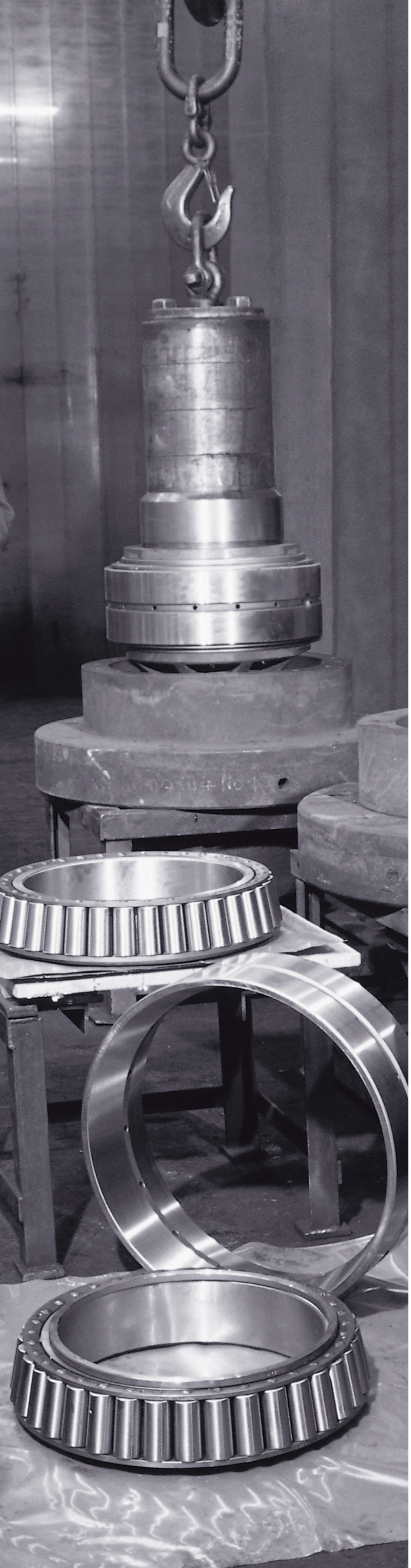
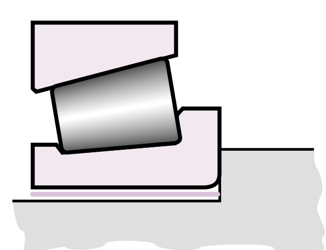


4. MOUNTING, FITTING AND SETTING YOUR BEARINGS

2.1. Fitting guidelines for metric bearings (ISO and J Prefix)
Industrial equipment bearing classes K and N



SHAFT O.D. (µm)

Deviation from nominal (maximum) bearing bore and resultant fit (µm)

Bearing bore			Rotating shaft Ground Constant loads with moderate shock			Rotating or stationary shaft Unground or ground Heavy loads or high speed or shock		
Range mm		Tolerance µm						
over	incl.		Symbol	Shaft O.D. deviation	Resultant fit	Symbol	Shaft O.D. deviation	Resultant fit
10	18	-12 0	m6	+18 +7	30T 7T	n6	+23 +12	35T 12T
18	30	-12 0	m6	+21 +8	33T 8T	n6	+28 +15	40T 15T
30	50	-12 0	m6	+25 +9	37T 9T	n6	+33 +17	45T 17T
50	80	-15 0	m6	+30 +11	45T 11T	n6	+39 +20	54T 20T
80	120	-20 0	m6	+35 +13	55T 13T	n6	+45 +23	65T 23T
120	180	-25 0	m6	+40 +15	65T 15T	p6	+68 +43	93T 43T
180	200	-30 0	m6	+46 +17	76T 17T	r6	+106 +77	136T 77T
200	225						+109 +80	139T 80T
225	250						+113 +84	143T 84T
250	280	-35 0	m6	+52 +20	87T 20T	r6	+126 +94	161T 94T
280	315						+130 +98	165T 98T
315	355	-40 0	n6	+73 +37	113T 37T	r6	+144 +108	184T 108T
355	400						+150 +114	190T 114T
400	450	-45 0	n6	+80 +40	125T 40T	r6	+166 +126	211T 126T
450	500						+172 +132	217T 132T
500	560	-50 0	n6	+88 +44	138T 44T	r6	+194 +150	244T 150T
560	630						+199 +155	249T 155T
630	710	-80 0	n7	+130 +50	210T 50T	r7	+255 +175	335T 175T
710	800						+265 +185	345T 185T
800	900	-100 0	n7	+146 +56	246T 56T	r7	+300 +210	400T 210T
900	1000						+310 +220	410T 220T

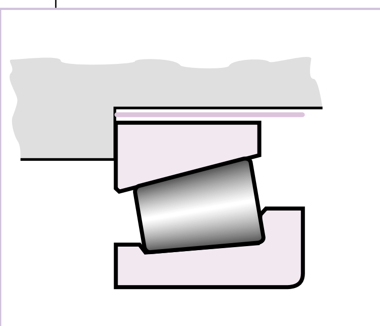
T = Tight
L = Loose

Stationary shaft											
Unground Moderate loads, no shock			Ground Moderate loads, no shock			Unground Sheaves, wheels, idlers			Hardened and ground Wheel spindles		
Symbol	Shaft O.D. deviation	Resultant fit	Symbol	Shaft O.D. deviation	Resultant fit	Symbol	Shaft O.D. deviation	Resultant fit	Symbol	Shaft O.D. deviation	Resultant fit
h6	0 –11	12T 11L	g6	–6 –17	6T 17L	g6	–6 –17	6T 17L	f6	–16 –27	4L 27L
h6	0 –13	12T 13L	g6	–7 –20	5T 20L	g6	–7 –20	5T 20L	f6	–20 –33	8L 33L
h6	0 –16	12T 16L	g6	–9 –25	3T 25L	g6	–9 –25	3T 25L	f6	–25 –41	13L 41L
h6	0 –19	15T 19L	g6	–10 –29	5T 29L	g6	–10 –29	5T 29L	f6	–30 –49	15L 49L
h6	0 –22	20T 22L	g6	–12 –34	8T 34L	g6	–12 –34	8T 34L	f6	–36 –58	16L 58L
h6	0 –25	25T 25L	g6	–14 –39	11T 39L	g6	–14 –39	11T 39L	f6	–43 –68	18L 68L
h6	0 –29	30T 29L	g6	–15 –44	15T 44L	g6	–15 –44	15T 44L	f6	–50 –79	20L 79L
h6	0 –32	35T 32L	g6	–17 –49	18T 49L	g6	–17 –49	18T 49L	f6	–56 –88	21L 88L
h6	0 –36	40T 36L	g6	–18 –54	22T 54L	g6	–18 –54	22T 54L	–	– –	– –
h6	0 –40	45T 40L	g6	–20 –60	25T 60L	g6	–20 –60	25T 60L	–	– –	– –
h6	0 –44	50T 44L	g6	–22 –66	28T 66L	g6	–22 –66	28T 66L	–	– –	– –
h7	0 –80	80T 80L	g7	–24 –104	56T 104L	g7	–24 –104	56T 104L	–	– –	– –
h7	0 –90	100T 90L	g7	–26 –116	74T 116L	g7	–26 –116	74T 116L	–	– –	– –

Fitting guidelines for metric bearings (ISO and J Prefix)
Industrial equipment bearing classes K and N

HOUSING BORE (µm)

Deviation from nominal (maximum) bearing O.D. and resultant fit (µm)



Bearing O.D. Range mm over	Bearing O.D. Range mm incl.	Tolerance µm	Stationary housing, Floating or clamped race: Symbol	Housing bore deviation	Resultant fit
18	30	0 –12	G7	+7 +28	7L 40L
30	50	0 –14	G7	+9 +34	9L 48L
50 65	65 80	0 –16	G7	+10 +40	10L 56L
80 100	100 120	0 –18	G7	+12 +47	12L 65L
120 140	140 150	0 –20	G7	+14 +54	14L 74L
150 160	160 180	0 –25	G7	+14 +54	14L 79L
180 200 225	200 225 250	0 –30	G7	+15 +61	15L 91L
250 280	280 315	0 –35	G7	+17 +69	17L 104L
315 355	355 400	0 –40	F7	+62 +119	62L 159L
400 450	450 500	0 –45	F7	+68 +131	68L 176L
500 560	560 630	0 –50	F7	+76 +146	76L 196L
630 710	710 800	0 –80	F7	+80 +160	80L 240L
800 900	900 1000	0 –100	F7	+86 +176	86L 276L

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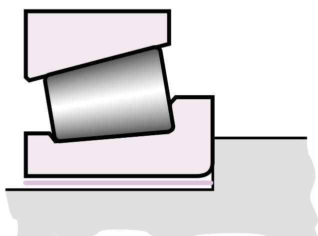
T = Tight
L = Loose

Stationary housing						Rotating housing		
Adjustable race			Non-adjustable race or in carrier			Non-adjustable race or in carrier or sheave - clamped race		
Symbol	Housing bore deviation	Resultant fit	Symbol	Housing bore deviation	Resultant fit	Symbol	Housing bore deviation	Resultant fit
J7	–9 +12	9T 24L	P7	–35 –14	35T 2T	R7	–41 –20	41T 8T
J7	–11 +14	11T 28L	P7	–42 –17	42T 3T	R7	–50 –25	50T 11T
J7	–12 +18	12T 34L	P7	–51 –21	51T 5T	R7	–60 –30 –62 –32	60T 14T 62T 16T
J7	–13 +22	13T 40L	P7	–59 –24	59T 6T	R7	–73 –38 –76 –41	73T 20T 76T 23T
J7	–14 +26	14T 46L	P7	–68 –28	68T 8T	R7	–88 –48 –90 –50	88T 28T 90T 30T
J7	–14 +26	14T 51L	P7	–68 –28	68T 3T	R7	–90 –50 –93 –53	90T 25T 93T 28T
J7	–16 +30	16T 60L	P7	–79 –33	79T 3T	R7	–106 –60 –109 –63 –113 –67	106T 30T 109T 33T 113T 37T
J7	–16 +36	16T 71L	P7	–88 –36	88T 1T	R7	–126 –74 –130 –78	126T 39T 130T 43T
J7	–18 +39	18T 79L	P7	–98 –41	98T 1T	R7	–144 –87 –150 –93	144T 47T 150T 53T
J7	–20 +43	20T 88L	P7	–108 –45	108T 0	R7	–166 –103 –172 –109	166T 58T 172T 64T
JS7	–35 +35	35T 85L	P7	–148 –78	148T 28T	R7	–220 –150 –225 –155	220T 100T 225T 105T
JS7	–40 +40	40T 120L	P7	–168 –88	168T 8T	R7	–255 –175 –245 –185	255T 95T 265T 105T
JS7	–45 +45	45T 145L	P7	–190 –100	190T 0	R7	–300 –210 –310 –220	300T 110T 310T 120T

2.2. Fitting guidelines for inch bearings
Industrial equipment bearing classes 4 and 2

SHAFT O.D. (inches - µm)

Deviation from nominal (minimum) bearing bore and resultant fit (0.0001 inches - µm)

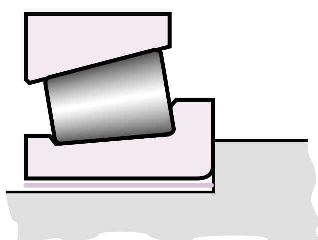


Bearing bore			Rotating shaft	
Range inches (mm)		Tolerance 0.0001 in (µm)	Ground constant loads with moderate shock	
over	incl.		Shaft O.D. deviation	Resultant fit
0 0	3.0000 76.2	0 +5 0 +13	+15 +10 +38 +25	15T 5T 38T 12T
3.0000 76.2	3.5000 88.9	0 +10 0 +25	+25 +15 +64 +38	25T 5T 64T 13T
3.5000 88.9	4.5000 114.3			
4.5000 114.3	5.5000 139.7			
5.5000 139.7	6.5000 165.1			
6.5000 165.1	7.5000 190.5			
7.5000 190.5	8.5000 215.9			
8.5000 215.9	9.5000 241.3			
9.5000 241.3	10.5000 266.7			
10.5000 266.7	11.5000 292.1			
11.5000 292.1	12.0000 304.8			
12.0000 304.8	12.5000 317.5	0 +20 0 +51	+50 +30 +127 +76	50T 10T 127T 25T
12.5000 317.5	13.5000 342.9			

Suggested heavy-duty fitting practices shown above are applicable for case carburized bearings. Consult your Timken Company Sales Engineer or Representative for the suggested heavy duty fitting practices that are specified for through hardened bearings.

T = Tight
L = Loose

Rotating or stationary shaft		Stationary shaft							
Unground or ground heavy loads, high speed or shock		Unground moderate loads, no shock		Ground moderate loads, no shock		Unground sheaves, wheels, idlers		Hardened and ground wheel spindles	
Shaft O.D. deviation	Resultant fit	Shaft O.D. deviation	Resultant fit	Shaft O.D. deviation	Resultant fit	Shaft O.D. deviation	Resultant fit	Shaft O.D. deviation	Resultant fit
+25 +15 +64 +38	25T 10T 64T 25T	+5 0 +13 0	5T 5L 13T 13L	0 –5 0 –13	0 10L 0 26L	0 –5 0 –13	0 10L 0 26L	–2 –7 –5 –18	2L 12L 5L 31L
+30 +20 +76 +51	30T 10T 76T 25T								
+30 +20 +76 +51	30T 10T 76T 25T								
+35 +25 +89 +64	35T 15T 89T 38T								
+40 +30 +102 +76	40T 20T 102T 51T								
+45 +35 +114 +89	45T 25T 114T 64T	+10 0 +25 0	10T 10L 25T 25L	0 –10 0 –25	0 20L 0 50L	0 –10 0 –25	0 20L 0 50L	–2 –12 –5 –30	2L 22L 5L 55L
+50 +40 +127 +102	50T 30T 127T 76T								
+55 +45 +140 +114	55T 35T 140T 89T								
+60 +50 +152 +127	60T 40T 152T 102T								
+65 +55 +165 +140	65T 45T 165T 114T								
+70 +60 +178 +152	70T 50T 178T 127T								
+80 +60 +203 +152	80T 40T 203T 101T	+20 0 +51 0	20T 20L 51T 51L	0 –20 0 –51	0 40L 0 102L	0 –20 0 –51	0 40L 0 102L	– –	– –
+85 +65 +216 +165	85T 45T 216T 114T								



2.2. Fitting guidelines for inch bearings
Industrial equipment bearing classes 4 and 2

SHAFT O.D. (inches - µm)

Deviation from nominal (minimum) bearing bore and resultant fit (0.0001 inches - µm)

Bearing bore			Rotating shaft	
Range inches (mm)		Tolerance 0.0001 in (µm)	Ground constant loads with moderate shock	
over	incl.		Shaft O.D. deviation	Resultant fit
13.5000 342.9	14.5000 368.3			
14.5000 368.3	15.5000 393.7			
15.5000 393.7	16.5000 419.1			
16.5000 419.1	17.5000 444.5			
17.5000 444.5	18.5000 469.9			
18.5000 469.9	19.5000 495.3	0 +20 0 +51	+50 +30 +127 +76	50T 10T 127T 25T
19.5000 495.3	20.5000 520.7			
20.5000 520.7	21.5000 546.1			
21.5000 546.1	22.5000 571.5			
22.5000 571.5	23.5000 596.9			
23.5000 596.9	24.0000 609.6			
24.0000 609.6	36.0000 914.4	0 +30 0 +76	+75 +45 +190 +114	75T 15T 190T 38T
36.0000 914.4	48.0000 1219.2	0 +40 0 +102	+100 +60 +252 +150	100T 20T 252T 48T
48.0000 1219.2	– –	0 +50 0 +127	+120 +70 +305 +178	120T 20T 305T 51T

Suggested heavy-duty fitting practices shown above are applicable for case carburized bearings. Consult your Timken Company Sales Engineer or Representative for the suggested heavy duty fitting practices that are specified for through hardened bearings.

