4. Bearing Tolerances

Bearing tolerances; i.e., dimensional accuracy, running accuracy, etc., are regulated by standards such as ISO and JIS. For dimensional accuracy these standards prescibe tolerances and allowable error limitations for those boundry dimensions (bore diameter, outside diameter, width, assembled bearing width, chamfer, and taper) necessary when installing bearings on shafts or in housings. For machining accuracy the standards provide allowable variation limits on bore, mean bore, outside diameter, mean outside diameter and raceway width or wall thickness (for thrust bearings). Running accuracy is defined as the allowable limits for bearing runout. Bearing runout tolerances are included in the standards for inner and outer ring radial and axial runout; inner ring side runout with bore; and outer ring outside surface runout with side.

Tolerances and allowable error limitations are established for each tolerance grade or class. For example, JIS standard B 1514 (tolerances for rolling bearings) establishes five tolerance classifications (classes 0, 6, 5, 4, 2).

Starting with class 0 (normal precision class bearings), the bearing precision becomes progressively greater as the class number becomes smaller.

A comparison of relative tolerance class standards between the JIS B1514 standard classes and other standards is shown in the comparative Table 4.1.

Table 4.2 indicates which standard and tolerance class is applicable to each bearing type.

Table 4.1 Comparison of tolerance classifications of national standards

Standard		Tolerance Class					Bearing Types
Japanese Industrial Standard	JIS B 1514	Class 0 Class 6X	Class 6	Class 5	Class 4	Class 2	All types
International Organization for Standardization	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 620	P0	P6	P5	P4	P2	All types
American National Standards Institute (ANSI) Anti-Friction Bearing Manufacturers (AFBMA)	ANSI/AFBMA Std. 20[1)]	ABEC-1 RBEC-1	ABEC-3 RBEC-3	ABEC-5 RBEC-5	ABEC-7	ABEC-9	Radial bearings (Except tapered roller bearings)
	ANSI/AFBMA Std. 19.1	Class K	Class N	Class C	Class B	Class A	Tapered roller bearings (Metric series)
	ANSI B 3.19 AFBMA Std. 19	Class 4	Class 2	Class 3	Class 0	Class 00	Tapered roller bearings (Inch series)
	ANSI/AFBMA Std. 12.1	—	Class 3P	Class 5P Class 5T	Class 7P Class 7T	Class 9P	Precision instrument ball bearings (Metric series)
	ANSI/AFBMA Sts. 12.2	—	Class 3P	Class 5P Class 5T	Class 7P Class 7T	Class 9P	Precision instrument ball bearings (Inch series)

1) "ABEC" is applied for ball bearings and "RBEC" for roller bearings.

Notes: 1. JIS B 1514, ISO 492 and 199, and DIN 620 have the same specification level.
2. The tolerance and allowance of JIS B 1514 are a little different from those of AFBMA standards.

Table 4.2 Bearing types and applicable tolerance

Bearing Type		Applicable standard	Applicable tolerance					Tolerance table
Deep groove ball bearing		ISO 492	class 0	class 6	class 5	class 4	class 2	Table 4.3
Angular contact ball bearings			class 0	class 6	class 5	class 4	class 2	
Self-aligning ball bearings			class 0	—	—	—	—	
Cylindrical roller bearings			class 0	class 6	class 5	class 4	class 2	
Needle roller bearings			class 0	class 6	class 5	class 4	—	
Spherical roller bearings			class 0	—	—	—	—	
Tapered roller bearings	metric	ISO 492	class 0,6X	class 6	class 5	class 4	—	Table 4.4
	inch	AFBMA Std. 19	class 4	class 2	class 3	class 0	class 00	Table 4.5
	J series	ANSI/AFBMA Std.19.1	class K	class N	class C	class B	class A	Table 4.6
Thrust ball bearings		ISO 199	class 0	class 6	class 5	class 4	—	Table 4.7
Thrust roller bearings		NTN standard	class 0	class 6	class 5	class 4	—	Page B-219 Table 2
Spherical roller thrust bearings		ISO 199	class 0	—	—	—	—	Table 4.8
Double direction angular contact thrust ball bearings		NTN standard	—	—	class 5	class 4	—	Table 4.9

The following is a list of codes and symbols used in the bearing tolerance standards tables. However, in some cases the code or symbol definition has been abbreviated.

