3. Ball bearing tolerances

3.1 Standard of tolerances

Ball bearing "tolerances"or dimensional accuracy and running accuracy, are regulated by ISO and JIS standards (rolling bearing tolerances). 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.

Table 3.1 Comparison of tolerance classifications of national standards

Standard		Tolerance class				
Japanese industrial standard (JIS)	JIS	class 0,6X	class 6	class 5	class 4	class 2
International Organization for Standardization (ISO)	ISO	Normal class Class 6X	Class 6	Class 5	Class 4	Class 2
Deutsches Institut fur Normung(ISO)	DIN	P0	P6	P5	P4	P2
American National Standards Institute (ANSI)	ANSI/ABMA	ABEC-1	ABEC-3	ABEC-5	ABEC-7	ABEC-9

3.2 Tolerances for radial bearings

Table 3.2 Inner rings (Unit: μm)

Nominal bore diameter d mm		Single plane mean bore diameter deviation Δ_{dmp}										Single radial plane bore diameter variation V_{dp}									
		class 0		class 6		class 5		class 4●		class 2●		diameter series 9					maxdiameter series 0.1				
												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.		
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
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
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
50	80	0	-15	0	-12	0	-9	0	-7	0	-4.0	19	15	9	7	4.0	19	15	7	5	4.0
80	120	0	-20	0	-15	0	-10	0	-8	0	-5.0	25	19	10	8	5.0	25	19	8	6	5.0

Table 3.3 Inner rings

Nominal bore diameter d mm		Single radial plane bore diameter variation V_{dp}					Mean single plane bore diameter variation V_{dmp}					Inner ring radial runout K_{ia}					Face runout with bore S_d		
		maxdiameter 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 5	class 4	class 2
over	incl.			max.					max.					max.				max.	
10	18	6	5	4	3	2.5	6	5	3	2.0	1.5	10	7	4	2.5	1.5	7.0	3.0	1.5
18	30	8	6	5	4	2.5	8	6	3	2.5	1.5	13	8	4	3.0	2.5	8.0	4.0	1.5
30	50	9	8	6	5	2.5	9	8	4	3.0	1.5	15	10	5	4.0	2.5	8.0	4.0	1.5
50	80	11	9	7	5	4.0	11	9	5	3.5	2.0	20	10	5	4.0	2.5	8.0	5.0	1.5
80	120	15	11	8	6	5.0	15	11	5	4.0	2.5	25	13	6	5.0	2.5	9.0	5.0	2.5

Table 3.4 Inner rings

Nominal bore diameter d mm		Inner ring axial runout (with side) S_{ia}❷			Inner ring width deviation $\triangle B_s$										Inner ring width variation V_{Bs}				
					normal						modified❸								
		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
over	incl.				high	low	high	low	high	low	high	low	high	low	max.				
10	18	7	3	1.5	0	-120	0	- 80	0	- 80	0	- 250	0	- 250	20	20	5	2.5	1.5
18	30	8	4	2.5	0	-120	0	-120	0	-120	0	-250	0	-250	20	20	5	2.5	1.5
30	50	8	4	2.5	0	-120	0	-120	0	-120	0	-380	0	-250	20	20	5	3.0	1.5
50	80	8	5	2.5	0	-150	0	-150	0	-150	0	-380	0	-250	25	25	6	4.0	1.5
80	120	9	5	2.5	0	-200	0	-200	0	-200	0	-380	0	-380	25	25	7	4.0	2.5

Note: ❶ The dimensional difference $\triangle d_s$ of bore diameter to applied for class 4 and 2 is the same as the tolerance of dimentional difference $\triangle d_{mp}$ of average bore diameter. However, the dimensional difference is applied to diameter series 0, 1, 2, 3 and 4 against Class 4, and to all the diameter series against Class 2.

❷ To be applied for deep groove ball bearing and angular contact ball bearings.

❸ To be applied for individual raceway rings manufactured for combined bearing use.

