameter d mm		Dimensional tolerance of mean bore diameter within plane Δ_{dmp}										Bore diameter variation V_{dp}														
												diameter series 9					diameter series 0.1					diameter series 2.3.4				
		class 0		class 6		class 5		class 4		class 2		class 0	class 6	class 5	class 4	class 2	class 0	class 6	class 5	class 4	class 2	class 0	class 6	class 5	class 4	class 2
over	incl.	high	low	high	low	high	low	high	low	high	low	max					max					max				
0.6	2.5	0	-8	0	-7	0	-5	0	-4	0	-2.5	10	9	5	4	2.5	8	7	4	3	2.5	6	5	4	3	2.5
2.5	10	0	-8	0	-7	0	-5	0	-4	0	-2.5	10	9	5	4	2.5	8	7	4	3	2.5	6	5	4	3	2.5
10	18	0	-8	0	-7	0	-5	0	-4	0	-2.5	10	9	5	4	2.5	8	7	4	3	2.5	6	5	4	3	2.5
18	30	0	-10	0	-8	0	-6	0	-5	0	-2.5	13	10	6	5	2.5	10	8	5	4	2.5	8	6	5	4	2.5
30	50	0	-12	0	-10	0	-8	0	-6	0	-2.5	15	13	8	6	2.5	12	10	6	5	2.5	9	8	6	5	2.5
50	80	0	-15	0	-12	0	-9	0	-7	0	-4	19	15	9	7	4	19	15	7	5	4	11	9	7	5	4
80	120	0	-20	0	-15	0	-10	0	-8	0	-5	25	19	10	8	5	25	19	8	6	5	15	11	8	6	5
120	150	0	-25	0	-18	0	-13	0	-10	0	-7	31	23	13	10	7	31	23	10	8	7	19	14	10	8	7
150	180	0	-25	0	-18	0	-13	0	-10	0	-7	31	23	13	10	7	31	23	10	8	7	19	14	10	8	7
180	250	0	-30	0	-22	0	-15	0	-12	0	-8	38	28	15	12	8	38	28	12	9	8	23	17	12	9	8
250	315	0	-35	0	-25	0	-18	—	—	—	—	44	31	18	—	—	44	31	14	—	—	26	19	14	—	—
315	400	0	-40	0	-30	0	-23	—	—	—	—	50	38	23	—	—	50	38	18	—	—	30	23	18	—	—
400	500	0	-45	0	-35	—	—	—	—	—	—	56	44	—	—	—	56	44	—	—	—	34	26	—	—	—
500	630	0	-50	0	-40	—	—	—	—	—	—	63	50	—	—	—	63	50	—	—	—	38	30	—	—	—

Table a.2 Outer rings

Nominal outside diameter D mm		Dimensional tolerance of mean outside diameter within plane Δ_{Dmp}										Outside diameter variation V_{Dp} open type														
												diameter series 9					diameter series 0.1					diameter series 2.3.4				
		class 0		class 6		class 5		class 4		class 2		class 0	class 6	class 5	class 4	class 2	class 0	class 6	class 5	class 4	class 2	class 0	class 6	class 5	class 4	class 2
over	incl.	high	low	high	low	high	low	high	low	high	low	max					max					max				
2.5	6	0	-8	0	-7	0	-5	0	-4	0	-2.5	10	9	5	4	2.5	8	7	4	3	2.5	6	5	4	3	2.5
6	18	0	-8	0	-7	0	-5	0	-4	0	-2.5	10	9	5	4	2.5	8	7	4	3	2.5	6	5	4	3	2.5
18	30	0	-9	0	-8	0	-6	0	-5	0	-4	12	10	6	5	4	9	8	5	4	4	7	6	5	4	4
30	50	0	-11	0	-9	0	-7	0	-6	0	-4	14	11	7	6	4	11	9	5	5	4	8	7	5	5	4
50	80	0	-13	0	-11	0	-9	0	-7	0	-4	16	14	9	7	4	13	11	7	5	4	10	8	7	5	4
80	120	0	-15	0	-13	0	-10	0	-8	0	-5	19	16	10	8	5	19	16	8	6	5	11	10	8	6	5
120	150	0	-18	0	-15	0	-11	0	-9	0	-5	23	19	11	9	5	23	19	8	7	5	14	11	8	7	5
150	180	0	-25	0	-18	0	-13	0	-10	0	-7	31	23	13	10	7	31	23	10	8	7	19	14	10	8	7
180	250	0	-30	0	-20	0	-15	0	-11	0	-8	38	25	15	11	8	38	25	11	8	8	23	15	11	8	8
250	315	0	-35	0	-25	0	-18	0	-13	0	-8	44	31	18	13	8	44	31	14	10	8	26	19	14	10	8
315	400	0	-40	0	-28	0	-20	0	-15	0	-10	50	35	20	15	10	50	35	15	11	10	30	21	15	11	10
400	500	0	-45	0	-33	0	-23	—	—	—	—	56	41	23	—	—	56	41	17	—	—	34	25	17	—	—
500	630	0	-50	0	-38	0	-28	—	—	—	—	63	48	28	—	—	63	48	21	—	—	38	29	21	—	—
630	800	0	-75	0	-45	0	-35	—	—	—	—	94	56	35	—	—	94	56	26	—	—	55	34	26	—	—

Unit μm

Mean bore diameter variation V_{dmp}					Inner ring radial runout K_{ia}					Side runout with bore S_d			Inner ring axial runout S_{ia}			Inner ring width deviation Δ_{Bs}								Inner ring width variation V_{Bs}				
																normal						modified							
class 0	class 6	class 5	class 4	class 2	class 0	class 6	class 5	class 4	class 2	class 5	class 4	class 2	class 5	class 4	class 2	class 0,6		class 5,4		class 2		class 0,6		class 5,4		class 0	class 6	class 5	class 4	class 2
max					max					max			max			high	low	high	low	high	low	high	low	high	low	max				
6	5	3	2	1.5	10	5	4	2.5	1.5	7	3	1.5	7	3	1.5	0	-40	0	-40	0	-40	—	—	0	-250	12	12	5	2.5	1.5
6	5	3	2	1.5	10	6	4	2.5	1.5	7	3	1.5	7	3	1.5	0	-120	0	-40	0	-40	0	-250	0	-250	15	15	5	2.5	1.5
6	5	3	2	1.5	10	7	4	2.5	1.5	7	3	1.5	7	3	1.5	0	-120	0	-80	0	-80	0	-250	0	-250	20	20	5	2.5	1.5
8	6	3	2.5	1.5	13	8	4	3	2.5	8	4	1.5	8	4	2.5	0	-120	0	-120	0	-120	0	-250	0	-250	20	20	5	2.5	1.5
9	8	4	3	1.5	15	10	5	4	2.5	8	4	1.5	8	4	2.5	0	-120	0	-120	0	-120	0	-250	0	-250	20	20	5	3	1.5
11	9	5	3.5	2	20	10	5	4	2.5	8	5	1.5	8	5	2.5	0	-150	0	-150	0	-150	0	-380	0	-250	25	25	6	4	1.5
15	11	5	4	2.5	25	13	6	5	2.5	9	5	2.5	9	5	2.5	0	-200	0	-200	0	-200	0	-380	0	-380	25	25	7	4	2.5
19	14	7	5	3.5	30	18	8	6	2.5	10	6	2.5	10	7	2.5	0	-250	0	-250	0	-250	0	-500	0	-380	30	30	8	5	2.5
19	14	7	5	3.5	30	18	8	6	5	10	6	4	10	7	5	0	-250	0	-250	0	-250	0	-500	0	-380	30	30	8	5	4
23	17	8	6	4	40	20	10	8	5	11	7	5	13	8	5	0	-300	0	-300	0	-300	0	-500	0	-500	30	30	10	6	5
26	19	9	—	—	50	25	13	—	—	13	—	—	15	—	—	0	-350	0	—	—	—	0	-500	0	—	35	35	13	—	—
30	23	12	—	—	60	30	15	—	—	15	—	—	20	—	—	0	-400	0	—	—	—	0	-630	0	—	40	40	15	—	—
34	26	—	—	—	65	35	—	—	—	—	—	—	—	—	—	0	-450	—	—	—	—	—	—	—	—	50	45	—	—	—
38	30	—	—	—	70	40	—	—	—	—	—	—	—	—	—	0	-500	—	—	—	—	—	—	—	—	60	50	—	—	—

Unit μm

Outside diameter variation V_{DP} Sealed/shield bearings diameter series		Mean bore diameter variation V_{Dmp}					Outer ring radial runout K_{ea}					Outside surface inclination S_D			Outside ring axial runout S_{ea}			Outer ring width deviation Δ_{Cs}	Outer ring width variation V_{Cs}				
2,3,4 class 0	0,1,2,3,4 class 6	class 0	class 6	class 5	class 4	class 2	class 0	class 6	class 5	class 4	class 2	class 5	class 4	class 2	class 5	class 4	class 2		class 0,6	class 5	class 4	class 2
max		max					max					max			max			all type	max				
10	9	6	5	3	2	1.5	15	8	5	3	1.5	8	4	1.5	8	5	1.5			5	2.5	1.5
10	9	6	5	3	2	1.5	15	8	5	3	1.5	8	4	1.5	8	5	1.5	Depends on tolerance of Δ_{Bs} in relation to d of same bearing	Depends on tolerance of Δ_{Bs} in relation to d of same bearing	5	2.5	1.5
12	10	7	6	3	2.5	2	15	9	6	4	2.5	8	4	1.5	8	5	2.5			5	2.5	1.5
16	13	8	7	4	3	2	20	10	7	5	2.5	8	4	1.5	8	5	2.5			5	2.5	1.5
20	16	10	8	5	3.5	2	25	13	8	5	4	8	4	1.5	10	5	4			6	3	1.5
26	20	11	10	5	4	2.5	35	18	10	6	5	9	5	2.5	11	6	5			8	4	2.5
30	25	14	11	6	5	2.5	40	20	11	7	5	10	5	2.5	13	7	5			8	5	2.5
38	30	19	14	7	5	3.5	45	23	13	8	5	10	5	2.5	14	8	5			8	5	2.5
—	—	23	15	8	6	4	50	25	15	10	7	11	7	4	15	10	7			10	7	4
—	—	26	19	9	7	4	60	30	18	11	7	13	8	5	18	10	7			11	7	5
—	—	30	21	10	8	5	70	35	20	13	8	13	10	7	20	13	8			13	8	7
—	—	34	25	12	—	—	80	40	23	—	—	15	—	—	23	—	—			15	—	—
—	—	38	29	14	—	—	100	50	25	—	—	18	—	—	25	—	—			18	—	—
—	—	55	34	18	—	—	120	60	30	—	—	20	—	—	30	—	—			20	—	—