(1) Dimension

- d : Nominal bore diameter
- d_2 : Nominal bore diameter (double direction thrust ball bearing)
- D : Nominal outside diameter
- B : Nominal inner ring width or nominal center washer height
- C : Nominal outer ring width[1)]
  Note 1) For radial bearings (except tapered roller bearings) this is equivalent to the nominal bearing width.
- T : Nominal bearing width of single row tapered roller bearing, or nominal height of single direction thrust bearing
- T_1 : Nominal height of double direction thrust ball bearing, or nominal effective width of inner ring and roller assembly of tapered roller bearing
- T_2 : Nominal height from back face of housing washer to back face of center washer on double direction thrust ball bearings, or nominal effective outer ring width of tapered roller bearing
- r : Chamfer dimensions of inner and outer rings (for tapered roller bearings, large end of inner rilng only)
- r_1 : Chamfer dimensions of center washer, or small end of inner and outer ring of angular contact ball bearing, and large end of outer ring of tapered roller bearing
- r_2 : Chamfer dimensions of small end of inner and outer rings of tapered roller bearing

(2) Dimension deviation

- Δ_{ds} : Single bore diameter deviation
- Δ_{dmp} : Single plane mean bore diameter deviation
- Δ_{d2mp} : Single plane mean bore diameter deviation (double direction thrust ball bearing)
- Δ_{Ds} : Single outside diameter deviation
- Δ_{Dmp} : Single plane mean outside diameter deviation
- Δ_{Bs} : Inner ring width deviation, or center washer height deviation
- Δ_{Cs} : Outer ring width deviation
- Δ_{Ts} : Overall width deviation of assembled single row tapered roller bearing, or height deviation of single direction thrust bearing
- Δ_{T1s} : Height deviation of double direction thrust ball bearing, or effective width deviation of roller and inner ring assembly of tapered roller bearing
- Δ_{T2s} : Double direction thrust ball bearing housing washer back face to center washer back face height deviation, or tapered roller bearing outer ring effective width deviation

(3) Chamfer boundry

- r_s min : Minimum allowable chamfer dimension for inner/outer ring, or small end of inner ring on tapered roller bearing
- r_s max : Maximum allowable chamfer dimension for inner/outer ring, or large end of inner ring on tapered roller bearing
- r_{1s} min : Minimum allowable chamfer dimension for double direction thrust ball bearing center washer, small end of inner/outer ring of angular contact ball bearing, large end of outer ring of tapered roller bearing
- r_{1s} max : Maximum allowable chamfer dimension for double direction thrust ball bearing center washer, small end of inner/outer ring of angular contact ball bearing, large end of outer ring of tapered roller bearing
- r_{2s} min : Minimum allowable chamfer dimension for small end of inner/outer ring of tapered roller bearing
- r_{2s} max : Maximum allowable chamfer dimension for small end of inner/outer ring of tapered roller bearing

(4) Dimension variation

- V_{dp} : Single radial plane bore diameter variation
- V_{d2p} : Single radial plane bore diameter variation (double direction thrust ball bearing)
- V_{dmp} : Mean single plane bore diameter variation
- V_{Dp} : Single radial plane outside diameter variation
- V_{Dmp} : Mean single plane outside diameter variation
- V_{Bs} : Inner ring width variation
- V_{Cs} : Outer ring width variation

(5) Rotation tolerance

- K_{ia} : Inner ring radial runout
- S_{ia} : Inner ring axial runout (with side)
- S_d : Face runout with bore
- K_{ea} : Outer ring radial runout
- S_{ea} : Outer ring axial runout
- S_D : Outside surface inclination
- S_i : Thrust beaing shaft washer raceway (or center washer raceway) thickness variation
- S_e : Thrust bearing housing washer raceway thickness variation


NTN

Table 4.3 Tolerance for radial bearings (Except tapered roller bearings) max

Table 4.3 (1) Inner rings

Nominal bore diameter d (mm)		Δ_{dmp}										V_{dp}														
		class 0		class 6		class 5		class 4 [1]		class 2 [1]		diameter series 7,8,9					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
over	inc.	high	low	high	low	high	low	high	low	high	low	max					max					max				
0.6[1]	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	23	—	—	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	—	—	—
630	800	0	−75	—	—	—	—	—	—	—	—	94	—	—	—	—	94	—	—	—	—	55	—	—	—	—
800	1000	0	−100	—	—	—	—	—	—	—	—	125	—	—	—	—	125	—	—	—	—	75	—	—	—	—
1000	1250	0	−125	—	—	—	—	—	—	—	—	155	—	—	—	—	155	—	—	—	—	94	—	—	—	—
1250	1600	0	−160	—	—	—	—	—	—	—	—	200	—	—	—	—	200	—	—	—	—	120	—	—	—	—
1600	2000	0	−200	—	—	—	—	—	—	—	—	250	—	—	—	—	250	—	—	—	—	150	—	—	—	—

1) The dimensional difference Δ_{ds} of bore diameter to be applied for classes 4 and 2 is the same as the tolerance of dimensional difference Δ_{dmp} of average bore diameter. However, the dimensional difference is applied to diameter series 0,1,2,3 and 4 against Class 4, and also to all the diameter series against Class 2.