T = Tight
L = Loose

Rotating or stationary shaft		Stationary shaft							
Unground or ground heavy loads, high speed or shock		Unground moderate loads, no shock		Ground moderate loads, no shock		Unground sheaves, wheels, idlers		Hardened and ground Wheel spindles	
Shaft O.D. deviation	Resultant fit	Shaft O.D. deviation	Resultant fit	Shaft O.D. deviation	Resultant fit	Shaft O.D. deviation	Resultant fit	Shaft O.D. deviation	Resultant fit
+90 +70 +229 +178	90T 50T 229T 127T								
+95 +75 +241 +190	95T 55T 241T 139T								
+100 +80 +254 +203	100T 60T 254T 152T								
+105 +85 +267 +216	105T 65T 267T 165T								
+110 +90 +279 +229	110T 70T 279T 178T								
+115 +95 +292 +241	115T 75T 292T 190T	+20 0 +51 0	20T 20L 51T 51L	0 –20 0 –51	0 40L 0 102L	0 –20 0 –51	0 40L 0 102L	– –	– –
+120 +100 +305 +254	120T 80T 305T 203T								
+125 +105 +318 +267	125T 85T 318T 216T								
+130 +110 +330 +279	130T 90T 330T 228T								
+135 +115 +343 +292	135T 95T 343T 241T								
+140 +120 +356 +305	140T 100T 356T 254T								
+180 +150 +457 +331	180T 120T 457T 305T	+30 0 +76 0	30T 30L 76T 76L	0 –30 0 –76	0 60L 0 152L	0 –30 0 –76	0 60L 0 152L	– –	– –
+250 +210 +625 +534	250T 170T 625T 432T	+40 0 +102 0	40T 40L 102T 102L	0 –40 0 –102	0 80L 0 204L	0 –40 0 –102	0 80L 0 204L	– –	– –
+320 +270 +813 +686	320T 220T 813T 559T	+50 0 +127 0	50T 50L 127T 127L	0 –50 0 –127	0 100L 0 254L	0 –50 0 –127	0 100L 0 254L	– –	– –

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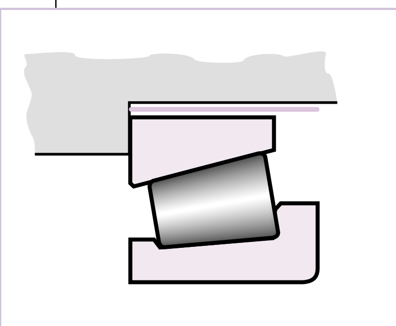
Fitting guidelines for inch bearings
Industrial equipment bearing classes 4 and 2



HOUSING BORE (μm)

Deviation from nominal (minimum) bearing O.D. and resultant fit (μm)

Bearing O.D.			Stationary housing	
Range mm		Tolerance μm	Floating or clamped race	
over	incl.		Housing bore deviation	Resultant fit
0	76.2	+25 0	+51 +76	26L 76L
76.2	127	+25 0	+51 +76	26L 76L
127	304.8	+25 0	+51 +76	26L 76L
304.8	609.6	+51 0	+102 +152	51L 152L
609.6	914.4	+76 0	+152 +229	76L 229L
914.4	1219.2	+102 0	+204 +305	102L 305L
1219.2	–	+127 0	+254 +381	127L 381L

* Unclamped race design is applicable only to sheaves with negligible fleet angle.

HOUSING BORE (inches)

Deviation from nominal (minimum) bearing O.D. and resultant fit (0.0001 in)

Bearing O.D.			Stationary housing	
Range inches		Tolerance 0.0001 in	Floating or clamped race	
over	incl.		Housing bore deviation	Resultant fit
0	3.0000	+10 0	+20 +30	10L 30L
3.0000	5.0000	+10 0	+20 +30	10L 30L
5.0000	12.0000	+10 0	+20 +30	10L 30L
12.0000	24.0000	+20 0	+40 +60	20L 60L
24.0000	36.0000	+30 0	+60 +90	30L 90L
36.0000	48.0000	+40 0	+80 +120	40L 120L
48.0000	–	+50 0	+100 +150	50L 150L

* Unclamped race design is applicable only to sheaves with negligible fleet angle.

T = Tight
L = Loose

Stationary housing		Stationary or rotating housing		Rotating housing	
Adjustable race		Non-adjustable race or in carrier or sheave - clamped race		Sheave-unclamped race*	
Housing bore deviation	Resultant fit	Housing bore deviation	Resultant fit	Housing bore deviation	Resultant fit
0 +25	25T 25L	–38 –13	63T 13T	–76 –51	101T 51T
0 +25	25T 25L	–51 –25	76T 25T	–76 –51	101T 51T
0 +51	25T 51L	–51 –25	76T 25T	–76 –51	101T 51T
+26 +76	25T 76L	–76 –25	127T 25T	–102 –51	153T 51T
+51 +127	25T 127L	–102 –25	178T 25T	– –	– –
+76 +178	25T 178L	–127 –25	229T 25T	– –	– –
+102 +229	25T 229L	–152 –25	279T 25T	– –	– –

Stationary housing		Stationary or rotating housing		Rotating housing	
Adjustable race		Non-adjustable race or in carrier or sheave - clamped race		Sheave-unclamped race*	
Housing bore deviation	Resultant fit	Housing bore deviation	Resultant fit	Housing bore deviation	Resultant fit
0 +10	10T 10L	–15 –5	25T 5T	–30 –20	40T 20T
0 +10	10T 10L	–20 –10	30T 10T	–30 –20	40T 20T
0 +20	10T 20L	–20 –10	30T 10T	–30 –20	40T 20T
+10 +30	10T 30L	–30 –10	50T 10T	–40 –20	60T 20T
+20 +50	10T 50L	–40 –10	70T 10T	– –	– –
+30 +70	10T 70L	–50 –10	90T 10T	– –	– –
+40 +90	10T 90L	–60 –10	110T 10T	– –	– –

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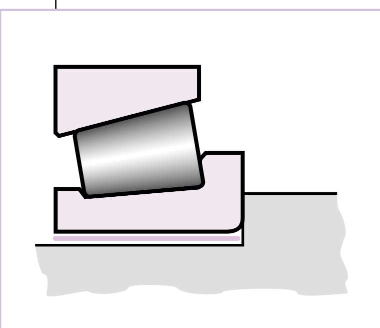
2.3. Fitting guidelines for PRECISION bearings

METRIC BEARINGS (ISO and J Prefix)
SHAFT O.D.

Deviation from nominal (maximum) bearing bore and resultant fit (µm)



Bearing bore Range mm over	incl.	CLASS C Bearing bore tolerance µm	Symbol	Shaft O.D. deviation	Resultant fit
10	18	–7 0	k5	+9 +1	16T 1T
18	30	–8 0	k5	+11 +2	19T 2T
30	50	–10 0	k5	+13 +2	23T 2T
50	80	–12 0	k5	+15 +2	27T 2T
80	120	–15 0	k5	+18 +3	33T 3T
120	180	–18 0	k5	+21 +3	39T 3T
180	250	–22 0	k5	+24 +4	46T 4T
250	315	–22 0	k5	+27 +4	49T 4T

INCH BEARINGS
SHAFT O.D. (inches)

Deviation from nominal (minimum) bearing bore and resultant fit (0.0001 in and µm) T = Tight

Bearing bore Range mm (in) over	incl.	CLASS 3 AND 0① Bearing bore tolerance µm (0.0001in)	Shaft O.D. deviation	Resultant fit	CLASS 00 AND 000 Bearing bore tolerance	Shaft O.D. deviation	Resultant fit
–	12	0 +5	+12 +7	12T 2T	0 +3	+8 +5	8T 2T
–	304.8	0 +13	+30 +18	30T 5T	0 +8	+20 +13	20T 5T
12	24	0 +10	+25 +15	25T 5T	–	–	–
304.8	609.6	0 +25	+64 +38	64T 13T	–	–	–
24	36	0 +15	+40 +25	40T 10T	–	–	–
609.6	914.4	0 +38	+102 +64	102T 26T	–	–	–

① Class O made only to 304.8 mm (12 inch) O.D.

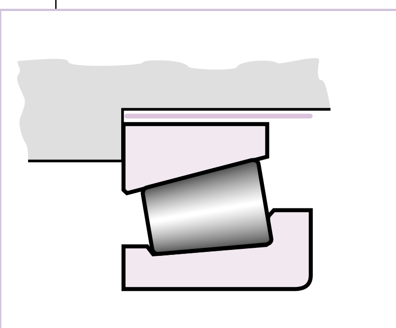
T = Tight

CLASS B				Bearing bore		CLASS A AND AA			
Bearing bore tolerance	Symbol	Shaft O.D. deviation	Resultant fit	Range mm over	incl.	Bearing bore tolerance	Symbol	Shaft O.D. deviation	Resultant fit
–5 0	k5	+9 +1	14T 1T	10	18	–5 0	k4	+6 +1	11T 1T
–6 0	k5	+11 +2	17T 2T	18	30	–6 0	k4	+8 +2	14T 2T
–8 0	k5	+13 +2	21T 2T	30	315	–8 0		+13 +5	21T 5T
–9 0	k5	+15 +2	24T 2T						
–10 0	k5	+18 +3	28T 3T						
–13 0	k5	+21 +3	34T 3T						
–15 0	k5	+24 +4	39T 4T						
–15 0	k5	+27 +4	42T 4T						

Fitting guidelines for PRECISION bearings (Contd.)

METRIC BEARINGS (ISO and J Prefix)
HOUSING BORE (µm)

Deviation from nominal (maximum) bearing O.D. and resultant fit (µm)



Bearing O.D. range mm over	incl.	Bearing O.D. tolerance µm	CLASS C Non-adjustable or in carrier Symbol	Housing bore deviation	Resultant fit	Floating Symbol	Housing bore deviation	Resultant fit	Adjustable Symbol	Housing bore deviation	Resultant fit
18	30	0 -8	N5	-21 -12	21T 4T	G5	+7 +16	7L 24L	K5	-8 +1	8T 9L
30	50	0 -9	N5	-24 -13	24T 4T	G5	+9 +20	9L 29L	K5	-9 +2	9T 11L
50	80	0 -11	N5	-28 -15	28T 4T	G5	+10 +23	10L 34L	K5	-10 +3	10T 14L
80	120	0 -13	N5	-33 -18	33T 5T	G5	+12 +27	12L 40L	K5	-13 +2	13T 15L
120	150	0 -15	N5	-39 -21	39T 6T	G5	+14 +32	14L 47L	K5	-15 +3	15T 18L
150	180	0 -18	N5	-39 -21	39T 3T	G5	+14 +32	14L 50L	K5	-15 +3	15T 21L
180	250	0 -20	N5	-45 -25	45T 5T	G5	+15 +35	15L 55L	K5	-18 +2	18T 27L
250	315	0 -25	N5	-50 -27	50T 2T	G5	+17 +40	17L 65L	K5	-20 +3	20T 28L

INCH BEARINGS
HOUSING BORE (inches)

Deviation from nominal (minimum) bearing O.D. and resultant fits (0.0001 in and µm)

Bearing O.D. Range in (mm) over	incl.	Bearing O.D. tolerance (0.0001 in) (µm)	CLASS 3 AND 0① Non-adjustable or in carrier Housing bore deviation	Resultant fit	Floating Housing bore deviation	Resultant fit	Adjustable Housing bore deviation	Resultant fit
– (–)	6 (152.4)	+5 0 (+13) (0)	-5 0 (-13) (0)	10T 0 (26T) (0)	+10 +15 (+25) (+38)	5L 15L (12L) (38L)	0 +5 (0) (+13)	5T 5L (13T) (13L)
6 (152.4)	12 (304.8)	+5 0 (+13) (0)	-10 0 (-25) (0)	15T 0 (38T) (0)	+10 +15 (+25) (+38)	5L 15L (12L) (38L)	0 +10 (0) (+25)	5T 10L (13T) (25L)
12 (304.8)	24 (609.6)	+10 0 (+25) (0)	-10 0 (-25) (0)	20T 0 (50T) (0)	+15 +25 (+38) (+64)	5L 25L (13L) (64L)	0 +10 (0) (+25)	10T 10L (25T) (25L)
24 (609.6)	36 (914.4)	+15 0 (+38) (0)	-15 0 (-38) (0)	30T 0 (76T) (0)	+20 +35 (+51) (+89)	5L 35L (13L) (89L)	0 +15 (0) (+38)	15T 15L (38T) (38L)

① Class O made only to 304.8 mm (12 inch) O.D.

T = Tight
L = Loose

Bearing O.D. tolerance	CLASS B Non-adjustable or in carrier Symbol	Housing bore deviation	Resultant fit	Floating Symbol	Housing bore deviation	Resultant fit	Adjustable Symbol	Housing bore deviation	Resultant fit
0 –6	M5	–14 –5	14T 1L	G5	+7 +16	7L 22L	K5	–8 +1	8T 7L
0 –7	M5	–16 –5	16T 2L	G5	+9 +20	9L 27L	K5	–9 +2	9T 9L
0 –9	M5	–19 –6	19T 3L	G5	+10 +23	10L 32L	K5	–10 +3	10T 12L
0 –10	M5	–23 –8	23T 2L	G5	+12 +27	12L 37L	K5	–13 +2	13T 12L
0 –11	M5	–27 –9	27T 2L	G5	+14 +32	14L 43L	K5	–15 +3	15T 12L
0 –13	M5	–27 –9	27T 4L	G5	+14 +32	14L 45L	K5	–15 +3	15T 16L
0 –15	M5	–31 –11	31T 4L	G5	+15 +35	15L 50L	K5	–18 +2	18T 17L
0 –18	M5	–36 –13	36T 5L	G5	+17 +40	17L 58L	K5	–20 +3	20T 21L

Bearing O.D. range mm (in) over	incl.	Bearing O.D. tolerance	CLASS A AND AA Non-adjustable or in carrier Housing bore deviation	Resultant fit	Floating Housing bore deviation	Resultant fit	Adjustable Housing bore deviation	Resultant fit
0	315	0 –8	–16 –8	16T 0	+8 +16	8L 24L	–8 0	8T 8L

Bearing O.D. Range in (mm) over	incl.	Bearing O.D. tolerance	CLASS 00 AND 000 Non-adjustable or in carrier Housing bore deviation	Resultant fit	Floating Housing bore deviation	Resultant fit	Adjustable Housing bore deviation	Resultant fit
0	12	+3 0	-3 0	6T 0	+6 +9	3L 9L	0 +3	3T 3L
0	304.8	+8 0	–8 0	16T 0	+15 +23	7L 23L	0 +8	8T 8L

3. Particular cases

3.1. Thrust bearings types TTC, TTSP and TTHD

Type TTC (cageless) and TTSP (steering pivot) oscillating thrust bearings are generally fitted from 125 µm to 400 µm (0.0050 in to 0.0150 in) loose on the I.D.

Sufficient clearance should be provided on the O.D. to permit free centering of the bearing without interference.

