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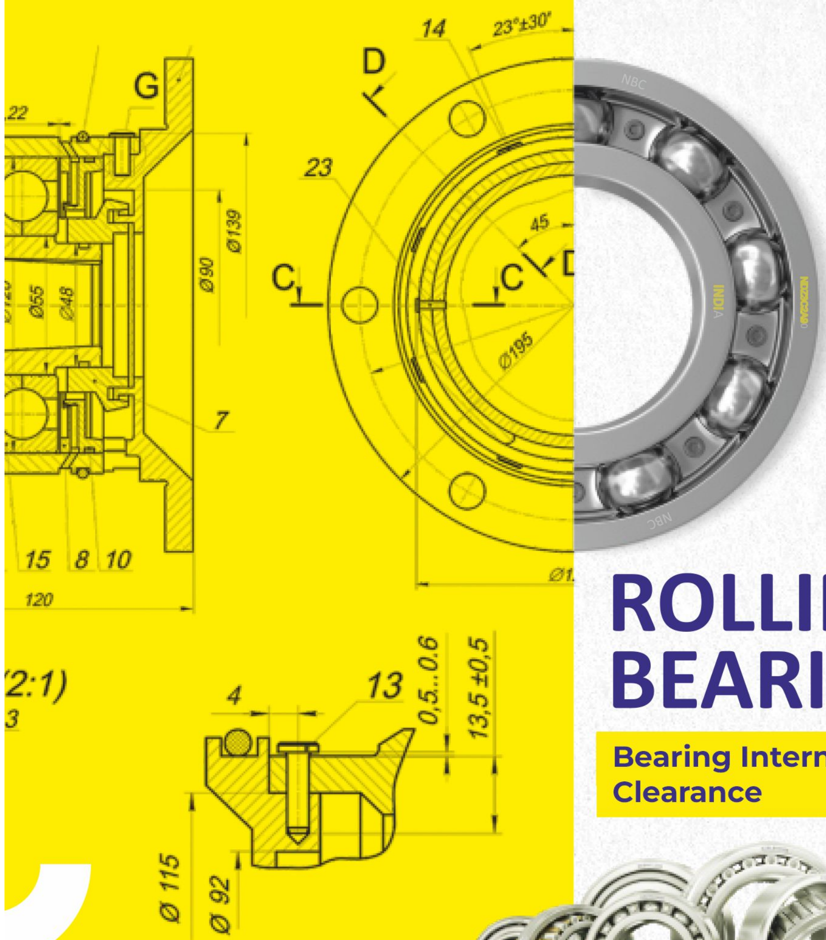

ROLLING BEARINGS

Bearing Internal Clearance

2 WHEELERS | 3 WHEELERS | 4 WHEELERS | TRACTORS | LCV, HCV | INDUSTRIES | RAILWAYS | AEROSPACE

WINNER DEMING GRAND PRIZE

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CATALOGUE/TC-106, 01/2024

This version supersedes all previously published versions. All the bearing mentioned in this catalogue are manufactured with normal tolerance class. We can, however, supply other class bearing against specific requirement.

