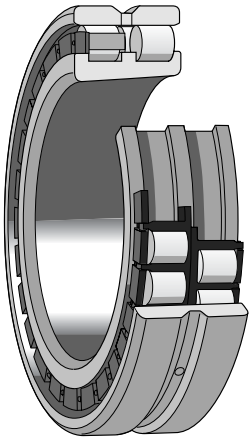
Precision Double Row Cylindrical Roller Bearings With Tapered Bore

High precision cylindrical roller bearings are bearings with a low cross section, high load carrying capacity and speed capability. These properties make them particularly suitable for machine tool applications where spindle bearing arrangements are required to support heavy loads and have high stiffness.

MRC can furnish the NN style double row cylindrical roller bearing with a tapered bore in the 31 series. The tapered bore (Taper 1:12) allows adjustment in mounting to a given radial internal clearance or preload. The rollers are guided by integral flanges in the inner ring. The inner ring, cage and roller assembly is separable from the outer ring for simplification of mounting and dismounting. To facilitate lubrication, bearings with a bore diameter of 50 mm and over have an annular groove and three oil holes in the outer ring.



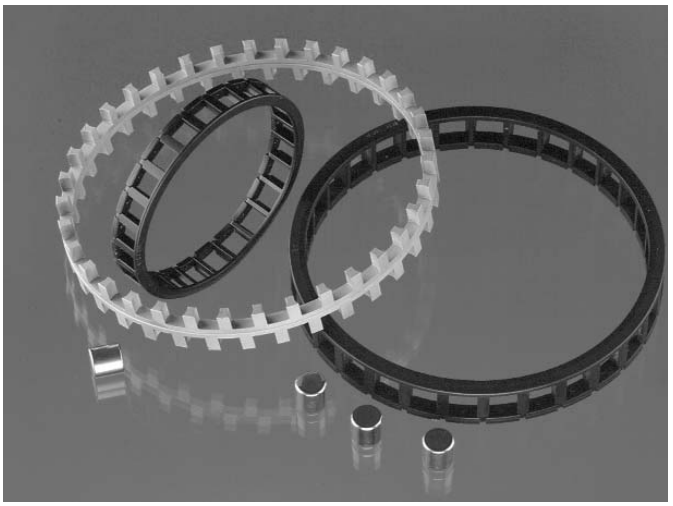
NN31X Series

Tolerances

High precision cylindrical roller bearings are manufactured to tolerances specifically defined for machine tool applications. The tolerances are shown in the table on page 44.

Cages

The NN 31 series incorporates two separate polyamide cages as standard. Machined brass is furnished on some sizes; either material is suitable at temperatures normally encountered, in machine tool applications, and are not affected by lubricants commonly used, with the exception of some synthetic oils or greases with synthetic base oils.



Cages for double row cylindrical roller bearings

Internal Clearance

The NN 31X series are manufactured to a C1 internal radial clearance as standard as shown in the table below. Clearance greater than C1 can be furnished on request.

Bore Diameter d		C1 Internal Clearance			
Over	Incl	Min		Max	
mm		mm	in	mm	in
24	30	.015	.0006	.025	.0010
30	40	.015	.0006	.025	.0010
40	50	.017	.0007	.030	.0012
50	65	.020	.0008	.035	.0014
65	80	.025	.0010	.040	.0016
80	100	.035	.0014	.055	.0022
100	120	.040	.0016	.060	.0024
120	140	.045	.0018	.070	.0028
140	160	.050	.0020	.075	.0030
160	180	.055	.0022	.085	.0033
180	200	.060	.0024	.090	.0035
200	225	.060	.0024	095	.0037
225	250	.065	.0026	.100	.0039
250	280	.075	.0030	.110	.0043
280	315	.080	.0031	.120	.0047

Speed Ratings

The ratings quoted in the bearing tables are guideline values which apply provided the bearings have a maximum preload in operation of 2 μm (.00008 in) and the associated components are made with the recommended accuracy. Where heavier preloads occur or where the associated components are less accurate, the speed ratings must be reduced.