Fitting guidelines - TTHD bearings

(Tolerances and fits in 0.0001 in and µm)

Bore in (mm)		Rotating race						Stationary race	
		Class 2			Class 3			Class 2 and 3	
over	incl.	Tolerance	Shaft O.D. deviation	Resultant fit	Tolerance	Shaft O.D. deviation	Resultant fit		
0 0	12 304.800	0 + 10 0 + 25	+ 30 + 20 + 76 + 50	30 T 10 T 76 T 25 T	0 + 5 0 + 13	+ 20 + 15 + 51 + 38	20 T 10 T 51 T 25 T		
12 304.800	24 609.600	0 + 20 0 + 51	+ 60 + 40 + 152 + 102	60 T 20 T 152 T 51 T	0 + 10 0 + 25	+ 40 + 30 +102 + 76	40 T 20 T 102 T 51 T		
24 609.600	36 914.400	0 + 30 0 + 76	+ 80 + 50 + 204 +127	80 T 20 T 204 T 51 T	0 + 15 0 + 38	+ 50 + 35 + 127 + 89	50 T 20 T 127 T 51 T	All sizes	Provide a minimum radial clearance of 2.5 mm (0.1 in) between race bore and shaft O.D.
36 914.400	48 1219.200	0 + 40 0 + 102	+100 + 60 +254 + 153	100 T 20 T 254 T 51 T	0 + 20 0 + 51	+ 60 + 40 + 153 + 102	60 T 20 T 153 T 51 T		
48 1219.200		0 + 50 0 + 127	+ 120 + 70 + 305 +178	120 T 20 T 305 T 51 T	0 + 30 0 + 76	+ 80 + 50 + 204 + 127	80 T 20 T 204 T 51 T		

- Rotating race O.D. must have a minimum radial clearance of 2.5 mm (0.1 in)
- TTHD stationary race O.D. must have a minimum loose fit of 0.25 to 0.37 mm (0.01 to 0.015 in)
- TTHDFL flat race when stationary may be loose fit on its O.D. (same as the TTHD) or may be 0.025 to 0.076 mm (0.001 to 0.003 in) tight.

Fitting guidelines for inch bearings
Automotive equipment bearing classes 4 and 2

Shaft O.D. (inches - μm)

Deviation from nominal (minimum) bearing bore and resultant fit (0.001 inches - μm)

Cone Bore			Stationary Cone		Rotating Cone				Rotating Cone									
			front wheels rear wheels (full floating axles) trailer wheels		rear wheels (semi-floating axles)		rear wheels (UNIT-BEARING) (semi-floating axles)		pinion						differential		transaxles transmissions transfer cases cross shafts	
			non-adjustable		non-adjustable		non-adjustable		clamped		collapsible spacer		non-adjustable		non-adjustable		non-adjustable	
over	incl	tolerance	deviation	resultant fit	shaft o.d. deviation	resultant fit	shaft o.d. deviation	resultant fit	shaft o.d. deviation	resultant fit	shaft o.d. deviation	resultant fit	shaft o.d. deviation	resultant fit	shaft o.d. deviation	resultant fit	shaft o.d. deviation	resultant fit
in	in	in	in	in	in	in	in	in	in	in	in	in	in	in	in	in	in	in
0	3.0000	0 +.0005	–.0002 –.0007	.0002 L .0012 L	+.0020 +.0015	.0020 T .0010 T	+.0022 +.0015	.0022 T .0010 T	+.0015 +.0010	.0015 T .0005 T	+.0012 +.0007	.0012 T .0002 T	+.0020 +.0015	.0020T .0010T	+.0040 +.0025	+.0040 T .0020 T	+.0015 +.0010	.0015 T .0005 T
3.0000	12.0000	0 +.0010	–.0005 –.0015	.0005 L .0025 L	+.0030 +.0020	.0030 T .0010 T			.0025 .0015	.0025 T .0005 T			+.0030 +.0020	.0030T .0010T	+.0040 +.0025	.0040 T .0020 T	+.0025 +.0015	.0025 T .0005 T
μm	μm	μm	μm	μm	μm	μm	μm	μm	μm	μm	μm	μm	μm	μm	μm	μm	μm	μm
0	76.200	0 +13	–5 –18	5 L 31 L	+51 +38	51 T 25 T	+56 +38	56 T 25 T	+38 +25	38 T 13 T	+30 +18	30 T 5 T	+51 +38	51T 25T	+102 +64	102 T 51 T	+38 +25	38 T 12 T
76.200	304.800	0 +25	–13 –38	13 L 63 L	+76 +51	76 T 26 T			+63 +38	63 T 13 T			+76 +51	76T 26T	+102 +76	102 T 51 T	+64 +38	64 T 13 T

Heavy duty min. fit of .0005 inch per inch of cone bore

Fitting guidelines for metric bearings
Automotive equipment bearing classes K and N

Shaft O.D. (inches - µm)

Deviation from nominal (minimum) bearing bore and resultant fit (0.001 inches - µm)

Cone Bore			Stationary Cone			Rotating Cone						Rotating Cone													
			front wheels / rear wheels (full floating axles)			rear wheels (semi-floating axles)			rear wheels (Unit-Bearing) (semi-flowing axles)			pinion									differential		transaxles, trans-missions, transfer cases		
			non-adjustable			non-adjustable			non-adjustable			clamped			collapsible spacer			non-adjustable			non-adjustable		non-adjustable		
over	incl	toler-ance	shaft o.d. deviation		resultant fit	shaft o.d. deviation		resultant fit	shaft o.d. deviation		resultant fit	shaft o.d. deviation		resultant fit	shaft o.d. deviation		resultant fit	shaft o.d. deviation		resultant fit	shaft o.d. deviation	resultant fit	shaft o.d. deviation		resultant fit
µm	µm	µm	µm		µm	µm		µm	µm		µm	µm		µm	µm		µm	µm		µm	µm	µm	µm		µm
18	30	−12 0	f6	−20 −33	8 L 33 L	p6	+35 +22	47 T 22 T	p6	+35 +22	47 T 22 T	k6	+15 +2	27 T 2 T	k6	+15 +2	27 T 2 T	p6	+35 +22	47T 22T	+56 +35	68T 35 T	m6 +8	+21 8 T	33 T
30	50	−12 0	f6	−25 −41	13 L 41 L	p6	+42 +26	54 T 26 T	p6	+42 +26	54 T 26 T	k6	+18 +2	30 T 2 T	k6	+18 +2	30 T 2 T	p6	+42 +26	54T 26T	+68 +43	80 T 43 T	m6 +9	+25 9 T	37 T
50	80	−15 0	f6	−30 −49	15 L 49 L	p6	+51 +32	66 T 32 T				k6	+21 +2	36 T 2 T	k6	+21 +2	36 T 2 T	p6	+51 +32	66T 32T	+89 +59	104 T 59 T	m6 +11	+30 11 T	45 T
80	120	−20 0	f6	−36 −58	16 L 58 L	n6	+45 +23	65 T 23 T				j6	+13 −9	33 T 9 L				n6	+45 +23	65T 23T	+114 +79	134 T 79 T	m6	+35 +13	55 T 13 T
120	180	−25 0	f6	−43 −68	18 L 68 L	n6	+52 +27	77 T 29 T				j6	+14 −11	39 T 11 L				n6	+52 +27	77T 29T	+140 +100	165 T 100 T	m6	+40 +15	66 T 15 T
in	in	in	in		in	in		in	in		in	in		in	in		in	in		in	in	in	in		in
.7087	1.1811	−.0005 0	f6	−.0008 −.0013	.0003 L .0013 L	p6	+.0013 +.0008	.0018 T .0008 T	p6	+.0013 +.0008	.0018 T .0008 T	k6	+.0006 +.0001	.0011 T .0001 T	k6	+.0006 +.0001	.0011 T .0001 T	p6	+.0013 +.0008	.0018 T .0008 T	+.0022 +.0014	.0027 T .0014 T	m6	+.0008 +.0003	.0013 T .0003 T
1.1811	1.9865	−.0005 0	f6	−.0010 −.0016	.0005 L .0016 L	p6	+.0016 +.0010	.0021 T .0010 T	p6	+.0016 +.0010	.0021 T .0010 T	k6	+.0007 +.0001	.0012 T .0001 T	k6	+.0007 +.0001	.0012 T .0001 T	p6	+.0016 +.0010	.0021 T .0010 T	+.0028 +.0018	.0033 T .0018 T	m6	+.0010 +.0004	.0015 T .0004 T
1.9685	3.1496	−.0006 0	f6	−.0012 −.0019	.0006 L .0019 L	p6	+.0021 +.0014	.0027 T .0014 T				k6	+.0008 −.0001	.0014 T .0001 L	k6	+.0008 +.0001	.0014 T .0001 L	p6	+.0021 +.0014	.0027 T .0014 T	+.0034 +.0022	.0040 T .0022 T	m6	+.0012 +.0005	.0018 T .0005 T
3.1496	4.7244	−.0008 0	f6	−.0014 −.0023	.0006 L .0023 L	n6	+.0019 +.0010	.0027 T .0010 T				j6	+.0005 −.0004	.0013 T .0004 L				n6	+.0019 +.0010	.0027 T .0010 T	+.0044 +.0030	.0052 T .0030 T	m6	+.0014 +.0005	.0022 T .0005 T
4.7244	7.0866	−.0010 0	f6	−.0016 −.0026	.0006 L .0026 L	n6	+.0022 +.0012	.0032 T .0012 T				j6	+.0006 −.0004	.0016 T .0004 L				n6	+.0022 +.0012	.0032 T .0012 T	+.0056 +.0040	.0066 T .0040 T	m6	+.0016 +.0006	.0026 T .0006 T

Heavy duty min. fit of .0005 inch per inch of cone bore

TIMKEN®

Housing bore (inches - µm)

Deviation from nominal (minimum) bearing bore and resultant fit (0.001 inches - µm)

	Cup O.D.			Rotating Cup		Stationary Cup		Stationary Cup					
				front wheels	rear wheels (full floating trailer wheels	rear wheels	(semi-floating axles)	differential	(split seat)	*transmissions	transfer cases cross shafts	pinion (solid seat) *transmission	differential *transaxles transfer cases
				non-adjustable		adjustable (TS)	clamped (TSU)	adjustable		adjustable		non-adjustable	
	over	incl	tolerance	housing bore deviation	resultant fit	housing bore deviation	resultant fit	housing bore deviation	resultant fit	housing bore deviation	resultant fit	housing bore deviation	resultant fit
Inch System Bearings Classes 4 and 2	in	in	in	in	in	in	in	in	in	in	in	in	in
	0	3.0000	+.0010	–.0020	.0030 T	+.0015	.0005 L	+.0010	0	0	.0010 T	–.0015	.0025 T
			0	–.0005	.0005 T	+.0030	.0030 L	+.0020	.0020 L	+.0010	.0010 L	–.0005	.0005 T
	3.0000	5.0000	+.0010	–.0030	.0040 T	+.0015	.0005 L	+.0010	0	0	.0010 T	–.0020	.0030 T
			0	–.0010	.0010 T	+.0030	.0030 L	+.0020	.0020 L	+.0010	.0010 L	–.0010	.0010 T
	5.0000	12.0000	+.0010	–.0030	.0040 T			0	.0010 T	0	.0010 T	–.0030	.0040 T
			0	–.0010	.0010 T			+.0020	.0020 L	+.0020	.0020 L	–.0010	.0010 T
	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm	µm
	0	76.200	+25	–51	76 T	+38	13 L	+25	0	0	25 T	–38	63 T
			0	–13	13 T	+76	76 L	+51	51 L	+25	25 L	–13	13 T
	76.200	127.00	+25	–77	102 T	+38	13 L	+25	0	0	25 T	–51	76 T
			0	–25	25 T	+76	76 L	+51	51 L	+25	25 L	–25	25 T
	127.00	304.800	+25	–77	102 T			0	25 T	0	25 T	–77	102 T
			0	–25	25 T			+51	51 L	+51	51 L	–25	25 T

Aluminum housings min. fit of .001 inch per inch of cup OD
Magnesium housings min. fit of .0015 inch per inch of cup OD

Fitting guidelines for inch bearings
Automotive equipment bearing classes K and N

Housing bore (inches - μm)

Deviation from nominal (minimum) bearing bore and resultant fit (0.001 inches - μm)

Cup O.D.			Rotating Cup			Stationary Cup											
			front wheels rear wheels (full floating axles)			rear wheels (semi-floating axles)			differential (split seat)			*transmissions transfer cases cross shafts			pinion differential (solid seat) *transaxles *transmissions transfer cases		
			non-adjustable			adjustable (TS) clamped (TSU)			adjustable			adjustable			non-adjustable		
over	incl	toler-ance	housing bore deviation		resultant fit	housing bore deviation		resultant fit	housing bore deviation		resultant fit	housing bore deviation		resultant fit	housing bore deviation		resultant fit
μm	μm	μm		μm	μm		μm	μm		μm	μm		μm	μm		μm	μm
30	50	0 –14	R7	–50 –25	50 T 11 T	G7	+9 +34	9 L 48 L	H7	0 +25	0 39 L	K6	–13 +3	13 T 17 L	R7	–50 –25	50 T 11 T
50	65	0 –16	R7	–60 –30	60 T 14 T	G7	+10 +40	10 L 56 L	H7	0 +30	0 46 L	K6	–15 +4	15 T 20 L	R7	–60 –30	60 T 14 T
65	80	0 –16	R7	–62 –32	62 T 16 T										R7	–62 –32	62 T 16 T
80	100	0 –18	R7	–73 –38	73 T 20 T	G7	+12 +47	12 L 65 L	H7	0 +35	0 53 L	K6	–18 +4	18 T 22 L	R7	–73 –38	73 T 20 T
100	120	0 –18	R7	–76 –41	76 T 23 T										R7	–76 –41	76 T 23 T
120	140	0 –20	R7	–88 –48	88 T 28 T	G7	+14 +54	14 L 74 L	J7	–14 +26	14 T 46 L	K6	–21 +4	21 T 24 L	R7	–88 –48	88 T 28 T
140	150	0 –20	R7	–90 –50	90 T 30 T										R7	–90 –50	90 T 30 T
150	160	0 –25	R7	–90 –50	90 T 25 T	G7	+14 +54	14 L 79 L	J7	–14 +26	14 T 51 L	K6	–21 +4	21 T 29 L	R7	–90 –50	90 T 25 T
160	180	0 –25	R7	–93 –53	93 T 28 T										R7	–93 –53	93 T 28 T
180	200	0 –30	R7	–106 –60	106 T 30 T										R7	–106 –60	106 T 30 T
200	225	0 –30	R7	–109 –63	109 T 33 T				J7	–16 +30	16 T 60 L	J7	–16 +30	16 T 60 L	R7	–109 –63	109 T 33 T
225	250	0 –30	R7	–113 –67	113 T 37 T										R7	–113 –67	113 T 37 T
250	280	0 –35	R7	–126 –74	126 T 39 T				J7	–16 +36	16 T 71 L	J7	–16 +36	16 T 71 L	R7	–126 –74	126 T 39 T
280	315	0 –35	R7	–130 –78	130 T 43 T										R7	–130 –78	130 T 43 T
in	in	in		in	in		in	in		in	in		in	in		in	in
1.1811	1.9685	0 –.0006	R7	–.0020 –.0010	.0020 T .0004 T	G7	+.0004 +.0014	.0004 L .0020 L	H7	0 +.0010	0 .0016 L	K6	–.0005 +.0001	.0005 T .0007 L	R7	–.0020 –.0010	.0020 T .0004 T
1.9685	2.5591	0 –.0006	R7	–.0023 –.0011	.0023 T .0005 T	G7	+.0004 +.0016	.0004 L .0022 L	H7	0 +.0012	0 .0018 L	K6	–.0006 +.0001	.0006 T .0007 L	R7	–.0023 –.0011	.0023 T .0005 T
2.5591	3.1496	0 –.0006	R7	–.0023 –.0011	.0023 T .0005 T										R7	–.0023 –.0011	.0023 T .0005 T
3.1496	3.9370	0 –.0007	R7	–.0029 –.0015	.0029 T .0008 T	G7	+.0005 +.0019	.0005 L .0026 L	H7	0 +.0014	0 .0021 L	K6	–.0007 +.0002	.0007 T .0009 L	R7	–.0029 –.0015	.0029 T .0008 T
3.9370	4.7244	0 –.0007	R7	–.0029 –.0015	.0029 T .0008 T										R7	–.0029 –.0015	.0029 T .0008 T
4.7244	5.5118	0 –.0008	R7	–.0035 –.0019	.0035 T .0011 T	G7	+.0006 +.0022	.0006 L .0030 L	J7	–.0006 +.0010	.0006 T .0018 L	K6	–.0008 +.0002	.0008 T .0010 L	R7	–.0035 –.0019	.0035 T .0011 T
5.5118	5.9055	0 –.0008	R7	–.0035 –.0019	.0035 T .0011 T										R7	–.0035 –.0019	.0035 T .0011 T
5.9055	6.2992	0 –.0010	R7	–.0035 –.0019	.0035 T .0009 T	G7	+.0006 +.0022	.0006 L .0032 L	J7	–.0006 +.0010	.0006 T .0020 L	K6	–.0008 +.0002	.0008 T .0012 L	R7	–.0035 –.0019	.0035 T .0009 T
6.2992	7.0866	0 –.0010	R7	–.0035 –.0019	.0035 T .0009 T										R7	–.0035 –.0019	.0035 T .0009 T
7.0866	7.8740	0 –.0012	R7	–.0042 –.0024	.0042 T .0012 T										R7	–.0042 –.0024	.0042 T .0012 T
7.8740	8.8583	0 –.0012	R7	–.0042 –.0024	.0042 T .0012 T				J7	–.0007 +.0011	.0007 T .0023 L	J7	–.0007 +.0011	.0007 T .0023 L	R7	–.0042 –.0024	.0042 T .0012 T
8.8583	9.8425	0 –.0012	R7	–.0042 –.0024	.0042 T .0012 T										R7	–.0042 –.0024	.0042 T .0012 T
9.8425	11.0236	0 –.0014	R7	–.0047 –.0027	.0047 T .0013 T				J7	–.0007 +.0013	.0007 T .0027 L	J7	–.0007 +.0013	.0007 T .0027 L	R7	–.0047 –.0027	.0047 T .0013 T
11.0236	12.4016	0 –.0014	R7	–.0047 –.0027	.0047 T .0013 T										R7	–.0047 –.0027	.0047 T .0013 T