Table 4.3 (2) Outer rings

Nominal outside diameter D (mm)		Δ_{Dmp}										V_{Dp} [6] open type														
		class 0		class 6		class 5		class 4 [5]		class 2 [5]		diameter series 7,8,9					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
over	inc.	high	low	high	low	high	low	high	low	high	low	max					max					max				
2.5[8]	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	—	—
800	1000	0	−100	0	−60	—	—	—	—	—	—	125	75	—	—	—	125	75	—	—	—	75	45	—	—	—
1000	1250	0	−125	—	—	—	—	—	—	—	—	155	—	—	—	—	155	—	—	—	—	94	—	—	—	—
1250	1600	0	−160	—	—	—	—	—	—	—	—	200	—	—	—	—	200	—	—	—	—	120	—	—	—	—
1600	2000	0	−200	—	—	—	—	—	—	—	—	250	—	—	—	—	250	—	—	—	—	150	—	—	—	—
2000	2500	0	−250	—	—	—	—	—	—	—	—	310	—	—	—	—	310	—	—	—	—	190	—	—	—	—

5) The dimensional difference Δ_{Ds} of outer diameter to be applied for classes 4 and 2 is the same as the tolerance of dimensional difference Δ_{Dmp} of average outer diameter. However, the dimensional difference is applied to diameter series 0,1,2,3 and 4 against Class 4, and also to all the diameter series against Class 2.

Unit μm

V_{dp}					K_{ia}					S_d			S_{ia} 2)			Δ_{Bs}										V_{Bs}				
																normal						modified 3)								
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	–300	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	–350	0	–500	0	–500	30	30	10	6	5
26	19	9	—	—	50	25	13	—	—	13	—	—	15	—	—	0	–350	0	–350	—	—	0	–500	0	–500	35	35	13	—	—
30	23	12	—	—	60	30	15	—	—	15	—	—	20	—	—	0	–400	0	–400	—	—	0	–630	0	–630	40	40	15	—	—
34	26	—	—	—	65	35	—	—	—	—	—	—	—	—	—	0	–450	—	—	—	—	—	—	—	—	50	45	—	—	—
38	30	—	—	—	70	40	—	—	—	—	—	—	—	—	—	0	–500	—	—	—	—	—	—	—	—	60	50	—	—	—
55	—	—	—	—	80	—	—	—	—	—	—	—	—	—	—	0	–750	—	—	—	—	—	—	—	—	70	—	—	—	—
75	—	—	—	—	90	—	—	—	—	—	—	—	—	—	—	0	–1000	—	—	—	—	—	—	—	—	80	—	—	—	—
94	—	—	—	—	100	—	—	—	—	—	—	—	—	—	—	0	–1250	—	—	—	—	—	—	—	—	100	—	—	—	—
120	—	—	—	—	120	—	—	—	—	—	—	—	—	—	—	0	–1600	—	—	—	—	—	—	—	—	120	—	—	—	—
150	—	—	—	—	140	—	—	—	—	—	—	—	—	—	—	0	–2000	—	—	—	—	—	—	—	—	140	—	—	—	—

2) To be applied for deep groove ball bearings and angular contact ball bearings.
3) To be applied for individual raceway rings manufactured for combined bearing use.
4) Nominal bore diameter of bearings of 0.6 mm is included in this dimensional division.

Unit μm

V_{Dp} 6) capped bearings diameter series		V_{Dmp}					K_{ea}					S_D			S_{ea}			Δ_{Cs}	V_{Cs}			
class 6	class 0	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	all type	class 0,6	class 5	class 4	class 2
max		max					max					max			max				max			
10	9	6	5	3	2	1.5	15	8	5	3	1.5	8	4	1.5	8	5	1.5	Identical to Δ_{Bs} of inner ring of same bearing	Identical to Δ_{Bs} and V_{Bs} of inner ring of same bearing	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			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	—	—
—	—	75	45	—	—	—	140	75	—	—	—	—	—	—	—	—	—			—	—	—
—	—	94	—	—	—	—	160	—	—	—	—	—	—	—	—	—	—			—	—	—
—	—	120	—	—	—	—	190	—	—	—	—	—	—	—	—	—	—			—	—	—
—	—	150	—	—	—	—	220	—	—	—	—	—	—	—	—	—	—			—	—	—
—	—	190	—	—	—	—	250	—	—	—	—	—	—	—	—	—	—			—	—	—

6) To be applied in case snap rings are not installed on the bearings.
7) To be applied for deep groove ball bearings and angular contact ball bearings.
8) Nominal outer diameter of bearings of 2.5 mm is included in this dimensional division.

