

Main Spindle Bearings

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12. Tapered Roller Bearings

Tapered roller bearings are designed so that the apexes of the inner ring, outer ring, and rollers are located at a common point on the bearing center line. Accordingly, the rollers roll on the raceway surfaces and slide along the back rib of the inner ring cone, guided by the resultant force from the inner ring and outer ring raceways.

This bearing is suitable for handling a radial load, an axial load in one direction, and the resultant load. Also, it has a large load capacity.

In general, the cage of a tapered roller bearing is a punched steel plate type. If P4 or higher is needed for running accuracy, NTN recommends that a high-strength machined brass cage to be used.

① Load calculation

Tapered roller bearings are generally used in pairs, so their dynamic equivalent load can be calculated according to **Table 12.1**.

② Bearing designations

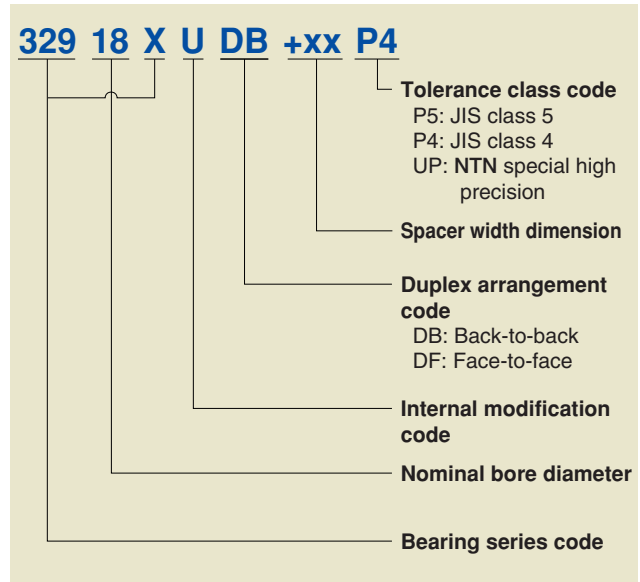


Table 12.1 Bearing arrangement and equivalent load

Bearing arrangement	Load condition	Axial load	Equivalent radial load
DB arrangement	$\frac{0.5F_{rI}}{Y_I} \leq \frac{0.5F_{rII}}{Y_{II}} + F_a$	$F_{aI} = \frac{0.5F_{rII}}{Y_{II}} + F_a$ $F_{aII} = \frac{0.5F_{rII}}{Y_{II}}$	$P_{rI} = XF_{rI} + Y_I \left(\frac{0.5F_{rII}}{Y_{II}} + F_a \right)$ $P_{rII} = F_{rII}$
DF arrangement	$\frac{0.5F_{rI}}{Y_I} > \frac{0.5F_{rII}}{Y_{II}} + F_a$	$F_{aI} = \frac{0.5F_{rI}}{Y_I}$ $F_{aII} = \frac{0.5F_{rI}}{Y_I} - F_a$	$P_{rI} = F_{rI}$ $P_{rII} = XF_{rII} + Y_{II} \left(\frac{0.5F_{rI}}{Y_I} - F_a \right)$
DB arrangement	$\frac{0.5F_{rII}}{Y_{II}} \leq \frac{0.5F_{rI}}{Y_I} + F_a$	$F_{aI} = \frac{0.5F_{rI}}{Y_I}$ $F_{aII} = \frac{0.5F_{rI}}{Y_I} + F_a$	$P_{rI} = F_{rI}$ $P_{rII} = XF_{rII} + Y_{II} \left(\frac{0.5F_{rI}}{Y_I} + F_a \right)$
DF arrangement	$\frac{0.5F_{rII}}{Y_{II}} > \frac{0.5F_{rI}}{Y_I} + F_a$	$F_{aI} = \frac{0.5F_{rII}}{Y_{II}} - F_a$ $F_{aII} = \frac{0.5F_{rII}}{Y_{II}}$	$P_{rI} = XF_{rI} + Y_I \left(\frac{0.5F_{rII}}{Y_{II}} - F_a \right)$ $P_{rII} = F_{rII}$

Note 1: The above are valid when the bearing internal clearance and preload are zero.

2: Radial forces in the opposite direction to the arrow in the above illustration are also regarded as positive.