Table b Tolerance of tapered roller bearings (Metric series)

Table b.1 Inner rings

Nominal bore diameter d mm		Dimensional tolerance of mean bore diameter within plane Δ_{dmp}						Bore diameter variation V_{dp}				Mean bore diameter variation V_{dmp}				Inner ring radial runout K_{ia}				Side runout with bore S_d	
		class 0,6X		class 5,6		class 4		class 0,6X	class 6	class 5	class 4	class 0,6X	class 6	class 5	class 4	class 0,6X	class 6	class 5	class 4	class 5	class 4
over	incl.	high	low	high	low	high	low	max				max				max				max	
10	18	0	-12	0	-7	0	-5	12	7	5	4	9	5	5	4	15	7	5	3	7	3
18	30	0	-12	0	-8	0	-6	12	8	6	5	9	6	5	4	18	8	5	3	8	4
30	50	0	-12	0	-10	0	-8	12	10	8	6	9	8	5	5	20	10	6	4	8	4
50	80	0	-15	0	-12	0	-9	15	12	9	7	11	9	6	5	25	10	7	4	8	5
80	120	0	-20	0	-15	0	-10	20	15	11	8	15	11	8	5	30	13	8	5	9	5
120	180	0	-25	0	-18	0	-13	25	18	14	10	19	14	9	7	35	18	11	6	10	6
180	250	0	-30	0	-22	0	-15	30	22	17	11	23	16	11	8	50	20	13	8	11	7
250	315	0	-35	—	—	—	—	35	—	—	—	26	—	—	—	60	—	—	—	—	—
315	400	0	-40	—	—	—	—	40	—	—	—	30	—	—	—	70	—	—	—	—	—

Table b.2 Outer rings

Nominal outside diameter D mm		Dimensional tolerance of mean outside diameter within plane Δ_{Dmp}						Outside diameter variation V_{Dp}				Mean bore diameter variation V_{Dmp}				Outer ring radial runout K_{ea}				Outside surface inclination S_D	
		class 0,6X		class 5,6		class 4		class 0,6X	class 6	class 5	class 4	class 0,6X	class 6	class 5	class 4	class 0,6X	class 6	class 5	class 4	class 5	class 4
over	incl.	high	low	high	low	high	low	max				max				max				max	
18	30	0	-12	0	-8	0	-6	12	8	6	5	9	6	5	4	18	9	6	4	8	4
30	50	0	-14	0	-9	0	-7	14	9	7	5	11	7	5	5	20	10	7	5	8	4
50	80	0	-16	0	-11	0	-9	16	11	8	7	12	8	6	5	25	13	8	5	8	4
80	120	0	-18	0	-13	0	-10	18	13	10	8	14	10	7	5	35	18	10	6	9	5
120	150	0	-20	0	-15	0	-11	20	15	11	8	15	11	8	6	40	20	11	7	10	5
150	180	0	-25	0	-18	0	-13	25	18	14	10	19	14	9	7	45	23	13	8	10	5
180	250	0	-30	0	-20	0	-15	30	20	15	11	23	15	10	8	50	25	15	10	11	7
250	315	0	-35	0	-25	0	-18	35	25	19	14	26	19	13	9	60	30	18	11	13	8
315	400	0	-40	0	-28	0	-20	40	28	22	15	30	21	14	10	70	35	20	13	13	10

Table b.3 Effective width of outer and inner rings with roller Unit μm

Nominal bore diameter d mm		Effective width deviation of roller and inner ring assembly of tapered roller bearing Δ_{T1s}				Tapered roller bearing outer ring effective width deviation Δ_{T2s}			
		class 0		class 6X		class 0		class 6X	
over	incl.	high	low	high	low	high	low	high	low
10	18	+100	0	+50	0	+100	0	+50	0
18	30	+100	0	+50	0	+100	0	+50	0
30	50	+100	0	+50	0	+100	0	+50	0
50	80	+100	0	+50	0	+100	0	+50	0
80	120	+100	-100	+50	0	+100	-100	+50	0
120	180	+150	-150	+50	0	+200	-100	+100	0
180	250	+150	-150	+50	0	+200	-100	+100	0
250	315	+150	-150	+100	0	+200	-100	+100	0
315	400	+200	-200	+100	0	+200	-200	+100	0

Unit μm

Inner ring axial runout S_{ia}	Inner ring width deviation Δ_{Bs}						Assembly width deviation of single-row tapered roller bearings Δ_{Ts}						Combination width deviation of double row bearings Δ_{B1s}, Δ_{C1s}		Combination width deviation of 4-row bearings Δ_{B2s}, Δ_{C2s}	
class 4	class 0,6		class 6X		class 4,5		class 0,6		class 6X		class 4,5		class 0,6,5		class 0,6,5	
max	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low
3	0	-120	0	-50	0	-200	+200	0	+100	0	+200	-200	—	—	—	—
4	0	-120	0	-50	0	-200	+200	0	+100	0	+200	-200	—	—	—	—
4	0	-120	0	-50	0	-240	+200	0	+100	0	+200	-200	+240	-240	—	—
4	0	-150	0	-50	0	-300	+200	0	+100	0	+200	-200	+300	-300	—	—
5	0	-200	0	-50	0	-400	+200	-200	+100	0	+200	-200	+400	-400	+500	-500
7	0	-250	0	-50	0	-500	+350	-250	+150	0	+350	-250	+500	-500	+600	-600
8	0	-300	0	-50	0	-600	+350	-250	+150	0	+350	-250	+600	-600	+750	-750
—	0	-350	0	-50	—	—	+350	-250	+200	0	—	—	+700	-700	+900	-900
—	0	-400	0	-50	—	—	+400	-400	+200	0	—	—	+800	-800	+1 000	-1 000

Unit μm

Outer ring axial runout S_{ea}	Outer ring width deviation Δ_{Cs}			
class 4	class 0,6,5,4		class 6X	
max	sup.	inf.	sup.	inf.
5	Depends on tolerance of Δ_{Bs} in relation to d of same bearing		0	-100
5			0	-100
5			0	-100
6			0	-100
7			0	-100
8			0	-100
10			0	-100
10			0	-100
13			0	-100

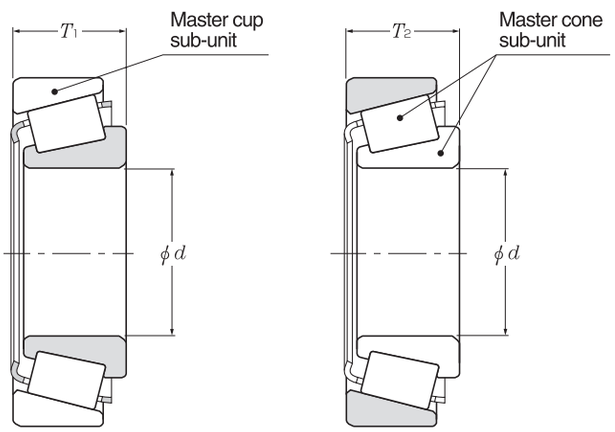


Table c Tolerance of tapered roller bearings (Inch series)

Table c.1 Inner rings

Unit μm

Nominal bore diameter d mm (inch)		Single bore diameter deviation Δ_{ds}									
		Class 4		Class 2		Class 3		Class 0		Class 00	
over	incl.	high	low	high	low	high	low	high	low	high	low
—	76.2 (3)	+13	0	+13	0	+13	0	+13	0	+8	0
76.2 (3)	266.7 (10.5)	+25	0	+25	0	+13	0	+13	0	+8	0
266.7 (10.5)	304.8 (12)	+25	0	+25	0	+13	0	+13	0	—	—
304.8 (12)	609.6 (24)	+51	0	+51	0	+25	0	—	—	—	—
609.6 (24)	914.4 (36)	+76	0	—	—	+38	0	—	—	—	—
914.4 (36)	1 219.2 (48)	+102	0	—	—	+51	0	—	—	—	—
1 219.2 (48)	—	+127	0	—	—	+76	0	—	—	—	—

Table c.2 Outer rings

Unit μm

Nominal outside diameter D mm (inch)		Single outside diameter deviation Δ_{Ds}									
		Class 4		Class 2		Class 3		Class 0		Class 00	
over	incl.	high	low	high	low	high	low	high	low	high	low
—	266.7 (10.5)	+25	0	+25	0	+13	0	+13	0	+8	0
266.7 (10.5)	304.8 (12)	+25	0	+25	0	+13	0	+13	0	—	—
304.8 (12)	609.6 (24)	+51	0	+51	0	+25	0	—	—	—	—
609.6 (24)	914.4 (36)	+76	0	+76	0	+38	0	—	—	—	—
914.4 (36)	1 219.2 (48)	+102	0	—	—	+51	0	—	—	—	—
1 219.2 (48)	—	+127	0	—	—	+76	0	—	—	—	—

Table d Tolerance of thrust ball bearings

Table d.1 Shaft raceway washer

Unit μm

Nominal bore diameter d mm		Mean bore diameter deviation Δ_{dmp}				Bore diameter variation V_{dp}		Raceway thickness variation S_i			
		Class 0,6,5		Class 4		Class 0,6,5	Class 4	Class 0	Class 6	Class 5	Class 4
over	incl.	high	low	high	low	max		max			
—	18	0	-8	0	-7	6	5	10	5	3	2
18	30	0	-10	0	-8	8	6	10	5	3	2
30	50	0	-12	0	-10	9	8	10	6	3	2
50	80	0	-15	0	-12	11	9	10	7	4	3
80	120	0	-20	0	-15	15	11	15	8	4	3
120	180	0	-25	0	-18	19	14	15	9	5	4
180	250	0	-30	0	-22	23	17	20	10	5	4
250	315	0	-35	0	-25	26	19	25	13	7	5
315	400	0	-40	0	-30	30	23	30	15	7	5
400	500	0	-45	0	-35	34	26	30	18	9	6
500	630	0	-50	0	-40	38	30	35	21	11	7

