Bearing accuracy consists of dimensional accuracy and running accuracy. The normal accuracy grade is P0, a higher grade is P6 and P2 is the highest grade. Application requirements decide which grade accuracy should be applied.

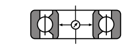
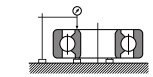
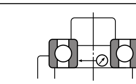
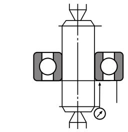
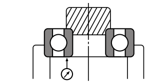
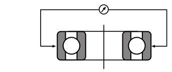
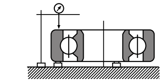
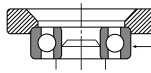
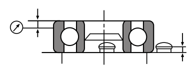
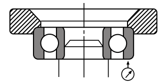
Accuracy Grade Standard Conversion Table

GB	Equivalents			
	ISO	ABMA	DIN	JIS
P0	Normal Class	ABEC 1	P0	JIS0
P6	Class 6	ABEC 3	P6	JIS6
P5	Class 5	ABEC 5	P5	JIS5
P4	Class 4	ABEC 7	P4	JIS4
P2	Class 2	ABEC 9	P2	JIS2

Notes:
1. P0(GB) is normal grade, P6 higher grade and P2 the highest accuracy grade.
2. GB : Chinese National Standards
3. ISO : International Standardization Organization
4. ABMA : The American Bearing Manufacturers Association
5. DIN : Deutsch Industrie Norm
6. JIS : Japanese Industrial Standards

Guide for Selection of Bearing Accuracy

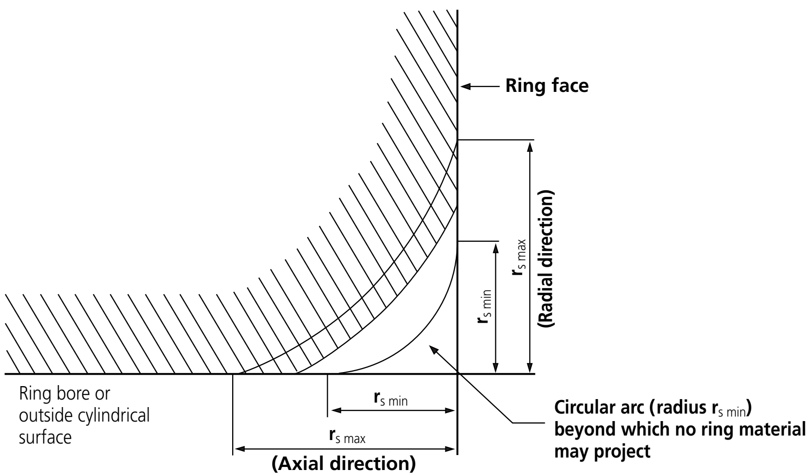
Application	ISO
Computer printers, copy machine-feed rollers, micro motors, stepping motors, fan motors, VCR pinch rollers	Normal Class 6
High precision motors, hard disk drive motors, dental spindles, servo motors, encoders, VCR drum spindles, VCR capstan motors, polygonal mirror scanner motors	Class 5 Class 4
High frequency spindles, gyro rotors, gyro gimbals	Class 4

Symbol	Definition	Inspection
d	Nominal bore diameter	
Δ_{dmp}	Mean bore diameter deviation in a single plane	
Δ_{ds}	Deviation of a single bore diameter	
V_{dp}	Bore diameter variation in a single radial plane	
V_{dmp}	Mean bore diameter variation	
Δ_{Bs}	Deviation of a single inner ring width	
V_{Bs}	Variation of inner ring width	
K_{ia}	Radial runout of assembled bearing inner ring	
S_d	Face runout with bore	
S_{ia}	Face runout with raceway of assembled bearing inner ring	
D	Nominal outside diameter	
Δ_{Dmp}	Mean outside diameter deviation in a single plane	
Δ_{Ds}	Deviation of a single outside diameter	
V_{Dp}	Outside diameter variation in a single radial plane	
V_{Dmp}	Mean outside diameter variation	
Δ_{Cs}	Deviation of a single outer ring width	
V_{Cs}	Variation of outer ring width	
Δ_{D1s}	Flange outside diameter deviation	
Δ_{C1s}	Flange width deviation	
K_{ea}	Radial runout of assembled bearing outer ring	
S_D	Variation of outside surface generatrix with inclination of outer ring benchmark face	
S_{ea}	Assembled bearing outer ring face runout with raceway	