Table 4.4 Tolerance for tapered roller bearings (Metric system)

Table 4.4 (1) Inner rings

Nominal bore diameter *d* (mm)		Δ_{dmp}						V_{dp}				V_{dmp}				K_{ia}				S_d	
		class 0,6X		class 5,6		class 4[1)]		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	—	—	—	—	—
400	500	0	–45	—	—	—	—	45	—	—	—	34	—	—	—	80	—	—	—	—	—
500	630	0	–50	—	—	—	—	50	—	—	—	38	—	—	—	90	—	—	—	—	—
630	800	0	–75	—	—	—	—	75	—	—	—	56	—	—	—	105	—	—	—	—	—
800	1000	0	–100	—	—	—	—	100	—	—	—	75	—	—	—	120	—	—	—	—	—

1) The dimensional difference Δ_{ds} of bore diameter to be applied for class 4 is the same as the tolerance of dimensional difference Δ_{dmp} of average bore diameter.

Table 4.4 (2) Outer rings

Nominal bore diameter *D* (mm)		Δ_{Dmp}						V_{Dp}				V_{Dmp}				K_{ea}				S_D	
		class 0,6X		class 5,6		class 4[2)]		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
400	500	0	–45	—	—	—	—	45	—	—	—	34	—	—	—	80	—	—	—	—	—
500	630	0	–50	—	—	—	—	50	—	—	—	38	—	—	—	100	—	—	—	—	—
630	800	0	–75	—	—	—	—	75	—	—	—	56	—	—	—	120	—	—	—	—	—
800	1000	0	–100	—	—	—	—	100	—	—	—	75	—	—	—	140	—	—	—	—	—
1000	1250	0	–125	—	—	—	—	125	—	—	—	84	—	—	—	165	—	—	—	—	—
1250	1600	0	–160	—	—	—	—	160	—	—	—	120	—	—	—	190	—	—	—	—	—

2) The dimensional difference Δ_{Ds} of outside diameter to be applied for class 4 is the same as the tolerance of dimensional difference Δ_{Dmp} of average outside diameter.

Unit μm

S_{ia}	Δ_{B_S}						Δ_{T_S}						Δ_{B1_S}, Δ_{C1_S}		Δ_{B2_S}, Δ_{C2_S}	
class 4	class 0,6		class 6X		class 4, 5		class 0,6		class 6X		class 4, 5		class 4, 5		class 4, 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	–80	—	—	+400	–400	+200	0	—	—	+800	–800	+1000	–1000
—	0	–450	—	—	—	—	—	—	—	—	—	—	+900	–900	+1200	–1200
—	0	–500	—	—	—	—	—	—	—	—	—	—	+1000	–1000	+1200	–1200
—	0	–750	—	—	—	—	—	—	—	—	—	—	+1500	–1500	+1500	–1500
—	0	–1000	—	—	—	—	—	—	—	—	—	—	+1500	–1500	+1500	–1500

S_{ea}	Δ_{C_S}			
class 4	class 0, 6, 5, 4		class 6X	
max	high	low	high	low
5	Identical to Δ_{B_S} of inner ring 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
—			0	–100
—			0	–100
—			—	—
—			—	—
—			—	—
—			—	—

Table 4.4 (3) Effective width of outer and inner rings with roller

Unit μm

Nominal bore diameter d (mm)		Δ_{T1_S}				Δ_{T2_S}			
		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

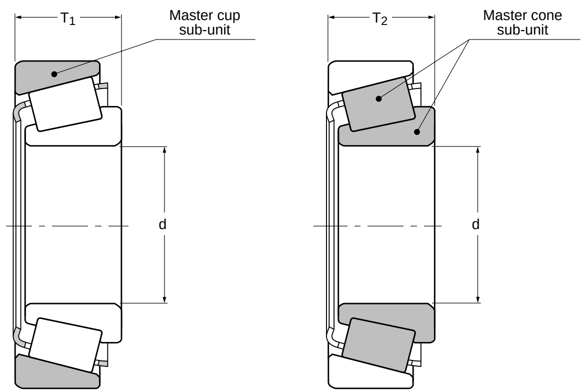


Table 4.5 Tolerance for tapered roller bearings of inch system

Table 4.5 (1) Inner rings

Unit μm
0.0001 inch

Nominal bore diameter d (mm, inch)		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	+13	0	+13	0	+13	0	+13	0	+8	0
—	3	+5	0	+5	0	+5	0	+5	0	+3	0
76.2	304.8	+25	0	+25	0	+13	0	+13	0	+8	0
3	12	+10	0	+10	0	+5	0	+5	0	+3	0

Table 4.5 (2) Outer rings

Unit μm
0.0001 inch

Nominal outside diameter D (mm, inch)		Δ_{Ds}									
		Class 4		Class 2		Class 3		Class 0		Class 00	
over	incl.	over	incl.	over	incl.	over	incl.	over	incl.	over	incl.
—	304.8	+25	0	+25	0	+13	0	+13	0	+8	0
—	12	+10	0	+10	0	+5	0	+5	0	+3	0
304.8	609.6	+51	0	+51	0	+25	0	—	—	—	—
12	24	+20	0	+20	0	+10	0	—	—	—	—

