6. Bearing tolerances

6.1 Dimensional and rotational accuracy

Bearing “tolerances” or dimensional accuracy and running accuracy, are regulated by ISO and JIS standards, JIS B 1514 (rolling bearing tolerances) series. For **dimensional accuracy**, these standards prescribe the tolerances necessary when installing bearings on shafts or in housings. **Running accuracy** is defined as the allowable limits for bearing runout during operation.

Dimensional accuracy

Dimensional accuracy constitutes the acceptable values for bore diameter, outside 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 variation of mean bore diameter within a plane, outside diameter within a plane, mean outside diameter within a plane, as well as raceway thickness (for thrust bearings).

Running accuracy

Running accuracy constitutes the acceptable values for inner and outer ring radial runout and axial runout, inner ring side surface squareness, and outer ring outside diameter squareness.

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 JIS Class 0.

Table 6.1 indicates which standards and precision classes are applicable to the major bearing types. **Table 6.2** shows a relative comparison between JIS B 1514 precision class standards and other standards.

For details of allowable limitations and values, refer to **Table 6.4** through **Table 6.10**, which are described in the application table column of **Table 6.1**. Allowable values for chamfer dimensions are shown in **Table 6.11**. Allowable limitations and values for radial bearing inner ring tapered bores are shown in **Table 6.12**.

Table 6.1 Bearing types and applicable tolerance

Bearing type		Applicable standard	Accuracy class					Tolerance table
Deep groove ball bearings		JIS B 1514-1 (ISO 492)	Class 0	Class 6	Class 5	Class 4	Class 2	Table 6.4
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 series (single-row)	JIS B 1514	Class 0, 6X	Class 6 1)	Class 5	Class 4	—	Table 6.5
	Metric series (double-row/four-row)	—	Class 0 1)	—	—	—	—	Table 6.7
	Inch series	ANSI/ABMA Std.19	Class 4	Class 2	Class 3	Class 0	Class 00	Table 6.6
	J series	ANSI/ABMA Std.19.1	Class K	Class N	Class C	Class B	Class A	Table 6.8
Thrust ball bearings		JIS B 1514-2 (ISO 199)	Class 0	Class 6	Class 5	Class 4	—	Table 6.9
Thrust spherical roller bearings			Class 0	—	—	—	—	Table 6.10

1) The class is the **NTN** standard class.

Table 6.2 Comparison of tolerance classifications of national standards

Standard	Applicable standard	Accuracy class					Bearing type
Japanese industrial standards (JIS)	JIS B 1514-1	Class 0, 6	Class 6	Class 5	Class 4	Class 2	Radial bearings
	JIS B 1514-2	Class 0	Class 6	Class 5	Class 4	—	Thrust bearings
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 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 types
American National Standards Institute (ANSI) American Bearing Manufacturer's Association (ABMA)	ANSI/ABMA Std.20 1)	ABEC-1 RBEC-1	ABEC-3 RBEC-3	ABEC-5 RBEC-5	ABEC-7	ABEC-9	Radial bearings (excluding tapered roller bearings)
	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)

1) “ABEC” is applied to ball bearings and “RBEC” to roller bearings.
Note: 1. JIS B 1514 series, ISO 492, 199, and DIN 620 have the same specification level.
2. The tolerance and allowance of JIS B 1514 series are slightly different from those of ABMA standards.

Application of accuracy class

Ordinary precision JIS Class 0 is applied to general roller bearings. However, depending on the conditions and applications, bearings with JIS Class 5 or higher may be necessary.

Table 6.3 shows application examples of accuracy class according to the required performance of bearings to be used.

Table 6.3 Application example of accuracy class

Required performance	Application example	Applied accuracy class
Accuracy under high speed	Machine tool main spindles Printing machine body bearings Magnetic tape guides	JIS Class 5, JIS Class 4 or higher JIS Class 5 JIS Class 5
High rotational speed	Jet engine main spindles Turbochargers Machine tool main spindles Touchdown bearings of magnetic bearing spindles for turbo-molecular pumps	JIS Class 4 or higher Equivalent to JIS Class 4 JIS Class 5, JIS Class 4 or higher JIS Class 5
Low torque low noise	Machine tool main spindles Hubs of road bikes Cleaner motors Hand spinners Fan motors	JIS Class 5, JIS Class 4 or higher JIS Class 5 JIS Class 0 JIS Class 0 JIS Class 0

6.2 JIS terms

The following is a description of JIS accuracy terms used in **Table 6.4**.

(However, the outside diameter surface is omitted because the meaning is similar.)