Limit Tolerance Values (Metric) of Chamfer Dimensions of Radial Bearings

$r_{s\,min}$	d (mm)		$r_{s\,max}$		$r_{a\,max}$ (1)
	Over	Incl.	Radial	Axial	
0.05	–	–	0.1	0.2	0.05
0.08	–	–	0.16	0.3	0.08
0.1	–	–	0.2	0.4	0.1
0.15	–	–	0.3	0.6	0.15
0.2	–	–	0.5	0.8	0.2
0.3	–	40	0.6	1	0.3
	40	–	0.8	1	
0.6	–	40	1	2	0.6
	40	–	1.3	2	
1	–	50	1.5	3	1
	50	–	1.9	3	
1.1	–	120	2	3.5	1
	120	–	2.5	4	

Unit mm



$r_{s\,min}$ = smallest permissible single chamfer dimension (minimum limit)
$r_{s\,max}$ = largest permissible single chamfer dimension (maximum limit)
$r_{a\,max}$ = largest permissible single shaft and housing fillet radius

Note : The exact shape of the chamfer surface is not specified, but its contour in an axial plane shall not be allowed to project beyond the imaginary circular arc, of radius $r_{s\,min}$, tangential to the ring face and bore or outside cylindrical surface of the ring (see figure).

Normal Tolerances for Radial Bearings (Except Taper Roller Bearings)

Inner Ring

d		Δ_{dmp} 1)		V_{dmp}	K_{ia}
over	incl.	high	low	max	max
mm		µm		µm	µm
2,5	10	0	– 8	6	10
10	18	0	– 8	6	10
18	30	0	– 10	8	13
30	50	0	– 12	9	15
50	80	0	– 15	11	20
80	120	0	– 20	15	25
120	180	0	– 25	19	30
180	250	0	– 30	23	40
250	315	0	– 35	26	50
315	400	0	– 40	30	60
400	500	0	– 45	34	65
500	630	0	– 50	38	70
630	800	0	– 75	–	80
800	1000	0	– 100	–	90
1000	1250	0	– 125	–	100
1250	1600	0	– 160	–	120
1600	2000	0	– 200	–	140

1) Tolerances for tapered bores (taper 1:12 and 1:30) are given on pages on 84 and 85

Outer Ring

D		Δ_{Dmp} 1)		V_{Dmp}	K_{ea}
over	incl.	high	low	max	max
mm		µm		µm	µm
6	18	0	– 8	6	15
18	30	0	– 9	7	15
30	50	0	– 11	8	20
50	80	0	– 13	10	25
80	120	0	– 15	11	35
120	150	0	– 18	14	40
150	180	0	– 25	19	45
180	250	0	– 30	23	50
250	315	0	– 35	26	60
315	400	0	– 40	30	70
400	500	0	– 45	34	80
500	630	0	– 50	38	100
630	800	0	– 75	55	120
800	1000	0	– 100	75	140
1000	1250	0	– 125	–	160
1250	1600	0	– 160	–	190
1600	2000	0	– 200	–	220
2000	2500	0	– 250	–	250

1) Applies only to bearings of Diameter Series 2, 3 and 4

Normal Tolerances for Radial Bearings (Except Taper Roller Bearings)