Table 4.5 (3) Effective width of inner rings with roller and outer rings

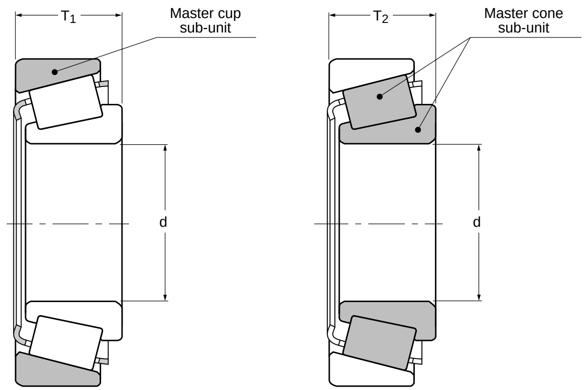
Unit μm
0.0001 inch

Nominal bore diameter d (mm, inch)		Nominal outside diameter D (mm, inch)		Δ_{Ts}								Δ_{B2s}, Δ_{C2s}	
				Class 4		Class 2		Class 3		Class 0, 00		Class 4, 2, 3, 0	
over	incl.	over	incl.	high	low	high	low	high	low	high	low	high	low
—	101.6			+203	0	+203	0	+203	–203	+203	–203	+1520	–1520
—	4			+80	0	+80	0	+80	–80	+80	–80	+599	–599
101.6	304.8			+356	–254	+203	0	+203	–203	+203	–203	+1520	–1520
4	12			+140	–100	+80	0	+80	–80	+80	–80	+599	–599
304.8	609.6	—	508.0	+381	–381	+381	–381	+203	–203	—	—	+1520	–1520
12	24	—	20	+150	–150	+150	–150	+80	–80	—	—	+599	–599
304.8	609.6	508.0	—	+381	–381	+381	–381	+381	–381	—	—	+1520	–1520
12	24	20	—	+150	–150	+150	–150	+150	–150	—	—	+599	–599

Table 4.5 (4) Radial deflection of inner and outer rings

Unit μm
0.0001 inch

Nominal outside diameter D (mm, inch)		K_{ia}, K_{ea}				
over	incl.	Class 4	Class 2	Class 3	Class 0	Class 00
—	304.8	51	38	8	4	2
—	12	20	15	3	1.5	0.75
304.8	609.6	51	38	18	—	—
12	24	20	15	7	—	—



Unit μm
0.0001 inch

Δ_{T1s}						Δ_{T2s}					
Class 4		Class 2		Class 3		Class 4		Class 2		Class 3	
high	low	high	low	high	low	high	low	high	low	high	low
+102	0	+102	0	+102	–102	+102	0	+102	0	+102	–102
+40	0	+40	0	+40	–40	+40	0	+40	0	+40	–40
+152	–152	+102	0	+102	–102	+203	–102	+102	0	+102	–102
+60	–60	+40	0	+40	–40	+80	–40	+40	0	+40	–40
—	—	+178	–178[1)]	+102	–102[1)]	—	—	+203	–203[1)]	+102	–102[1)]
—	—	+70	–70	+40	–40	—	—	+80	–80	+40	–40
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—

1) To be applied for nominal bore diameters of 406.400 mm 16 inch or less.

Table 4.6 Tolerance of tapered roller bearings of J series (Metric system)

Table 4.6 (1) Inner rings

Nominal bore diameter d (mm)		Δ_{dmp}								V_{dp}				V_{dmp}			
		Class K		Class N		Class C		Class B		Class K	Class N	Class C	Class B	Class K	Class N	Class C	Class B
over	incl.	high	low	high	low	high	low	high	low	max				max			
10	18	0	–12	0	–12	0	–7	0	–5	12	12	4	3	9	9	5	4
18	30	0	–12	0	–12	0	–8	0	–6	12	12	4	3	9	9	5	4
30	50	0	–12	0	12	0	–10	0	–8	12	12	4	3	9	9	5	5
50	80	0	–15	0	–15	0	–12	0	–9	15	15	5	3	11	11	5	5
80	120	0	–20	0	–20	0	–15	0	–10	20	20	5	3	15	15	5	5
120	180	0	–25	0	–25	0	–18	0	–13	25	25	5	3	19	19	5	7
180	250	0	–30	0	–30	0	–22	0	–15	30	30	6	4	23	23	5	8