Internal Clearance or Preload in Mounted Bearings

To ensure maximum running accuracy and stiffness of the complete machine tool spindle, the bearings should have a minimum radial internal clearance or a preload after mounting. Because of this, cylindrical roller bearings with tapered bore are generally mounted with preload.

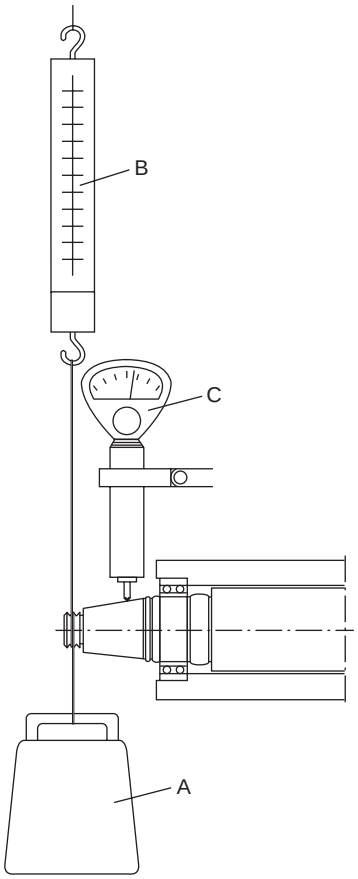
The magnitude of the operational clearance or preload in a bearing depends on the speed, load, lubrication and requisite stiffness. It is also dependent on the accuracy of form of the bearing seatings. Temperature conditions in the bearing should also be taken into consideration, since a reduction in clearance or an increase in preload can result.

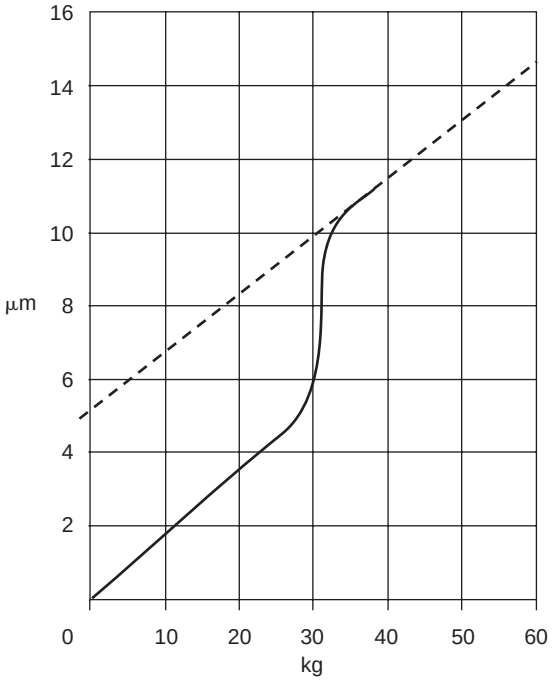
The maximum preload for bearings operating at relatively slow speeds lies between .001 and .004 mm (.0004 and .0016 in) depending on bearing size and must be appropriately reduced at higher speeds.

Adjustment of Clearance or Preload

The adjustment of clearance or preload for double and single row cylindrical roller bearings with tapered bore is achieved by driving up the bearing on its tapered seating. The axial displacement of the inner ring on its tapered seating must be determined in accordance with the required preload or clearance. In order to do this, the outer ring should be mounted in the housing, the inner ring then pushed on to the seating and the residual clearance measured.

A method often used to measure the clearance is shown in the adjacent figure. The spindle end under load A is incrementally unloaded and the values shown by the dial gauge C (which should be as close as possible to the bear-





ing) and the spring balance B are read off. The force directed upwards should be increased until it exceeds the load A, which acts downwards. If the values that are read off are plotted on a graph, a curve will be obtained, which resembles that shown in the adjacent diagram. The two inclined sections of the curve represent spindle resilience, whereas the vertical distance between slopes represents the magnitude of the radial internal clearance; in the case shown, this is 5 μm. To obtain maximum accuracy when measuring, other bearings or even seals, which could restrict movement of the spindle, should not be mounted in the vicinity of the bearing being measured.