Aluminum housings min. fit of .001 inch per inch of cup OD
Magnesium housings min. fit of .0015 inch per inch of cup OD

3.2. Non ferrous housings

Care should be taken when pressing cups into aluminum or magnesium housings to avoid metal pick up. This may result in unsatisfactory fits, backing, and alignment from debris trapped between the cup and backing shoulder. Preferably, the cup should be frozen or the housing heated, or both, during assembly. Also, a special lubricant may be used to ease assembly. In some cases, cups are mounted in steel inserts which are attached to the aluminum or magnesium housings. Table fits may then be used. Where the cup is fitted directly into an aluminum housing, it is suggested that a *minimum* tight fit of 1.0 µm per mm (0.0010 in per in) of cup outside diameter be used. For a magnesium housing, a *minimum* tight fit of 1.5 µm per mm (0.0015 in per in) of cup outside diameter is suggested.

3.3. Hollow shafts

In case of a thin section hollow shaft, the fits mentioned in the tables for industrial applications should be increased to avoid possible cone creeping under some load conditions.

3.4. Heavy duty fitting practice

Where heavy duty loads, shock loads, or high speeds are involved, the heavy-duty fitting practice should be used, regardless of whether the cone seats are ground or unground. Where it is impractical to grind the shaft OD for the cone seats, the tighter heavy-duty fitting practice should be followed. In this case the turned shaft OD should not exceed a maximum surface finish of 3.2 µm (125 µin) arithmetic average.

The *average* interference cone fit for *inch bearings* above 76.2 mm (3 in) bore should be 0.5 µm per mm (0.0005 in per in) of bearing bore. See inch fitting practice tables for cones with smaller bores. The minimum fit should not be less than 25 µm (0.0010 in) tight. If the shaft diameter is held to the same tolerance as the bearing bore, use the *average* interference fit. For example, average interference fit between a 609.6 mm (24 in) bore cone and shaft will be 305 µm (0.0120 in). The fit range will be 305 µm (0.0120 in) tight plus or minus the bearing bore tolerance.

See metric fitting practice tables for heavy-duty metric cone fitting practice.

3.5. Double-row assemblies with double cups

Non-rotating double outer races of types TDO and TNA bearings are generally mounted with loose fits to permit assembly and disassembly (fig. 4-10). The loose fit also permits axial floating when the bearing is mounted in conjunction with an axially fixed (locating) bearing on the other end of the shaft. Double outer races types CD and DC can be pinned to prevent rotation in the housing. Fitting values can be taken from general industrial guidelines.

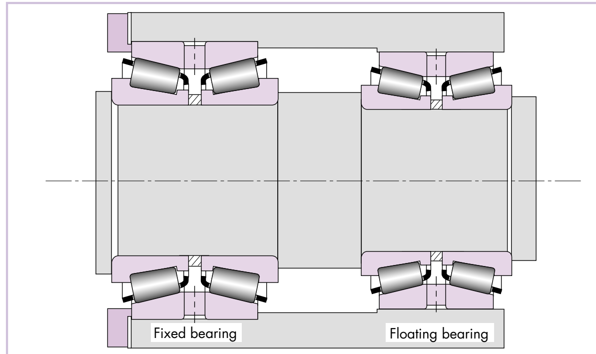


Fig. 4-10
Double-row bearing arrangement assembled with loose fit.

3.6. Bearing assemblies SR, TNA, TNASW, TNASWE types

The tolerance and fits for bearing types SR, TNA, TNASW, and TNASWE are tabulated along with the other dimensions in the bearing tables. Failure to use the specified fits may result in improper bearing setting. Reduced bearing performance or malfunction may occur. This may cause damage to machinery in which the bearing is a component. If interference fits are either greater or less than those specified, the mounted bearing setting will be other than intended.

D. Mounting procedure

Bearing performances can be adversely affected by improper mounting procedures or lack of care during the assembly phase.

Environment

Cleanliness during the bearing mounting operation is essential for a tapered roller bearing to operate for maximum service life. Bearings in their shipping containers or wrapping have been coated for rust protection. While this coating is not sufficient to properly lubricate the bearing, it is compatible with most lubricants and therefore does not have to be removed when mounting the bearing in the majority of applications.
Burrs, foreign matter and damaged bearing seats cause misalignment. Care should be taken to avoid shearing or damaging bearing seats during assembly which may introduce misalignment or result in a change of bearing setting during operation.

Fitting

Adequate tools must be provided to properly fit the inner and outer races on shafts or in housings to avoid damage. Direct shock on the races must be avoided. Normally, bearing races have to be heated or cooled to ease assembly. Do not heat standard bearings above 150°C (300°F) or freeze outer races below –55°C (–65°F). For precision bearings, do not heat above 65°C (150°F) or freeze below –30°C (–20°F).
Note: for more information on this subject, please contact a Timken Company service engineer or refer to the Timken Maintenance Manuals.

E. Setting

1. Introduction

Setting is defined as a specific amount of either endplay or preload. Establishing the setting at the time of assembly is an inherent advantage of tapered roller bearings. They can be set to provide optimum performance in almost any application. Fig. 4-11 gives an example of the relationship between fatigue life and bearing setting. Unlike some types of anti-friction bearings, tapered roller bearings do not rely strictly on housing or shaft fits to obtain a certain bearing setting. One race can be moved axially relative to the other to obtain the desired bearing setting.

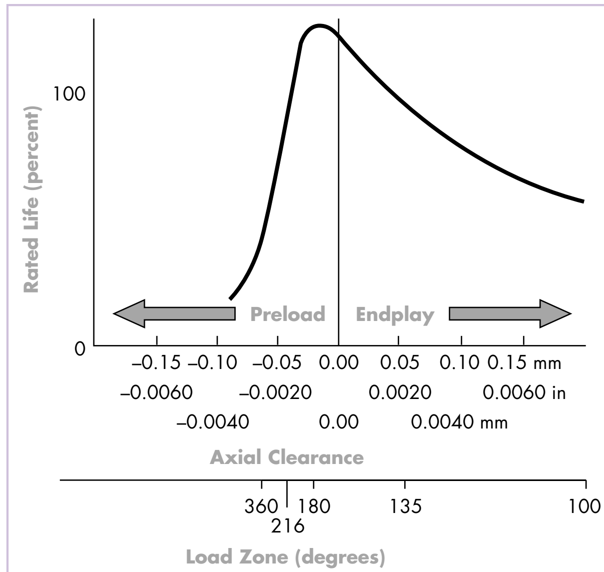


Fig. 4-11
Relationship between bearing setting and fatigue life.

At assembly, the conditions of bearing setting are defined as:

- Endplay - An axial clearance between rollers and races producing a measurable axial shaft movement when a small axial force is applied - first in one direction, then in the other, while oscillating or rotating the shaft (fig. 4-12).

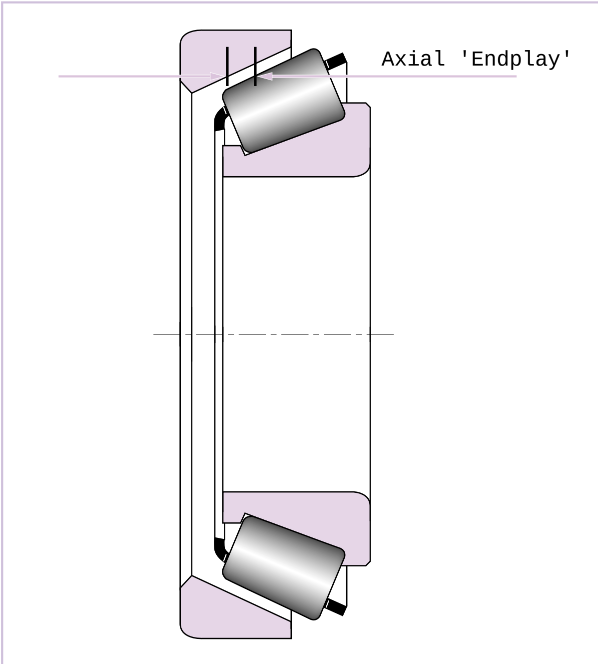


Fig. 4-12
Internal clearance - "Endplay".

- Preload - An axial interference between rollers and races such that there is no measurable axial shaft movement when a small axial force is applied - in both directions, while oscillating or rotating the shaft.
- Line-to-line - A zero setting condition: the transitional point between endplay and preload.

Bearing setting obtained during initial assembly and adjustment is the cold or ambient bearing setting and is established before the equipment is subjected to service.

Bearing setting during operation is known as the operating bearing setting and is a result of changes in the ambient bearing setting due to thermal expansion and deflections encountered during service.

The ambient bearing setting necessary to produce the optimum operating bearing setting varies with the application. Application experience, or testing, generally permits the determination of optimum settings. Frequently, however, the exact relationship of ambient to operating bearing setting is an unknown and an educated estimate has to be made. To determine a suggested ambient bearing setting for a specific application, contact a Timken Company sales engineer or representative.

Generally, the ideal operating bearing setting is near zero to maximize bearing life (fig. 4-11). Most bearings are set with endplay at assembly to reach the desired near zero setting at operating temperature.

2. Influence on bearing setting

2.1. General comments

There is an ideal bearing setting value for every application. To achieve this condition, the bearing setting must take account of deflection under load (radial + axial) as well as the thermal expansions and material used.

a) Standard mounting

Operating setting = mounted setting ± temperature effect + deflection

b) Pre-set assemblies

Mounted EP or PL = Bench EP or Bench PL – effect of fits

Operating setting = mounted EP or PL (MEP or MPL) + deflection ± temperature effect

The temperature and fit effects will depend upon the type of mounting, bearing geometry and size, shaft and housing size and material according to the following sketch (fig. 4-13):

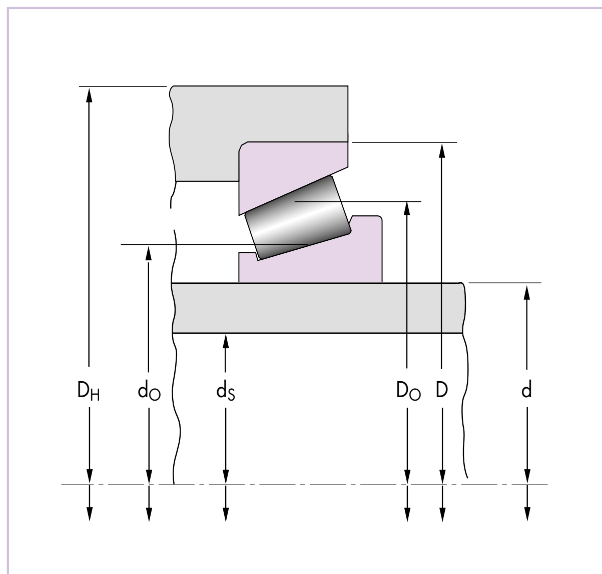


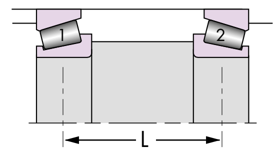
Fig. 4-13
Influence factors on temperature and fit.

δ_S = interference fit of inner race on shaft
δ_H = interference fit of outer race in housing
K = bearing K-factor
d = bearing bore diameter
d_O = mean inner race diameter
D = bearing outside diameter
D_O = mean outer race diameter
L = distance between bearing geometric center lines, mm (in)
α = coefficient of linear expansion : 11×10^{-6}/ °C (6.1×10^{-6}/ °F) for ferrous metal shaft and housing materials
d_S = shaft inside diameter
D_H = housing outside diameter
ΔT = temperature difference between shaft/inner race + rollers and housing/bearing outer race

2.2. Temperature effect (in a two-row mounting)

Direct mounting

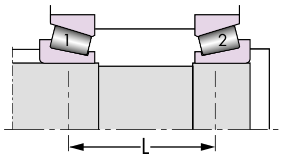
$$T = \alpha \, \Delta T \left[\left(\frac{K_1}{0.39} \times \frac{D_{O1}}{2} \right) + \left(\frac{K_2}{0.39} \times \frac{D_{O2}}{2} \right) + L \right]$$



Direct mounting

Indirect mounting

$$T = \alpha \, \Delta T \left[\left(\frac{K_1}{0.39} \times \frac{D_{O1}}{2} \right) + \left(\frac{K_2}{0.39} \times \frac{D_{O2}}{2} \right) - L \right]$$



Indirect mounting

2.3. Fit effect (single-row)

Solid shaft/heavy section housing

Inner race:

$$F = 0.5 \left(\frac{K}{0.39} \right) \left(\frac{d}{d_O} \right) \delta_S$$

Outer race:

$$F = 0.5 \left(\frac{K}{0.39} \right) \left(\frac{D_O}{D} \right) \delta_H$$

Hollow shaft/thin wall section

Inner race:

$$F = 0.5 \left(\frac{K}{0.39} \right) \left(\frac{d}{d_O} \right) \left[\frac{1 - \left(\frac{d_S}{d} \right)^2}{1 - \left(\frac{d_S}{d_O} \right)^2} \right] \delta_S$$

Outer race:

$$F = 0.5 \left(\frac{K}{0.39} \right) \left(\frac{D_O}{D} \right) \left[\frac{1 - \left(\frac{D}{D_H} \right)^2}{1 - \left(\frac{D_O}{D_H} \right)^2} \right] \delta_H$$

Note: these equations apply only to ferrous shaft and housing.