Note: Please consult NTN for bearings of Class A

Table 4.6 (2) Outer rings

Nominal outside diameter D (mm)		Δ_{Dmp}								V_{Dp}				V_{Dmp}			
		Class K		Class N		Class C		Class B		Class K	Class N	Class C	Class B	Class K	Class N	Class C	Class B
over	incl.	high	low	high	low	high	low	high	low	max				max			
18	30	0	–12	0	–12	0	–8	0	–6	12	12	4	3	9	9	5	4
30	50	0	–14	0	–14	0	–9	0	–7	14	14	4	3	11	11	5	5
50	80	0	–16	0	–16	0	–11	0	–9	16	16	4	3	12	12	6	5
80	120	0	–18	0	–18	0	–13	0	–10	18	18	5	3	14	14	7	5
120	150	0	–20	0	–20	0	–15	0	–11	20	20	5	3	15	15	8	6
150	180	0	–25	0	–25	0	–18	0	–13	25	25	5	3	19	19	9	7
180	250	0	–30	0	–30	0	–20	0	–15	30	30	6	4	23	23	10	8
250	315	0	–35	0	–35	0	–25	0	–18	35	35	8	5	26	26	13	9
315	400	0	–40	0	–40	0	–28	0	–20	40	40	10	5	30	30	14	10

Note: Please consult NTN for bearings of Class A

Table 4.6 (3) Effective width of inner and outer rings

Nominal bore diameter d (mm)		Δ_{T1s}								Δ_{T2s}							
		Class K		Class N		Class C		Class B		Class K		Class N		Class C		Class B	
over	incl.	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low
10	80	+100	0	+50	0	+100	–100	⁎	⁎	+100	0	+50	0	+100	–100	⁎	⁎
80	120	+100	–100	+50	0	+100	–100	⁎	⁎	+100	–100	+50	0	+100	–100	⁎	⁎
120	180	+150	–150	+50	0	+100	–100	⁎	⁎	+200	–100	+100	0	+100	–150	⁎	⁎
180	250	+150	–150	+50	0	+100	–150	⁎	⁎	+200	–100	+100	0	+100	–150	⁎	⁎

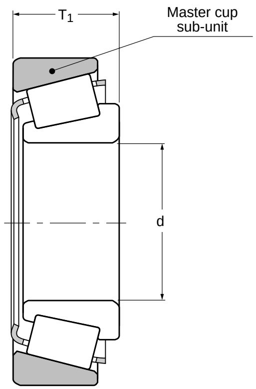
Note: 1) "⁎" mark are to be manufactured only for combined bearings.
2) Please consult NTN for the bearings of Class A.

Unit μm

K_{ia}				K_{ia}	Δ_{T_s}							
Class K	Class N	Class C	Class B	Class B	Class K		Class N		Class C		Class B	
max				max	high	low	high	low	high	low	high	low
15	15	5	3	3	+200	0	+100	0	+200	–200	+200	–200
18	18	5	3	4	+200	0	+100	0	+200	–200	+200	–200
20	20	6	4	4	+200	0	+100	0	+200	–200	+200	–200
25	25	6	4	4	+200	0	+100	0	+200	–200	+200	–200
30	30	6	5	5	+200	–200	+100	0	+200	–200	+200	–200
35	35	8	6	7	+350	–250	+150	0	+200	–250	+200	–250
50	50	10	8	8	+350	–250	+150	0	+200	–300	+200	–300

Unit μm

K_{ea}				S_{ea}
Class K	Class N	Class C	Class B	Class B
max				max
18	18	5	3	3
20	20	6	3	3
25	25	6	4	4
35	35	6	4	4
40	40	7	4	4
45	45	8	4	5
50	50	10	5	6
60	60	11	5	6
70	70	13	5	6



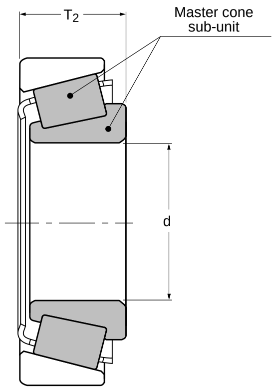


Table 4.7 Tolerance of thrust ball bearings

Table 4.7 (1) Inner rings

Unit μm

Nominal bore diameter d or d_2 (mm)		Δ_{dmp}, Δ_{d2mp}				V_{dp}, V_{d2p}		S_i 1)			
		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

1) The division of double direction type bearings will be in accordance with division "*d*" of single direction type bearings corresponding to the identical nominal outer diameter of bearings, not according to division "d_2".

Table 4.7 (2) Outer rings

Unit μm

Nominal outside diameter D (mm)		Δ_{Dmp}				V_{Dp}		S_e 2)
		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*" or "d_2" 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	

2) To be applied only for bearings with flat seats.