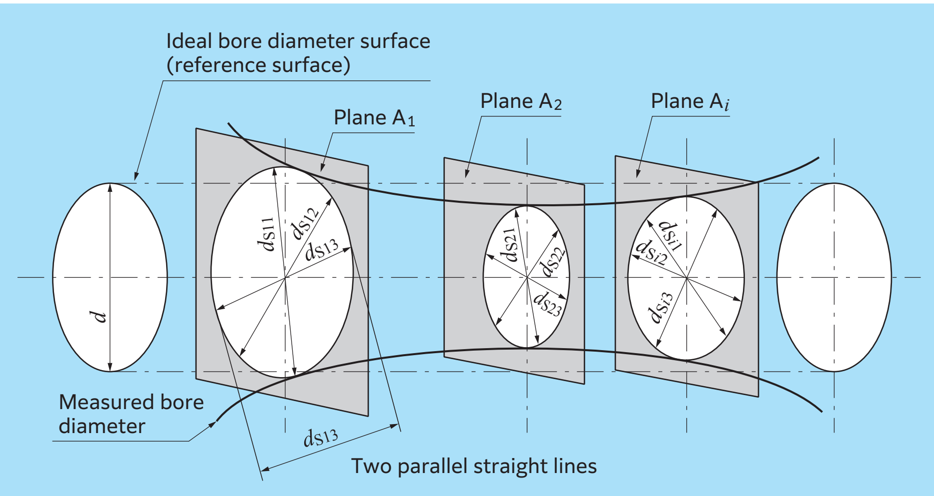


Fig. 6.1 Shape model figure

Terms	Quantifiers	Description
Nominal bore diameter	d	Reference dimension representing the bore diameter size, and reference value with respect to the dimensional difference of the actual bore diameter surface.
Single bore diameter	d_s	Distance between two parallel straight lines that are in contact with the intersection line of the actual bearing bore diameter surface and the radial plane.
Deviation of a single bore diameter	Δ_{ds}	Difference between d_s and d (difference of nominal diameter serving as the measured bore and standard).
Mean bore diameter in a single plane	d_{mp}	Arithmetic mean of the maximum and minimum measured bore diameters within one radial plane. In the model figure (see **Fig. 6.1**), in arbitrary radial plane A_i, when the maximum bore diameter is d_{si1} and the minimum bore diameter is d_{si3}, the value is obtained by $(d_{si1} + d_{si3})/2$. There is one value for each plane.
Mean bore diameter	d_m	Arithmetic mean of the maximum and minimum measured bore diameters obtained from all the cylindrical surfaces. In the model figure (see **Fig. 6.1**), when the maximum measured bore diameter is d_{s11} and the minimum measured bore diameter is d_{s23}, which are obtained from the all the planes A_1, A_2,…A_i, the mean bore diameter is obtained by $(d_{s11} + d_{s23})/2$. There is one value for one cylindrical surface.
Deviation of mean bore diameter	Δ_{dm}	Difference between the mean bore diameter and the nominal bore diameter.
Deviation of mean bore diameter in a single plane	Δ_{dmp}	Difference between the arithmetic mean and the nominal bore diameter of the maximum and minimum measured bore diameters within one radial plane. The value is specified in JIS.
Variation of bore diameter in a single plane	V_{dsp}	Difference between the maximum and minimum measured bore diameters within one radial plane. In the model figure (see **Fig. 6.1**), in radial plane A_1, when the maximum measured bore diameter is d_{s11} and the minimum measured bore diameter is d_{s13}, the difference is V_{dsp} and one value can be obtained for one plane. This characteristic is an index that indicates the roundness. The value is specified in JIS.
Variation of mean bore diameter	V_{dmp}	Difference between the maximum and minimum values of the mean bore diameter within a plane that are obtained from all the planes. A unique value is obtained for each product, and it is near to cylindricity (that is different from geometric cylindricity). The value is specified in JIS.
Nominal inner ring width	B	Distance between both theoretical side surfaces of a raceway. This value is a reference dimension that represents the raceway surface (distance between both side surfaces).
Single inner ring width	B_s	Distance between two intersections. The straight is perpendicular to the plane that is in contact with the inner ring reference side and both actual side surfaces. This value represents the actual width dimension of an inner ring.
Deviation of a single inner ring width	Δ_{Bs}	Difference between the measured inner ring width and the nominal inner ring width. This value is also the difference between the measured inner ring width dimension and the reference dimension that represents the inner ring width. The value is specified in JIS.
Variation of inner ring width	V_{Bs}	Difference between the maximum and minimum measured inner ring widths. The value is specified in JIS.
Radial runout of inner ring of assembled bearing	K_{ia}	Difference between the maximum and minimum values of the radial distance between the inner ring bore diameter at each angle position and one fixed point of the outer ring outside diameter surface with respect to radial runout.
Axial runout of inner ring of assembled bearing	S_{ia}	Difference between the maximum and minimum values of the axial distance between the inner ring reference side surface at each angle position and one fixed point of the outer ring outside diameter surface with respect to half the radial distance of the raceway contact diameter from the inner ring central axis and the inner ring of a deep groove ball bearing.

Bearing Tolerances NTN
Commentary

Table 6.4 Tolerance of radial bearings (except tapered roller bearings)

Table 6.4 (1) Inner rings

Unit: μm

Nominal bore diameter d mm		Deviation of mean bore diameter in a single plane Δ_{dmp}										Variation of bore diameter in a single plane V_{dsp}														
		Class 0		Class 6		Class 5		Class 4[1]		Class 2[1]		Diameter series 9 (Max.)					Diameter series 0, 1 (Max.)					Diameter series 2, 3, 4 (Max.)				
Over	Incl.	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	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
0.6[4]	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	—	—	—
630	800	0	−75	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
800	1 000	0	−100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1 000	1 250	0	−125	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1 250	1 600	0	−160	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1 600	2 000	0	−200	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Nominal bore diameter d mm		Variation of mean bore diameter V_{dmp} (Max.)					Radial runout of inner ring of assembled bearing K_{ia} (Max.)					Perpendicularity of inner ring face with respect to the bore S_d (Max.)			Axial runout of inner ring of assembled bearing S_{ia}[2] (Max.)			Deviation of a single inner ring width Δ_{Bs}										Variation of inner ring width V_{Bs} (Max.)				
																		Normal bearings						Duplex bearings[3]								
																		Class 0, Class 6		Class 5, Class 4		Class 2		Class 0, Class 6		Class 5, Class 4						
Over	Incl.	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	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Class 0	Class 6	Class 5	Class 4	Class 2
0.6[4]	2.5	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
2.5	10	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
10	18	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
18	30	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
30	50	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
50	80	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
80	120	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
120	150	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
150	180	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
180	250	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
250	315	26	19	9	—	—	50	25	13	—	—	13	—	—	15	—	—	0	−350	0	—	—	—	0	−500	0	—	35	35	13	—	—
315	400	30	23	12	—	—	60	30	15	—	—	15	—	—	20	—	—	0	−400	0	—	—	—	0	−630	0	—	40	40	15	—	—
400	500	34	26	—	—	—	65	35	—	—	—	—	—	—	—	—	—	0	−450	—	—	—	—	—	—	—	—	50	45	—	—	—
500	630	38	30	—	—	—	70	40	—	—	—	—	—	—	—	—	—	0	−500	—	—	—	—	—	—	—	—	60	50	—	—	—
630	800	55	—	—	—	—	80	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	70	—	—	—	—
800	1 000	75	—	—	—	—	90	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	80	—	—	—	—
1 000	1 250	94	—	—	—	—	100	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	100	—	—	—	—
1 250	1 600	120	—	—	—	—	120	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	120	—	—	—	—
1 600	2 000	150	—	—	—	—	140	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	140	—	—	—	—

1) The dimensional difference Δ_{ds} of the measured bore diameter applied to Classes 4 and 2 is the same as the tolerance of dimensional difference Δ_{dmp} of the mean bore diameter within a plane. However, the dimensional difference is applied to diameter series 0, 1, 2, 3 and 4 for Class 4, and also to all the diameter series for Class 2.

2) Applies to ball bearings such as deep groove ball bearings and angular ball bearings.

3) Applies to individual raceway rings manufactured for combined bearing use.

4) The nominal bore diameter of bearings of 0.6 mm is included in this dimensional division.