Table d.2 Housing raceway washer

Unit μm

Nominal outside diameter D mm		Mean outside diameter deviation Δ_{Dmp}				Outside diameter variation V_{Dp}		Raceway thickness variation S_e			
		Class 0,6,5		Class 4		Class 0,6,5	Class 4	Class 0	Class 6	Class 5	Class 4
over	incl.	high	low	high	low	max		max			
10	18	0	-11	0	-7	8	5	According to the tolerance of S_1 against "d" of the same bearings			
18	30	0	-13	0	-8	10	6				
30	50	0	-16	0	-9	12	7				
50	80	0	-19	0	-11	14	8				
80	120	0	-22	0	-13	17	10				
120	180	0	-25	0	-15	19	11				
180	250	0	-30	0	-20	23	15				
250	315	0	-35	0	-25	26	19				
315	400	0	-40	0	-28	30	21				
400	500	0	-45	0	-33	34	25				
500	630	0	-50	0	-38	38	29				
630	800	0	-75	0	-45	55	34				

Table d.3 Bearing height

Unit μm

Nominal bore diameter d mm		Single direction Bearing height deviation Δ_{Ts}	
over	incl.	high	low
—	30	0	-75
30	50	0	-100
50	80	0	-125
80	120	0	-150
120	180	0	-175
180	250	0	-200
250	315	0	-225
315	400	0	-300
400	500	0	-350
500	630	0	-400

Table e Tolerance of spherical thrust roller bearing

Table e.1 Shaft raceway washer

Unit μm

Nominal bore diameter d mm		Mean bore diameter deviation Δ_{dmp}		Bore diameter variation V_{dp}	Side runout with bore S_d	Bearing height deviation Δ_{Ts}	
over	incl.	high	low	max	max	high	low
50	80	0	-15	11	25	+150	-150
80	120	0	-20	15	25	+200	-200
120	180	0	-25	19	30	+250	-250
180	250	0	-30	23	30	+300	-300
250	315	0	-35	26	35	+350	-350
315	400	0	-40	30	40	+400	-400
400	500	0	-45	34	45	+450	-450

Table e.2 Housing raceway washer

Unit μm

Nominal outside diameter D mm		Single plane mean outside diameter deviation Δ_{Dmp}	
over	incl.	high	low
120	180	0	-25
180	250	0	-30
250	315	0	-35
315	400	0	-40
400	500	0	-45
500	630	0	-50
630	800	0	-75
800	1,000	0	-100

Interference

For rolling bearings, inner and outer rings are fixed on the shaft or in the housing so that relative movement does not occur between fitting surfaces during operation or under load. This relative movement between the fitting surfaces of the bearing and the shaft or housing can occur in a radial direction, an axial direction, or in the direction of rotation. Types of fitting include tight, transition and loose fitting, which may be selected depending on whether or not there is interference.
The most effective way to fix the fitting surfaces between a bearing's raceway and shaft or housing is to apply a "tight fit." The advantage of this tight fit for thin walled bearings is that it provides uniform load support over the entire ring circumference without any loss of load carrying capacity. However, with a tight fit, ease of installation and disassembly is lost; and when using a non-separable bearing as the floating-side bearing, axial displacement is not possible. For this reason, a tight fit cannot be recommended in all cases.

The necessity of a proper fit

In some cases, improper fit may lead to damage and shorten bearing life, therefore it is necessary to make a careful investigation in selecting a proper fit. Some of the bearing failure caused by improper fit are listed below.

- Raceway cracking, early flaking and displacement of raceway
- Raceway and shaft or housing abrasion caused by creeping and fretting corrosion
- Seizing caused by negative internal clearances
- Increased noise and deteriorated rotational accuracy due to raceway groove deformation

Fit selection

Selection of a proper fit is dependent upon thorough analysis of bearing operating conditions, including consideration of:

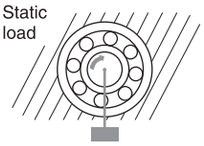
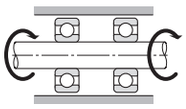
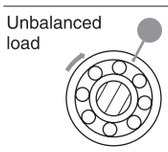
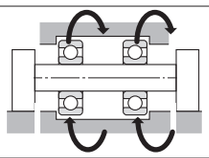
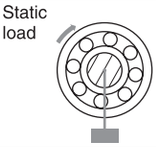
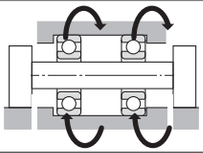
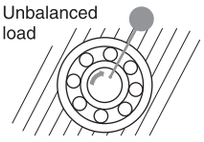
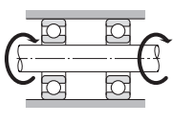
- Shaft and housing material, wall thickness, finished surface accuracy, etc.
- Machinery operating conditions (nature and magnitude of load, rotational speed, temperature, etc.)

"Tight fit" or "Loose fit"

(1) For raceways under rotating loads, a tight fit is necessary. "Raceways under rotating loads" refers to raceways receiving loads rotating relative to their radial direction. For raceways under static loads, on the other hand, a loose fit is sufficient.

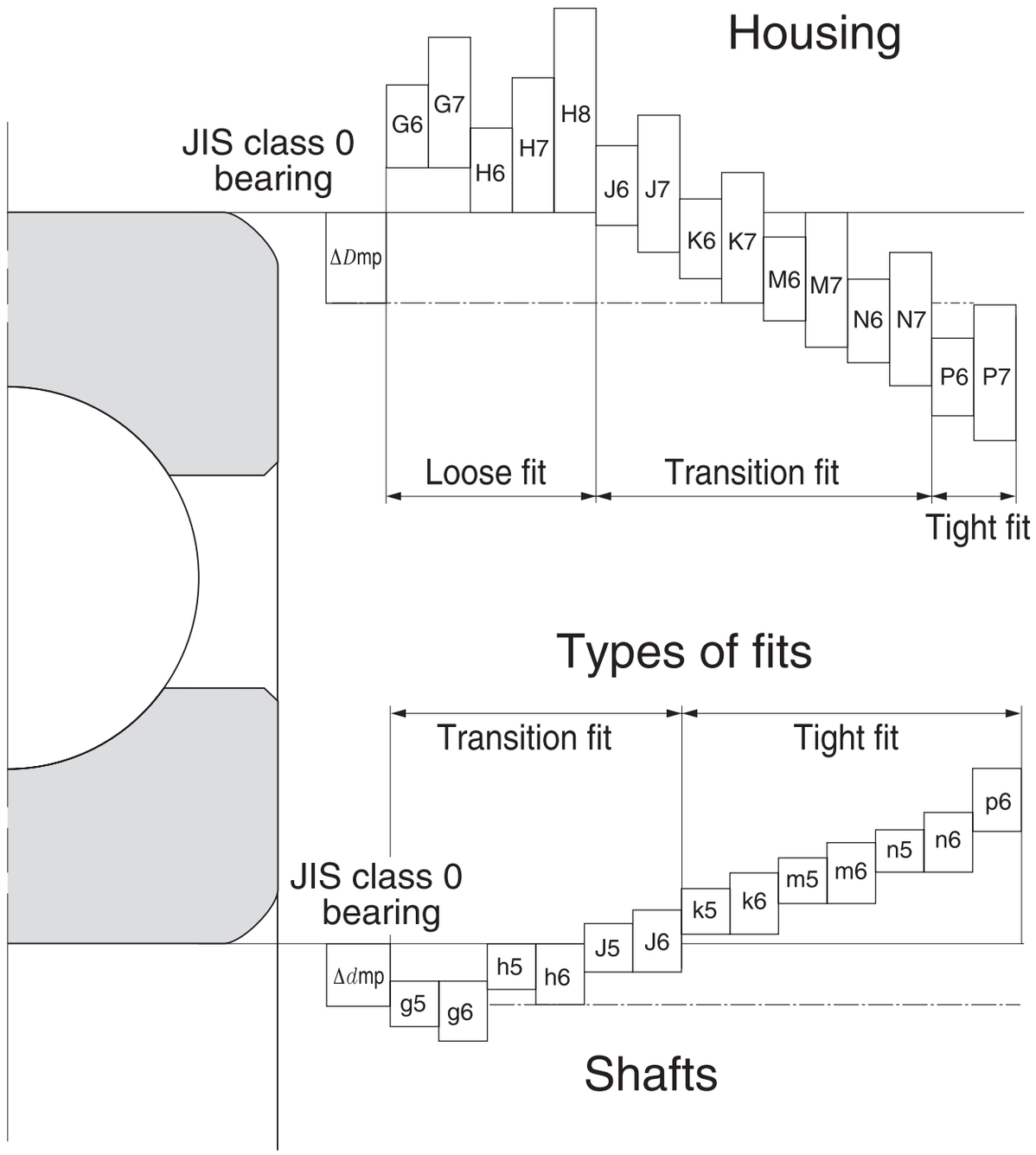
(2) For non-separable bearings, such as deep groove ball bearings, it is generally recommended that either the inner ring or outer ring be given a loose fit.

Radial load and bearing fit

Illustration	Bearing rotation	Ring load	Fit
Static load 	 Inner ring: Rotating Outer ring: Stationary	Rotating inner ring load	Inner ring : Tight fit
Unbalanced load 	 Inner ring: Stationary Outer ring: Rotating	Static outer ring load	Outer ring : Loose fit
Static load 	 Inner ring: Stationary Outer ring: Rotating	Static inner ring load	Inner ring : Loose fit
Unbalanced load 	 Inner ring: Rotating Outer ring: Stationary	Rotating outer ring load	Outer ring : Tight fit

Recommended Fits

Bearing fit is governed by the selection tolerances for bearing shaft diameters and housing bore diameters. Widely used fits for 0 Class tolerance bearings and various shaft and housing bore diameter tolerances are shown below.