③ Accuracy

Table 12.2 Inner rings

Unit: μm

Nominal bore diameter d		Deviation of mean bore diameter in a single plane Δd_{mp}				Variation of bore diameter in a single plane V_{dsp}		Mean bore diameter deviation V_{dmp}		Radial runout K_{ia}		Perpendicularity of inner ring face with respect to the bore S_d		Axial runout S_{ia}	Width variation ΔB_s		Deviation of the actual bearing width ΔT_s	
		mm over	mm incl.	Class 5 high	Class 4 high	Class 5 max	Class 4 max	Class 5 max	Class 4 max	Class 5 max	Class 4 max	Class 5 max	Class 4 max	Class 4 max	Class 5 high	Class 4 low	Class 5 high	Class 4 low
18	30	0	-8	0	-6	6	5	5	4	5	3	8	4	4	0	-200	+200	-200
30	50	0	-10	0	-8	8	6	5	5	6	4	8	4	4	0	-240	+200	-200
50	80	0	-12	0	-9	9	7	6	5	7	4	8	5	4	0	-300	+200	-200
80	120	0	-15	0	-10	11	8	8	5	8	5	9	5	5	0	-400	+200	-200
120	180	0	-18	0	-13	14	10	9	7	11	6	10	6	7	0	-500	+350	-250
180	250	0	-22	0	-15	17	11	11	8	13	8	11	7	8	0	-600	+350	-250

① The tolerance of bore diameter deviation Δd_s applicable to class 4 is the same as the tolerance of single plane mean bore diameter deviation Δd_{mp} .

Table 12.3 Outer rings

Unit: μm

Nominal bore diameter D		Deviation of mean outside diameter in a single plane ΔD_{mp}				Variation of outside diameter in a single plane V_{Dsp}		Mean single plane outside diameter variation V_{Dmp}		Radial runout K_{ea}		Perpendicularity of outer ring outside surface with respect to the face S_D		Axial runout S_{ea}
		mm over	mm incl.	Class 5 high	Class 4 high	Class 5 max	Class 4 max	Class 5 max	Class 4 max	Class 5 max	Class 4 max	Class 5 max	Class 4 max	Class 4 max
30	50	0	-9	0	-7	7	5	5	5	7	5	8	4	5
50	80	0	-11	0	-9	8	7	6	5	8	5	8	4	5
80	12	0	-13	0	-10	10	8	7	5	10	6	9	5	6
120	150	0	-15	0	-11	11	8	8	6	11	7	10	5	7
150	180	0	-18	0	-13	14	10	9	7	13	8	10	5	8
180	250	0	-20	0	-15	15	11	10	8	15	10	11	7	10
250	315	0	-25	0	-18	19	14	13	9	18	11	13	8	10

② The tolerance of outside diameter deviation ΔD_s applicable to class 4 is the same as the tolerance of single plane mean outside diameter deviation ΔD_{mp} .

④ Recommended fit for high-precision tapered roller bearings

Table 12.4 Fit to shaft

Unit: μm

Nominal bore diameter d		Fit between inner ring and shaft	
		Fixed side	Floating side
mm over	mm incl.	Targeted interference ①	Targeted interference ①
18	30	0~5T	0~1T
30	50	0~6T	0~2T
50	80	0~7T	0~3T
80	120	0~8T	0~4T
120	180	0~10T	0~5T
180	250	0~13T	0~6T
250	315	0~15T	0~6T
315	400	0~18T	0~8T

① Target the median value.
T: Tight (Interference)

Table 12.5 Fit to housing

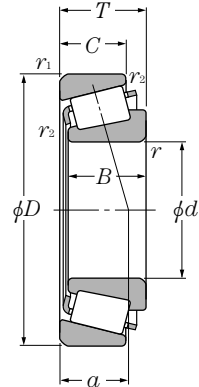
Unit: μm

Nominal bore diameter D		Fit between outer ring and housing
		Targeted interference ①
mm over	mm incl.	Targeted interference ①
30	50	0~3T
50	80	0~3T
80	120	0~4T
120	150	0~4T
150	180	0~4T
180	250	0~5T
250	315	0~5T
315	400	0~6T
400	500	0~7T