Table 3.5 Outer rings (Unit: μm)

Nominal Outside diameter D mm		Single plane mean outside diameter deviation $\triangle D_{mp}$										Single radial plane outside diameter variation V_{Dp}									
												diameter series 9					maxdiameter series 0.1				
		class 0		class 6		class 5		class 4❶		class 2❶		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.		
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
18	30	0	-9	0	-8	0	-6	0	-5	0	-4.0	12	10	6	5	4.0	9	8	5	4	4.0
30	50	0	-11	0	-9	0	-7	0	-6	0	-4.0	14	11	7	6	4.0	11	9	5	5	4.0
50	80	0	-13	0	-11	0	-9	0	-7	0	-4.0	16	14	9	7	4.0	13	11	7	5	4.0
80	120	0	-15	0	-13	0	-10	0	-8	0	-5.0	19	16	10	8	5.0	19	16	8	6	5.0
120	150	0	-18	0	-15	0	-11	0	-9	0	-5.0	23	19	11	9	5.0	23	19	8	7	5.0
150	180	0	-25	0	-18	0	-13	0	-10	0	-7.0	31	23	13	10	7.0	31	23	10	8	7.0
180	250	0	-30	0	-20	0	-15	0	-11	0	-8.0	38	25	15	11	8.0	38	25	11	8	8.0

Table 3.6 Outer rings

Nominal Outside diameter D mm		Single radial plane outside diameter variation V_{Dp}					Single radial plane outside diameter variation V_{Dp}❷		Mean single plane outside diameter variation V_{Dmp}				
		maxdiameter series 2.3.4					capped bearings diameter series						
		class 0	class 6	class 5	class 4	class 2	2,3,4 class 0	0,1,2,3,4 class 6	class 0	class 6	class 5	class 4	class 2
over	incl.		max.				max.				max.		
6	18	6	5	4	3	2.5	10	9	6	5	3	2.0	1.5
18	30	7	6	5	4	4.0	12	10	7	6	3	2.5	2.0
30	50	8	7	5	5	4.0	16	13	8	7	4	3.0	2.0
50	80	10	8	7	5	4.0	20	16	10	8	5	3.5	2.0
80	120	11	10	8	6	5.0	26	20	11	10	5	4.0	2.5
120	150	14	11	8	7	5.0	30	25	14	11	6	5.0	2.5
150	180	19	14	10	8	7.0	38	30	19	14	7	5.0	3.5
180	250	23	15	11	8	8.0	—	—	23	15	8	6.0	4.0

Table 3.7 Outer rings

Nominal Outside diameter D mm		Outer ring radial runout K_{ea}					Outside surface inclination S_D			Outside ring axial runout S_{ea}❼			Outer ring width deviation Δ_{Cs}	Outer ring width variation V_{Cs}			
		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
over	incl.	max.					max.			max.			all type		max.		
6	18	15	8	5	3	1.5	8	4	1.5	8	5	1.5	Identical to ΔB_s of inner ring of same bearing	Identical to ΔB_s and V_{Bs} of inner ring of same bearing	5	2.5	1.5
18	30	15	9	6	4	2.5	8	4	1.5	8	5	2.5			5	2.5	1.5
30	50	20	10	7	5	2.5	8	4	1.5	8	5	2.5			5	2.5	1.5
50	80	25	13	8	5	4.0	8	4	1.5	10	5	4.0			6	3.0	1.5
80	120	35	18	10	6	5.0	9	5	2.5	11	6	5.0			8	4.0	2.5
120	150	40	20	11	7	5.0	10	5	2.5	13	7	5.0			8	5.0	2.5
150	180	45	23	13	8	5.0	10	5	2.5	14	8	5.0			8	5.0	2.5
180	250	50	25	15	10	7.0	11	7	4.0	15	10	7.0			10	7.0	4.0

Note: ❺ The dimensional difference ΔD_s of outer diameter to be applied for classes 4 and 2 is the same as the tolerance of dimensional difference ΔD_{mp} 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 Cfass 2.

❻ To be applied in case snap rings are not installed on the bearings.

❼ To be applied for Deep Groove Ball Bearings and Angular Contact Ball Bearings.

4. Bearing fits

4.1 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 fitted surfaces during operation or under load. This relative movement (referred to as "creep") between the fitted surfaces of the bearing and the shaft or housing can occur in a radial direction, an axial direction, or in the direction of rotation. To help prevent this creeping movement, bearing rings and the shaft or housing are installed with one of three interference fits, a "tight fit" (also called shrink fit), "transition fit," or "loose fit" (also called clearance fit), and the degree of interference between their fitted surfaces varies.

The most effective way to fix the fitted 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.

4.2 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 analysis in selecting a proper fit. Some of the negative conditions caused by improper fit are listed below.

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