3. Setting methods

3.1. Setting range factors

Upper and lower limits of bearing setting value are determined by consideration of the following factors:

- Application type
- Duty
- Operational features of adjacent mechanical drive elements
- Changes in bearing setting due to temperature differentials and deflections
- Size of bearing and method of obtaining bearing setting
- Lubrication method
- Housing and shaft material.

The setting value to be applied during assembly will depend on any changes that may occur during operation. In the absence of experience with bearings of similar size and operating conditions, bearing setting range suggestions should be obtained from The Timken Company.

3.2. Manual setting

Use the push-pull method to measure any axial endplay (used as reference) while rotating the shaft or the housing. Correct this reference value to the final required endplay or preload by changing the setting on the adjusting device.

Fig. 4-14 and 4-15 are typical examples of manual setting applications.

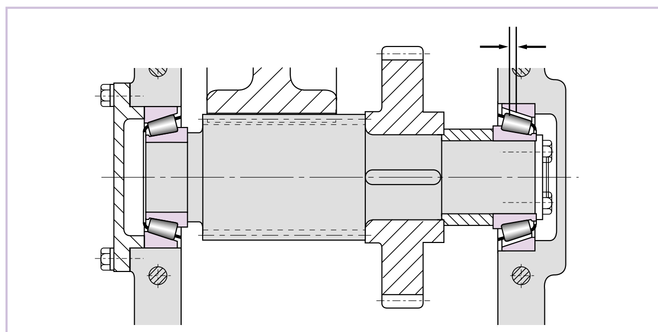


Fig. 4-14
Axial clearance (endplay).

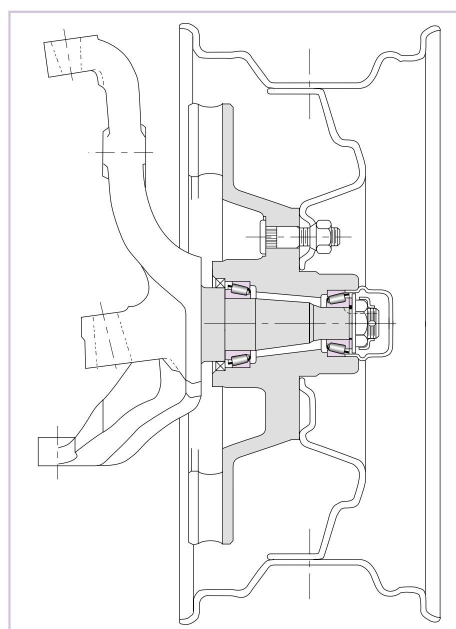


Fig. 4-15
Truck nondriven wheel.

3.3. Preset bearing assemblies

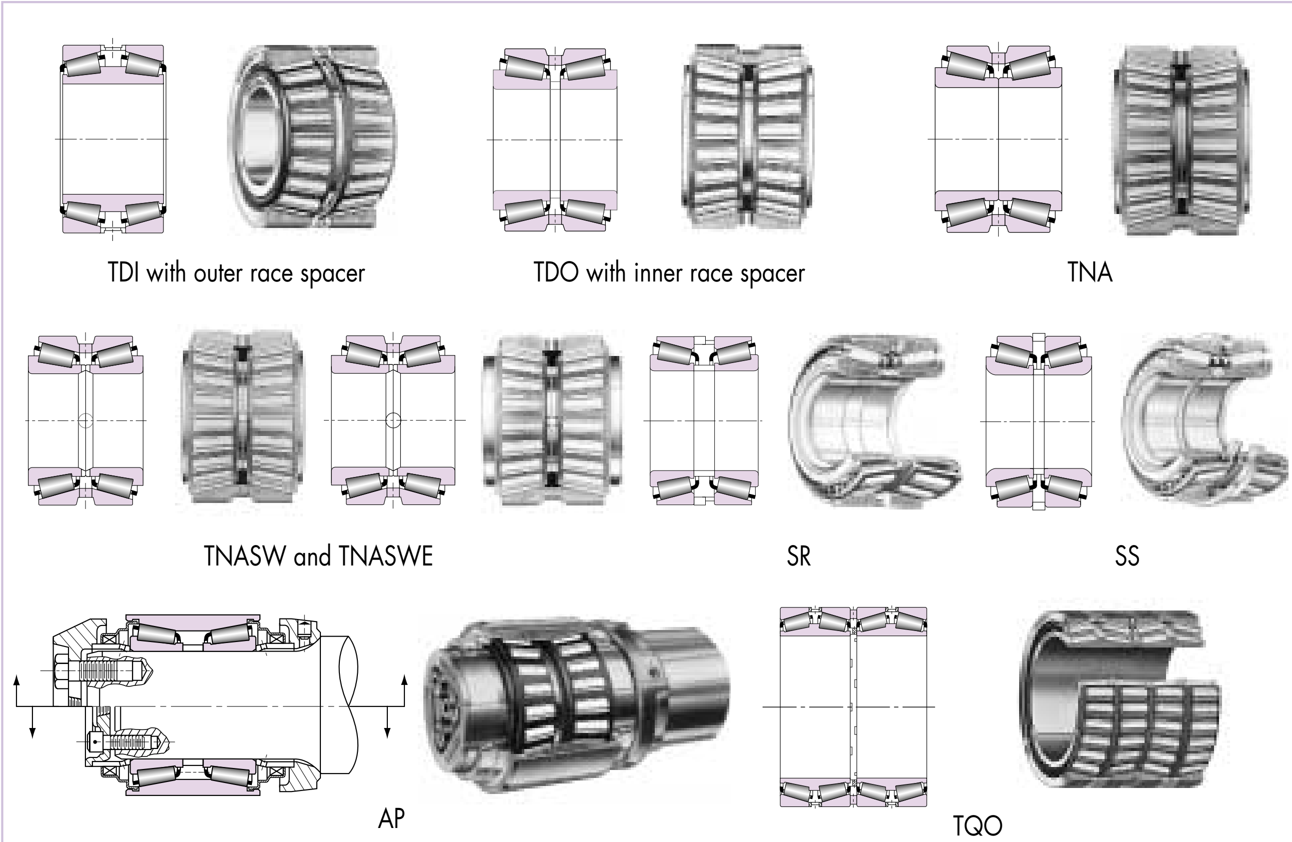


Fig. 4-16
Typical preset bearing assemblies.

If the application requires the use of multi-row bearing assemblies, preset bearings can be used (fig. 4-16).
Various types of multi-row bearing combinations can be provided with spacers that are ground and custom fitted to provide a bearing setting to meet the requirements of the application (fig. 4-17). Types SS, TDI, TDIT and TDO, listed in this publication, are examples.
Each matched assembly has an identifying serial number marked on each outer race, inner race and spacer. Some small preset assemblies are not marked with a serial number but their component parts are supplied as a boxed set.
A preset bearing assembly contains a specific fixed internal clearance (or preload) built in during manufacture. The value of this “setting” is referred to as “bench endplay” (BEP) or “bench preload” (BPL) and is normally determined by The Timken Company during the design stage of new equipment. Components from one bearing assembly are NOT interchangeable with similar parts from another.
Bearing settings for types TNA, TNASW, TNASWE (standard version) and SR bearings are obtained through close axial tolerance control and components from these assemblies are interchangeable for bearings having bore sizes under 305 mm (12 in).

4. Automated setting techniques

The Timken Company has developed various automated bearing setting techniques. The advantages of these techniques are:

- Reduced set-up time
- Reduces assembly cost
- Provides consistent and reliable bearing settings
- Requires minimal skill and human judgment
- In most cases they can be applied to the assembly line for moderate and high volume production.

It is possible to select and adapt one of the following automated setting methods for a wide range of applications.

Fig. 4-17
TDO spacers
This photo shows what a type TDO spacer bearing looks like. The left hand is holding a spacer which fits between the two single inner races.

4.1. "Set-Right"™

This technique applies the laws of probability. The setting in the bearing is controlled by the radial and axial tolerances of the various components of the assembly.

4.2. "Acro-Set"™

The Acro-Set method is achieved through measurement of a shim or spacer gap with a specified set-up load applied. The correct shim or spacer dimension is then taken from a prepared chart or by a direct instrument reading.
This technique is based on Hooke's law, which states that within the elastic limit, deformation or deflection is proportional to the load applied. It is applicable to either endplay or preload bearing settings.

4.3. "Torque-Set"™

The Torque-Set technique is a method of obtaining correct bearing settings by using low-speed bearing rolling torque as a basis for determining the amount of deformation or deflection of the assembly parts affecting bearing settings. This technique is applicable regardless of whether the final bearing setting is preload or endplay.

4.4. "Projecta-Set"™

The Projecta-Set technique is used to "project" an inaccessible shim or spacer gap to a position where it can easily be measured. This is achieved using a spacer and a gauging sleeve. The Projecta-Set technique is of most benefit on applications where the inner and outer races are an interference fit and therefore disassembly for adjustment is more difficult and time-consuming than with loose-fitting races.

Deciding which automated bearing setting technique should be used must be made early in the design sequence. It is necessary to review each application to determine the most economical method and necessary fixtures and tools. The final decision will be based on the size and weight of the unit, machining tolerances, production volume, access to retaining devices (locknuts, end plates, etc...) and available tools.
Timken sales engineers and representatives can assist in determining the best method to obtain the correct bearing setting.
A special brochure on automated setting methods is available on request.

F. Sealing

When selecting the proper seal design for any Timken® bearing application, it is necessary to consider the type of lubricant, the operation environment, the speed of the application and general operating conditions.

1. General comments

1.1. Shaft finish

It is important to ensure that no spiral grooves result from machining of shaft surfaces since these will tend to draw lubricant out of, or contaminant into, the bearing cavity. Plunge grinding normally produces a satisfactory surface finish.

1.2. Grease lubrication - venting

Venting should be provided in the cavity between the two bearings when grease lubrication is used in conjunction with rubbing or non-rubbing seals. This will prevent an ingress of contamination past the seals, in the event of a pressure differential between the bearing cavity and atmosphere.

1.3. Vertical shaft closures - oil lubrication

Lubricating vertical shaft bearings is a difficult problem. Normally, grease, oil mist or oil-air lubrication is used because of the simplicity. However, some high speed and/or heavy load applications will use circulating oil. This requires a very good sealing system and a suction pump to remove the oil from the bottom bearing position.

2. Non-rubbing seals

2.1. Metal stampings

Metal stamping closures are effective in clean applications. Where environmental conditions are dirty, stampings are used in combination with other closure elements to provide an effective labyrinth against the entry of foreign matter into the bearing chamber.
The stamping shown in fig. 4-18 is effective for applications that are grease lubricated and operate in clean conditions. The design illustrated in fig. 4-19 uses stampings on both sides of the bearing to keep the grease in close proximity to the bearing. The flinger mounted at the outer side of the bearing adds a labyrinth effect.
Stampings should be designed to provide a clearance of 0.5 to 0.6 mm (0.020 to 0.025 in) on diameter between rotating and stationary parts. A minimum axial clearance of 3.2 mm (0.125 in) should be provided.

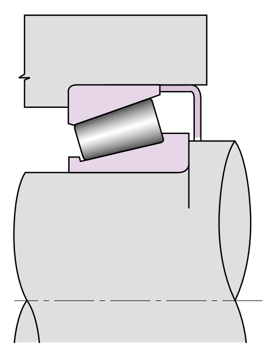


Fig. 4-18
Metal stamping.

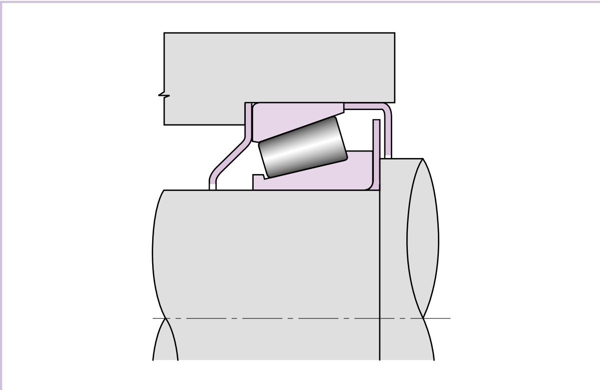


Fig. 4-19
Metal stampings.

2.2. Machined flingers

Machined parts, along with other closure elements, can be used in place of stampings where closer clearances are desired. This results in a more efficient retention of lubricant and exclusion of foreign matter from the bearing housing. Examples are shown in fig. 4-20 and 4-21.

An umbrella shaped flinger is shown in fig. 4-21 combined with an annular groove closure. At high shaft speeds this combination effectively retains oil and keeps out dirt.

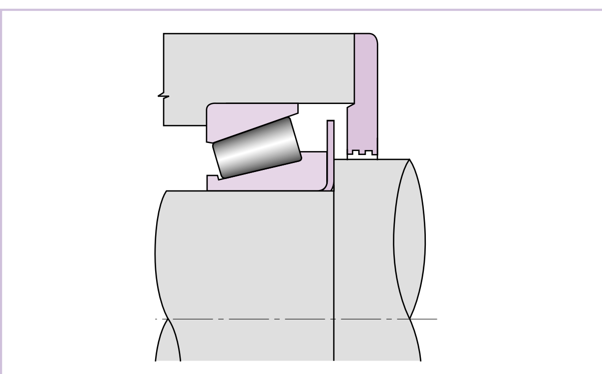


Fig. 4-20
Machined flinger combined with annular grooves.

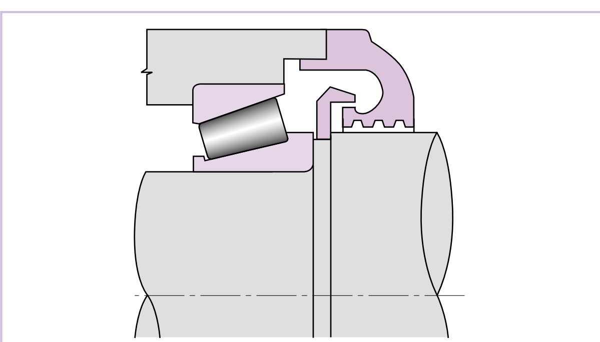


Fig. 4-21
Machined umbrella flinger combined with annular grooves.

2.3. Annular grooves

Annular groove closures are often used with grease lubrication in place of radial lip seals where considerable grit and dust are encountered. The closure usually has several grooves machined in the bore or on the outside diameter depending on the design. They become filled with grease, which tends to harden and provide a tight closure. When used with oil, the grooves tend to interrupt the capillary action which would otherwise draw oil out of the bearing cavity.
Annular grooves with a machined labyrinth effectively protect a grease lubricated bearing when the unit is required to operate in an extremely dirty environment (fig. 4-22).
This type of closure is most effective when applied with close running clearances and the maximum possible number of grooves. Suggested dimensions are shown in fig. 4-23.