Using the value so obtained for the radial internal clearance, the axial displacement, i.e. the additional distance through which the bearing must be pushed up on to its tapered seating, can be obtained from the formula shown below.

$$B_a = \frac{ec}{1\,000}$$

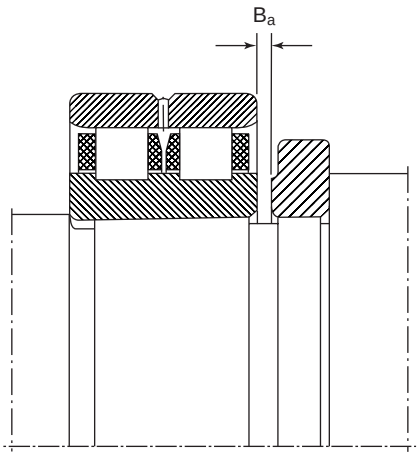
where

B_a = axial displacement, mm
e = factor depending on bearing series, see adjacent table
c = requisite clearance reduction, including any preload, μm

If the bearing is to be mounted against a distance ring, e.g. as shown in the adjacent figure, the width of the distance ring must be appropriate to the value obtained for B_a. In all other cases, the axial displacement must be measured from a reference surface on the spindle.

Factor e

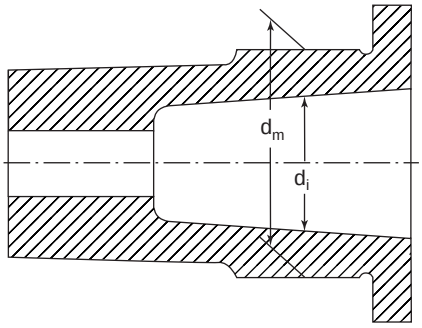
Diameter Ratio d_i/d_m	Factor e Bearing Series NN 31 X
≤0.2	12.5
0.3	14.5
0.4	15
0.5	16
0.6	17
0.7	18



Example

How large is the axial displacement, i.e. the distance which bearing NN 3132X should be pushed further up on to its tapered seating, if

- the measured radial internal clearance is 10 μm,
- the requisite preload is 2 μm
- the mean bearing seating diameter d_m = 163 mm, and
- the internal diameter of the hollow spindle d_i = 120 mm



Using e = 18 for $d_i/d_m = 120/163 = 0.74$ from the adjacent table and c = 10 + 2 = 12 μm, then

$$B_a = \frac{e\,c}{1\,000} = \frac{18 \times 12}{1\,000} = 0.216 \text{ mm}$$

Inner Ring

Bore Diameter (mm)	Over Incl.	10 18	18 30	30 50	50 80	80 120	120 150	150 180	180 250
Bore		.0001	.0001	.00015	.0002	.0002	.0003	.0003	.0003
Out-of-Round (Max)		.003	.003	.004	.005	.005	.007	.007	.008
Radial Runout (Max)		.0001	.0001	.00015	.00015	.0002	.00025	.00025	.0003
		.003	.003	.004	.004	.005	.006	.006	.008
Width Variation (Max)		.0002	.0002	.0002	.00025	.0003	.0003	.0003	.0004
		.005	.005	.005	.006	.007	.008	.008	.010
Side Runout		.0003	.0003	.0003	.0003	.00035	.0004	.0004	.00045
With Bore (Max)		.008	.008	.008	.008	.009	.010	.010	.011
Ring Width	+.0000	−.0039	−.0039	−.0047	−.0059	−.0079	−.0098	−.0098	−.0118
		−.100	−.100	−.120	−.150	−.200	−.250	−. 250	−.300