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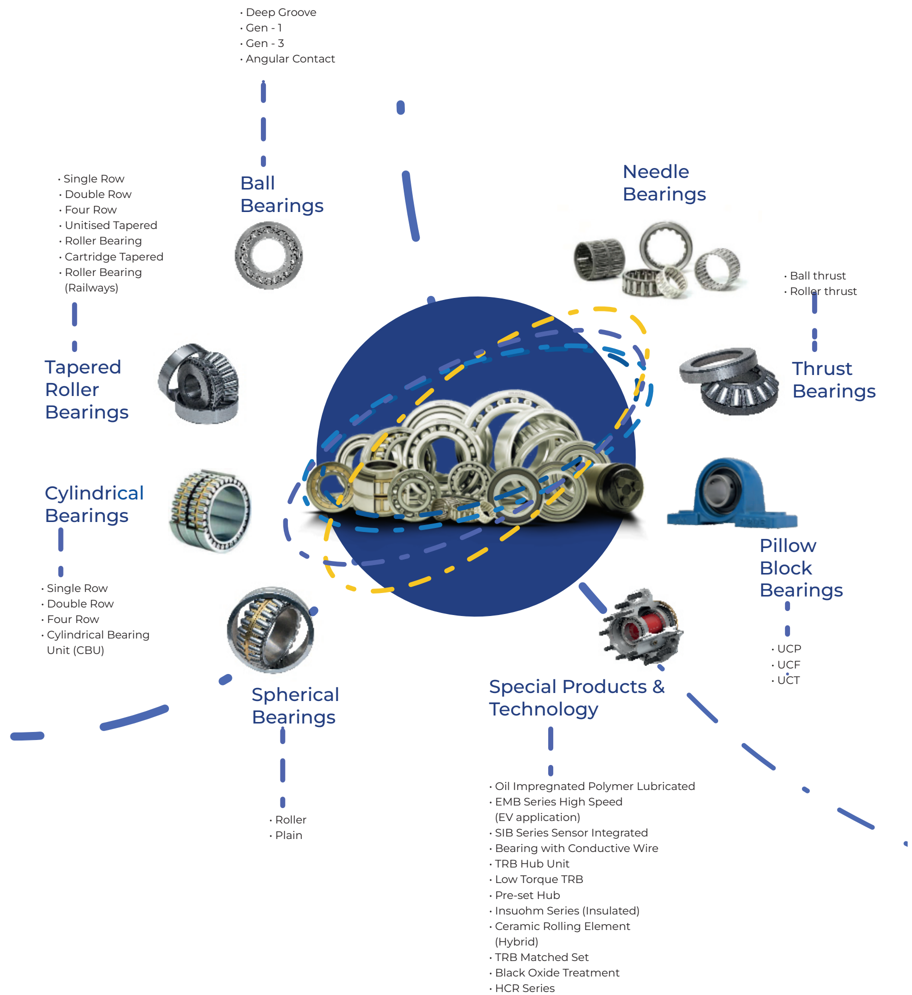
Founded in 1946, NBC is India's first bearings manufacturer and the last word in quality and durability. In 2020, the company acquired leading European manufacturer, Kinex Bearings to further boost its expertise.

75 years since its beginning, NBC remains India's leading bearings manufacturer andexporter. NBC is also the world's only bearings manufacturer to receive the prestigious Deming Grand Prize for Total Quality Management.

- 1946 India's first bearing manufacturer
- 250+ million bearings manufactured/ annum
- 3100+ variants of bearings offered
- 5 manufacturing locations
- Leading exporter
- Happy customers in 30+ countries
- R&D and Innovation Centre
- 2800+People
- Automotive
- Industrial
- Railway
- Aerospace

Products from NBC

Since the challenges faced by industry are many, NBC offers a diverse range of exceptional bearings. NBC bearings are available in sizes from 04 mm bore to 2000 mm outer diameter.



∗ Products with special features like high temperature application, special heat treatment, coated roller/races and cage options are also available across product range.

06 Bearing Internal Clearance

6.1 Type of Clearance During Operation

Internal clearance of a bearing is an important factor affecting not only the bearing performance but also the proper functioning of a machine. Bearing internal clearance is defined as the relative movement of either rings in radial or axial direction, when one ring is fixed. Movement in the diametrical direction is radial clearance, while movement in the shaft's direction is axial clearance. Internal clearance is critical to bearing performance for many reasons. The amount of clearance influences the load distribution in a bearing, which in turn affects smooth operation. It also influences bearing noise and vibration. There are three types of clearance present in the bearing during operation.

Initial clearance: The clearance present inside the bearing before it is mounted on a shaft or housing.

Mounted clearance: The clearance in the bearing after mounting but before the bearing comes into operation.

Operating clearance: The clearance remaining in the bearing after temperature affect and mounting.

For satisfactorily performance bearings must have the appropriate operating clearance. If sufficient amount of clearance is not present in the bearing it may fail. For calculating clearance, effect of fits and temperature is considered. The selection of the clearance is dependent upon the application. In some cases negative clearance (preload) is required when stiffness or bearing positioning is important. Bearing internal clearances changes due to:

- Thermal expansion or contraction of shaft or housing.
- Elastic deformation of rings under load
- Axial clamping can influence clearance or preload.
- Misalignment during running
- Improper mounting of bearing

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To get the accurate measurement of internal clearance a certain 'measured load' has to be applied on the raceways. However, under this 'measured load' a slight elastic deformation of the bearing occurs due to which the measured internal clearance value will be slight greater than the true clearance value. This difference between the bearing's true clearance and the measured clearance under the load must be compensated. These compensation values are given in Table 6.1. (Table Below)

Nominal Bore Diameter *d* mm		Measuring Load		Adjustment of internal clearance (Unit μm)				
over	incl.	N	{Kgf}	C2	CN	C3	C4	C5
10 [1]	18	24.5	{2.5}	3 ~ 4	4	4	4	4
18	50	49	{5}	4 ~ 5	5	6	6	6
50	200	147	{15}	6 ~ 8	8	9	9	9

Note : For roller bearings the amount of elastic deformation is small enough, to be ignored.