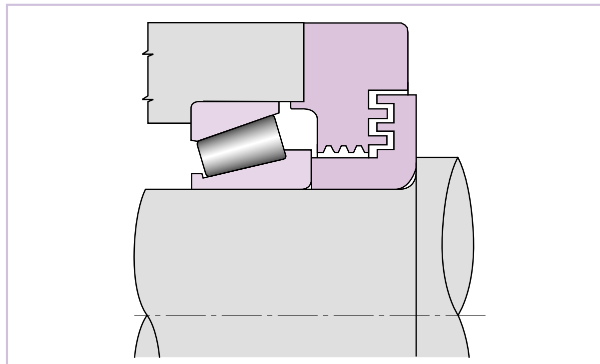
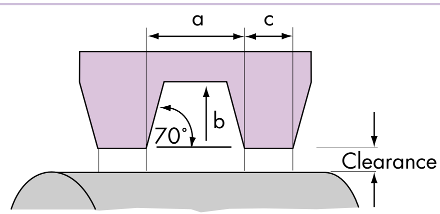


Fig. 4-22
Annular grooves combined with machined labyrinth.



dimension "a"	3.20 - 4.80 0.125 - 0.190	
dimension "b"	4.00 - 4.80 0.160 - 0.190	
dimension "c"	0.5a	
diametral clearance	0.25 - 0.40 0.010 - 0.016	for diameters to 50 mm (2 in)
	1.3 max. 0.05 max.	for diameters over 50 mm (2 in)

Fig. 4-23
Annular grooves. Suggested dimensions (mm, in).

3. Rubbing seals

3.1. Radial lip seals

Many types and styles of radial lip seals are commercially available to satisfy different sealing requirements. In clean environments, where the primary requirement is the retention of lubricant in the bearing housing, a single lip seal with the lip pointing inward is often used. Where the critical concern is exclusion of contaminants, the lip is usually pointed outwards (fig. 4-24).
Lip seals are available with or without a spring-loaded lip. The spring maintains a constant pressure of the lip on the sealing surface, thereby providing a more efficient seal for a longer period of time. When environmental conditions require a seal to prevent contaminants from entering the bearing chamber as well as retaining the lubricant, a double or triple lip seal is

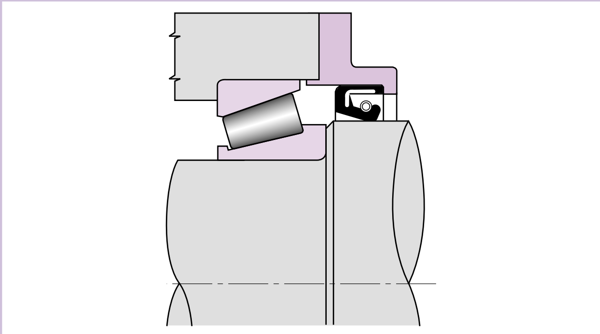


Fig. 4-24
Radial lip seals.

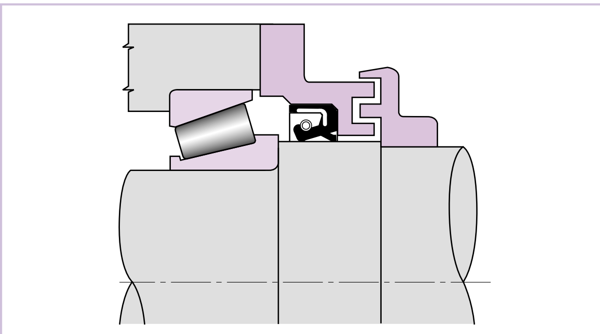


Fig. 4-25
Lip seal plus machined labyrinth.

often used. Additional flingers or shrouds should be used as primary seals where extremely dirty conditions are present so that the seal lip and sealing surface are protected to avoid rapid wear and premature seal damage (fig. 4-25).
Seal wear surfaces are normally required to have a surface finish in the order of 0.25-0.40 µm (10-15 µin) R_a. For applications exposed to severe contamination, the seal wear surface should in general have a minimum surface hardness of Rockwell C-45. The seal supplier should be consulted for more specific guidance.

3.2. "DUO FACE®-PLUS" seals

The "DUO FACE-PLUS" seal (fig. 4-26) has double lips that seal in the housing bore and the ground surface of the outer race front face. This eliminates the need to machine a special seal surface. The "DUO FACE-PLUS" seal has proven successful in many different types of grease lubricated applications. The range of Timken bearings available with "DUO FACE-PLUS" seals is listed in this book. Also, a brochure showing application examples is available on request.

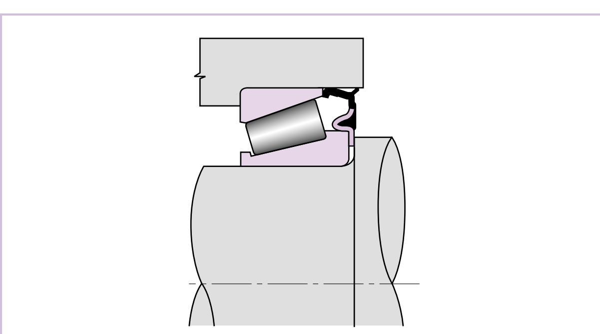


Fig. 4-26
DUO FACE® -PLUS seal.

3.3. Diaphragm seals

Diaphragm seals fig. (4-27) are commercially available. The metallic lip is designed to be spring loaded against the narrow face of the outer race. The type shown in fig. 4-28 has a second lip which seals against the housing.

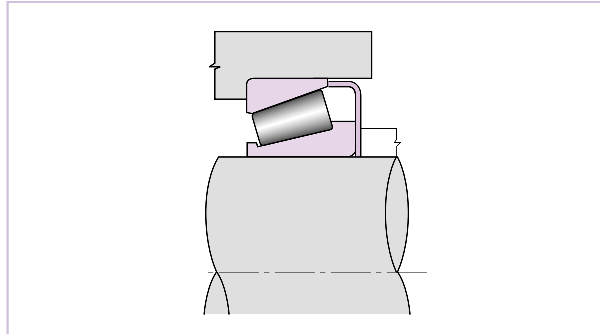


Fig. 4-27
Diaphragm seal.

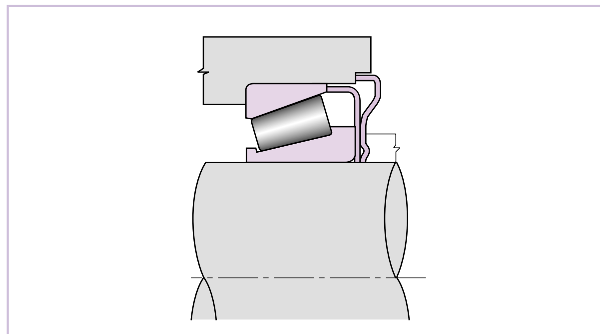


Fig. 4-28
Diaphragm seal.

3.4. Mechanical face seals

These are often used in extremely dirty environments where rotational speeds are low. Fig. 4-29 shows one of the proprietary types of mechanical face seals available. This type of seal generally needs to run in an oil bath. Designs are also available for high-speed and other special applications.

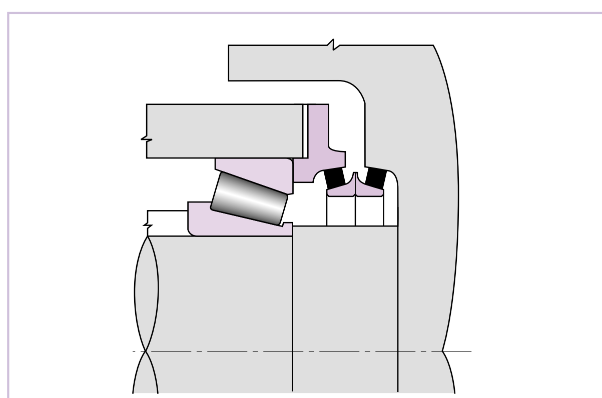


Fig. 4-29
Mechanical face seal for low speeds and contaminated environment.

3.5. V-Ring Seals

V-ring seals can be used in conjunction with grease or oil lubrication. As rotational speeds increase, the lip tends to pull away from the sealing surface and act like a flinger. This seal may be used with either oil or grease lubrication (fig 4-30). Consult your V-Ring seal supplier for application restrictions.

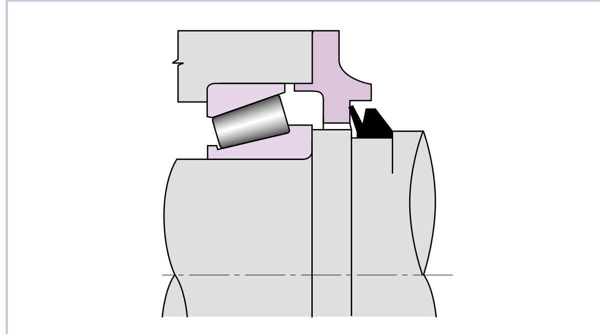


Fig.4-30
V-ring seals.

TIMKEN®

Notes

A. Bearing tolerances

1. Introduction

Bearing classes

Timken bearings are manufactured to a number of specifications or "classes" that define tolerances on dimensions such as bore, O.D., width, runout, etc.
The Timken Company produces bearings to both inch and metric systems. The boundary dimension tolerances applicable to these two categories of bearings differ.
The major difference between the two tolerance systems is that inch bearings have historically been manufactured to positive bore and O.D. tolerances, whereas metric bearings have been manufactured to negative tolerances.

2. Metric system bearings (ISO and "J" prefix parts)

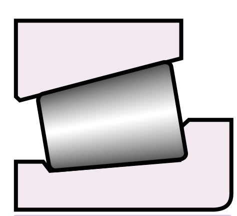
The Timken Company manufactures metric system bearings to six tolerance classes. Classes K and N are often referred to as standard classes. Class N has more closely controlled bearing width tolerances than K. Classes C, B, A and AA are "precision" classes. These tolerances lie within those currently specified in ISO 492 with the exception of a small number of dimensions indicated in the tables. The differences normally have an insignificant effect on the mounting and performance of tapered roller bearings.

The following table illustrates the current ISO bearing class that corresponds approximately to each of The Timken Company metric bearing classes.

	Bearing class					
The Timken Company	K	N	C	B	A	AA
ISO	Normal	6X	5	4	-	-

For the exact comparison, please consult a Timken Company sales engineer or representative.

Metric bearing tolerances (µm)



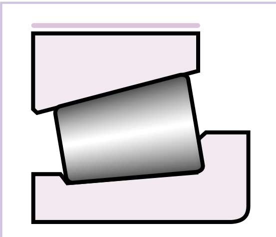
CONE BORE

			BEARING CLASS											
			Standard				Precision							
			K		N		C		B		A		AA	
Bearing types	Bore, mm over	incl.	max	min	max	min	max	min	max	min	max	min	max	min
	10	18	0	–12	0	–12	0	–7	0	–5	0	–5	0	–5
	18	30	0	–12	0	–12	0	–8	0	–6	0	–6	0	–6
	30	50	0	–12	0	–12	0	–10	0	–8	0	–8	0	–8
	50	80	0	–15	0	–15	0	–12	0	–9	0	–8	0	–8
	80	120	0	–20	0	–20	0	–15	0	–10	0	–8	0	–8
	120	180	0	–25	0	–25	0	–18	0	–13	0	–8	0	–8
TS	180	250	0	–30	0	–30	0	–22	0	–15	0	–8	0	–8
	250	265	0	–35	0	–35	0	–22	0	–15	0	–8	0	–8
TSF	265	315	0	–35	0	–35	0	–22	0	–15	–	–	–	–
	315	400	0	–40	0	–40	0	–25	–	–	–	–	–	–
SR①	400	500	0	–45	0	–45	0	–25	–	–	–	–	–	–
	500	630	0	–50	–	–	0	–30	–	–	–	–	–	–
	630	800	0	–80	–	–	0	–40	–	–	–	–	–	–
	800	1000	0	–100	–	–	0	–50	–	–	–	–	–	–
	1000	1200	0	–130	–	–	0	–60	–	–	–	–	–	–
	1200	1600	0	–150	–	–	0	–80	–	–	–	–	–	–
	1600	2000	0	–200	–	–	–	–	–	–	–	–	–	–
	2000		0	–250	–	–	–	–	–	–	–	–	–	–

① SR assemblies are manufactured to tolerance class N only.

Metric bearing tolerances (µm)
Contd.

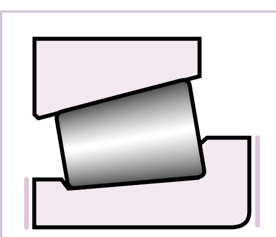
CUP O.D.



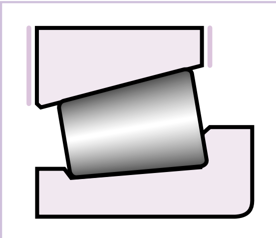
Bearing types	O.D., mm over	O.D., mm incl.	Standard K max	Standard K min	Standard N max	Standard N min	Precision C max	Precision C min	Precision B max	Precision B min	Precision A max	Precision A min	Precision AA max	Precision AA min
	10	18	–	–	–	–	–	–	–	–	0	–8	0	–8
	18	30	0	–12	0	–12	0	–8	0	–6	0	–8	0	–8
	30	50	0	–14	0	–14	0	–9	0	–7	0	–8	0	–8
	50	80	0	–16	0	–16	0	–11	0	–9	0	–8	0	–8
	80	120	0	–18	0	–18	0	–13	0	–10	0	–8	0	–8
	120	150	0	–20	0	–20	0	–15	0	–11	0	–8	0	–8
	150	180	0	–25	0	–25	0	–18	0	–13	0	–8	0	–8
TS	180	250	0	–30	0	–30	0	–20	0	–15	0	–8	0	–8
	250	265	0	–35	0	–35	0	–25	0	–18	0	–8	0	–8
TSF	265	315	0	–35	0	–35	0	–25	0	–18	–	–	–	–
	315	400	0	–40	0	–40	0	–28	–	–	–	–	–	–
SR①	400	500	0	–45	0	–45	0	–30	–	–	–	–	–	–
	500	630	0	–50	0	–50	0	–35	–	–	–	–	–	–
	630	800	0	–80	–	–	0	–40	–	–	–	–	–	–
	800	1000	0	–100	–	–	0	–50	–	–	–	–	–	–
	1000	1200	0	–130	–	–	0	–60	–	–	–	–	–	–
	1200	1600	0	–165	–	–	0	–80	–	–	–	–	–	–
	1600	2000	0	–200	–	–	–	–	–	–	–	–	–	–
	2000		0	–250	–	–	–	–	–	–	–	–	–	–

① SR assemblies are manufactured to tolerance class N only.