Outer Ring

Outside Diameter	Over Incl.	30 50	50 80	80 120	120 150	150 180	180 250	250 315	315 400
Outside	+.0000	−.0003	−.00035	−.0004	−.00045	−.0005	−.0006	−.0007	−.0008
Diameter		−.007	−.009	−.010	−.011	−.013	−.015	−.018	−.020
Outside Diameter		.00015	.0002	.0002	.00025	.0003	.0003	.00035	.0004
Out-of-Round (Max)		.004	.005	.005	.006	.007	.008	.009	.010
Radial Runout (Max)		.0002	.0002	.00025	.0003	.0003	.0004	.00045	.0005
		.005	.005	.006	.007	.008	.010	.011	.013
Width Variation (Max)		Identical to inner ring of same bearing							
O.D. Runout		.0003	.0003	.00035	.0004	.0004	.00045	.0005	.0005
With Side (Max)		.008	.008	.009	.010	.010	.011	.013	.013
Ring Width		Identical to inner ring of same bearing							

Tolerances for Tapered Bore

Bore Diameter d (mm)	Over Incl.	18 30	30 50	50 80	80 120	120 180	180 250
d_1	−.0000	+.0004	+.00045	+.0006	+.0008	+.0010	+.0012
		+.010	+.012	+.015	+.020	+.025	+.030
$d_1 - d_2$[1)]	−.0000	+.00015	+.00015	+.0002	+.00025	+.0003	+.0004
		+.004	+.004	+.005	+.006	+.008	+.010

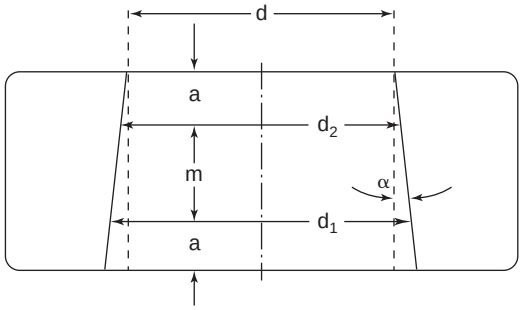
[1)] Angular deviation over measuring length m
d_1 mean bore diameter at large end of tapered bore; arithmetical mean of largest and smallest single bore diameters at distance a
d_2 mean bore diameter at small end of tapered bore: arithmetical mean of largest and smallest single bore diameters at distance a
Tapered bore
Half angle taper $\alpha = 2° 23' 9.4''$

Housing Fits

The recommended housing bore diameters for precision double row cylindrical rollers bearings for machine tool spindle applications are shown in the table below, for a rotating shaft and stationary housing. The recommended interference for precision double row cylindrical rollers bearings is 0-2 μm.

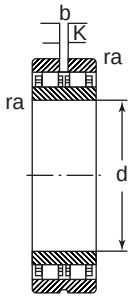
Housing Bore Limits

Housing Bore Diameter Nominal (mm)		Normal & Light Loads K5 Tolerance				Heavy Loads & Rotating Outerring Loads M5 Tolerance			
		Millimeter		Inch		Millimeter		Inch	
Over	Incl.	High	Low	High	Low	High	Low	High	Low
18	30	+.001	-.008	+.00004	-.0003	-.005	-.014	-.0002	-.0006
30	50	+.002	-.009	+.0001	-.00035	-.006	-.016	-.0002	-.0006
50	80	+.003	-.010	+.0001	-.0004	-.006	-.019	-.0002	-.0007
80	120	+.002	-.013	+.0001	-.0005	-.008	-.023	-.0003	-.0009
120	180	+.003	-.015	+.0001	-.0006	-.009	-.027	-.00035	-.0011
180	250	+.002	-.018	+.0001	-.0007	-.011	-.031	-.0004	-.0012
250	315	+.003	-.020	+.0001	-.0008	-.013	-.036	-.0005	-.0014
315	400	+.003	-.022	+.0001	-.0009	-.014	-.039	-.0006	-.0015



α = 2° 23' 9.4"
(1:12 taper)

Measuring Distance a			
Chamfer Dimension r_2 (min)		Measuring Distance a	
mm	in	mm	in
0.6	024	2.5	.098
1.0	.039	3.0	.118
1.1	.043	4.0	.157
1.5	.060	5.0	.197
2.0	.080	5.5	.217
2.1	.083	6.0	.236