Radial clearance of the bearing is built up for following reasons:

1. Accommodate the reduction of clearance in a bearing due to interference for inner ring on the shaft or outer ring in the housing.
2. Accommodate the minor changes in the dimensions of parts without affecting the bearing performance.
3. Compensate for the differential expansion of the two rings when the inner ring of a bearing operates at a higher temperature than the outer ring.
4. It allows a slight misalignment between the shaft and the housing and thereby prevents the premature failure of the bearing.
5. It affects the end play of radial ball bearing, and also affects their capacity for carrying axial loads, the greater the radial clearance the greater the capacity for supporting axial load.

Important: Once ball and roller bearings are mounted and running, a small amount of radial internal or running clearance is normally desirable. In the case of bearings under radial load, quieter running is generally obtained when this clearance is minimum.

6.2 Types of Radial Internal Clearance:

Radial bearings are made with following different ranges of radial internal clearance- C2, Normal, C3 and C4

C2: These bearings have the smallest amount of radial internal clearance. They should only be used where freedom is required in the assembled bearings and there is no possibility of the initial radial internal clearances being eliminated by external causes. Therefore, special attention must be given to the seating dimensions as the expansion of the inner ring or contraction of the outer ring may cause tight bearings. In this respect a C2 bearing should not be used unless recommended.

CN: This grade of radial internal clearance is intended for use where only when one ring is made an interference fit and there is no appreciable loss of clearance due to temperature difference. ball and roller bearings for general engineering applications are usually of this clearance.

C3: This grade of radial internal clearance should be used when both rings of a bearing are made an interference fit or when only one ring is an interference fit but there is likely to be some loss of clearance due to temperature differences. It is the grade normally used for radial ball bearings that take axial loading but for some purposes even bearings with C4 clearance may be required.

C4: Where there will be some loss of clearance due to temperature differences and both rings are interference fit, this grade of radial internal clearance is employed. One example of its use is in bearings for traction motors. Customers should always consult us before ordering bearings with this grade of radial internal clearance.

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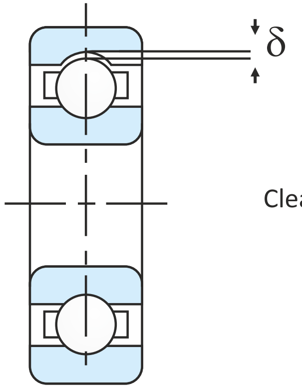

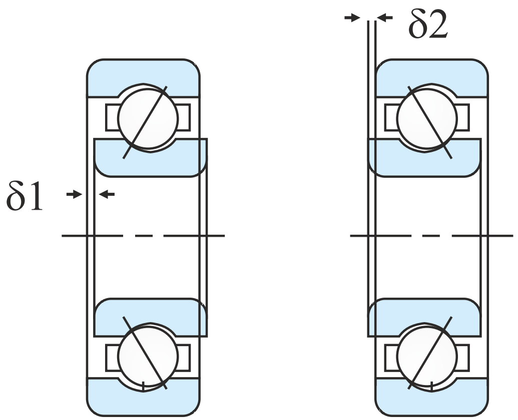

6.3 Criteria For Selection of Internal Clearance

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

Effective Internal Clearance:

The internal clearance differential between the initial clearance and the operating (effective) clearance (the amount of clearance reduction caused by interference fits, or clearance variation due to the temperature difference between the inner and outer rings) can be calculated by the following formula:

$\delta eff = \delta o - (\delta f + \delta t)$

Where,

δ eff: Effective internal clearance, mm

δo: Bearing internal clearance, mm

δf: Reduced amount of clearance due to interference, mm

Reduced clearance due to interference:

After installation of bearings with interference fit on shaft and housing, the inner ring will expand and the outer ring will contract; thus reducing the bearings' internal clearance. The amount of expansion or contraction will depend on the shape of the bearing, the shape of the shaft or housing, dimensions of the respective parts, and the type of materials used. The differential can range from approximately 70% to 90% of the effective interference.