Tolerances for Tapered Bore, Taper 1:12

Tolerances Classes Normal, P6						
d		Δ_{dmp}		V_{dp} [1)]	$\Delta_{d1mp}-\Delta_{dmp}$	
over	incl.	high	low	max	high	low
mm		µm		µm	µm	
18	30	+ 21	0	13	+ 21	0
30	50	+ 25	0	15	+ 25	0
50	80	+ 30	0	19	+ 30	0
80	120	+ 35	0	25	+ 35	0
120	180	+ 40	0	31	+ 40	0
180	250	+ 46	0	38	+ 46	0
250	315	+ 52	0	44	+ 52	0
315	400	+ 57	0	50	+ 57	0
400	500	+ 63	0	56	+ 63	0
500	630	+ 70	0	–	+ 70	0
630	800	+ 80	0	–	+ 80	0
800	1000	+ 90	0	–	+ 90	0
1000	1250	+ 105	0	–	+ 105	0
1250	1600	+ 125	0	–	+ 125	0
1600	2000	+ 150	0	–	+ 150	0

1) Applies in any single radial plane of the bore

Tolerances for Tapered Bore, Taper 1:30

Tolerances Classes Normal						
d		Δ_{dmp}		V_{dp} [1)]	$\Delta_{d1mp}-\Delta_{dmp}$	
over	incl.	high	low	max	high	low
mm		µm		µm	µm	
80	120	+ 20	0	25	+ 40	0
120	180	+ 25	0	31	+ 50	0
180	250	+ 30	0	38	+ 55	0
250	315	+ 35	0	44	+ 60	0
315	400	+ 40	0	50	+ 65	0
400	500	+ 45	0	56	+ 75	0
500	630	+ 50	0	63	+ 85	0
630	800	+ 75	0	–	+ 100	0
800	1000	+ 100	0	–	+ 100	0
1000	1250	+ 125	0	–	+ 115	0
1250	1600	+ 160	0	–	+ 125	0
1600	2000	+ 200	0	–	+ 150	0

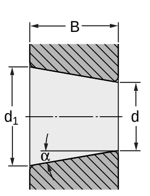
1) Applies in any single radial plane of the bore

Tapered Bores

Half angle of taper α:

$\alpha = 2° 23' 9{,}4''$ (taper 1:12)

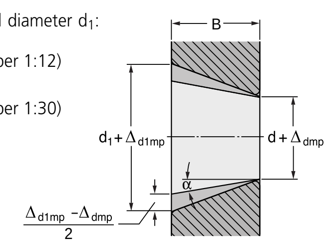
$\alpha = 0° 57' 17{,}4''$ (taper 1:30)



Largest theoretical diameter d_1:

$d_1 = d + \frac{1}{12} B$ (taper 1:12)

$d_1 = d + \frac{1}{30} B$ (taper 1:30)



Normal Tolerances for Taper Roller Bearings (Metric Sizes)

Inner Ring and Bearing Width

d		Δ_{dmp}		V_{dmp}	K_{ia}
over	incl.	high	low	max	max
mm		µm		µm	µm
10	18	0	– 12	9	15
18	30	0	– 12	9	18
30	50	0	– 12	9	20
50	80	0	– 15	11	25
80	120	0	– 20	15	30
120	180	0	– 25	19	35
180	250	0	– 30	23	50
250	315	0	– 35	26	60
315	400	0	– 40	30	70
400	500	0	– 45	34	70
500	630	0	– 50	38	85
630	800	0	– 75	56	100
800	1000	0	– 100	75	120
1000	1250	0	– 125	–	120
1250	1600	0	– 160	–	120
1600	2000	0	– 200	–	120

Outer Ring

D		Δ_{Dmp}		V_{Dmp}	K_{ea}
over	incl.	high	low	max	max
mm		µm		µm	µm
18	30	0	– 12	9	18
30	50	0	– 14	11	20
50	80	0	– 16	12	25
80	120	0	– 18	14	35
120	150	0	– 20	15	40
150	180	0	– 25	19	45
180	250	0	– 30	23	50
250	315	0	– 35	26	60
315	400	0	– 40	30	70
400	500	0	– 45	34	80
500	630	0	– 50	38	100
630	800	0	– 75	55	120
800	1000	0	– 100	75	120
1000	1250	0	– 125	94	120
1250	1600	0	– 160	120	120
1600	2000	0	– 200	–	120
2000	2500	0	– 250	–	120

Tolerances for Taper Roller Bearings (Inch Sizes)