Table 6.4 (2) Outer rings

Unit: μm

Nominal outside diameter D mm		Deviation of mean outside diameter in a single plane Δ_{Dmp}										Variation of outside diameter in a single plane[6] V_{Dsp} Open bearing														
		Class 0		Class 6		Class 5		Class 4[5]		Class 2[5]		Diameter series 9 (Max.)					Diameter series 0, 1 (Max.)					Diameter series 2, 3, 4 (Max.)				
Over	Incl.	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	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
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	1 000	0	−100	0	−60	—	—	—	—	—	—	125	75	—	—	—	125	75	—	—	—	75	45	—	—	—
1 000	1 250	0	−125	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1 250	1 600	0	−160	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1 600	2 000	0	−200	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2 000	2 500	0	−250	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Nominal outside diameter D mm		Variation of outside diameter in a single plane V_{Dsp}[6] Sealed/shield bearings diameter (Max.)		Variation of mean outside diameter V_{Dmp} (Max.)					Radial runout of outer ring of assembled bearing K_{ea} (Max.)					Perpendicularity of outer ring outside surface with respect to the face S_D (Max.)			Axial runout of outer ring of assembled bearing S_{ea}[7] (Max.)			Deviation of a single outer ring width Δ_{Cs}	Variation of outer ring width V_{Cs} (Max.)			
		Diameter series 2, 3, 4	Diameter series 0,1,2,3,4																					
Over	Incl.	Class 0	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	All classes	Class 0,6	Class 5	Class 4	Class 2
2.5[8]	6	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 the same bearing	Depends on tolerance of V_{Bs} in relation to d of the same bearing	5	2.5	1.5
6	18	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
18	30	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
30	50	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
50	80	20	16	10	8	5	3.5	2	25	13	8	5	4	8	4	1.5	10	5	4			6	3	1.5
80	120	26	20	11	10	5	4	2.5	35	18	10	6	5	9	5	2.5	11	6	5			8	4	2.5
120	150	30	25	14	11	6	5	2.5	40	20	11	7	5	10	5	2.5	13	7	5			8	5	2.5
150	180	38	30	19	14	7	5	3.5	45	23	13	8	5	10	5	2.5	14	8	5			8	5	2.5
180	250	—	—	23	15	8	6	4	50	25	15	10	7	11	7	4	15	10	7			10	7	4
250	315	—	—	26	19	9	7	4	60	30	18	11	7	13	8	5	18	10	7			11	7	5
315	400	—	—	30	21	10	8	5	70	35	20	13	8	13	10	7	20	13	8			13	8	7
400	500	—	—	34	25	12	—	—	80	40	23	—	—	15	—	—	23	—	—			15	—	—
500	630	—	—	38	29	14	—	—	100	50	25	—	—	18	—	—	25	—	—			18	—	—
630	800	—	—	55	34	18	—	—	120	60	30	—	—	20	—	—	30	—	—			20	—	—
800	1 000	—	—	75	45	—	—	—	140	75	—	—	—	—	—	—	—	—	—			—	—	—
1 000	1 250	—	—	—	—	—	—	—	160	—	—	—	—	—	—	—	—	—	—			—	—	—
1 250	1 600	—	—	—	—	—	—	—	190	—	—	—	—	—	—	—	—	—	—			—	—	—
1 600	2 000	—	—	—	—	—	—	—	220	—	—	—	—	—	—	—	—	—	—			—	—	—
2 000	2 500	—	—	—	—	—	—	—	250	—	—	—	—	—	—	—	—	—	—			—	—	—

5) The dimensional difference Δ_{Ds} of the measured outside diameter applied to Classes 4 and 2 is the same as the tolerance of dimensional difference Δ_{Dmp} of the mean outside diameter within a plane. However, the dimensional difference is applied to diameter series 0, 1, 2, 3 and 4 for Class 4, and also to all the diameter series for Class 2.

6) Applies to cases where snap rings are not installed on the bearings.

7) Applies to ball bearings such as deep groove ball bearings and angula r ball bearings.

8) The nominal bore diameter of bearings of 2.5 mm is included in this dimensional division.

Table 6.5 Tolerance of tapered roller bearings (metric series)
Table 6.5 (1) Inner rings

Unit: μm

Nominal bore diameter d mm		Deviation of mean bore diameter in a single plane Δ_{dmp}						Variation of bore diameter in a single plane V_{dsp}				Variation of mean bore diameter V_{dmp}				Radial runout of inner ring of assembled bearing K_{ia}				Perpendicularity of inner ring face with respect to the bore S_d	
		Class 0, Class 6×		Class 6 1), Class 5		Class 4 2)		Class 0, Class 6×	Class 6 1)	Class 5	Class 4	Class 0, Class 6×	Class 6 1)	Class 5	Class 4	Class 0, Class 6×	Class 6 1)	Class 5	Class 4	Class 5	Class 4
Over	Incl.	Upper	Lower	Upper	Lower	Upper	Lower	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	—	—	—	—	—

Nominal bore diameter d mm		Axial runout of inner ring of assembled bearing S_{ia}	Deviation of a single inner ring width Δ_{Bs}						Deviation of the actual assembled bearing width Δ_{Ts}					
		Class 4	Class 0, Class 6		Class 6×		Class 5, Class 4		Class 0, Class 6		Class 6×		Class 5, Class 4	
Over	Incl.	Max.	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
10	18	3	0	−120	0	−50	0	−200	+200	0	+100	0	+200	−200
18	30	4	0	−120	0	−50	0	−200	+200	0	+100	0	+200	−200
30	50	4	0	−120	0	−50	0	−240	+200	0	+100	0	+200	−200
50	80	4	0	−150	0	−50	0	−300	+200	0	+100	0	+200	−200
80	120	5	0	−200	0	−50	0	−400	+200	−200	+100	0	+200	−200
120	180	7	0	−250	0	−50	0	−500	+350	−250	+150	0	+350	−250
180	250	8	0	−300	0	−50	0	−600	+350	−250	+150	0	+350	−250
250	315	—	0	−350	0	−50	—	—	+350	−250	+200	0	—	—
315	400	—	0	−400	0	−50	—	—	+400	−400	+200	0	—	—

1) Class 6 is the **NTN** standard class.
2) The dimensional difference Δ_{ds} of the measured bore diameter applied to Class 4 is the same as the tolerance of dimensional difference Δ_{dmp} of the mean bore diameter within a plane.