$\delta f = (0.70 \sim 0.90)\, \Delta deff$

Where,

δf: Reduced amount of clearance due to interference, mm

Δ deff: Effective interference, mm

Reduced internal clearance due to inner/outer ring temperature difference.

In operation, normally the outer ring will be 5 to 10˚C cooler than the inner ring or rotating parts. However, if the cooling effect of the housing is large, the shaft is connected to a heat source, or a heated substance is conducted through the hollow shaft; the temperature difference between the two rings can be even greater. The amount of internal clearance is thus further reduced by the differential expansion of the two rings as given in the formula:

$\delta t = \alpha . \Delta T . Do$

Where,

δt: Amount of reduced clearance due to heat differential, mm

α : Bearing material expansion coefficient 12.5 × 10-6/˚C

ΔT: Inner/outer ring temperature differential, ˚C

Do: Outer ring raceway diameter, mm

Outer ring raceway diameter, Do, values can be approximated by using formula

For ball bearings and spherical roller bearings,

$Do = 0.20 (d + 4.0D)$

For roller bearings (except spherical roller bearing),

$Do = 0.25 (d + 3.0D)$

Where,

d: Bearing bore diameter, mm

D: Bearing outside diameter, mm

6.4 Radial Internal Clearance Values

Bearing Internal Clearance Values As Per ISO: 5753 / IS: 5935

6.4.1Deep Groove Ball Bearings (Cylindrical bore)

Table 6.2 Radial internal clearance for Deep groove ball bearing with cylindrical bore.

Clearance values in microns

Bore diameter d (mm)		Group 2 (C2)		Group N (CN)		Group 3 (C3)		Group 4 (C4)		Group 5 (C5)	
Over	Incl.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
2.5	6	0	7	2	13	8	23	-	-	-	-
6	10	0	7	2	13	8	23	14	29	20	37
10	18	0	9	3	18	11	25	18	33	25	45
18	24	0	10	5	20	13	28	20	36	28	48
24	30	1	11	5	20	13	28	23	41	30	53
30	40	1	11	6	20	15	33	28	46	40	64
40	50	1	11	6	23	18	36	30	51	45	73
50	65	1	15	8	28	23	43	38	61	55	90
65	80	1	15	10	30	25	51	46	71	65	105
80	100	1	18	12	36	30	58	53	84	75	120
100	120	2	20	15	41	36	66	61	97	90	140
120	140	2	23	18	48	41	81	71	114	105	160
140	160	2	23	18	53	46	91	81	130	120	180
160	180	2	25	20	61	53	102	91	147	135	200
180	200	2	30	25	71	63	117	107	163	150	230
200	225	2	35	25	85	75	140	125	195	175	265
225	250	2	40	30	95	85	160	145	225	205	300
250	280	2	45	35	105	90	170	155	245	225	340
280	315	2	55	40	115	100	190	175	270	245	370
315	355	3	60	45	125	110	210	195	300	275	410
355	400	3	70	55	145	130	240	225	340	315	460
400	450	3	80	60	170	150	270	250	380	350	510
450	500	3	90	70	190	170	300	280	420	390	570
500	560	10	100	80	210	190	330	310	470	440	630
560	630	10	110	90	230	210	360	340	520	490	690
630	710	20	130	110	260	240	400	380	570	540	760
710	800	20	140	120	290	270	450	430	630	600	840
800	900	20	160	140	320	300	500	480	700	670	940
900	1000	20	170	150	350	330	550	530	770	740	1040
1000	1120	20	180	160	380	360	600	580	850	820	1150
1120	1250	20	190	170	410	390	650	630	920	890	1260

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6.4.2(A) Cylindrical Roller Bearing (Interchangeable)

Table 6.3 Radial internal clearance for cylindrical roller bearing (interchangeable) with cylindrical bore.