CONE WIDTH



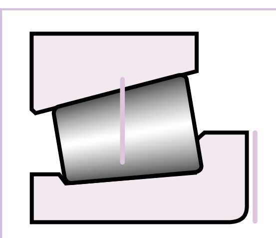
Bearing types	Bore, mm over	Bore, mm incl.	Standard K max	Standard K min	Standard N max	Standard N min	Precision C max	Precision C min	Precision B max	Precision B min	Precision A max	Precision A min	Precision AA max	Precision AA min
	10	50	0	–100	0	–50	0	–200	0	–200	0	–200	0	–200
	50	120	0	–150	0	–50	0	–300	0	–300	0	–300	0	–300
	120	180	0	–200	0	–50	0	–300	0	–300	0	–300	0	–300
	180	250	0	–200	0	–50	0	–350	0	–350	0	–350	0	–350
TS	250	265	0	–200	0	–50	0	–350	0	–350	0	–350	0	–350
	265	315	0	–200	0	–50	0	–350	0	–350	–	–	–	–
TSF	315	500	0	–250	0	–50	0	–350	–	–	–	–	–	–
	500	630	0	–250	–	–	0	–350	–	–	–	–	–	–
	630	1200	0	–300	–	–	0	–350	–	–	–	–	–	–
	1200	1600	0	–350	–	–	0	–350	–	–	–	–	–	–
	1600		0	–350	–	–	–	–	–	–	–	–	–	–



CUP WIDTH

			BEARING CLASS											
			Standard				Precision							
			K		N		C		B		A		AA	
Bearing types	O.D., mm over	incl.	max	▲ min	max	min	max	min	max	min	max	min	max	min
	10	18	0	–120	0	–100	–	–	–	–	–	–	–	–
	18	80	0	–150	0	–100	0	–150	0	–150	0	–150	0	–150
	80	150	0	–200	0	–100	0	–200	0	–200	0	–200	0	–200
	150	180	0	–200	0	–100	0	–250	0	–250	0	–250	0	–250
	180	250	0	–250	0	–100	0	–250	0	–250	0	–250	0	–250
TS	250	265	0	–250	0	–100	0	–300	0	–300	0	–300	0	–300
	265	315	0	–250	0	–100	0	–300	0	–300	–	–	–	–
TSF	315	400	0	–250	0	–100	0	–300	–	–	–	–	–	–
	400	500	0	–300	0	–100	0	–350	–	–	–	–	–	–
	500	800	0	–300	–	–	0	–350	–	–	–	–	–	–
	800	1200	0	–350	–	–	0	–400	–	–	–	–	–	–
	1200	1600	0	–400	–	–	0	–400	–	–	–	–	–	–
	1600		0	–400	–	–	–	–	–	–	–	–	–	–

▲ These differ slightly from tolerances in ISO 492. These differences normally have an insignificant effect on the mounting and performance of tapered roller bearings. The 30000 series ISO bearings are also available with the above parameter according to ISO 492.

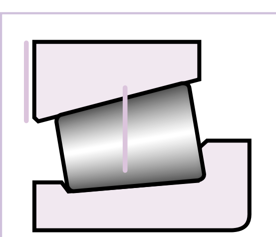


Cone Stand. Cone stand is a measure of the variation in cone raceway size and taper and roller diameter and taper which is checked by measuring the axial location of the reference surface of a master cup or other type gage with respect to the reference face of the cone.

CONE STAND

			BEARING CLASS											
			Standard				Precision							
			K		N		C		B		A		AA	
Bearing types	Bore, mm over	incl.	max	min	max	min	max	min	max	min	max	min	max	min
	10	80	+100	0	+50	0	+100	–100	*	*	*	*	*	*
	80	120	+100	–100	+50	0	+100	–100	*	*	*	*	*	*
TS	120	180	+150	–150	+50	0	+100	–100	*	*	*	*	*	*
	180	250	+150	–150	+50	0	+100	–150	*	*	*	*	*	*
TSF	250	265	+150	–150	+100	0	+100	–150	*	*	*	*	*	*
	265	315	+150	–150	+100	0	+100	–150	*	*	–	–	–	–
	315	400	+200	–200	+100	0	+150	–150	–	–	–	–	–	–
	400		*	*	*	*	*	*	–	–	–	–	–	–

* These sizes manufactured as matched assemblies only.



Cup Stand. Cup stand is a measure of the variation in cup I.D. size and taper which is checked by measuring the axial location of the reference surface of a master plug or other type gage with respect to the reference face of the cup.

CUP STAND

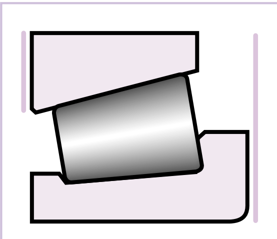
			BEARING CLASS											
			Standard				Precision							
			K		N		C		B		A		AA	
Bearing types	Bore, mm over	incl.	max	min	max	min	max	min	max	min	max	min	max	min
	10	18	+100	0	+50	0	–	–	*	*	*	*	*	*
	18	80	+100	0	+50	0	+100	–100	*	*	*	*	*	*
TS	80	120	+100	–100	+50	0	+100	–100	*	*	*	*	*	*
	120	265	+200	–100	+100	0	+100	–150	*	*	*	*	*	*
TSF①	265	315	+200	–100	+100	0	+100	–150	*	*	–	–	–	–
	315	400	+200	–200	+100	0	+100	–150	–	–	–	–	–	–
	400		*	*	*	*	*	*	–	–	–	–	–	–

* These sizes manufactured as matched assemblies only.
① Stand for flanged cup is measured from flange backface (seating face).

Metric bearing tolerances (µm)

Contd.

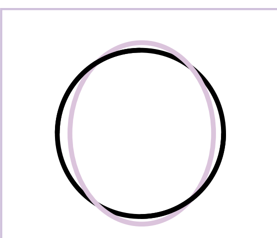
OVERALL BEARING WIDTH



Bearing types	Bore, mm over	Bore, mm incl.	Standard K max	Standard K min	Standard N max	Standard N min	Precision C max	Precision C min	Precision B max	Precision B min	Precision A max	Precision A min	Precision AA max	Precision AA min
TS, TSF②	10	80	+200	0	+100	0	+200	–200	+200	–200	+200	–200	+200	–200
	80	120	+200	–200	+100	0	+200	–200	+200	–200	+200	–200	+200	–200
	120	180	+350	–250	+150	0	+350	–250	+200	–250	+200	–250	+200	–250
	180	250	+350	–250	+150	0	+350	–250	+200	–300	+200	–300	+200	–300
	250	265	+350	–250	+200	0	+350	–300	+200	–300	+200	–300	+200	–300
	265	315	+350	–250	+200	0	+350	–300	+200	–300	–	–	–	–
	315	500	+400	–400	+200	0	+350	–300	–	–	–	–	–	–
	500	800	+400	–400	–	–	+350	–400	–	–	–	–	–	–
	800	1000	+450	–450	–	–	+350	–400	–	–	–	–	–	–
	1000	1200	+450	–450	–	–	+350	–450	–	–	–	–	–	–
	1200	1600	+450	–450	–	–	+350	–500	–	–	–	–	–	–
	1600		+450	–450	–	–	–	–	–	–	–	–	–	–
SR③	10	500	–	–	0	–150	–	–	–	–	–	–	–	–

② For bearing type TSF the tolerance applies to the dimension T_1.
③ SR assemblies are manufactured to tolerance class N only.

ASSEMBLED BEARING MAXIMUM RADIAL RUNOUT

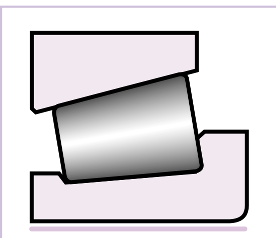


Bearing types	O.D., mm over	O.D., mm incl.	Standard K	Standard N	C	Precision B	Precision A	AA
TS, TSF, SR①	10	18	–	–	–	–	1.9	1
	18	30	18	18	5	3	1.9	1
	30	50	20	20	6	3	1.9	1
	50	80	25	25	6	4	1.9	1
	80	120	35	35	6	4	1.9	1
	120	150	40	40	7	4	1.9	1
	150	180	45	45	8	4	1.9	1
	180	250	50	50	10	5	1.9	1
	250	265	60	60	11	5	1.9	1
	265	315	60	60	11	5	–	–
	315	400	70	70	13	–	–	–
	400	500	80	80	18	–	–	–
	500	630	100	–	25	–	–	–
	630	800	120	–	35	–	–	–
	800	1000	140	–	50	–	–	–
	1000	1200	160	–	60	–	–	–
	1200	1600	180	–	80	–	–	–
	1600	2000	200	–	–	–	–	–
	2000		200	–	–	–	–	–

① SR assemblies are manufactured to tolerance class N only.

Inch system bearings are manufactured to a number of tolerance classes. Classes 4 and 2 are often referred to as "standard" classes. Class 2 has certain tolerances more closely controlled than class 4 and thus may be required for specific applications. Classes 3, 0, 00 and 000 are "precision" classes.

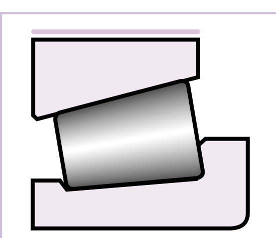
Inch bearing tolerances (0.0001 inch and µm)



CONE BORE			BEARING CLASS: Standard 4		Standard 2		Precision 3		Precision 0		Precision 00		Precision 000	
Bearing types	Bore, in (mm) over	incl.	max	min	max	min	max	min	max	min	max	min	max	min
TS TSF TSL① SS TDI TDIT TDO TNA	0 0	3.0000 76.200	+5 +13	0 0	+5 +13	0 0	+5 +13	0 0	+5 +13	0 0	+3 +8	0 0	+3 +8	0 0
	3.0000 76.200	10.5000 266.700	+10 +25	0 0	+10 +25	0 0	+5 +13	0 0	+5 +13	0 0	+3 +8	0 0	+3 +8	0 0
	10.5000 266.700	12.0000 304.800	+10 +25	0 0	+10 +25	0 0	+5 +13	0 0	+5 +13	0 0	+3 +8	0 0	+3 +8	0 0
	12.0000 304.800	24.0000 609.600	– –	– –	+20 +51	0 0	+10 +25	0 0	– –	– –	– –	– –	– –	– –
	24.0000 609.600	36.0000 914.400	+30 +76	0 0	– –	– –	+15 +38	0 0	– –	– –	– –	– –	– –	– –
	36.0000 914.400	48.0000 1219.200	+40 +102	0 0	– –	– –	+20 +51	0 0	– –	– –	– –	– –	– –	– –
	48.0000 1219.200		+50 +127	0 0	– –	– –	+30 +76	0 0	– –	– –	– –	– –	– –	– –

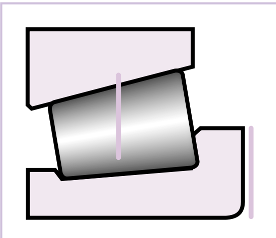
① For TSL bearings these are the normal tolerances of cone bore. However bore size can be slightly reduced at large end due to tight fit assembly of the seal on the rib. This should not have any effect on the performance of the bearing.

Note: For bore tolerances of bearing types TNASW and TNASWE see bearing data tables on page 319.



CUP O.D.			BEARING CLASS: Standard 4		Standard 2		Precision 3		Precision 0		Precision 00		Precision 000	
Bearing types	O.D., in (mm) over	incl.	max	min	max	min	max	min	max	min	max	min	max	min
TS TSF TSL SS TDI TDIT TDO TNA TNASW TNASWE	0 0	10.5000 266.700	+10 +25	0 0	+10 +25	0 0	+5 +13	0 0	+5 +13	0 0	+3 +8	0 0	+3 +8	0 0
	10.5000 266.700	12.0000 304.800	+10 +25	0 0	+10 +25	0 0	+5 +13	0 0	+5 +13	0 0	+3 +8	0 0	+3 +8	0 0
	12.0000 304.800	24.0000 609.600	+20 +51	0 0	+20 +51	0 0	+10 +25	0 0	– –	– –	– –	– –	– –	– –
	24.0000 609.600	36.0000 914.400	+30 +76	0 0	+30 +76	0 0	+15 +38	0 0	– –	– –	– –	– –	– –	– –
	36.0000 914.400	48.0000 1219.200	+40 +102	0 0	– –	– –	+20 +51	0 0	– –	– –	– –	– –	– –	– –
	48.0000 1219.200		+50 +127	0 0	– –	– –	+30 +76	0 0	– –	– –	– –	– –	– –	– –

Inch bearing tolerances (0.0001 inch and µm) Contd.

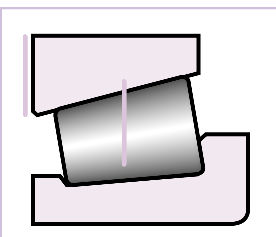


Cone Stand. Cone stand is a measure of the variation in cone raceway size and taper and roller diameter and taper which is checked by measuring the axial location of the reference surface of a master cup or other type gage with respect to the reference face of the cone.

CONE STAND

			BEARING CLASS											
			Standard				Precision							
			4		2		3		0		00		000	
Bearing types	O.D., in (mm) over	incl.	max	min	max	min	max	min	max	min	max	min	max	min
TS, TSL, SS, TDI①, TDIT①, TDO	0	4.0000	+40	0	+40	0	+40	–40	*	*	*	*	*	*
	0	101.600	+102	0	+102	0	+102	–102	*	*	*	*	*	*
	4.0000	10.5000	+60	–60	+40	0	+40	–40	*	*	*	*	*	*
	101.600	266.700	+152	–152	+102	0	+102	–102	*	*	*	*	*	*
	10.5000	12.0000	+60	–60	+40	0	+40	–40	*	*	–	–	–	–
	266.700	304.800	+152	–152	+102	0	+102	–102	*	*	–	–	–	–
	12.0000	16.0000	–	–	+70	–70	+40	–40	–	–	–	–	–	–
	304.800	406.400	–	–	+178	–178	+102	–102	–	–	–	–	–	–
	16.0000		*	*	*	*	*	*	–	–	–	–	–	–
	406.400		*	*	*	*	*	*	–	–	–	–	–	–

* These sizes manufactured as matched assemblies only.
① For class 2, TDI and TDIT bearings with cone bore of 101.600 to 304.800 mm (4 in to 12 in), the cone stand is ±102 (±40).



Cup Stand. Cup stand is a measure of the variation in cup I.D. size and taper which is checked by measuring the axial location of the reference surface of a master plug or other type gage with respect to the reference face of the cup.

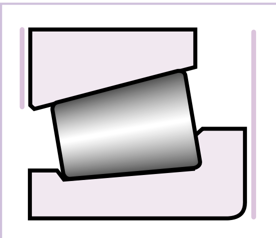
CUP STAND

			BEARING CLASS											
			Standard				Precision							
			4		2		3		0		00		000	
Bearing types	Bore, in (mm) over	incl.	max	min	max	min	max	min	max	min	max	min	max	min
TS, TSF①, TSL, SS, TDI, TDIT	0	4.0000	+40	0	+40	0	+40	–40	*	*	*	*	*	*
	0	101.600	+102	0	+102	0	+102	–102	*	*	*	*	*	*
	4.0000	10.5000	+80	–40	+40	0	+40	–40	*	*	*	*	*	*
	101.600	266.700	+203	–102	+102	0	+102	–102	*	*	*	*	*	*
	10.5000	12.0000	+80	–40	+40	0	+40	–40	*	*	–	–	–	–
	266.700	304.800	+203	–102	+102	0	+102	–102	*	*	–	–	–	–
	12.0000	16.0000	–	–	+80	–80	+40	–40	–	–	–	–	–	–
	304.800	406.400	–	–	+203	–203	+102	–102	–	–	–	–	–	–
	16.0000		*	*	*	*	*	*	–	–	–	–	–	–
	406.400		*	*	*	*	*	*	–	–	–	–	–	–

* These sizes manufactured as matched assemblies only.
① Stand for flanged cup is measured from flange backface (seating face).

Inch bearing tolerances (0.0001 inch and µm)
Contd.