Table 6.5 (2) Outer rings

Unit: μm

Nominal outside diameter D mm		Deviation of mean outside diameter in a single plane Δ_{Dmp}						Variation of outside diameter in a single plane V_{Dsp}				Variation of mean outside diameter V_{Dmp}				Radial runout of outer ring of assembled bearing K_{ea}				Perpendicularity of outer ring outside surface with respect to the face S_D 3)	
		Class 0, Class 6×		Class 6 1), Class 5		Class 4 4)		Class 0, Class 6×	Class 6 1)	Class 5	Class 4	Class 0, Class 6×	Class 6 1)	Class 5	Class 4	Class 0, Class 6×	Class 6 1)	Class 5	Class 4	Class 5	Class 4
Over	Incl.	Upper	Lower	Upper	Lower	Upper	Lower	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	—	—	—	—	60	—	—	—	38	—	—	—	100	—	—	—	—	—

Nominal outside diameter D mm		Axial runout of outer ring of assembled bearing S_{ea}	Deviation of a single outer ring width Δ_{Cs}		
		Class 4	Class 0, Class 6 1), Class 5, Class 4	Class 6× 5)	
Over	Incl.	Max.	Upper Lower	Upper	Lower
18	30	5	Depends on tolerance of Δ_{Bs} in relation to d of the same bearing	0	−100
30	50	5		0	−100
50	80	5		0	−100
80	120	6		0	−100
120	150	7		0	−100
150	180	8		0	−100
180	250	10		0	−100
250	315	10		0	−100
315	400	13		0	−100
400	500	—		0	−100
500	630	—		0	−100

3) Does not apply to bearings with flange.
4) The dimensional difference Δ_{Ds} of the measured outside diameter applied to Class 4 is the same as the tolerance of dimensional difference Δ_{Dmp} of the mean outside diameter within a plane.
5) Applies to bearings with a nominal bore diameter d over 10 mm and 400 mm or less.

Table 6.5 (3) Effective width of inner subunits and outer rings

Unit: μm

Nominal bore diameter d mm		Deviation of the actual effective width of inner subunit assembled with a master outer ring Δ_{T1s}				Deviation of the actual effective width of outer ring assembled with a master inner subunit Δ_{T2s}			
		Class 0		Class 6×		Class 0		Class 6×	
Over	Incl.	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
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

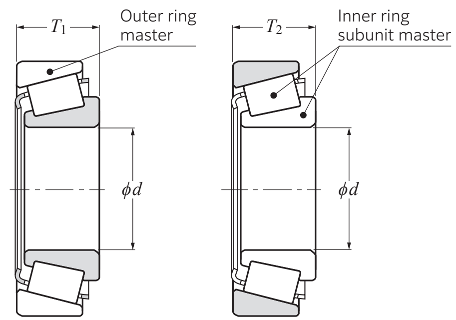


Table 6.6 Tolerance of tapered roller bearings (inch series)

Table 6.6 (1) Inner rings

Unit: μm

Nominal bore diameter d mm (inch) Over	Incl.	Deviation of a single bore diameter Δ_{ds} Class 4 Upper	Class 4 Lower	Class 2 Upper	Class 2 Lower	Class 3 Upper	Class 3 Lower	Class 0 Upper	Class 0 Lower	Class 00 Upper	Class 00 Lower
—	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 6.6 (2) Outer rings

Unit: μm

Nominal outside diameter D mm (inch) Over	Incl.	Deviation of a single outside diameter Δ_{Ds} Class 4 Upper	Class 4 Lower	Class 2 Upper	Class 2 Lower	Class 3 Upper	Class 3 Lower	Class 0 Upper	Class 0 Lower	Class 00 Upper	Class 00 Lower
—	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	—	—	—	—

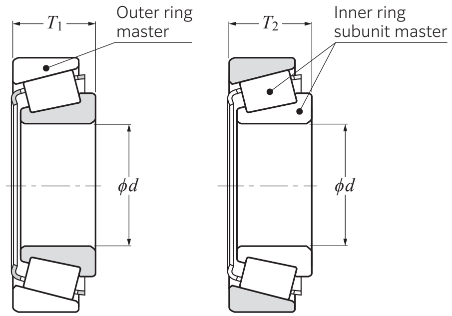
Table 6.6 (3) Assembly width of single-row bearings, combination width of 4-row bearings, effective width of inner ring subunits, effective width of outer rings

Nominal bore diameter d mm (inch) Over	Incl.	Nominal outside diameter D mm (inch) Over	Incl.	Deviation of the actual assembled single row bearing width Δ_{Ts} Class 4 Upper	Class 4 Lower	Class 2 Upper	Class 2 Lower	Class 3 Upper	Class 3 Lower	Class 0,00 Upper	Class 0,00 Lower	Deviation of four-row bearing overall width Δ_{B2s}, Δ_{C2s} Class 4,2,3,0 Upper	Lower
—	101.6 (4)			+203	0	+203	0	+203	−203	+203	−203	+1 524	−1 524
101.6 (4)	304.8 (12)			+356	−254	+203	0	+203	−203	+203	−203	+1 524	−1 524
304.8 (12)	609.6 (24)	—	508.0 (20)	+381	−381	+381	−381	+203	−203	—	—	+1 524	−1 524
304.8 (12)	609.6 (24)	508.0 (20)	—	+381	−381	+381	−381	+381	−381	—	—	+1 524	−1 524
609.6 (24)	—			+381	−381	—	—	+381	−381	—	—	+1 524	−1 524

Table 6.6 (4) Radial runout of inner and outer rings

Unit: μm

Nominal outside diameter D mm (inch) Over	Incl.	Radial runout of inner ring of assembled bearing K_{ia} / Radial runout of outer ring of assembled bearing K_{ea} Class 4 Max.	Class 2 Max.	Class 3 Max.	Class 0 Max.	Class 00 Max.
—	304.8 (14)	51	38	8	4	2
304.8 (14)	609.6 (24)	51	38	18	—	—
609.6 (24)	914.4 (36)	76	51	51	—	—
914.4 (36)	—	76	—	76	—	—



Unit: μm

Nominal bore diameter d mm (inch) Over	Incl.	Nominal outside diameter D mm (inch) Over	Incl.	Deviation of the actual effective width of inner subunit assembled with a master outer ring Δ_{T1s} Class 4 Upper	Class 4 Lower	Class 2 Upper	Class 2 Lower	Class 3 Upper	Class 3 Lower	Deviation of the actual effective width of outer ring assembled with a master inner subunit Δ_{T2s} Class 4 Upper	Class 4 Lower	Class 2 Upper	Class 2 Lower	Class 3 Upper	Class 3 Lower
—	101.6 (4)			+102	0	+102	0	+102	−102	+102	0	+102	0	+102	−102
101.6 (4)	304.8 (12)			+152	−152	+102	0	+102	−102	+203	−102	+102	0	+102	−102
304.8 (12)	609.6 (24)	—	508.0 (20)	—	—	+178	−178 1)	+102	−102 1)	—	—	+203	−203 1)	+102	−102 1)
304.8 (12)	609.6 (24)	508.0 (20)	—	—	—	—	—	—	—	—	—	—	—	—	—
609.6 (24)	—			—	—	—	—	—	—	—	—	—	—	—	—

1) Applies to nominal bore diameters d of 406.400 mm (16 inch) or less.