Clearance values in microns

Bore diameter d (mm)		Group 2 (C2)		Group N (CN)		Group 3 (C3)		Group 4 (C4)		Group 5 (C5)	
Over	Incl.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
-	10	0	25	20	45	35	60	50	75	-	-
10	24	0	25	20	45	35	60	50	75	65	90
24	30	0	25	20	45	35	60	50	75	70	95
30	40	5	30	25	50	45	70	60	85	80	105
40	50	5	35	30	60	50	80	70	100	95	125
50	65	10	40	40	70	60	90	80	110	110	140
65	80	10	45	40	75	65	100	90	125	130	165
80	100	15	50	50	85	75	110	105	140	155	190
100	120	15	55	50	90	85	125	125	165	180	220
120	140	15	60	60	105	100	145	145	190	200	245
140	160	20	70	70	120	115	165	165	215	225	275
160	180	25	75	75	125	120	170	170	220	250	300
180	200	35	90	90	145	140	195	195	250	275	330
200	225	45	105	105	165	160	220	220	280	305	365
225	250	45	110	110	175	170	235	235	300	330	395
250	280	55	125	125	195	190	260	260	330	370	440
280	315	55	130	130	205	200	275	275	350	410	485
315	355	65	145	145	225	225	305	305	385	455	535
355	400	100	190	190	280	280	370	370	460	510	600
400	450	110	210	210	310	310	410	410	510	565	665
450	500	110	220	220	330	330	440	440	550	625	735

6.4.2(B.1) Cylindrical Roller Bearings (Non-interchangeable)

Table 6.4 Radial internal clearance for Cylindrical roller bearing (non-interchangeable) with cylindrical bore.

Clearance values in microns

Nominal Bore diameter d (mm)		C1NA		C2NA		NA[1]		C3NA		C4NA		C5NA	
Over	Incl.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
-	10	5	10	10	20	20	30	35	45	45	55	-	-
10	18	5	10	10	20	20	30	35	45	45	55	65	75
18	24	5	10	10	20	20	30	35	45	45	55	65	75
24	30	5	10	10	25	25	35	40	50	50	60	70	80
30	40	5	12	12	25	25	40	45	55	55	70	80	95
40	50	5	15	15	30	30	45	50	65	65	80	95	110
50	65	5	15	15	35	35	50	55	75	75	90	110	130
65	80	10	20	20	40	40	60	70	90	90	110	130	150
80	100	10	25	25	45	45	70	80	105	105	125	155	180
100	120	10	25	25	50	50	80	95	120	120	145	180	205
120	140	15	30	30	60	60	90	105	135	135	160	200	230
140	160	15	35	35	65	65	100	115	150	150	180	225	260
160	180	15	35	35	75	75	110	125	165	165	200	250	285
180	200	20	40	40	80	80	120	140	180	180	220	275	315
200	225	20	45	45	90	90	135	155	200	200	240	305	350
225	250	25	50	50	100	100	150	170	215	215	265	330	380
250	280	25	55	55	110	110	165	185	240	240	295	370	420
280	315	30	60	60	120	120	180	205	265	265	325	410	470
315	355	30	65	65	135	135	200	225	295	295	360	455	520
355	400	35	75	75	150	150	225	255	330	330	405	510	585
400	450	45	85	85	170	170	255	285	370	370	455	565	650

Note: For bearing with normal clearance, NA is added to bearing number, Ex. NU305NA

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6.4.2(B.2) Cylindrical Roller Bearings (Non-interchangeable)

Table 6.5 Radial internal clearance for Cylindrical roller bearing (non-interchangeable) with tapered bore.

Clearance values in microns

Nominal Bore diameter d (mm)		C9NA❷		CONA❷		C1NA		C2NA		NA❶		C3NA	
Over	Incl.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
-	10	5	5	7	17	10	20	20	30	35	45	45	55
10	18	5	10	7	17	10	20	20	30	35	45	45	55
18	24	5	10	7	17	10	20	20	30	35	45	45	55
24	30	5	10	10	20	10	25	25	35	40	50	50	60
30	40	5	12	10	20	12	25	25	40	45	55	55	70
40	50	5	15	10	20	15	30	30	45	50	65	65	80
50	65	5	15	10	20	15	35	35	50	55	75	75	90
65	80	10	20	15	30	20	40	40	60	70	90	90	110
80	100	10	25	20	35	25	45	45	70	80	105	105	125
100	120	10	25	20	35	25	50	50	80	95	120	120	145
120	140	15	30	25	40	30	60	60	90	105	135	135	160
140	160	15	35	30	45	35	65	65	100	115	150	150	180
160	180	15	35	30	45	35	75	75	110	120	165	165	200
180	200	20	40	30	50	40	80	80	120	140	180	180	220
200	225	20	45	35	55	45	90	90	105	155	200	200	240
225	250	25	50	40	65	50	10	100	150	170	210	215	265
250	280	25	55	40	65	55	110	110	165	185	240	240	295
280	315	30	60	45	75	60	120	120	180	205	265	265	325
315	355	30	65	45	75	65	135	135	200	225	295	295	360
355	400	35	75	50	90	75	150	150	225	255	330	330	405
400	450	45	85	60	10	85	170	170	255	285	370	370	455
450	500	50	95	70	115	95	190	190	285	315	410	410	505