Interference minimum and maximum values

The following points should be considered when it is necessary to calculate the interference for an application:

- In calculating the minimum required amount of interference keep in mind that:
  1) interference is reduced by radial loads
  2) interference is reduced by differences between bearing temperature and ambient temperature
  3) interference is reduced by variation of fitting surfaces
- The upper limit value should not exceed 1/1000 of the shaft diameter.

General standards for radial bearing fits (JIS Class 0, 6X, 6)

Tolerance class of shafts commonly used for radial bearings (classes 0, 6X and 6)

Conditions		Ball bearings		Cylindrical roller bearing Tapered roller bearing		Spherical roller bearing		Shaft tolerance class	Remarks
		Shaft diameter (mm)							
		Over	Under	Over	Under	Over	Under		
Cylindrical bore bearing (Classes 0, 6X and 6)									
Inner ring rotational load or load of undetermined direction	Light load or fluctuating load	— 18 100 —	18 100 200 —	— — 40 140	— 40 140 200	— — — —	— — — —	h5 js6 k6 m6	When greater accuracy is required js5, k5, and m5 may be substituted for js6, k6, and m6.
	Ordinary load	— 18 100 140 200 — —	18 100 140 200 280 — —	— — 40 100 140 200 —	— 40 100 140 200 400 —	— — 40 65 100 140 280	— 40 65 100 140 280 500	js5 k5 m5 m6 n6 p6 r6	Alteration of inner clearances to accommodate fit is not a consideration with single-row angular contact bearings and tapered roller bearings. Therefore, k5 and m5 may be substituted for k6 and m6.
	Heavy load or impact load	— — —	— — —	50 140 200	140 200 —	50 100 140	100 140 200	n6 p6 r6	Use bearings with larger internal clearances than CN clearance bearings.
Inner ring static load	Inner ring must move easily over shaft	Overall shaft diameter						g6	When greater accuracy is required use g5. For large bearings, f6 will suffice for to facilitate movement.
	Inner does not have to move easily over shaft	Overall shaft diameter						h6	When greater accuracy is required use h5.
Center axial load		Overall shaft diameter						js6	Generally, shaft and inner rings are not fixed using interferance.
Tapered bore bearing (class 0) (with adapter or withdrawal sleeve)									
Overall load		Overall shaft diameter						h9/IT5	h10/IT7 will suffice for power transmitting shafts.

Tolerance class of housing bore commonly used for radial bearings (classes 0, 6X and 6)

Conditions				Toleration class of housing bore	Remarks
Housing	Types of load		Outer ring axial direction movement		
Single housing or divided housing	Outer ring static load	All types of loads	Able to move.	H7	G7 will suffice for large bearings or bearings with large temperature differential between the outer ring and housing.
		Light load or ordinary load	Able to move.	H8	——
		Shaft and inner ring become hot.	Able to move easily.	G7	F7 will suffice for large bearings or bearings with large temperature differential between the outer ring and housing.
Single housing		Requires precision rotation with light or ordinary loads.	As a rule, cannot move.	K6	Primarily applies to roller bearings.
			Able to move.	JS6	Primarily applies to ball bearings.
		Requires quiet operation.	Able to move.	H6	——
	Indeterminate load	Light or ordinary load	Able to move.	JS7	If precision is required, JS6 and K6 are used in place of JS7 and K7.
		Ordinary load or heavy load	As a rule, cannot move.	K7	
		Large impact load	Cannot move.	M7	——
	Outer ring rotational load	Light or fluctuating load	Cannot move.	M7	——
		Ordinary or heavy load	Cannot move.	N7	Primarily applies to ball bearings.
		Heavy load or large impact load with thin housing	Cannot move.	P7	Primarily applies to roller bearings.

Standard fits for thrust bearings (JIS Class 0 and 6)

Shaft fits

Bearing type	Load conditions		Fit	Shaft diameter mm over — incl.	Tolerance class
All thrust bearings	Centered axial load only		Transition fit	All sizes	js6 or h6
Spherical roller thrust bearings	Combined load	Inner ring static load	Transition fit	All sizes	js6
		Inner ring rotating load or Indeterminate load	Transition fit	— ～ 200	k6 or js6
				200 ～ 400	m6 or k6
			Tight fit	400 ～	n6 or m6

Housing fits

Bearing type	Load conditions		Fit	Tolerance class	Remarks
All thrust bearings	Centered axial load only		Loose fit	Select a tolerance class that will provide clearance between outer ring and housing.	
				H8	Greater accuracy required with thrust ball bearings
Spherical roller thrust bearings	Combined load	Outer ring static load		H7	——
		Indeterminate load or outer ring rotating load	Transition fit	K7	Normal operating conditions
				M7	For relatively large radial loads

Note: All values and fits listed in the above tables are for cast iron or steel housings.

Fits for electric motor bearings

Bearing type	Shaft fits		Housing fits	
	Shaft diameter mm over — incl.	Tolerance class	Housing bore diameter	Tolerance class
Deep groove ball bearings	～ 18	j5	All sizes	H6 or J6
	18 ～100	k5		
	100 ～160	m5		
Cylindrical roller bearings	～ 40	k5	All sizes	H6 or J6
	40 ～160	m5		
	160 ～200	n6		

Fitting against shaft - class 0

Nominal bore diameter of bearing d mm over	incl.	Mean bore diameter deviation Δ_{dmp} high	low	g5 bearing shaft	g6 bearing shaft	h5 bearing shaft	h6 bearing shaft	j5 bearing shaft	js5 bearing shaft	j6 bearing shaft
3	6	0	-8	4T～ 9L	4T～12L	8T～ 5L	8T～ 8L	11T～ 2L	10.5T～ 2.5L	14T～ 2L
6	10	0	-8	3T～11L	3T～14L	8T～ 6L	8T～ 9L	12T～ 2L	11T ～ 3L	15T～ 2L
10	18	0	-8	2T～14L	2T～17L	8T～ 8L	8T～11L	13T～ 3L	12T ～ 4L	16T～ 3L
18	30	0	-10	3T～16L	3T～20L	10T～ 9L	10T～13L	15T～ 4L	14.5T～ 4.5L	19T～ 4L
30	50	0	-12	3T～20L	3T～25L	12T～11L	12T～16L	18T～ 5L	17.5T～ 5.5L	23T～ 5L
50	80	0	-15	5T～23L	5T～29L	15T～13L	15T～19L	21T～ 7L	21.5T～ 6.5L	27T～ 7L
80	120	0	-20	8T～27L	8T～34L	20T～15L	20T～22L	26T～ 9L	27.5T～ 7.5L	33T～ 9L
120 140 160	140 160 180	0	-25	11T～32L	11T～39L	25T～18L	25T～25L	32T～11L	34T ～ 9L	39T～11L
180 200 225	200 225 250	0	-30	15T～35L	15T～44L	30T～20L	30T～29L	37T～13L	40T ～10L	46T～13L
250 280	280 315	0	-35	18T～40L	18T～49L	35T～23L	35T～32L	42T～16L	46.5T～11.5L	51T～16L
315 355	355 400	0	-40	22T～43L	22T～54L	40T～25L	40T～36L	47T～18L	52.5T～12.5L	58T～18L
400 450	450 500	0	-45	25T～47L	25T～60L	45T～27L	45T～40L	52T～20L	58.5T～13.5L	65T～20L

Fitting against housing - class 0

Nominal outside diameter of bearing D mm over	incl.	Mean outside diameter deviation Δ_{Dmp} high	low	G7 housing bearing	H6 housing bearing	H7 housing bearing	J6 housing bearing	J7 housing bearing	Js7 housing bearing	K6 housing bearing
6	10	0	-8	5L～ 28L	0～17L	0～ 23L	4T～13L	7T～16L	7.5T～15.5L	7T～10L
10	18	0	-8	6L～ 32L	0～19L	0～ 26L	5T～14L	8T～18L	9T ～17L	9T～10L
18	30	0	-9	7L～ 37L	0～22L	0～ 30L	5T～17L	9T～21L	10.5T～19.5L	11T～11L
30	50	0	-11	9L～ 45L	0～27L	0～ 36L	6T～21L	11T～25L	12.5T～23.5L	13T～14L
50	80	0	-13	10L～ 53L	0～32L	0～ 43L	6T～26L	12T～31L	15T ～28L	15T～17L
80	120	0	-15	12L～ 62L	0～37L	0～ 50L	6T～31L	13T～37L	17.5T～32.5L	18T～19L
120	150	0	-18	14L～ 72L	0～43L	0～ 58L	7T～36L	14T～44L	20T ～38L	21T～22L
150	180	0	-25	14L～ 79L	0～50L	0～ 65L	7T～43L	14T～51L	20T ～45L	21T～29L
180	250	0	-30	15L～ 91L	0～59L	0～ 76L	7T～52L	16T～60L	23T ～53L	24T～35L
250	315	0	-35	17L～104L	0～67L	0～ 87L	7T～60L	16T～71L	26T ～61L	27T～40L
315	400	0	-40	18L～115L	0～76L	0～ 97L	7T～69L	18T～79L	28.5T～68.5L	29T～47L
400	500	0	-45	20L～128L	0～85L	0～108L	7T～78L	20T～88L	31.5T～76.5L	32T～53L