Table 4.7 (3) Height of bearings center washer

Unit μm

Nominal bore diameter d (mm)		Single direction type Δ_{Ts}		Double direction type Δ_{T1s} [3]		Δ_{T2s} [3]		Δ_{Cs} [3]	
over	incl.	high	low	high	low	high	low	high	low
—	30	0	–75	+50	–150	0	–75	0	–50
30	50	0	–100	+75	–200	0	–100	0	–75
50	80	0	–125	+100	–250	0	–125	0	–100
80	120	0	–150	+125	–300	0	–150	0	–125
120	180	0	–175	+150	–350	0	–175	0	–150
180	250	0	–200	+175	–400	0	–200	0	–175
250	315	0	–225	+200	–450	0	–225	0	–200
315	400	0	–300	+250	–600	0	–300	0	–250
400	500	0	–350	—	—	—	—	—	—
500	630	0	–400	—	—	—	—	—	—

3) To be in accordance with division "*d*" of single direction type bearings corresponding to the identical outer diameter of bearings in the same bearing series.

Note: The specifications will be applied for the bearings with flat seats of Class 0.

Table 4.8 Tolerance of spherical thrust roller bearings

Table 4.8 (1) Inner rings

Unit μm

Nominal bore diameter d (mm)		Δ_{dmp}		V_{dp}	S_d	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 4.8 (2) Outer rings

Unit μm

Nominal bore diameter D (mm)		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	1000	0	–100

Table 4.9 Tolerance of double direction type angular contact thrust ball bearings

Table 4.9 (1) Inner rings and bearing height

Unit μm

Nominal bore diameter d (mm)		$\Delta_{dmp}, \Delta_{ds}$				S_d		S_{ia}		V_{Bs}		Δ_{Ts}	
		Class 5		Class 4		Class 5	Class 4	Class 5	Class 4	Class 5	Class 4	Class 5, Class 4	
over	incl.	high	low	high	low	max		max		max		high	low
18	30	0	–6	0	–5	8	4	5	3	5	2.5	0	–300
30	50	0	–8	0	–6	8	4	5	3	5	3	0	–400
50	80	0	–9	0	–7	8	5	6	5	6	4	0	–500
80	120	0	–10	0	–8	9	5	6	5	7	4	0	–600
120	180	0	–13	0	–10	10	6	8	6	8	5	0	–700
180	250	0	–15	0	–12	11	7	8	6	10	6	0	–800
250	315	0	–18	0	–15	13	8	10	8	13	7	0	–900
315	400	0	–23	0	–18	15	9	13	10	15	9	0	–1000

Table 4.9 (2) Outer rings

Unit μm

Nominal outside diameter D (mm)		$\Delta_{Dmp}, \Delta_{Ds}$		S_D		S_{ea}		V_{Cs}	
		Class 5	Class 4	Class 5	Class 4	Class 5	Class 4	Class 5	Class 4
over	incl.	high	low	max		max		max	
30	50	–30	–40	8	4	According to tolerance of S_{ia} against "*d*" of the same bearings		5	2.5
50	80	–40	–50	8	4			6	3
80	120	–50	–60	9	5			8	4
120	150	–60	–75	10	5			8	5
150	180	–60	–75	10	5			8	5
180	250	–75	–90	11	7			10	7
250	315	–90	–105	13	8			11	7
315	400	–110	–125	13	10			13	8
40	500	–120	–140	15	13			15	10

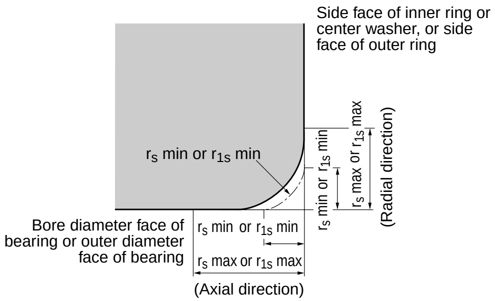


Table 4.10 Allowable critical-value of bearing chamfer

Table 4.10 (1) Radial bearings
(Except tapered roller bearings)

Unit mm

$r_{s\ min}$ 1)	Nominal bore diameter d		$r_{s\ max}$	
	over	incl.	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
1.5	—	120	2.3	4
	120	—	3	5
	—	80	3	4.5
2	80	220	3.5	5
	220	—	3.8	6
2.1	—	280	4	6.5
	280	—	4.5	7
	—	100	3.8	6
2.5	100	280	4.5	6
	280	—	5	7
3	—	280	5	8
	280	—	5.5	8
4	—	—	6.5	9
5	—	—	8	10
6	—	—	10	13
7.5	—	—	12.5	17
9.5	—	—	15	19
12	—	—	18	24
15	—	—	21	30
19	—	—	25	38

1) These are the allowable minimum dimensions of the chamfer dimension "*r*" and are described in the dimensional table.