Note: C9NA, CONA and CINA are applied only to precision bearing of class 5 or higher

6.4.3 Double Row Self Aligning Ball Bearing

Table 6.6(A) Radial internal clearance for Double row self-aligning ball bearing with cylindrical bore.

Clearance values in microns

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

Table 6.6(B) Radial internal clearance for Double Row Self Aligning Ball Bearing with tapered bore.

Clearance values in microns

Bore diameter d (mm)		Group 2 (C2)		Group N (CN)		Group 3 (C3)		Group 4 (C4)		Group 5 (C5)	
Over	Incl.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
18	24	7	17	13	26	20	33	28	42	37	55
24	30	9	20	15	28	23	39	33	50	44	62
30	40	12	24	19	35	29	46	40	59	52	72
40	50	14	27	22	39	33	52	45	65	58	79
50	65	18	32	27	47	41	61	56	80	73	99
65	80	23	39	35	57	50	75	69	98	91	123
80	100	29	47	42	68	62	90	84	116	109	144
100	120	35	56	50	81	75	108	100	139	130	170
120	140	40	68	60	98	90	130	120	165	155	205
140	160	45	74	65	110	100	150	140	191	180	240

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6.4.4 Spherical Roller Bearing

Table 6.7(A) Radial internal clearance for Spherical roller bearing with cylindrical bore.

Clearance values in microns

Nominal bore diameter d mm		Bearing with cylindrical bore									
		C2		CN		C3		C4		C5	
over	Incl.	min	max	min	max	min	max	min	max	min	max
14	18	10	20	20	35	35	45	45	60	60	75
18	24	10	20	20	35	35	45	45	60	60	75
24	30	15	25	25	40	40	55	55	75	75	95
30	40	15	30	30	45	45	60	60	80	80	100
40	50	20	35	35	55	55	75	75	100	100	125
50	65	20	40	40	65	65	90	90	120	120	150
65	80	30	50	50	80	80	110	110	145	145	180
80	100	35	60	60	100	100	135	135	180	180	225
100	120	40	75	75	120	120	160	160	210	210	26
120	140	50	95	95	145	145	190	190	240	240	300
140	160	60	110	110	170	170	220	220	280	280	350
160	180	65	120	120	180	180	240	240	310	310	390
180	200	70	130	130	200	200	260	260	340	340	430
200	225	80	140	140	220	220	290	290	380	380	470
225	250	90	150	150	240	240	320	320	420	420	520
250	280	100	170	170	260	260	350	350	460	460	570
280	315	110	190	190	280	280	370	370	500	500	630
315	355	120	200	200	310	310	410	410	550	550	690
355	400	130	220	220	340	340	450	450	600	600	750
400	450	140	240	240	370	370	500	500	660	660	820
450	500	140	260	260	410	410	550	550	720	720	900
500	560	150	280	280	440	440	600	600	780	780	1,000
560	630	170	310	310	480	480	650	650	850	850	1,100
630	710	190	350	350	530	530	700	700	920	920	1,190
710	800	210	390	390	580	580	770	770	1,010	1,010	1,300
800	900	230	430	430	650	650	860	860	1,120	1,120	1,440
900	1,000	260	480	480	710	710	930	930	1,220	1,220	1,570
1,000	1,120	290	530	530	780	780	1,020	1.020	1,330	1,330	1,720
1,120	1,250	320	580	580	860	860	1,120	1,120	1,460	1,460	1,870
1,250	1,400	350	640	640	950	950	1,240	1,240	1,620	1,620	2,080

Table 6.7(B) Radial internal clearance for Spherical roller bearing with tapered bore.