Table 6.7 Tolerance of double-row and four-row tapered roller bearings (metric series)

Table 6.7 (1) Inner rings

Unit: μm

Nominal bore diameter d mm		Deviation of mean bore diameter in a single plane Δ_{dmp}		Variation of bore diameter in a single plane V_{dsp}	Variation of mean bore diameter V_{dmp}	Radial runout of inner ring of assembled bearing K_{ia}	Deviation of a single inner ring width Δ_{Bs}		Deviation of bearing overall width: Double row bearing Δ_{B1s}		Deviation of bearing overall width: Four-row bearing Δ_{B2s}	
Over	Incl.	Upper	Lower	Max.	Max.	Max.	Upper	Lower	Upper	Lower	Upper	Lower
30	50	0	−12	12	9	20	0	−120	+240	−240	—	—
50	80	0	−15	15	11	25	0	−150	+300	−300	—	—
80	120	0	−20	20	15	30	0	−200	+400	−400	+500	−500
120	180	0	−25	25	19	35	0	−250	+500	−500	+600	−600
180	250	0	−30	30	23	50	0	−300	+600	−600	+750	−750
250	315	0	−35	35	26	60	0	−350	+700	−700	+900	−900
315	400	0	−40	40	30	70	0	−400	+800	−800	+1 000	−1 000
400	500	0	−45	45	34	80	0	−450	+900	−900	+1 200	−1 200
500	630	0	−60	60	40	90	0	−500	+1 000	−1 000	+1 200	−1 200
630	800	0	−75	75	45	100	0	−750	+1 500	−1 500	+1 500	−1 500
800	1 000	0	−100	100	55	115	0	−1 000	+1 500	−1 500	+1 500	−1 500

Note: This standard is the **NTN** standard.

Table 6.7 (2) Outer rings

Unit: μm

Nominal outside diameter D mm		Deviation of mean outside diameter in a single plane Δ_{Dmp}		Variation of outside diameter in a single plane V_{Dsp}	Variation of mean outside diameter V_{Dmp}	Radial runout of outer ring of assembled bearing K_{ea}	Deviation of a single outer ring width Δ_{Cs} (Upper, Lower)	Deviation of bearing overall width: Double row bearing Δ_{C1s} (Upper, Lower)	Deviation of bearing overall width: Four-row bearing Δ_{C2s} (Upper, Lower)
Over	Incl.	Upper	Lower	Max.	Max.	Max.	Upper Lower	Upper Lower	Upper Lower
50	80	0	−16	16	12	25	Depends on tolerance of Δ_{Bs} in relation to d of the same bearing	Depends on tolerance of Δ_{B1s} in relation to d of the same bearing	Depends on tolerance of Δ_{B2s} in relation to d of the same bearing
80	120	0	−18	18	14	35			
120	150	0	−20	20	15	40			
150	180	0	−25	25	19	45			
180	250	0	−30	30	23	50			
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	60	38	100			
630	800	0	−75	80	55	120			
800	1 000	0	−100	100	75	140			
1 000	1 250	0	−125	130	90	160			
1 250	1 600	0	−160	170	100	180			

Table 6.8 Tolerance of tapered roller bearings of J series (metric series)

Table 6.8 (1) Inner rings

Unit: μm

Nominal bore diameter d mm Over	Incl.	Deviation of mean bore diameter in a single plane Δ_{dmp} Class K Upper	Class K Lower	Class N Upper	Class N Lower	Class C Upper	Class C Lower	Class B Upper	Class B Lower	Variation of bore diameter in a single plane V_{dsp} Class K Max.	Class N Max.	Class C Max.	Class B Max.	Variation of mean bore diameter V_{dmp} Class K Max.	Class N Max.	Class C Max.	Class B Max.	Axial runout of inner ring of assembled bearing S_{ia} Class B Max.
10	18	0	−12	0	−12	0	−7	0	−5	12	12	4	3	9	9	5	4	3
18	30	0	−12	0	−12	0	−8	0	−6	12	12	4	3	9	9	5	4	4
30	50	0	−12	0	−12	0	−10	0	−8	12	12	4	3	9	9	5	5	4
50	80	0	−15	0	−15	0	−12	0	−9	15	15	5	3	11	11	5	5	4
80	120	0	−20	0	−20	0	−15	0	−10	20	20	5	3	15	15	5	5	5
120	180	0	−25	0	−25	0	−18	0	−13	25	25	5	3	19	19	5	7	7
180	250	0	−30	0	−30	0	−22	0	−15	30	30	6	4	23	23	5	8	8

Nominal bore diameter d mm Over	Incl.	Deviation of the actual assembled bearing width Δ_{Ts} Class K Upper	Class K Lower	Class N Upper	Class N Lower	Class C Upper	Class C Lower	Class B Upper	Class B Lower
10	18	+200	0	+100	0	+200	−200	+200	−200
18	30	+200	0	+100	0	+200	−200	+200	−200
30	50	+200	0	+100	0	+200	−200	+200	−200
50	80	+200	0	+100	0	+200	−200	+200	−200
80	120	+200	−200	+100	0	+200	−200	+200	−200
120	180	+350	−250	+150	0	+350	−250	+200	−250
180	250	+350	−250	+150	0	+350	−300	+200	−300

Note: Please consult **NTN** Engineering for Class A bearings.