Table 4.10 (2) Tapered roller bearings of metric system

Unit mm

$r_{s\ min}$ 2) or $r_{1s\ min}$	Nominal bore diameter of bearing "*d*" or nominal outside diameter "*D*" over	incl.	$r_{s\ max}$ or $r_{1s\ max}$ Radial direction	Axial direction
0.3	—	40	0.7	1.4
	40	—	0.9	1.6
0.6	—	40	1.1	1.7
	40	—	1.3	2
1	—	50	1.6	2.5
	50	—	1.9	3
1.5	—	120	2.8	4
	120	250	2.8	3.5
	250	—	3.5	4
2	—	120	2.8	4
	120	250	3.5	4.5
	250	—	4	5
2.5	—	120	3.5	5
	120	250	4	5.5
	250	—	4.5	6
3	—	120	4	5.5
	120	250	4.5	6.5
	250	400	5	7
	400	—	5.5	7.5
4	—	120	5	7
	120	250	5.5	7.5
	250	400	6	8
	400	—	6.5	8.5
5	—	180	6.5	8
	180	—	7.5	9
6	—	180	7.5	10
	180	—	9	11

2) These are the allowable minimum dimensions of the chamfer dimension "*r*" or "r_1" and are described in the dimensional table.

3) Inner rings shall be in accordance with the division of "*d*" and outer rings with that of "*D*".

Note: This standard will be applied to the bearings whose dimensional series (refer to the dimensional table) specified in the standard of ISO 355 or JIS B 1512. Further, please consult NTN for bearings other than those represented here.

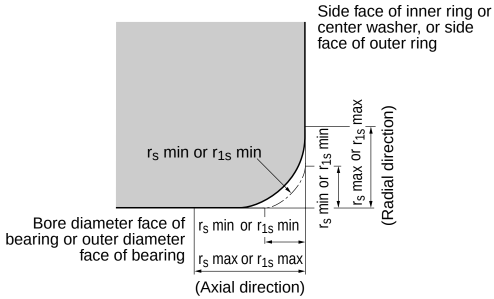
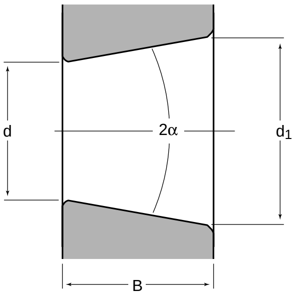


Table 4.10 (3) Thrust bearings

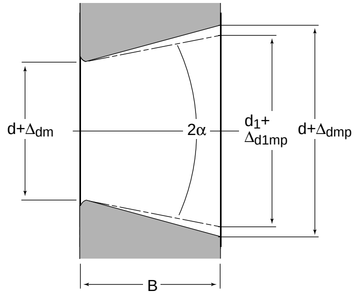
Unit mm

$r_{s\ min}$ or $r_{1s\ min}$ 4)	$r_{s\ max}$ or $r_{1s\ max}$ Radial and axial direction
0.05	0.1
0.08	0.16
0.1	0.2
0.15	0.3
0.2	0.5
0.3	0.8
0.6	1.5
1	2.2
1.1	2.7
1.5	3.5
2	4
2.1	4.5
3	5.5
4	6.5
5	8
6	10
7.5	12.5
9.5	15
12	18
15	21
19	25

4) These are the allowable minimum dimensions of the chamfer dimension "*r*" or "r_1" and are described in the dimensional table.



Theoretical tapered hole



Tapered bore with dimensional within a flat plane tolerance

Table 4.11 Tolerance and allowable values (Class 0) of tapered bore of radial bearings

Unit μm

Nominal bore diameter *d* (mm) over	incl.	Δ_{dmp} high	low	$\Delta_{d1mp}-\Delta_{dmp}$ high	low	V_{dp} [1] max
—	10	+15	0	+15	0	10
10	18	+18	0	+18	0	10
18	30	+21	0	+21	0	13
30	50	+25	0	+25	0	15
50	80	+30	0	+30	0	19
80	120	+35	0	+35	0	25
120	180	+40	0	+40	0	31
180	250	+46	0	+46	0	38
250	315	+52	0	+52	0	44
315	400	+57	0	+57	0	50
400	500	+63	0	+63	0	56

1) To be applied for all radial flat surfaces of tapered bore.

Note: 1. To be applied for tapered bores of 1/12.

2. Symbols of quantity or values

d_1: Basic diameter at the theoretically large end of the tapered bore

$$d_1 = d + \frac{1}{12}B$$

Δdmp: Dimensional difference of the average bore diameter within the flat surface at the theoretical small-end of the tapered bore.

Δd1mp: Dimensional difference of the average bore diameter within the flat surface at the theoretical large-end of the tapered bore.

Vdp: Inequality of the bore diameter within the flat surface

B: Nominal width of inner ring

α: Half of the nominal tapered angle of the tapered bore

α = 2°23’9.4”

= 2.38594°

= 0.041643 RAD