Clearance values in microns

Bore diameter d (mm)		Group 2 (C2)		Group N (CN)		Group 3 (C3)		Group 4 (C4)		Group 5 (C5)	
Over	Incl.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
18	24	15	25	25	35	35	45	45	60	60	75
24	30	20	30	30	40	40	55	55	75	75	95
30	40	25	35	35	50	50	65	65	85	85	105
40	50	30	45	45	60	60	80	80	100	100	130
50	65	40	55	55	75	75	95	95	120	120	160
65	80	50	70	70	95	95	120	120	150	150	200
80	100	55	80	80	110	110	140	140	180	180	230
100	120	65	100	100	135	135	170	170	220	220	280
120	140	80	120	120	160	160	200	200	260	260	330
140	160	90	130	130	180	180	230	230	300	300	380
160	180	100	140	140	200	200	260	260	340	340	430
180	200	110	160	160	220	220	290	290	370	370	470
200	225	120	180	180	250	250	320	320	410	410	520
225	250	140	200	200	270	270	350	350	450	450	570
250	280	150	220	220	300	300	390	390	490	490	620
280	315	170	240	240	330	330	430	430	540	540	680
315	355	190	270	270	360	360	470	470	590	590	740
355	400	210	300	300	400	400	520	520	650	650	820
400	450	230	330	330	450	450	570	570	720	720	910
450	500	260	270	270	490	490	630	630	790	790	1000
500	560	290	410	410	540	540	680	680	870	870	1100
560	630	320	460	460	600	600	760	760	980	980	1230
630	710	350	510	510	670	670	850	850	1090	1090	1360
710	800	390	370	370	750	750	960	960	1220	1220	1500
800	900	440	640	640	840	840	1070	1070	1370	1370	1690
900	1000	490	710	710	930	930	1190	1190	1520	1520	1860

nbc flexible solutions

6.5 Preload

Bearing Preload is the process of applying an axial load, independent of external loads, to a bearing. An axial preload ensures constant contact between the rolling element and raceways reducing or eliminating play inside bearing.

Bearings are preloaded to increase rigidity and thereby to reduce unwanted bearing's displacement. This means that the bearings' internal clearance is negative before operation. This is called "preload" and is commonly applied to angular ball bearings and tapered roller bearings.

The amount of preload applied is important. It must be sufficient to reduce the excess play, but care must be taken not to apply too much preload. Proper preload allows the rolling elements to freely rotate in the bearing races, while excessive preload could lead to skidding. This will increase friction and heat generation, which can ultimately lead to premature bearing failure.

Purpose of preload

(1) Bearing's rigidity increases, internal clearance tends not to be produced even when heavy load is applied.

(2) The particular frequency of the bearing increases and is becomes suitable for high-speed rotation.

(3) Shaft run-out is suppressed; rotation and position precision are enhanced.

(4) Vibration and noise are controlled.

(5) Sliding of rolling elements by turning, spinning, or pivoting, is controlled and smearing is reduced.

(6) Fretting produced by external vibration is prevented.

Preloading different types of bearings

1. Deep groove ball bearings

Deep groove ball bearings requiring a preload must be loaded axially. Axial load can be applied to the outer ring or inner ring. The race comes in contact with the ball and translates this load to the raceway of the outer or inner ring. This creates a contact angle, between the race, the ball and the outer race. Preloading of deep groove ball bearings is optional but preloading of angular contact bearings is mandatory. Preloading can be done using a constant-force adjustable spacer (spring washer). Spring preloading reduces noise and is widely used in electric motors

Preload on deep groove ball bearing is done in rare cases and is optional. In Deep Groove Ball Bearing, for applying preloading minimum two bearings will be needed i.e., matched pair bearings.

One very important point for preloading deep groove ball bearing is the selection of clearance. Higher Radial clearances (C3, C4) are required so that same contact angle is maintained between ball and both the races (inner and outer). Whenever inner ring is axially displaced (sa) with respect to the outer ring, thereby preload (few microns) is induced .

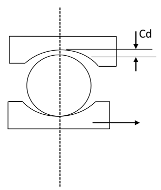


Fig.1

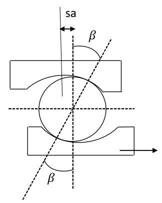


Fig.2

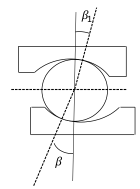


Fig.3

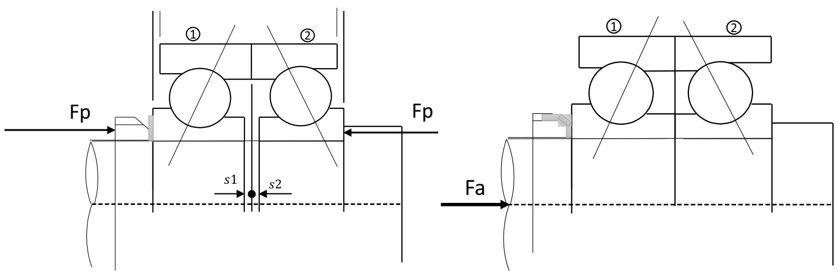
Note: Unequal Angles between ball and inner /outer race of will generate gyroscopic motion on ball (Fig.3)

In case of Deep groove ball bearings preloading is done in case of motors and encoders etc.