Inner Ring

d		Δ_{ds}	
		Tolerances class	
		Normal	
over	incl.	high	low
mm		µm	
–	76,2	+ 13	0
76,2	101,6	+ 25	0
101,6	266,7	+ 25	0
266,7	304,8	+ 25	0
304,8	609,6	+ 51	0
609,6	914,4	+ 76	0
914,4	1219,2	+ 102	0
1219,2	–	+ 127	0

Outer Ring

D		Δ_{Ds}		K_{ia}, K_{ea}, S_{ia}, S_{ea}		
		Tolerances class		Tolerances class		
		Normal		Normal	CL3	CL0
over	incl.	high	low	max	max	max
mm		µm		µm		
–	266,7	+ 25	0	51	8	4
266,7	304,8	+ 25	0	51	8	4
304,8	609,6	+ 51	0	51	18	9
609,6	914,4	+ 76	0	76	51	26
914,4	1219,2	+ 102	0	76	76	38
1219,2	–	+ 127	0	76	76	–

Life and Load Rating

Bearing Life

When bearing rotate, the inner, outer ring and rolling elements are constantly loaded. This produces material fatigue and eventually bearing failure. The total number of revolutions before a failure occurs is called the basic rating life.

Life of individual bearings varies considerably, even if they are of the same size, same material, same heat treatment and are under the same operating condition.

Statistically, the total number of revolutions reached or exceeded by 90% of a sufficiently large group of apparently identical bearings before the first evidence of material fatigue occurs is called the basic rating life.

Basic Dynamic Load Rating

The basic dynamic load rating of a bearing with rotating inner ring and stationary outer ring is that load of constant magnitude and size which a sufficiently large group of apparently identical bearings can endure for a basic rating life of one million revolutions.

Radial bearings take central load. Values given for C in the dimension tables of this catalogue are for standard high chromium steel. 80% to 85% of the chromium steel values should be used for stainless steel.

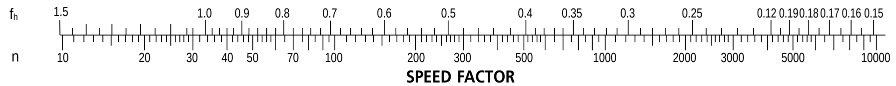
Life Formula

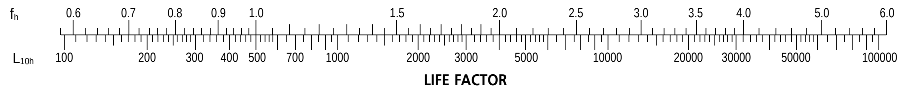
The equation for the basic rating life for dynamically loaded ball bearings is as follow:

$$L_{10} = \left(\frac{C_r}{P}\right)^3 \ (\times 10^6 \text{ Revolutions}) \qquad L_{10h} = \frac{16666}{n} \bullet \left(\frac{C_r}{P}\right)^3 \ (\text{Hours})$$

whereby :
- L_{10} = Basic Rating Life
- C_r = Basic Dynamic Load Rating (kgf)
- n = R.P.M. (Revolutions Per Minute)
- f_n = Speed Factor
- L_{10h} = Basic Rating Life in Operating Hours
- P = Equivalent Load (kgf)
- f_h = Life Factor

$$L_{10h} = 500 \bullet f_n^3 \quad , \quad f_h = f_n \bullet \frac{C_r}{P} \quad , \quad f_n = \left(\frac{33.3}{n}\right)^{1/3}$$





Examples of Rating Life L_{10h} Values Used:

Operating Conditions	Basic Rating Life L_{10h}
Infrequent operation.	500
Short or intermittent operation. Failure has little effect on function.	4,000 ~ 8,000
Intermittent operation. Failure has significant effect on function.	8,000 ~ 12,000
8 hours of non-continuous operation.	12,000 ~ 20,000
8 hours of continuous operation.	20,000 ~ 30,000
24 hours continuous operation.	40,000 ~ 60,000
24 hours of guaranteed trouble-free operation.	100,000 ~ 200,000