⑤ Dimension tables for tapered roller bearings

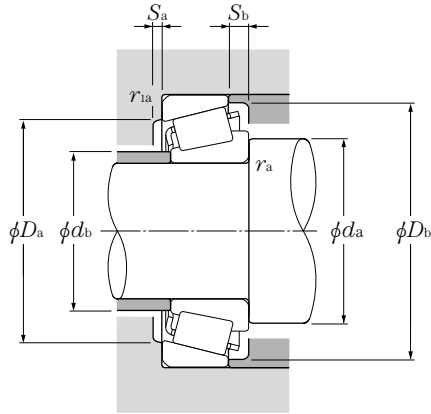
Tapered Roller Bearings

d 20~95mm



part number	Boundary dimensions									Basic load ratings				Limiting speed	
	mm									dynamic kN	static	dynamic kgf	static	min ⁻¹	
	d	D	T	B	C	r_1 s min ^①	r_1 s min ^①	r_2 s min ^①		C_r	C_{or}	C_r	C_{or}	grease lubrication	oil lubrication
4T-32004X	20	42	15	15	12	0.6	0.6	0.15		24.9	27.9	2 540	2 840	9 500	13 000
4T-32005X	25	47	15	15	11.5	0.6	0.6	0.15		27.8	33.5	2 830	3 450	7 900	11 000
4T-32006X	30	55	17	17	13	1	1	0.3		37.5	46.0	3 800	4 700	6 900	9 200
4T-32007X	35	62	18	18	14	1	1	0.3		41.5	52.5	4 250	5 350	6 100	8 100
4T-32008X	40	68	19	19	14.5	1	1	0.3		50.0	65.5	5 100	6 650	5 300	7 100
4T-32009X	45	75	20	20	15.5	1	1	0.3		57.5	76.5	5 850	7 800	4 800	6 400
32910XU	50	72	15	15	12	0.6	0.6	0.15		35.5	57.0	3 650	5 800	4 700	6 300
4T-32010X	50	80	20	20	15.5	1	1	0.3		62.5	88.0	6 400	9 000	4 400	5 800
32911XU	55	80	17	17	14	1	1	0.3		44.5	73.5	4 550	7 500	4 300	5 700
4T-32011X	55	90	23	23	17.5	1.5	1.5	0.6		80.5	118	8 200	12 000	4 000	5 400
32912XA	60	85	17	17	14	1	1	0.3		51.0	83.0	5 200	8 450	4 000	5 300
4T-32012X	60	95	23	23	17.5	1.5	1.5	0.6		82.0	123	8 350	12 500	3 700	4 900
32913XU	65	90	17	17	14	1	1	0.3		48.5	85.0	4 900	8 700	3 700	4 900
4T-32013X	65	100	23	23	17.5	1.5	1.5	0.6		83.0	128	8 450	13 000	3 400	4 600
32914XU	70	100	20	20	16	1	1	0.3		68.5	110	7 000	11 200	3 400	4 600
4T-32014X	70	110	25	25	19	1.5	1.5	0.6		105	160	10 700	16 400	3 200	4 200
32915XU	75	105	20	20	16	1	1	0.3		69.5	114	7 100	11 600	3 200	4 300
32015XU	75	115	25	25	19	1.5	1.5	0.6		106	167	10 800	17 000	3 000	4 000
32916XU	80	110	20	20	16	1	1	0.3		72.0	121	7 350	12 400	3 000	4 000
32016XU	80	125	29	29	22	1.5	1.5	0.6		139	216	14 200	22 000	2 800	3 700
32917XU	85	120	23	23	18	1.5	1.5	0.6		94.0	157	9 600	16 100	2 800	3 800
32017XU	85	130	29	29	22	1.5	1.5	0.6		142	224	14 400	22 900	2 600	3 500
32918XU	90	125	23	23	18	1.5	1.5	0.6		97.5	168	9 950	17 100	2 700	3 600
32018XU	90	140	32	32	24	2	1.5	0.6		168	270	17 200	27 600	2 500	3 300
32919XU	95	130	23	23	18	1.5	1.5	0.6		101	178	10 300	18 200	2 500	3 400
32019XU	95	145	32	32	24	2	1.5	0.6		171	280	17 500	28 600	2 300	3 100

① Minimum allowable value for chamfer dimension r_1 , r_1 s or r_2 s.



Dynamic equivalent radial load

$$P_r = XF_r + YF_a$$

$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
X	Y	X	Y
1	0	0.4	Y_2

Static equivalent radial load

$$P_{or} = 0.5F_r + Y_0F_a$$

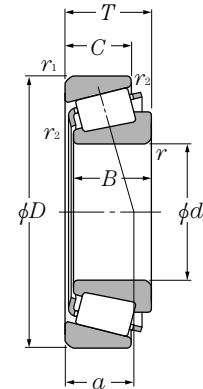
Note that when $P_{or} < F_r$, $P_{or} = F_r$.

The values for e , Y_2 and Y_0 are given in the table below.