Unit μm

js6		k5		k6		m5		m6		n6		p6		r6		Nominal bore diameter of bearing d mm	
bearing	shaft	bearing	shaft	bearing	shaft	bearing	shaft	bearing	shaft	bearing	shaft	bearing	shaft	bearing	shaft	over	incl.
12T ～ 4L		14T～1T		17T～1T		17T～ 4T		20T～ 4T		24T～ 8T		28T～12T		—	—	3	6
12.5T～ 4.5L		15T～1T		18T～1T		20T～ 6T		23T～ 6T		27T～10T		32T～15T		—	—	6	10
13.5T～ 5.5L		17T～1T		20T～1T		23T～ 7T		26T～ 7T		31T～12T		37T～18T		—	—	10	18
16.5T～ 6.5L		21T～2T		25T～2T		27T～ 8T		31T～ 8T		38T～15T		45T～22T		—	—	18	30
20T ～ 8L		25T～2T		30T～2T		32T～ 9T		37T～ 9T		45T～17T		54T～26T		—	—	30	50
24.5T～ 9.5L		30T～2T		36T～2T		39T～11T		45T～11T		54T～20T		66T～32T		—	—	50	80
31T ～11L		38T～3T		45T～2T		48T～13T		55T～13T		65T～23T		79T～37T		—	—	80	120
37.5T～12.5L		46T～3T		53T～3T		58T～15T		65T～15T		77T～27T		93T～43T		113T～ 63T		120	140
														115T～ 65T		140	160
														118T～ 68T		160	180
44.5T～14.5L		54T～4T		63T～4T		67T～17T		76T～17T		90T～31T		109T～50T		136T～ 77T		180	200
														139T～ 80T		200	225
														143T～ 84T		225	250
51T ～16L		62T～4T		71T～4T		78T～20T		87T～20T		101T～34T		123T～56T		161T～ 94T		250	280
														165T～ 98T		280	315
58T ～18L		69T～4T		80T～4T		86T～21T		97T～21T		113T～37T		138T～62T		184T～108T		315	355
														190T～114T		355	400
65T ～20L		77T～5T		90T～4T		95T～23T		108T～23T		125T～40T		153T～68T		211T～126T		400	450
														217T～132T		450	500

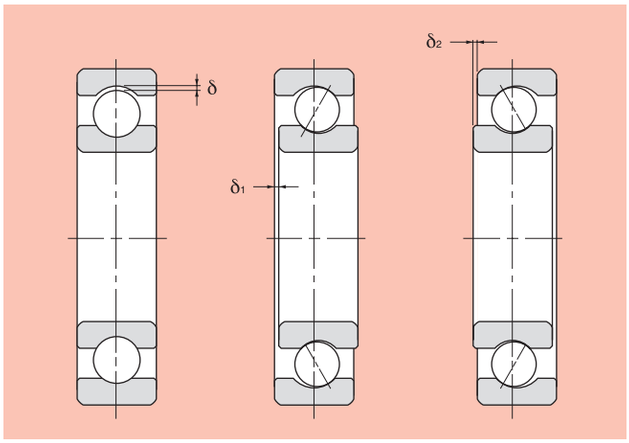
Unit μm

K7		M7		N7		P7		Nominal outside diameter of bearing D mm	
housing	bearing	housing	bearing	housing	bearing	housing	bearing	over	incl.
10T～13L		15T～ 8L		19T～ 4L		24T～ 1T		6	10
12T～14L		18T～ 8L		23T～ 3L		29T～ 3T		10	18
15T～15L		21T～ 9L		28T～ 2L		35T～ 5T		18	30
18T～18L		25T～11L		33T～ 3L		42T～ 6T		30	50
21T～22L		30T～13L		39T～ 4L		51T～ 8T		50	80
25T～25L		35T～15L		45T～ 5L		59T～ 9T		80	120
28T～30L		40T～18L		52T～ 6L		68T～10T		120	150
28T～37L		40T～25L		52T～13L		68T～ 3T		150	180
33T～43L		46T～30L		60T～16L		79T～ 3T		180	250
36T～51L		52T～35L		66T～21L		88T～ 1T		250	315
40T～57L		57T～40L		73T～24L		98T～ 1T		315	400
45T～63L		63T～45L		80T～28L		108T～ 0		400	500

Bearing internal clearance

Bearing internal clearance is the amount of internal free movement before mounting.

As shown below, when either the inner ring or the outer ring is fixed and the other ring is free to move, displacement can take place in either an axial or radial direction. This amount of displacement (radially or axially) is termed the internal clearance and, depending on the direction, is called the radial internal clearance or the axial internal clearance.



Radial clearance = δ Axial clearance = $\delta_1 + \delta_2$

Internal clearance

When the internal clearance of a bearing is measured, a slight measurement load is applied to the raceway so the internal clearance may be measured accurately. However, at this time, a slight amount of elastic deformation of the bearing occurs under the measurement load, and the clearance measurement value (measured clearance) is slightly larger than the true clearance. This difference between the true bearing clearance and the increased amount due to the elastic deformation must be compensated for. These compensation values are given in Table below.

Adjustment of radial internal clearance based on measured load (deep groove ball bearing)

Unit μm

Nominal Bore Diameter d mm		Measuring Load N {kgf}		Internal clearance adjustment				
over	incl.			C2	CN	C3	C4	C5
10	18	24.5	{2.5}	3～4	4	4	4	4
18	50	49	{5}	4～5	5	6	6	6
50	200	147	{15}	6～8	8	9	9	9

Internal clearance selection

The internal clearance of a bearing under operating conditions (effective clearance) is usually smaller than the same bearing's initial clearance before being installed and operated. This is due to several factors including bearing fit, the difference in temperature between the inner and outer rings, etc. As a bearing's operating clearance has an effect on bearing life, heat generation, vibration, noise, etc.; care must be taken in selecting the most suitable operating clearance.

Criteria for selecting bearing internal clearance

A bearing's life is theoretically maximum when operating clearance is slightly negative at steady operation. In reality it is however difficult to constantly maintain this optimal condition. If the negative clearance becomes enlarged by fluctuating operating conditions, heat will be produced and life will decrease dramatically. Under ordinary circumstances you should therefore select an initial internal clearance where the operating clearance is slightly larger than zero.

For ordinary operating conditions, use fitting for ordinary loads. If rotational speed and operating temperature are ordinary, selecting normal clearance enables you to obtain the proper operating clearance. Table below gives examples applying internal clearances other than CN (normal) clearance.

Examples of applications where bearing clearances other than CN (normal) clearance are used

Operating conditions	Applications	Selected clearance
With heavy or shock load, clearance is large.	Railway vehicle axles	C3
	Vibration screens	C3, C4
With indeterminate load, both inner and outer rings are tight-fitted.	Railway vehicle traction motors	C4
	Tractors and final speed regulators	C4
Shaft or inner ring is heated.	Paper making machines and driers	C3, C4
	Rolling mill table rollers	C3
Reduction of noise and vibration when rotating.	Micromotors	C2, CM
Adjustment of clearance to minimize shaft runout.	Main spindles of lathes (Double-row cylindrical roller bearings)	C9NA, C0NA
Loose fitting for both inner and outer rings.	Compressor roll neck	C2

Radial internal clearance of deep groove ball bearings

Unit μm

Nominal bore diameter d mm		C2		CN		C3		C4		C5	
over	incl.	min	max	min	max	min	max	min	max	min	max
—	2.5	0	6	4	11	10	20	—	—	—	—
2.5	6	0	7	2	13	8	23	—	—	—	—
6	10	0	7	2	13	8	23	14	29	20	37
10	18	0	9	3	18	11	25	18	33	25	45
18	24	0	10	5	20	13	28	20	36	28	48
24	30	1	11	5	20	13	28	23	41	30	53
30	40	1	11	6	20	15	33	28	46	40	64
40	50	1	11	6	23	18	36	30	51	45	73
50	65	1	15	8	28	23	43	38	61	55	90
65	80	1	15	10	30	25	51	46	71	65	105
80	100	1	18	12	36	30	58	53	84	75	120
100	120	2	20	15	41	36	66	61	97	90	140
120	140	2	23	18	48	41	81	71	114	105	160
140	160	2	23	18	53	46	91	81	130	120	180
160	180	2	25	20	61	53	102	91	147	135	200
180	200	2	30	25	71	63	117	107	163	150	230
200	225	2	35	25	85	75	140	125	195	175	265
225	250	2	40	30	95	85	160	145	225	205	300
250	280	2	45	35	105	90	170	155	245	225	340
280	315	2	55	40	115	100	190	175	270	245	370
315	355	3	60	45	125	110	210	195	300	275	410
355	400	3	70	55	145	130	240	225	340	315	460
400	450	3	80	60	170	150	270	250	380	350	510
450	500	3	90	70	190	170	300	280	420	390	570
500	560	10	100	80	210	190	330	310	470	440	630
560	630	10	110	90	230	210	360	340	520	490	690

Radial internal clearance of self-aligning ball bearings

Unit μm

Nominal bore diameter d mm		Bearing with cylindrical bore									
		C2		CN		C3		C4		C5	
over	incl.	min	max	min	max	min	max	min	max	min	max
2.5	6	1	8	5	15	10	20	15	25	21	33
6	10	2	9	6	17	12	25	19	33	27	42
10	14	2	10	6	19	13	26	21	35	30	48
14	18	3	12	8	21	15	28	23	37	32	50
18	24	4	14	10	23	17	30	25	39	34	52
24	30	5	16	11	24	19	35	29	46	40	58
30	40	6	18	13	29	23	40	34	53	46	66
40	50	6	19	14	31	25	44	37	57	50	71
50	65	7	21	16	36	30	50	45	69	62	88
65	80	8	24	18	40	35	60	54	83	76	108
80	100	9	27	22	48	42	70	64	96	89	124
100	120	10	31	25	56	50	83	75	114	105	145
120	140	10	38	30	68	60	100	90	135	125	175
140	160	15	44	35	80	70	120	110	161	150	210

Radial internal clearance of self-aligning ball bearings - Bearing with tapered bore

Unit μm

Nominal bore diameter d mm		Bearing with tapered bore									
		C2		CN		C3		C4		C5	
over	incl.	min	max	min	max	min	max	min	max	min	max
2.5	6	—	—	—	—	—	—	—	—	—	—
6	10	—	—	—	—	—	—	—	—	—	—
10	14	—	—	—	—	—	—	—	—	—	—
14	18	—	—	—	—	—	—	—	—	—	—
18	24	7	17	13	26	20	33	28	42	37	55
24	30	9	20	15	28	23	39	33	50	44	62
30	40	12	24	19	35	29	46	40	59	52	72
40	50	14	27	22	39	33	52	45	65	58	79
50	65	18	32	27	47	41	61	56	80	73	99
65	80	23	39	35	57	50	75	69	98	91	123
80	100	29	47	42	68	62	90	84	116	109	144
100	120	35	56	50	81	75	108	100	139	130	170
120	140	40	68	60	98	90	130	120	165	155	205
140	160	45	74	65	110	100	150	140	191	180	240