Table 6.8 (2) Outer rings

Unit: μm

Nominal outside diameter D mm Over	Incl.	Deviation of mean outside diameter in a single plane Δ_{Dmp} Class K Upper	Class K Lower	Class N Upper	Class N Lower	Class C Upper	Class C Lower	Class B Upper	Class B Lower	Variation of outside diameter in a single plane V_{Dsp} Class K Max.	Class N Max.	Class C Max.	Class B Max.	Variation of mean outside diameter V_{Dmp} Class K Max.	Class N Max.	Class C Max.	Class B Max.	Axial runout of outer ring of assembled bearing S_{ea} Class B Max.
18	30	0	−12	0	−12	0	−8	0	−6	12	12	4	3	9	9	5	4	3
30	50	0	−14	0	−14	0	−9	0	−7	14	14	4	3	11	11	5	5	3
50	80	0	−16	0	−16	0	−11	0	−9	16	16	4	3	12	12	6	5	4
80	120	0	−18	0	−18	0	−13	0	−10	18	18	5	3	14	14	7	5	4
120	150	0	−20	0	−20	0	−15	0	−11	20	20	5	3	15	15	8	6	4
150	180	0	−25	0	−25	0	−18	0	−13	25	25	5	3	19	19	9	7	5
180	250	0	−30	0	−30	0	−20	0	−15	30	30	6	4	23	23	10	8	6
250	315	0	−35	0	−35	0	−25	0	−18	35	35	8	5	26	26	13	9	6
315	400	0	−40	0	−40	0	−28	0	−20	40	40	10	5	30	30	14	10	6

Note: Please consult **NTN** Engineering for Class A bearings.

Table 6.8 (3) Effective width of inner subunits and outer rings

Unit: μm

Nominal bore diameter d mm Over	Incl.	Deviation of the actual effective width of inner subunit assembled with a master outer ring Δ_{T1s} Class K Upper	Class K Lower	Class N Upper	Class N Lower	Class C Upper	Class C Lower	Class B Upper	Class B Lower	Deviation of the actual effective width of outer ring assembled with a master inner subunit Δ_{T2s} Class K Upper	Class K Lower	Class N Upper	Class N Lower	Class C Upper	Class C Lower	Class B Upper	Class B Lower
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 bearings are manufactured only for combined bearings.
2. Please consult **NTN** Engineering for Class A bearings.

Table 6.8 (4) Radial runout of inner and outer rings

Unit: μm

Nominal outside diameter D mm Over	Incl.	Radial runout of inner ring of assembled bearing K_{ia} / Radial runout of outer ring of assembled bearing K_{ea} Class K Max.	Class N Max.	Class C Max.	Class B Max.
18	30	18	18	5	3
30	50	20	20	6	3
50	80	25	25	6	4
80	120	35	35	6	4
120	150	40	40	7	4
150	180	45	45	8	4
180	250	50	50	10	5
250	315	60	60	11	5
315	400	70	70	13	5

Note: Please consult **NTN** Engineering for Class A bearings.

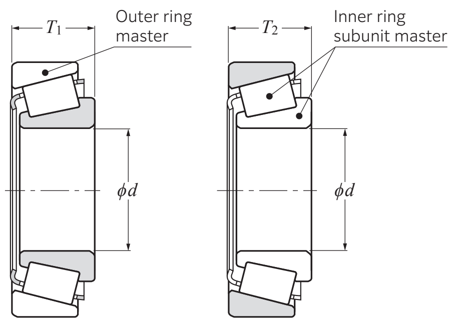


Table 6.9 Tolerance of thrust ball bearings

Table 6.9 (1) Shaft raceway washer

Unit: μm

Nominal bore diameter d mm		Deviation of mean bore diameter in a single plane Δ_{dmp}				Variation of bore diameter in a single plane V_{dsp}		Variation in thickness between shaft washer raceway and back face S_i			
		Class 0, 6, 5		Class 4		Class 0, 6, 5	Class 4	Class 0	Class 6	Class 5	Class 4
Over	Incl.	Upper	Lower	Upper	Lower	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 6.9 (2) Housing raceway washer

Unit: μm

Nominal outside diameter D mm		Deviation of mean outside diameter in a single plane Δ_{Dmp}				Variation of outside diameter in a single plane V_{Dsp}		Variation in thickness between housing washer raceway and back face S_e
		Class 0, 6, 5		Class 4		Class 0, 6, 5	Class 4	Class 0, 6, 5, 4
Over	Incl.	Upper	Lower	Upper	Lower	Max.		Max.
10	18	0	−11	0	−7	8	5	Depends on tolerance of S_i 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 6.9 (3) Bearing height

Unit: μm

Nominal bore diameter d mm		Deviation of the actual bearing height, single-direction bearing [1] Δ_{Ts}	
Over	Incl.	Upper	Lower
—	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

1) Applies to flat back face bearing of Class 0.
The values are the **NTN** standard.

Table 6.10 Tolerance of thrust spherical roller bearings

Table 6.10 (1) Shaft raceway washer

Unit: μm

Nominal bore diameter d mm		Deviation of mean bore diameter in a single plane Δ_{dmp}		Variation of bore diameter in a single plane V_{dsp}	Perpendicularity of shaft washer back face with respect to the bore [1] S_d	Deviation of the actual bearing height [1] Δ_{Ts}	
Over	Incl.	Upper	Lower	Max.	Max.	Upper	Lower
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

1) The standard conforms to JIS B 1539.

Table 6.10 (2) Housing raceway washer

Unit: μm

Nominal outside diameter D mm		Deviation of mean outside diameter in a single plane Δ_{Dmp}	
Over	Incl.	Upper	Lower
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

6.3 Chamfer measurements and tolerance or allowable values of tapered bore

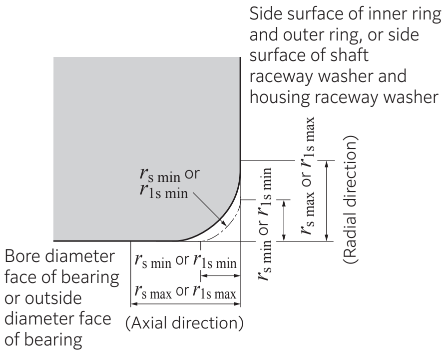


Table 6.11 Allowable critical-value of bearing chamfer

Table 6.11 (1) Radial bearings (except tapered roller bearing) Unit: mm

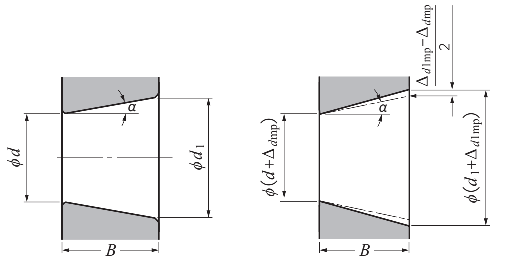
$r_{s\,min}$ 1) or $r_{1s\,min}$	Nominal bore diameter d Over	Incl.	$r_{s\,max}$ or $r_{1s\,max}$ Radial direction	Axial direction
0.05	—	—	0.1	0.2
0.08	—	—	0.16	0.3
0.1	—	—	0.2	0.4
0.15	—	—	0.3	0.6
0.2	—	—	0.5	0.8
0.3	— 40	40 —	0.6 0.8	1 1
0.6	— 40	40 —	1 1.3	2 2
1	— 50	50 —	1.5 1.9	3 3
1.1	— 120	120 —	2 2.5	3.5 4
1.5	— 120	120 —	2.3 3	4 5
2	— 80 220	80 220 —	3 3.5 3.8	4.5 5 6
2.1	— 280	280 —	4 4.5	6.5 7
2.5	— 100 280	100 280 —	3.8 4.5 5	6 6 7
3	— 280	280 —	5 5.5	8 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" or "r_1" and are described in the dimensional table.