Abutment and fillet dimensions										Load center mm	Factor <i>e</i>	Axial load factor		Mass kg (approx.)
d_a min	d_b max	D_a mm		D_b min	S_a min	S_b min	r_{as} max	r_{1as} max	<i>a</i>			Y_2	Y_0	
24.5	25	37.5	36	39	3	3	0.6	0.6	10.5	0.37	1.60	0.88	0.097	
29.5	30	42.5	40	44	3	3.5	0.6	0.6	12	0.43	1.39	0.77	0.114	
35.5	35	49.5	48	52	3	4	1	1	13.5	0.43	1.39	0.77	0.166	
40.5	40	56.5	54	59	4	4	1	1	15.5	0.45	1.32	0.73	0.224	
45.5	46	62.5	60	65	4	4.5	1	1	15	0.38	1.58	0.87	0.273	
50.5	51	69.5	67	72	4	4.5	1	1	16.5	0.39	1.53	0.84	0.346	
54.5	54	67.5	63.5	69	3	3	0.6	0.6	13.5	0.34	1.76	0.97	1.191	
55.5	56	74.5	72	77	4	4.5	1	1	17.5	0.42	1.42	0.78	0.366	
60.5	60.5	74.5	70.5	76.5	3	3	1	1	14.5	0.31	1.94	1.07	0.274	
63.5	63	81.5	81	86	4	5.5	1.5	1.5	20	0.41	1.48	0.81	0.563	
65.5	65.5	79.5	76.5	82	3	3	1	1	15.5	0.33	1.80	0.99	0.296	
68.5	67	86.5	85	91	4	5.5	1.5	1.5	21	0.43	1.39	0.77	0.576	
70.5	70	84.5	80	86.5	3	3	1	1	16.5	0.35	1.70	0.93	0.315	
73.5	72	91.5	90	97	4	5.5	1.5	1.5	22.5	0.46	1.31	0.72	0.63	
75.5	75	94.5	90	96	4	4	1	1	18	0.32	1.90	1.05	0.487	
78.5	78	101.5	98	105	5	6	1.5	1.5	24	0.43	1.38	0.76	0.848	
80.5	80	99.5	94	101.5	4	4	1	1	19	0.33	1.80	0.99	0.511	
83.5	83	106.5	103	110	5	6	1.5	1.5	25.5	0.46	1.31	0.72	0.909	
85.5	85	104.5	99	106.5	4	4	1	1	20	0.35	1.71	0.94	0.54	
88.5	89	116.5	112	120	6	7	1.5	1.5	27	0.42	1.42	0.78	1.28	
93.5	92	111.5	111	115	4	5	1.5	1.5	21	0.33	1.83	1.01	0.733	
93.5	94	121.5	117	125	6	7	1.5	1.5	28.5	0.44	1.36	0.75	1.35	
98.5	96	116.5	112.5	120.5	4	5	1.5	1.5	22	0.34	1.75	0.96	0.817	
100	100	131.5	125	134	6	8	2	1.5	30	0.42	1.42	0.78	1.79	
103.5	101	121.5	117	125.5	4	5	1.5	1.5	23.5	0.36	1.68	0.92	0.851	
105	105	136.5	130	140	6	8	2	1.5	31.5	0.44	1.36	0.75	1.83	