Radial internal clearance for duplex angular contact ball bearings

Unit μm

Nominal bore diameter d mm		C1		C2		CN		C3		C4	
over	incl.	min	max	min	max	min	max	min	max	min	max
—	10	3	8	6	12	8	15	15	22	22	30
10	18	3	8	6	12	8	15	15	24	30	40
18	30	3	10	6	12	10	20	20	32	40	55
30	50	3	10	8	14	14	25	25	40	55	75
50	80	3	11	11	17	17	32	32	50	75	95
80	100	3	13	13	22	22	40	40	60	95	120
100	120	3	15	15	30	30	50	50	75	110	140
120	150	3	16	16	33	35	55	55	80	130	170
150	180	3	18	18	35	35	60	60	90	150	200
180	200	3	20	20	40	40	65	65	100	180	240

Radial internal clearance of double row angular contact ball bearings

Unit μm

Nominal bore diameter d mm over	incl.	C2 min	C2 max	CN min	CN max	C3 min	C3 max	C4 min	C4 max	C5 min	C5 max
10	only	0	10	5	15	10	21	16	28	24	36
10	18	1	11	6	16	12	23	19	31	28	40
18	24	1	11	6	16	13	24	21	33	31	43
24	30	1	13	6	19	13	26	21	35	31	45
30	40	2	15	7	22	15	30	24	39	35	50
40	50	2	15	9	24	17	32	28	45	40	57
50	65	0	15	7	24	16	33	28	48	41	61
65	80	1	17	11	31	21	42	34	56	50	74
80	100	3	20	13	36	25	49	40	65	58	67

Radial internal clearance of bearings for electric motor

Unit μm

Nominal bore diameter d mm over	incl.	Radial internal clearance CM: Deep groove ball bearings min	Deep groove ball bearings max	Cylindrical roller bearings min	Cylindrical roller bearings max
10 (incl.)	18	4	11	—	—
18	24	5	12	—	—
24	30	5	12	15	30
30	40	9	17	15	30
40	50	9	17	20	35
50	65	12	22	25	40
65	80	12	22	30	45
80	100	18	30	35	55
100	120	18	30	35	60
120	140	24	38	40	65
140	160	24	38	50	80
160	180	—	—	60	90
180	200	—	—	65	100

Interchangeable radial internal clearance for cylindrical roller bearing (cylindrical bore)

Unit μm

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

Radial internal clearance of spherical roller bearings

Unit μm

Nominal bore diameter d mm		Bearing with cylindrical bore									
		C2		CN		C3		C4		C5	
over	incl.	min	max	min	max	min	max	min	max	min	max
14	18	10	20	20	35	35	45	45	60	60	75
18	24	10	20	20	35	35	45	45	60	60	75
24	30	15	25	25	40	40	55	55	75	75	95
30	40	15	30	30	45	45	60	60	80	80	100
40	50	20	35	35	55	55	75	75	100	100	125
50	65	20	40	40	65	65	90	90	120	120	150
65	80	30	50	50	80	80	110	110	145	145	180
80	100	35	60	60	100	100	135	135	180	180	225
100	120	40	75	75	120	120	160	160	210	210	260
120	140	50	95	95	145	145	190	190	240	240	300
140	160	60	110	110	170	170	220	220	280	280	350
160	180	65	120	120	180	180	240	240	310	310	390
180	200	70	130	130	200	200	260	260	340	340	430
200	225	80	140	140	220	220	290	290	380	380	470
225	250	90	150	150	240	240	320	320	420	420	520
250	280	100	170	170	260	260	350	350	460	460	570
280	315	110	190	190	280	280	370	370	500	500	630
315	355	120	200	200	310	310	410	410	550	550	690
355	400	130	220	220	340	340	450	450	600	600	750
400	450	140	240	240	370	370	500	500	660	660	820
450	500	140	260	260	410	410	550	550	720	720	900

Radial internal clearance of spherical roller bearings - Bearing with tapered bore

Unit μm

Nominal bore diameter d mm		Bearing with tapered bore									
		C2		CN		C3		C4		C5	
over	incl.	min	max	min	max	min	max	min	max	min	max
14	18	—	—	—	—	—	—	—	—	—	—
18	24	15	25	25	35	35	45	45	60	60	75
24	30	20	30	30	40	40	55	55	75	75	95
30	40	25	35	35	50	50	65	65	85	85	105
40	50	30	45	45	60	60	80	80	100	100	130
50	65	40	55	55	75	75	95	95	120	120	160
65	80	50	70	70	95	95	120	120	150	150	200
80	100	55	80	80	110	110	140	140	180	180	230
100	120	65	100	100	135	135	170	170	220	220	280
120	140	80	120	120	160	160	200	200	260	260	330
140	160	90	130	130	180	180	230	230	300	300	380
160	180	100	140	140	200	200	260	260	340	340	430
180	200	110	160	160	220	220	290	290	370	370	470
200	225	120	180	180	250	250	320	320	410	410	520
225	250	140	200	200	270	270	350	350	450	450	570
250	280	150	220	220	300	300	390	390	490	490	620
280	315	170	240	240	330	330	430	430	540	540	680
315	355	190	270	270	360	360	470	470	590	590	740
355	400	210	300	300	400	400	520	520	650	650	820
400	450	230	330	330	440	440	570	570	720	720	910
450	500	260	370	370	490	490	630	630	790	790	1,000

Bearing Lubrication

Proper lubrication for rolling element bearings is critical for reliable bearing operation and prevention of premature damage and a reduction in fatigue life. The proper bearing lubricant must provide a separating film between the rolling elements, raceways, and cage to prevent metal-to-metal contact. The lubricant film must be thick enough under operating conditions to prevent contact of rolling element and raceway asperities.

If the asperities of rolling elements and races of an anti-friction bearing come into contact with each other, a certain amount of molecular adhesion or micro-welding or shearing of these asperities as a result of the relative motion between them can be expected. The result is an undesirable surface change of the rolling surfaces. Ideal lubrication requires that an oil film be continually present to prevent contact of the surface asperities and metal to metal contact.

In addition to preventing metal-to-metal contact, proper bearing lubricants help perform the following function:

- Reduce friction, heat generation, torque, and power consumption
- Provide a heat transfer medium
- Prevent corrosion
- Aid in providing proper sealing and preventing contamination

Bearing lubrication is broadly categorized as being either grease or oil lubrication. The decision to use grease or oil and what type of lubricant system to use, are dependent on the bearing type and application operating conditions.

Bearing greasing methods and amounts

There are two methods of providing bearing grease lubrication. One is the closed lubrication, in which grease is filed in advance into a shielded or sealed bearing; the other is the feeding method in which the bearing and housing are greased at assembly with the proper amount and designed to allow re-greasing and replacement at specified intervals. The dosed method using a pre-lubricated shielded or sealed bearing is well suited for applications where cost and space limitations preclude the use of grease filled housing or where relubrication is not possible or necessary. Conversely, the use of the feeding method has the advantage of allowing the replacement on periodic intervals in those applications where operating conditions require grease replacement.

For bearing applications utilizing the feeding method, there should be a grease fitting and a vent at opposite ends of the housing near the top. Also, a drain plug should be located near the bottom of the housing to allow purging of the old grease during relubrication. A bearing should be initially greased at assembly by packing it in on both sides and making sure the grease is between the rolling elements and cage. Regreasing should always occur while the bearing is in motion at the normal operating temperature.

Grease amount

The amount of grease needed to effectively lubricate a bearing is normally very small. In general, grease fill should be one-third to one-half of the space around the bearing; however, this may vary according to the housing design and application requirements. In applications with high speed and low torque requirements, the bearings can be lubricated with very small quantities of greases. Similarly, in low speed applications where the bearing may be exposed to dirt or moisture, the space around the bearing can be filled from two-thirds to nearly full to prevent contamination. If an excessive amount of grease is used when not required, additional heat will be generated from the churning, resulting in a softening and deterioration of the grease, and a reduction in bearing life. The grease weight required for a bearing can be calculated in grams.

Grease quantity = 0.05 x D x B gms.

Regreasing intervals and grease life

With grease lubricated bearings, periodic relubrication is normally required to ensure efficient operation. Over a period of time, most grease will eventually start to harden due to oxidation. The exception to this is in presealed bearings where relubrication is usually not required.

When regreasing bearings, it is necessary to be sure that the grease fitting is clean prior to injecting the grease. A hand operated grease gun should be used for relubrication, but the use of high pressure needs to be avoided. High pressure may blow out seals. When using a grease gun, it should be calibrated for the

proper amount of grease, and confirmed that the grease in the gun is the same as what was initially applied to the bearings.

The main considerations for determining a relubrication cycle are operating speed, bearing size, operating temperature, and sealing efficiency. Seals are very critical with grease lubrication because of the importance to keep the grease free from contamination. Contamination that reaches the grease is trapped and will cause bearing damage and wear problems.