MRC Bearing Number	Bore d		Outside Diameter D		Width B		$r_{1,2}$	Fillet[1] Radius r_a		b		k		Basic Radial Load Rating				Speed Rating	
														Dynamic $C^{2)}$		Static C_0		Grease	Oil
	mm	in	mm	in	mm	in	min	mm	in	mm	in	mm	in	N	lbf	N	lbf	RPM	RPM
NN3107X	35	1.3780	62	2.4409	20	.7874	1	1.0	.040	—	—	—	—	39100	8790	50000	11200	14000	16000
NN3108X	40	1.5748	68	2.6772	21	.8268	1	1.0	.040	—	—	—	—	42900	9640	56000	12600	12000	14000
NN3109X	45	1.7717	75	2.9528	23	.9055	1	1.0	.040	—	—	—	—	50100	11300	65500	14700	11000	13000
NN3110X	50	1.9685	80	3.1496	23	.9055	1	1.0	.040	3.7	.146	2.0	.080	52800	11900	73500	16500	10000	12000
NN3111X	55	2.1654	90	3.5433	26	1.0236	1.1	1.0	.040	3.7	.146	2.0	.080	69300	15600	96500	21700	9500	11000
NN3112X	60	2.3622	95	3.7402	26	1.0236	1.1	1.0	.040	3.7	.146	2.0	.080	73700	16600	106000	23800	9000	10000
NN3113X	65	2.5591	100	3.9370	26	1.0236	1.1	1.0	.040	3.7	.146	3.0	.118	76500	17200	116000	26100	8500	9500
NN3114X	70	2.7559	110	4.3307	30	1.1811	1.1	1.0	.040	5.5	.217	3.0	.118	96800	21800	150000	33700	7500	8500
NN3115X	75	2.9528	115	4.5276	30	1.1811	1.1	1.0	.040	5.5	.217	3.0	.118	96800	21800	150000	33700	7000	8000
NN3116X	80	3.1496	125	4.9213	34	1.3386	1.1	1.0	.040	5.5	.217	3.0	.118	119000	26800	186000	41800	6700	7500
NN3117X	85	3.3465	130	5.1181	34	1.3386	1.1	1.0	.040	5.5	.217	3.0	.118	125000	28100	204000	45900	6300	7000
NN3118X	90	3.5433	140	5.5118	37	1.4567	1.5	1.5	.060	5.5	.217	3.0	.118	138000	31000	216000	48600	6000	6700
NN3119X	95	3.7402	145	5.7087	37	1.4567	1.5	1.5	.060	5.5	.217	3.0	.118	142000	31900	232000	52200	5600	6300
NN3120X	100	3.9370	150	5.9055	37	1.4567	1.5	1.5	.060	5.5	.217	3.0	.118	151000	33900	250000	56200	5300	6000
NN3121X	105	4.1339	160	6.2992	41	1.6142	2	2.0	.080	5.5	.217	3.0	.118	190000	42700	305000	68600	5000	5600
NN3122X	110	4.3307	170	6.6929	45	1.7717	2	2.0	.080	5.5	.217	3.0	.118	220000	49500	360000	80900	4800	5300
NN3124X	120	4.7244	180	7.0866	46	1.8110	2	2.0	.080	5.5	.217	3.0	.118	229000	51500	390000	87700	4500	5000
NN3126X	130	5.1181	200	7.8740	52	2.0472	1.1	2.0	.080	8.3	.327	4.5	.177	286000	64300	475000	107000	4000	4500
NN3128X	140	5.5118	210	8.2677	53	2.0866	2	2.0	.080	8.3	.327	4.5	.177	297000	66800	520000	117000	3800	4300
NN3130X	150	5.9055	225	8.8583	56	2.2047	2.1	2.0	.080	8.3	.327	4.5	.177	330000	74200	570000	128000	3600	4000
NN3132X	160	6.2992	240	9.4488	60	2.3622	2.1	2.0	.080	8.3	.327	4.5	.177	369000	83000	655000	147000	3400	3800

[1)] Fillet radius indicates maximum fillet radius on shaft or in housing which bearing corner will clear.
[2)] Rating for one million revolutions or 500 hours at 33 1/3 rpm.