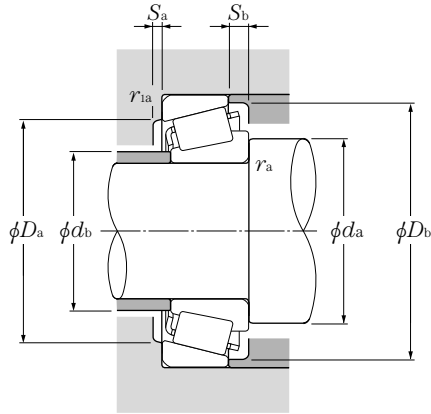
Tapered Roller Bearings

d 100~190mm



part number	Boundary dimensions									Basic load ratings				Limiting speed	
	mm									dynamic kN	static	dynamic kgf	static	min ⁻¹	
	d	D	T	B	C	r'_{1s} min ^①	r'_{2s} min ^①	r_1 min ^①	r_2 min ^①	C_r	C_{or}	C_r	C_{or}	grease lubrication	oil lubrication
32920XU	100	140	25	25	20	1.5	1.5	0.6		121	206	12 300	21 000	2 400	3 200
32020XU	100	150	32	32	24	2	1.5	0.6		170	281	17 300	28 600	2 200	3 000
32921XA	105	145	25	25	20	1.5	1.5	0.6		126	219	12 800	22 400	2 300	3 000
32021XU	105	160	35	35	26	2.5	2	0.6		201	335	20 500	34 000	2 100	2 800
32922XA	110	150	25	25	20	1.5	1.5	0.6		127	226	13 000	23 100	2 200	2 900
32022XU	110	170	38	38	29	2.5	2	0.6		236	390	24 000	39 500	2 000	2 700
32924XU	120	165	29	29	23	1.5	1.5	0.6		162	294	16 500	30 000	2 000	2 600
32024XU	120	180	38	38	29	2.5	2	0.6		245	420	25 000	43 000	1 800	2 500
32926XU	130	180	32	32	25	2	1.5	0.6		194	350	19 800	36 000	1 800	2 400
32026XU	130	200	45	45	34	2.5	2	0.6		320	545	32 500	55 500	1 700	2 200
32928XU	140	190	32	32	25	2	1.5	0.6		200	375	20 400	38 000	1 700	2 200
32028XU	140	210	45	45	34	2.5	2	0.6		330	580	33 500	59 500	1 600	2 100
32930XU	150	210	38	38	30	2.5	2	0.6		268	490	27 300	50 000	1 600	2 100
32030XU	150	225	48	48	36	3	2.5	1		370	655	37 500	67 000	1 400	1 900
32932XU	160	220	38	38	30	2.5	2	0.6		276	520	28 200	53 000	1 500	1 900
32032XU	160	240	51	51	38	3	2.5	1		435	790	44 500	80 500	1 400	1 800
32934XU	170	230	38	38	30	2.5	2	0.6		286	560	29 200	57 000	1 400	1 800
32034XU	170	260	57	57	43	3	2.5	1		500	895	51 000	91 000	1 300	1 700
32936XU	180	250	45	45	34	2.5	2	0.6		350	700	36 000	71 500	1 300	1 700
32938XU	190	260	45	45	34	2.5	2	0.6		355	710	36 000	72 000	1 200	1 600

① Minimum allowable value for chamfer dimension r , r_1 or r_2 .



Dynamic equivalent radial load

$$P_r = XF_r + YF_a$$

$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$	
X	Y	X	Y
1	0	0.4	Y_2

Static equivalent radial load

$$P_{or} = 0.5F_r + Y_0F_a$$

Note that when $P_{or} < F_r$, $P_{or} = F_r$.

The values for e , Y_2 and Y_0 are given in the table below.

Abutment and fillet dimensions										Load center mm	Factor <i>e</i>	Axial load factor		Mass kg (approx.)
mm												<i>a</i>	<i>e</i>	
d_a min	d_b max	D_a		D_b min	S_a min	S_b min	r_{as} max	r_{1as} max						
		max	min											
108.5	107.5	131.5	127.5	135.5	4	5	1.5	1.5	24.5	0.33	1.82	1.00	1.14	
110	109	141.5	134	144	6	8	2	1.5	32.5	0.46	1.31	0.72	1.91	
113.5	113.5	136.5	131.5	140.5	5	5	1.5	1.5	25	0.34	1.76	0.97	1.2	
117	116	150	143	154	6	9	2	2	34.5	0.44	1.35	0.74	2.42	
118.5	117.5	141.5	137	145.5	5	5	1.5	1.5	26.5	0.36	1.69	0.93	1.23	
122	122	160	152	163	7	9	2	2	36.5	0.43	1.39	0.77	3.07	
128.5	128.5	156.5	150	160	6	6	1.5	1.5	29.5	0.35	1.72	0.95	1.77	
132	131	170	161	173	7	9	2	2	39	0.46	1.31	0.72	3.25	
140	139	171.5	163.5	174	6	7	2	1.5	31.5	0.34	1.77	0.97	2.36	
142	144	190	178	192	8	11	2	2	43.5	0.43	1.38	0.76	4.96	
150	150	181.5	177	184	6	6	2	1.5	34	0.36	1.67	0.92	2.51	
152	153	200	187	202	8	11	2	2	46	0.46	1.31	0.72	5.28	
162	162	200	192	202	7	8	2	2	36.5	0.33	1.83	1.01	3.92	
164	164	213	200	216	8	12	2.5	2	49.5	0.46	1.31	0.72	6.37	
172	170.5	210	199	213.5	7	8	2	2	38.5	0.35	1.73	0.95	4.15	
174	175	228	213	231	8	13	2.5	2	52.5	0.46	1.31	0.72	7.8	
182	183	220	213	222	7	8	2	2	42.5	0.38	1.57	0.86	4.4	
184	187	248	230	249	10	14	2.5	2	56	0.44	1.35	0.74	10.5	
192	193	240	225	241	8	11	2	2	54	0.48	1.25	0.69	6.54	
202	204	250	235	251	8	11	2	2	55	0.48	1.26	0.69	6.77	