As the chart below shows leading grease available in the market with their specifications

Manufacturer	Product	BaseOil/thickener	Working temperature range ˚C	0.1mm Worked Penetration ˚C	Dropping Point ˚C	Remark
Kyodo Yushi	Multemp SRL	Polyol ester+Diester/ Lithium hydroxy Stearate	-50~150	250	190	Low noise Long life, High temperature
	Multemp PS	Diester+Refined mineral oil Lithium Stearate	-60~130	NO.2	190	Low torque, Outstanding noise Suppressant property
	Multemp SB-M	Synthetic hydrocarban/Diurea	-40~200	220	>260	High temperature,High speed operation, low noise property
	Raremax Super N	Polyol ester+Diester/ Lithium hydroxy Stearate	-40~180	260	120	Low noise Long life, High temperature
Shell	Alvania RLQ 2	Mineral oil / Lithium	-25~120	266	195	Wide applications available
	Alvania RL2	Mineral oil/ Lithium	-30~120	310	185	Wide applications available
	Alvania RL3	Mineral oil/ Lithium	-30~120	220	185	Not good for transmission
	Alvania EP 2	Mineral oil/ Lithium	-20~110	265	185	Long service life under heavy load water, resistance, Corrosian resistance
Kluber	Asonic GL Y 32	PAO, Ester oil/ Lithium	-50~140	265~295	>190	Low noise Long life, High temperature
	Asonic Q 74-73	PAO,Ester oil / Polyrea	-40~160	220~250	>250	Low noise, Long life, High temperature
	Klueberquiet BQH72-102	Ester oil / Polyurea	-40~180	250~280	>250	Low noise, Long life, High temperature
	Klueberquiet BEP72-82	Ester oil / Polyurea	-40~180	250~280	>250	High temperature, Available for auto generator bearings
	Petamo GHY 133 N	Mineral oil, PAO/ Polyrea	-30~160	265~295	>250	High temperature, Available for auto generator bearings
	Lsoflex LDS 18 Special A	Ester oil, Mineral oil / Li	-50~120	265~295	>190	Avaiable for pump bearings, Motor and its accessory
Exxon Mobil	Beacon 325	Diester / Lithium	-54~120	280	193	High Speed, Low noise Corrosian resistance
	Polyrex EM	Mineral / Diurea	-29~177	318	288	Low temperature
	Mobilgrease 28	Diester/ Microgel	-62~177	310	>260	Water resistance, High temperature
Chevron	SRI-2	ISOSYN/ Polyurea	-30~150	280	243	Water resistance, Corrosian resistance High temperature
Dupont	Krytox 240	Fluoinated / PTFE	-34~288	285		High temperature

Vibration of single bearing

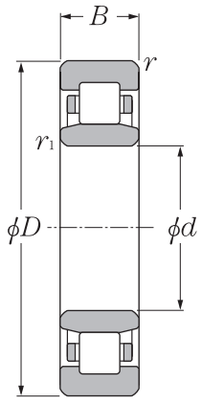
µm/s

Bore dia (mm)	V 0			V 1			V 2			V 3			V 4		
	LB	MB	HB	LB	MB	HB	LB	MB	HB	LB	MB	HB	LB	MB	HB
Miniature Ball Bearings															
3-4	80	44	44	60	35	32	48	26	22	31	16	15	28	10	10
5-6	110	72	60	74	48	40	58	36	30	35	21	18	32	11	11
7-9	130	96	80	92	66	54	72	48	40	44	28	24	38	12	12
Deep Groove Ball Bearings															
10-12	160	120	100	120	80	70	90	60	50	55	35	30	45	14	15
15-17	210	150	120	150	100	85	110	78	60	65	46	35	52	18	18
20-25	260	190	150	180	125	100	130	100	75	80	60	45	60	25	25
30-35	300	240	190	200	150	130	150	120	100	90	75	60	70	35	40
40-45	360	300	260	240	180	160	180	150	130	110	90	80	82	50	50
50-55	420	320	320	280	200	200	210	160	160	125	100	100	95	70	70
60	480	360	440	320	220	240	240	180	200	145	110	130	100	80	80

Maximum acceleration of single bearing

dB

Bore dia (mm)	For dia series 0				For dia series 2					For dia series 3				
	Z	Z1	Z2	Z3	Z	Z1	Z2	Z3	Z4	Z	Z1	Z2	Z3	Z4
Miniature Ball Bearings														
3-4	35	34	32	28	36	35	32	30		37	36	33	31	
5-6	37	36	34	30	38	37	34	32		39	37	35	33	
7-8	39	38	35	31	40	38	36	34						
9	41	40	36	32	42	40	37	35						
Deep Groove Ball Bearings														
10	43	42	38	33	44	42	39	35	30	46	44	40	37	32
12	44	43	39	34	45	43	39	35	30	47	45	40	37	32
15	45	44	40	35	46	44	41	36	31	48	46	42	38	33
17	45	44	40	35	46	45	41	36	31	48	46	42	38	33
20	47	45	41	36	48	46	42	38	33	50	48	43	39	34
25	48	46	42	38	49	47	43	40	36	51	49	44	41	37
30	49	47	43	39	50	48	44	41	37	52	50	45	42	38
35	41	49	45	41	52	50	46	43	39	54	52	47	44	40
40	53	51	46	42	54	52	47	44	40	56	54	49	45	41
45	55	53	48	45	56	54	49	46	43	58	56	51	47	44
50	57	54	50	47	58	55	51	48	45	60	57	53	49	46
55	59	56	52	49	60	57	53	50	47	62	59	54	51	48
60	61	58	54	51	62	59	54	51	48	61	61	56	53	50
65	49	48	46		50	49	47	42		51	50	48	43	
70	50	49	47		51	50	48	43		52	51	49	44	
75	51	50	48		52	51	49	44		53	52	50	45	
80	52	51	49		53	52	50	45		54	53	51	46	
85	53	52	50		54	53	51	46		56	55	52	47	
90	54	53	52		56	55	53	48		58	57	54	49	
95	56	55	54		58	57	55	50		60	59	56	51	
100	58	57	56		60	59	57	52		62	61	58	53	
105	60	59	58		62	61	59	54		64	63	60	55	
110	62	61	60		64	63	61	56		66	65	62	57	
115-120	64	63	62		66	65	63	58		68	67	64	59	



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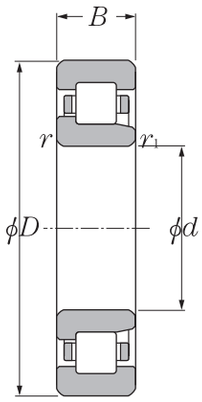

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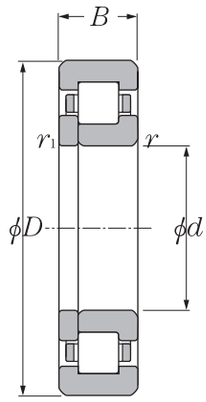

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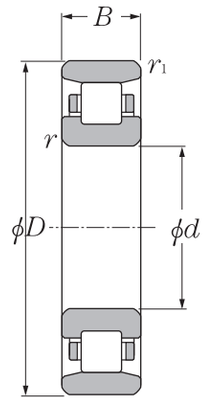
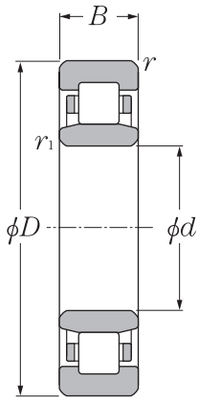


Type N

d 20~50mm

Boundary dimensions mm					Basic load ratings dynamic kN		Basic load ratings static kgf		Limiting speeds min^{-1}		Bearing numbers type NU	type NJ	type NUP	type N	Mass kg (approx.)
d	*D*	*B*	$r_{s\,min}$	$r_{1s\,min}$	C_r	C_{or}	C_r	C_{or}	grease	oil					
20	47	14	1.0	0.6	25.7	22.6	2 620	2 310	15 000	18 000	**NU204**	**NJ**	**NUP**	**—**	0.122
	47	18	1.0	0.6	30.5	28.3	3 100	2 890	14 000	16 000	**NU2204**	**NJ**	**NUP**	**—**	0.158
	52	15	1.1	0.6	31.5	26.9	3 200	2 740	13 000	15 000	**NU304**	**NJ**	**NUP**	**—**	0.176
	52	21	1.1	0.6	42.0	39.0	4 300	3 950	12 000	14 000	**NU2304**	**NJ**	**NUP**	**—**	0.242
25	52	15	1.0	0.6	29.3	27.7	2 990	2 830	13 000	15 000	**NU205**	**NJ**	**NUP**	**—**	0.151
	52	18	1.0	0.6	35.0	34.5	3 550	3 550	11 000	13 000	**NU2205**	**NJ**	**NUP**	**—**	0.186
	62	17	1.1	1.1	41.5	37.5	4 250	3 800	11 000	13 000	**NU305**	**NJ**	**NUP**	**—**	0.275
	62	24	1.1	1.1	57.0	56.0	5 800	5 700	9 700	11 000	**NU2305**	**NJ**	**NUP**	**—**	0.386
30	62	16	1.0	0.6	39.0	37.5	4 000	3 800	11 000	13 000	**NU206**	**NJ**	**NUP**	**—**	0.226
	62	20	1.0	0.6	49.0	50.0	5 000	5 100	9 700	11 000	**NU2206**	**NJ**	**NUP**	**—**	0.297
	72	19	1.1	1.1	53.0	50.0	5 400	5 100	9 300	11 000	**NU306**	**NJ**	**NUP**	**—**	0.398
	72	27	1.1	1.1	74.5	77.5	7 600	7 900	8 300	9 700	**NU2306**	**NJ**	**NUP**	**—**	0.580
35	72	17	1.1	0.6	50.5	50.0	5 150	5 100	9 500	11 000	**NU207**	**NJ**	**NUP**	**—**	0.327
	72	23	1.1	0.6	61.5	65.5	6 300	6 650	8 500	10 000	**NU2207**	**NJ**	**NUP**	**—**	0.455
	80	21	1.5	1.1	71.0	71.0	7 200	7 200	8 100	9 600	**NU307**	**NJ**	**NUP**	**—**	0.545
	80	31	1.5	1.1	99.0	109.0	10 100	11 100	7 200	8 500	**NU2307**	**NJ**	**NUP**	**—**	0.780
40	80	18	1.1	1.1	43.5	43.0	4 450	4 350	9 400	11 000	**NU208**	**NJ**	**NUP**	**N**	0.378
	80	23	1.1	1.1	58.0	62.0	5 950	6 300	8 500	10 000	**NU2208**	**NJ**	**NUP**	**N**	0.490
	90	23	1.5	1.5	58.5	57.0	6 000	5 800	8 000	9 400	**NU308**	**NJ**	**NUP**	**N**	0.658
	90	33	1.5	1.5	82.5	88.0	8 400	8 950	7 000	8 200	**NU2308**	**NJ**	**NUP**	**N**	0.951
45	85	19	1.1	1.1	46.0	47.0	4 700	4 800	8 400	9 900	**NU209**	**NJ**	**NUP**	**N**	0.432
	85	23	1.1	1.1	61.5	68.0	6 250	6 900	7 600	9 000	**NU2209**	**NJ**	**NUP**	**N**	0.530
	100	25	1.5	1.5	74.0	71.0	7 550	7 250	7 200	8 400	**NU309**	**NJ**	**NUP**	**N**	0.877
	100	36	1.5	1.5	99.0	104.0	10 100	10 600	6 300	7 400	**NU2309**	**NJ**	**NUP**	**N**	1.270
50	90	20	1.1	1.1	48.0	51.0	4 900	5 200	7 600	9 000	**NU210**	**NJ**	**NUP**	**N**	0.470
	90	23	1.1	1.1	64.0	73.5	6 550	7 500	6 900	8 100	**NU2210**	**NJ**	**NUP**	**N**	0.571
	110	27	2.0	2.0	87.0	86.0	8 850	8 800	6 500	7 700	**NU310**	**NJ**	**NUP**	**N**	1.140
	110	40	2.0	2.0	121.0	131.0	12 300	13 400	5 700	6 700	**NU2310**	**NJ**	**NUP**	**N**	1.700