Table 6.11 (2) Tapered roller bearings of metric series Unit: mm

$r_{s\,min}$ 2) or $r_{1s\,min}$	Nominal bore diameter d 3) or nominal outside diameter D Over	Incl.	$r_{s\,max}$ or $r_{1s\,max}$ Radial direction	Axial direction
0.3	— 40	40 —	0.7 0.9	1.4 1.6
0.6	— 40	40 —	1.1 1.3	1.7 2
1	— 50	50 —	1.6 1.9	2.5 3
1.5	— 120 250	120 250 —	2.3 2.8 3.5	3 3.5 4
2	— 120 250	120 250 —	2.8 3.5 4	4 4.5 5
2.5	— 120 250	120 250 —	3.5 4 4.5	5 5.5 6
3	— 120 250 400	120 250 400 —	4 4.5 5 5.5	5.5 6.5 7 7.5
4	— 120 250 400	120 250 400 —	5 5.5 6 6.5	7 7.5 8 8.5
5	— 180	180 —	6.5 7.5	8 9
6	— 180	180 —	7.5 9	10 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: The standard applies to the bearings whose dimensional series (refer to the dimensional table) are specified in the standard ISO 355 or JIS B 1512-3. For further information concerning bearings outside of these standards or tapered roller bearings using a US customary unit, please contact **NTN** Engineering.



Theoretical tapered bore

Tapered bore having dimensional difference of mean bore diameter within plane

Table 6.11 (3) Thrust bearings Unit: mm

$r_{s\,min}$ or $r_{1\,min}$ 4)	$r_{s\,max}$ or $r_{1s\,max}$ Radial and axial directions
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.

Table 6.12 (1) Tolerance of tapered bores of radial bearings and tapered bores with allowable standard taper ratio 1:12 (Class 0) Unit: μm

d mm Over	Incl.	Δ_{dmp} Upper	Lower	$\Delta_{d1mp}-\Delta_{dmp}$ Upper	Lower	V_{dsp} 1) 2) Max.
	10	+ 22	0	+ 15	0	9
10	18	+ 27	0	+ 18	0	11
18	30	+ 33	0	+ 21	0	13
30	50	+ 39	0	+ 25	0	16
50	80	+ 46	0	+ 30	0	19
80	120	+ 54	0	+ 35	0	22
120	180	+ 63	0	+ 40	0	40
180	250	+ 72	0	+ 46	0	46
250	315	+ 81	0	+ 52	0	52
315	400	+ 89	0	+ 57	0	57
400	500	+ 97	0	+ 63	0	63
500	630	+110	0	+ 70	0	70
630	800	+125	0	+ 80	0	—
800	1 000	+140	0	+ 90	0	—
1 000	1 250	+165	0	+105	0	—
1 250	1 600	+195	0	+125	0	—

Table 6.12 (2) Tolerance of tapered bores of radial bearings and tapered bores with allowable standard taper ratio 1:30 (Class 0) Unit: μm

d mm Over	Incl.	Δ_{dmp} Upper	Lower	$\Delta_{d1mp}-\Delta_{dmp}$ Upper	Lower	V_{dsp} 1) 2) Max.
50	80	+15	0	+30	0	19
80	120	+20	0	+35	0	22
120	180	+25	0	+40	0	40
180	250	+30	0	+46	0	46
250	315	+35	0	+52	0	52
315	400	+40	0	+57	0	57
400	500	+45	0	+63	0	63
500	630	+50	0	+70	0	70

1) Applies to all radial flat planes of tapered bores.
2) Does not apply to diameter series 7 and 8.
Note: Quantifiers
For a standard taper ratio of $\frac{1}{12}$, $d_1 = d + \frac{1}{12}B$
For a standard taper ratio of $\frac{1}{30}$, $d_1 = d + \frac{1}{30}B$
Δ_{dmp} : Dimensional difference of the mean bore diameter within the flat surface at the theoretical small end of the tapered bore
Δ_{d1mp} : Dimensional difference of the mean bore diameter within the flat surface at the theoretical large end of the tapered bore
V_{dsp} : Unevenness of the bore diameter with the flat surface
B : Nominal width of inner ring
α : $\frac{1}{2}$ of the tapered bore's standard taper angle

For a standard taper ratio of $\frac{1}{12}$
α = 2°23′9.4″
= 2.38594°
= 0.041643 rad

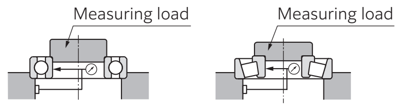
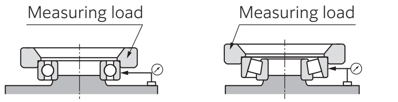
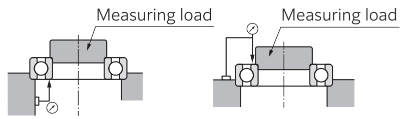
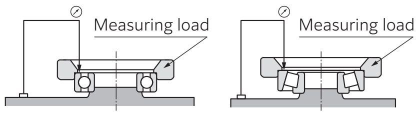
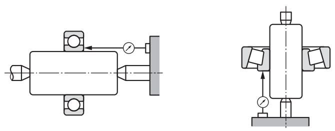
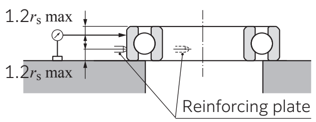
For standard taper ratio of $\frac{1}{30}$
α = 0°57′17.4″
= 0.95484°
= 0.016665 rad

6.4 Bearing tolerance measurement methods

For reference, measurement methods for rolling bearing tolerances are specified in JIS B 1515-2.