2. Angular contact bearing

Angular contact bearings have large contact angles typically 15°, 25°, 30° or 40°. Angular contact bearings which are manufactured in matched pairs are referred to as duplex bearings. Duplex bearings are manufactured with the bearing faces adjacent to each other in face to face or back-to-back arrangement. The raceways of duplex bearings are slightly offset but come together when the proper preload is applied during assembly.

Axial displacement of inner rings of bearing 1 & 2 while applying preload Force (Fp)



Where,

Fp is Preload applied during mounting

Fa is operational axial load

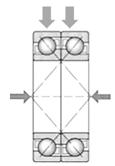
Preload force is applied on bearings from both sides as shown in figure,inside faces of inner ring will move towards each other reducing or eliminatinge the gap (s1 & s2)

Under Operation For Bearing 1

Total axial load = Fa + Fp

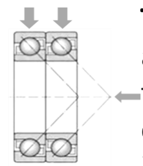
For bearing 2

Axial Load = Fa- Fp



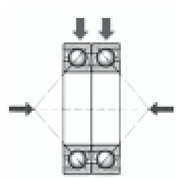
Face to Face

In Face-to-face bearings assembly, there is a clearance between the outer rings. After preloading, the outer ring faces and inner ring faces are clamped together, bringing the faces flush with each other, and resulting in contact angles that converge towards the centerline.



Tandem

Tandem assembly two or more bearings are arranged in the same orientation. During assembly, the inner rings are clamped together, resulting in contact angles that are parallel to each other and increases the thrust capacity in one direction only.



Back to Back

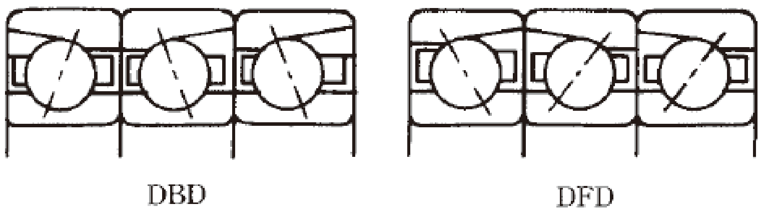
In Back to Back bearing assembly, bearing has clearance between inner ring faces. After preloading inner rings are clamped together, bringing the inner and outer ring faces flush with each other and resulting in contact angles that diverge towards centerline.

Universally Matched Single Row Angular Contact Ball Bearings with high ndm factor, preloading is done in applications such as:

- End Suctions Pumps
- High speed Motors
- Input shaft (Bevel and Spiral Bevel Input Drives)

It is important to select optimum Preload with the help of calculations and experience. Aiming for higher stiffness will increase the operating temperature and can lead to early bearing failure.

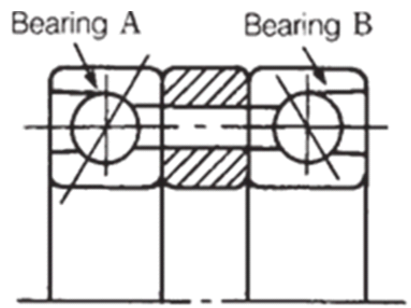
Triplex Bearing Arrangement should be chosen in case of high stiffness and axial forces.



Preload methods

Rigid preloading

It provides the higher radial and axial rigidity. The preload is obtained by applying a load with a precision locknut or clamping element and a spacers is used between the two bearings. The nut applies an axial load to the inner or outer bearing ring and thus preloads bearings. Shims may also be used to obtain the proper preload.



Spring preload

It provides the higher radial and axial rigidity. The preload is obtained by applying a load with a precision locknut or clamping element and a spacers is used between the two bearings. The nut applies an axial load to the inner or outer bearing ring and thus preloads bearings. Shims may also be used to obtain the proper preload.