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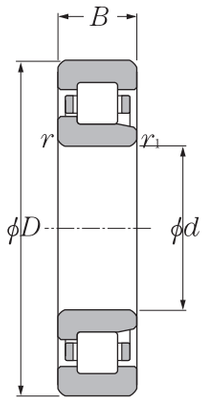

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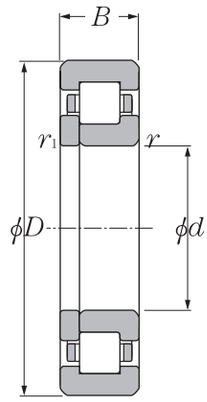
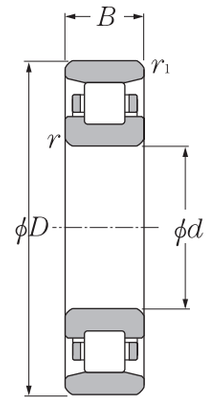


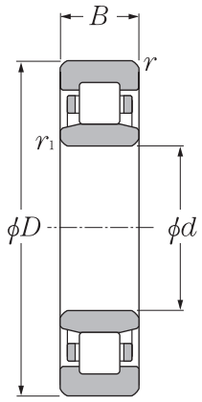
Type NUP



Type N

d 55~85mm

Boundary dimensions mm					Basic load ratings dynamic kN		static kN		Limiting speeds min^{-1}		Bearing numbers				Mass kg
d	*D*	*B*	$r_{s\,min}$	$r_{1s\,min}$	C_r	C_{or}	C_r	C_{or}	grease	oil	type NU	type NJ	type NUP	type N	(approx.)
55	100	21	1.5	1.1	58.0	62.5	5 900	6 350	6 900	8 200	**NU211**	**NJ**	**NUP**	**N**	0.638
	100	25	1.5	1.1	75.5	87.0	7 700	8 900	6 300	7 400	**NU2211**	**NJ**	**NUP**	**N**	0.773
	120	29	2.0	2.0	111.0	111.0	11 300	11 400	5 900	7 000	**NU311**	**NJ**	**NUP**	**N**	1.450
	120	43	2.0	2.0	148.0	162.0	15 100	16 500	5 200	6 100	**NU2311**	**NJ**	**NUP**	**N**	2.170
60	110	22	1.5	1.5	68.5	75.0	7 000	7 650	6 400	7 600	**NU212**	**NJ**	**NUP**	**N**	0.818
	110	28	1.5	1.5	96.0	116.0	9 800	11 800	5 800	6 800	**NU2212**	**NJ**	**NUP**	**N**	1.060
	130	31	2.1	2.1	124.0	126.0	12 600	12 900	5 500	6 500	**NU312**	**NJ**	**NUP**	**N**	1.800
	130	46	2.1	2.1	169.0	188.0	17 200	19 200	4 800	5 700	**NU2312**	**NJ**	**NUP**	**N**	2.710
65	120	23	1.5	1.5	84.0	94.5	8 550	9 650	5 900	7 000	**NU213**	**NJ**	**NUP**	**N**	1.020
	120	31	1.5	1.5	120.0	149.0	12 200	15 200	5 400	6 300	**NU2213**	**NJ**	**NUP**	**N**	1.400
	140	33	2.1	2.1	135.0	139.0	13 800	14 200	5 100	6 000	**NU313**	**NJ**	**NUP**	**N**	2.230
	140	48	2.1	2.1	188.0	212.0	19 100	21 700	4 400	5 200	**NU2313**	**NJ**	**NUP**	**N**	3.270
70	125	24	1.5	1.5	83.5	95.0	8 500	9 700	5 500	6 500	**NU214**	**NJ**	**NUP**	**N**	1.120
	125	31	1.5	1.5	119.0	151.0	12 200	15 400	5 000	5 900	**NU2214**	**NJ**	**NUP**	**N**	1.470
	150	35	2.1	2.1	158.0	168.0	16 100	17 200	4 700	5 500	**NU314**	**NJ**	**NUP**	**N**	2.710
	150	51	2.1	2.1	223.0	262.0	22 700	26 700	4 100	4 800	**NU2314**	**NJ**	**NUP**	**N**	3.980
75	130	25	1.5	1.5	96.5	111.0	9 850	11 300	5 100	6 000	**NU215**	**NJ**	**NUP**	**N**	1.230
	130	31	1.5	1.5	130.0	162.0	13 200	16 500	4 700	5 500	**NU2215**	**NJ**	**NUP**	**N**	1.550
	160	37	2.1	2.1	190.0	205.0	19 400	20 900	4 400	5 200	**NU315**	**NJ**	**NUP**	**N**	3.280
	160	55	2.1	2.1	258.0	300.0	26 300	31 000	3 800	4 500	**NU2315**	**NJ**	**NUP**	**N**	4.870
80	140	26	2.0	2.0	106.0	122.0	10 800	12 500	4 800	5 700	**NU216**	**NJ**	**NUP**	**N**	1.500
	140	33	2.0	2.0	147.0	186.0	15 000	19 000	4 400	5 100	**NU2216**	**NJ**	**NUP**	**N**	1.930
	170	39	2.1	2.1	190.0	207.0	19 400	21 100	4 100	4 800	**NU316**	**NJ**	**NUP**	**N**	3.860
	170	58	2.1	2.1	274.0	330.0	27 900	34 000	3 600	4 200	**NU2316**	**NJ**	**NUP**	**N**	5.790
85	150	28	2.0	2.0	120.0	140.0	12 300	14 300	4 500	5 300	**NU217**	**NJ**	**NUP**	**N**	1.870
	150	36	2.0	2.0	170.0	218.0	17 300	22 200	4 100	4 800	**NU2217**	**NJ**	**NUP**	**N**	2.440
	180	41	3.0	3.0	212.0	228.0	21 600	23 300	3 900	4 600	**NU317**	**NJ**	**NUP**	**N**	4.540
	180	60	3.0	3.0	315.0	380.0	32 000	39 000	3 400	4 000	**NU2317**	**NJ**	**NUP**	**N**	6.700



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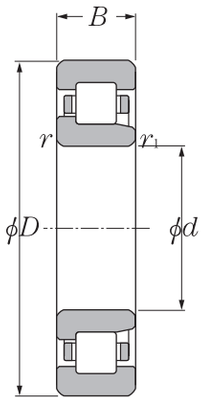

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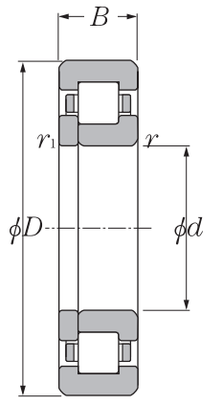

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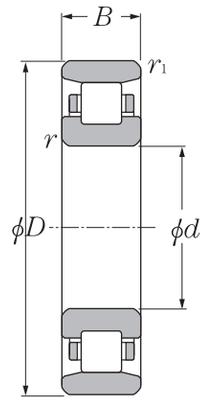

Type N

d 90~100mm

Boundary dimensions mm					Basic load ratings dynamic kN		static kN		Limiting speeds min^{-1}		Bearing numbers				Mass kg
d	*D*	*B*	$r_{s\,min}$	$r_{1s\,min}$	C_r	C_{or}	C_r	C_{or}	grease	oil	type NU	type NJ	type NUP	type N	(approx.)
90	160	30	2.0	2.0	152.0	178.0	15 500	18 100	4 300	5 000	**NU218**	**NJ**	**NUP**	**N**	2.300
	160	40	2.0	2.0	197.0	248.0	20 100	25 300	3 900	4 600	**NU2218**	**NJ**	**NUP**	**N**	3.100
	190	43	3.0	3.0	240.0	265.0	24 500	27 100	3 700	4 300	**NU318**	**NJ**	**NUP**	**N**	5.300
	190	64	3.0	3.0	325.0	395.0	33 500	40 000	3 200	3 800	**NU2318**	**NJ**	**NUP**	**N**	7.950
95	170	32	2.1	2.1	166.0	195.0	16 900	19 900	4 000	4 700	**NU219**	**NJ**	**NUP**	**N**	2.780
	170	43	2.1	2.1	230.0	298.0	23 500	30 500	3 600	4 300	**NU2219**	**NJ**	**NUP**	**N**	3.790
	200	45	3.0	3.0	259.0	285.0	26 400	29 500	3 400	4 000	**NU319**	**NJ**	**NUP**	**N**	6.130
	200	67	3.0	3.0	370.0	460.0	38 000	47 000	3 000	3 500	**NU2319**	**NJ**	**NUP**	**N**	9.200
100	180	34	2.1	2.1	183.0	217.0	18 600	22 200	3 800	4 500	**NU220**	**NJ**	**NUP**	**N**	3.330
	180	46	2.1	2.1	258.0	340.0	26 300	34 500	3 500	4 100	**NU2220**	**NJ**	**NUP**	**N**	4.570
	215	47	3.0	3.0	299.0	335.0	30 500	34 500	3 300	3 800	**NU320**	**NJ**	**NUP**	**N**	7.490
	215	73	3.0	3.0	410.0	505.0	42 000	51 500	2 900	3 400	**NU2320**	**NJ**	**NUP**	**N**	11.700