Table 6.13 shows some of the major methods of measuring rotation tolerances.

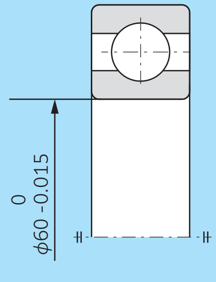
Table 6.13 Rotation tolerance measurement methods

Accuracy characteristics	Measurement methods	
Radial runout of inner ring of assembled bearing (K_{ia})		Radial runout of the inner ring is the difference between the maximum and minimum reading of the measuring device when the inner ring is turned one revolution.
Radial runout of outer ring of assembled bearing (K_{ea})		Radial runout of the outer ring is the difference between the maximum and minimum reading of the measuring device when the outer ring is turned one revolution.
Axial runout of inner ring of assembled bearing (S_{ia})		Axial runout of the inner ring is the difference between the maximum and minimum reading of the measuring device when the inner ring is turned one revolution.
Axial runout of outer ring of assembled bearing (S_{ea})		Axial runout of the outer ring is the difference between the maximum and minimum reading of the measuring device when the outer ring is turned one revolution.
Perpendicularity of inner ring face with respect to the bore (S_d)		The squareness of the inner ring side surface is the difference between the maximum and minimum readings of the measuring device when the inner ring is turned one revolution together with the tapered mandrel.
Perpendicularity of outer ring outside surface with respect to the face (S_D)		The squareness of the outer ring outside diameter surface is the difference between the maximum and minimum readings of the measuring device when the outer ring is turned one revolution along the reinforcing plate.

6.5 Geometrical product specifications (GPS)

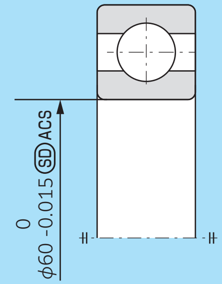
GPS is an abbreviation of geometrical product specifications. GPS is the new drawing notation for accurately describing the geometrical specifications of product shapes, dimensions, and surface characteristics.
The standard that specifies rules for making drawings with GPS is called “GPS standard”.

<Purpose of GPS>
While conventional drawing notation typically describes product dimensions and characteristics accurately, there are several “unclear” aspects of the conventional notation that can lead to varying interpretations (see **Fig. 6.2**). The main purpose of the GPS is to eliminate the ambiguity of drawing notation, thereby preventing troubles.



The dimensional tolerance of bearing bore diameters is specified in ISO/JIS as “Dimensional tolerance of mean bore diameter within plane” [see **Table 6.4 (1)**]. However, expressions such as “within plane” and “mean” are omitted in the conventional drawing notation as shown above. This can lead to several interpretations of the dimensional tolerance.

Conventional notation



GPS code “SD” represents “middle” and “ACS” represents “arbitrary cross section”. By adding these two codes after the bore diameter tolerance, it is possible to clearly express “middle of the measured diameter within an arbitrary cross section”, which is the dimensional tolerance of the mean bore diameter within a plane.

GPS notation

Fig. 6.2 Notation example of bearing bore diameter tolerance

<Applying GPS to rolling bearings>
In regards to standards related to roller bearings, ISO 492 specifying the tolerance of radial bearings and ISO 199 specifying the tolerance of thrust bearings were revised with GPS in 2014. In response to this, JIS B 1514–1 and JIS B 1514–2 were also revised in 2017.

<Example of bearing drawing applying GPS>
Fig. 6.3 shows an example of a bearing drawing that uses GPS.

Drawings that use GPS include notations and codes that are different from the ones used in conventional drawings.

For details, please contact **NTN** Engineering.

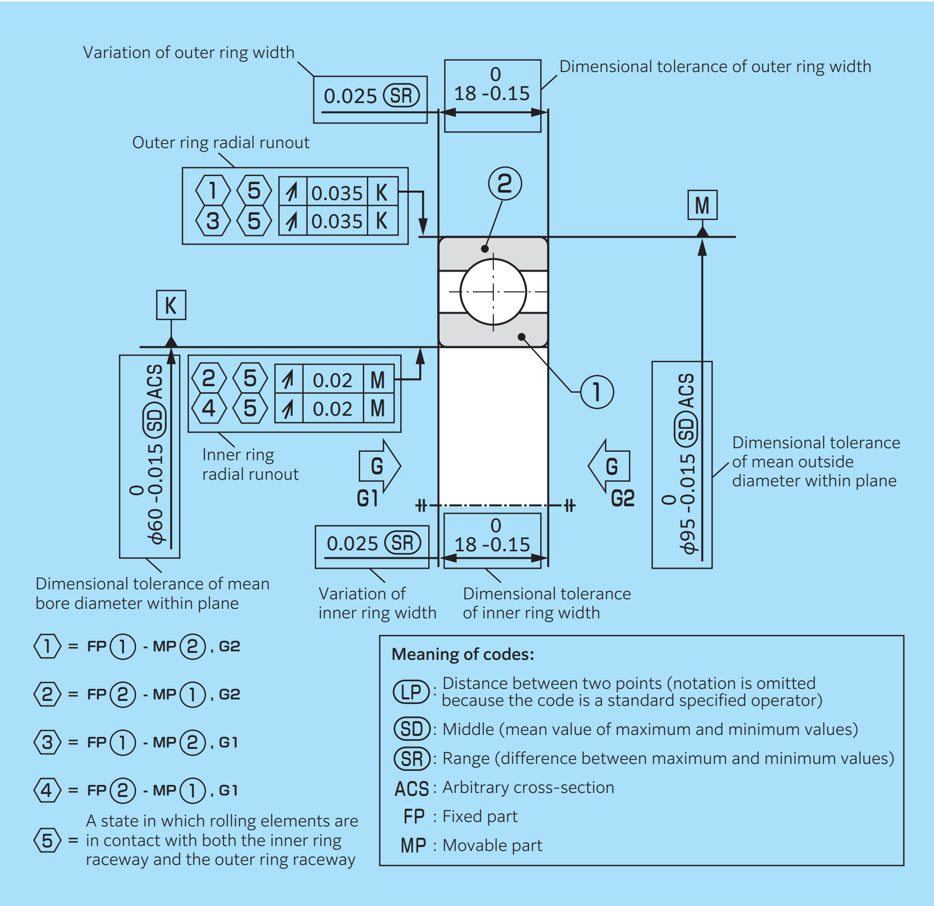


Fig. 6.3 Example of bearing drawing applying GPS