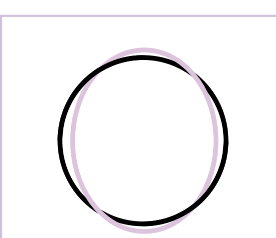
OVERALL BEARING WIDTH



Bearing types	Bore, in (mm) over	Bore, in (mm) incl.	O.D., in (mm) over	O.D., in (mm) incl.	Standard 4 max	Standard 4 min	Standard 2 max	Standard 2 min	Precision 3 max	Precision 3 min	Precision 0 max	Precision 0 min	Precision 00 max	Precision 00 min	Precision 000 max	Precision 000 min
TS TSF① TSL	0 0	4.0000 101.600	-	-	+80 +203	0 0	+80 +203	0 0	+80 +203	-80 -203	+80 +203	-80 -203	+80 +203	-80 -203	+80 +203	-80 -203
	4.0000 101.600	10.5000 266.700	-	-	+140 +356	-100 -254	+80 +203	0 0	+80 +203	-80 -203	+80 +203	-80 -203	+80 +203	-80 -203	+80 +203	-80 -203
	10.5000 266.700	12.0000 304.800	-	-	+140 +356	-100 -254	+80 +203	0 0	+80 +203	-80 -203	+80 +203	-80 -203	-	-	-	-
	12.0000 304.800	24.0000 609.600	0 0	20.0000 508.000	-	-	+150 +381	-150 -381	+80 +203	-80 -203	-	-	-	-	-	-
	12.0000 304.800	24.0000 609.600	20.0000 508.000		-	-	+150 +381	-150 -381	+150 +381	-150 -381	-	-	-	-	-	-
	24.0000 609.600		-	-	+150 +381	-150 -381	-	-	+150 +381	-150 -381	-	-	-	-	-	-
TNA TNASW TNASWE	0 0	5.0000 127.000	-	-	-	-	+100 +254	0 0	+100 +254	0 0	-	-	-	-	-	-
	5.0000 127.000		-	-	-	-	+300 +762	0 0	+300 +762	0 0	-	-	-	-	-	-
TDI TDIT TDO	0 0	4.0000 101.600	-	-	+160 +406	0 0	+160 +406	0 0	+160 +406	-160 -406	+160 +406	-160 -406	+160 +406	-160 -406	+160 +406	-160 -406
	4.0000 101.600	10.5000 266.700	-	-	+280 +711	-200 -508	+160 +406	-80 -203	+160 +406	-160 -406	+160 +406	-160 -406	+160 +406	-160 -406	+160 +406	-160 -406
	10.5000 266.700	12.0000 304.800	-	-	+280 +711	-200 -508	+160 +406	-80 -203	+160 +406	-160 -406	+160 +406	-160 -406	-	-	-	-
	12.0000 304.800	24.0000 609.600	0 0	20.0000 508.000	-	-	+300 +762	-300 -762	+160 +406	-160 -406	-	-	-	-	-	-
	12.0000 304.800	24.0000 609.600	20.0000 508.000		-	-	+300 +762	-300 -762	+300 +762	-300 -762	-	-	-	-	-	-
	24.0000 609.600		-	-	+300 +762	-300 -762	-	-	+300 +762	-300 -762	-	-	-	-	-	-
SS	0 0	4.0000 101.600	-	-	+180 +457	-20 -51	+180 +457	-20 -51	-	-	-	-	-	-	-	-

① For bearing type TSF the tolerance applies to the dimension T_1.

ASSEMBLED BEARING MAXIMUM RADIAL RUNOUT

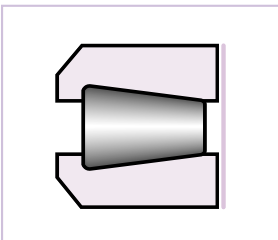


Bearing types	O.D., in (mm) over	O.D., in (mm) incl.	Standard 4	Standard 2	Precision 3	Precision 0	Precision 00	Precision 000
TS TSF TSL SS TDI TDIT TDO TNA TNASW TNASWE	0 0	10.5000 266.700	20 51	15 38	3 8	1.5 4	0.75 2	0.40 1
	10.5000 266.700	12.0000 304.800	20 51	15 38	3 8	1.5 4	0.75 2	0.40 1
	12.0000 304.800	24.0000 609.600	20 51	15 38	7 18	-	-	-
	24.0000 609.600	36.0000 914.400	30 76	20 51	20 51	-	-	-
	36.0000 914.400		30 76	-	30 76	-	-	-

Thrust bearings - type TTC and TTSP

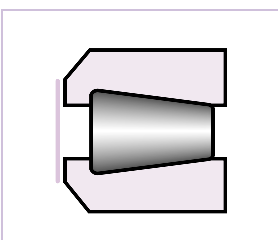
Tolerances (0.0001 in and µm)

BORE



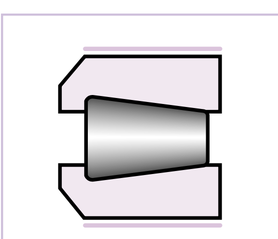
Range, in (mm)		Deviation	
over	incl.	max	min
0 0	1.0000 25.400	+30 +76	–30 –76
1.0000 25.400	3.0000 76.200	+40 +102	–40 –102
3.0000 76.200		+50 +127	–50 –127

OUTSIDE DIAMETER



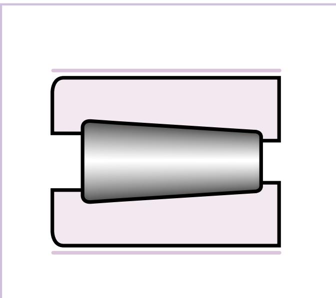
Range, in (mm)		Deviation	
over	incl.	max	min
0 0	5.0000 127.000	+100 +254	0 0
5.0000 127.000	8.0000 203.200	+150 +381	0 0
8.0000 203.200		+200 +508	0 0

WIDTH



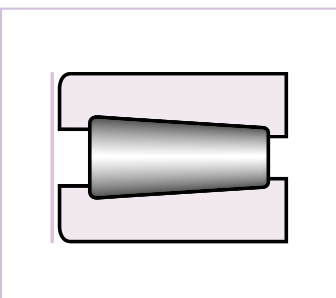
Bore range, in (mm)		Deviation	
over	incl.	max	min
0 0	3.0000 76.200	+100 +254	–100 –254
3.0000 76.200	5.0000 127.000	+150 +381	–150 –381
5.0000 127.000		+200 +508	–200 –508

Tolerances (0.0001 in and µm)



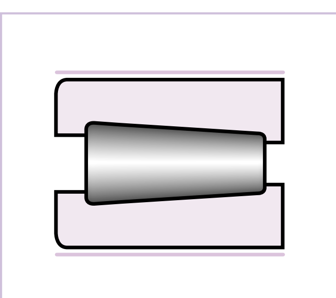
BORE

Range, in (mm)		BEARING CLASS Standard 2		Precision 3	
over	incl.	max	min	max	min
0 0	12.0000 304.800	+10 +25	0 0	+5 +13	0 0
12.0000 304.800	24.0000 609.600	+20 +51	0 0	+10 +25	0 0
24.0000 609.600	36.0000 914.400	+30 +76	0 0	+15 +38	0 0
36.0000 914.400	48.0000 1219.200	+40 +102	0 0	+20 +51	0 0
48.0000 1219.200		+50 +127	0 0	+30 +76	0 0



OUTSIDE DIAMETER

Range, in (mm)		BEARING CLASS Standard 2		Precision 3	
over	incl.	max	min	max	min
0 0	12.0000 304.800	+10 +25	0 0	+5 +13	0 0
12.0000 304.800	24.0000 609.600	+20 +51	0 0	+10 +25	0 0
24.0000 609.600	36.0000 914.400	+30 +76	0 0	+15 +38	0 0
36.0000 914.400	48.0000 1219.200	+40 +102	0 0	+20 +51	0 0
48.0000 1219.200		+50 +127	0 0	+30 +76	0 0



WIDTH

	BEARING CLASS Standard 2		Precision 3	
	max	min	max	min
All sizes	+150 +381	-150 -381	+80 +203	-80 -203

B. Mounting designs

1. Types of designs

The primary function of either the cone or cup backing shoulders is to positively establish the axial location and alignment of the bearing and its adjacent parts under all loading and operating conditions.
For a tapered roller bearing to operate for maximum service life, it is essential that a shoulder, square with the bearing axis and of sufficient diameter, is provided for each race. It must be of sufficient section and design to resist axial movement due to loading or distortion and must be wear-resistant at the interface with the bearing.
The conventional and most widely accepted method used to provide bearing backing is to machine a shoulder on a shaft or in the housing (fig. 4-1).

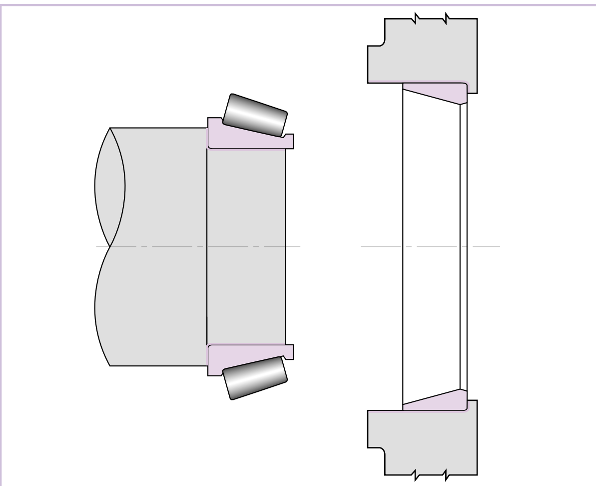


Fig. 4-1
Shaft and housing shoulders.

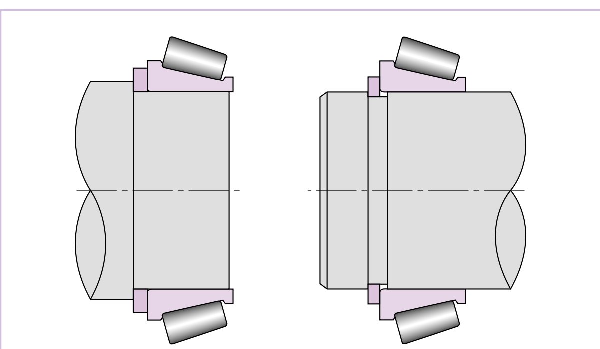


Fig. 4-2
Separate member used to provide adequate shaft shoulder diameter.

In some applications a spacer is used between a cone and shaft shoulder, or a snap ring. As a further alternative, a split spacer can be used (fig. 4-2).

A spacer or snap ring can also be used for cup backing (fig. 4-3). If a snap ring is used for bearing backing it is recommended that an interference cup fit be used.

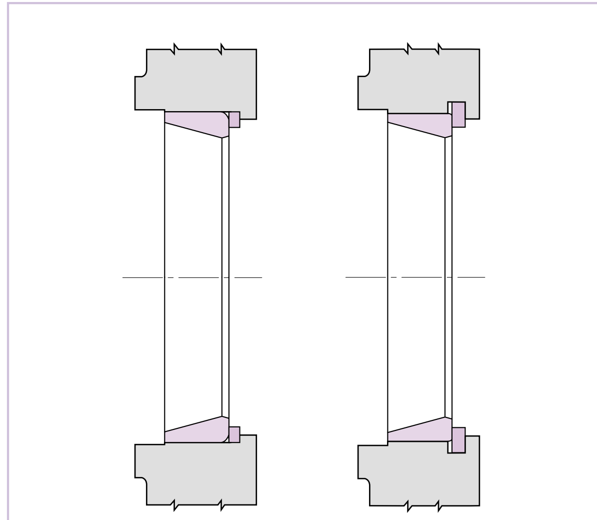


Fig. 4-3
Separate member used to provide adequate housing backing diameter.

The cup used for bearing setting in a direct mounting (roller small ends pointing outwards) is usually set in position by a cup carrier or by mounting in a carrier (fig. 4-4).

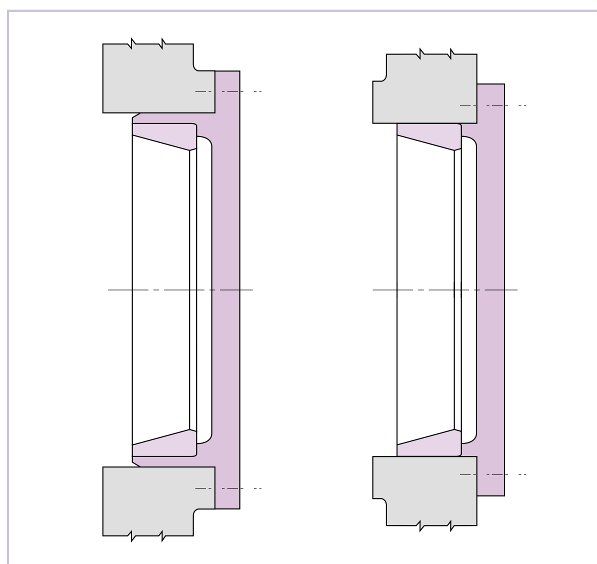


Fig. 4-4
Bearing setting devices - direct mounting.

With an indirect mounting (roller small ends pointing inwards), bearing setting can be achieved by a wide variety of devices (fig. 4-5).

In applications requiring precision class bearings, a special precision nut can be used. This has a soft metal shoe that is clamped against the threads with a locking screw. Other solutions can use split nut and/or ground spacers where setting cannot be altered (fig. 4-6).

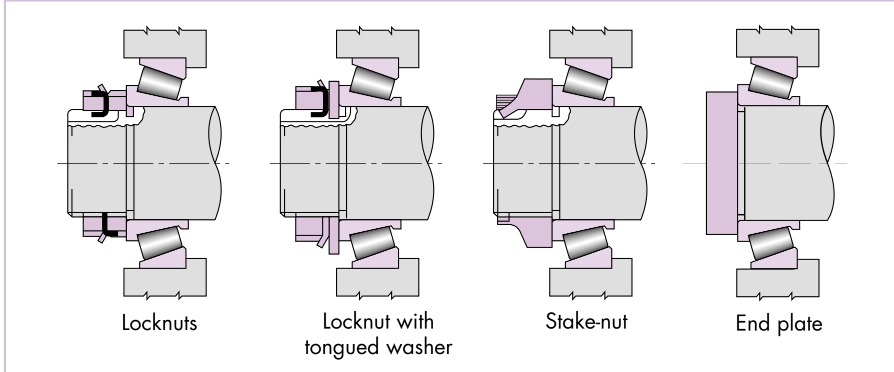
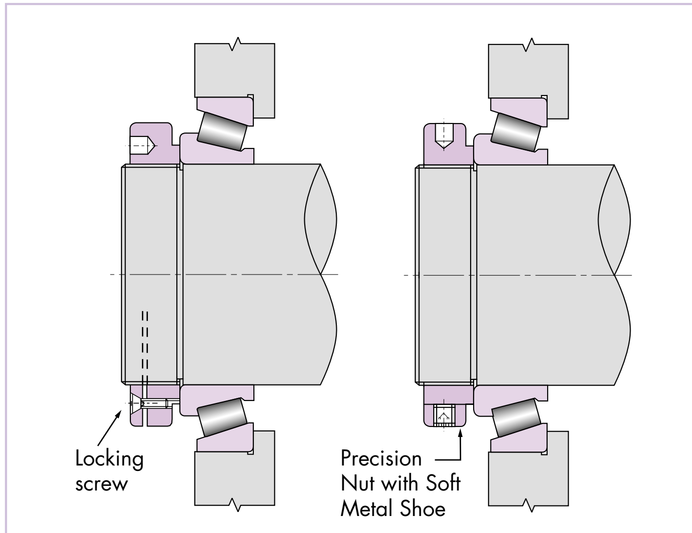


Fig. 4-5
Bearing setting devices - indirect mounting.

Fig. 4-6
Setting devices using split nut and precision nut with soft metal shoe.



Snap rings

In instances where snap rings are used to locate bearing components, it is important that they are of sufficient section to provide positive location. Care must be taken during installation or removal of the snap ring to prevent damage to the bearing cage.

Removal

Suitable means must be provided on adjacent bearing parts for easy bearing removal. Knockout slots, puller grooves and axial holes can be designed into the backing surfaces to ease removal of the cup or cone for servicing (fig. 4-7). In specific cases, hydraulic devices can also be used.

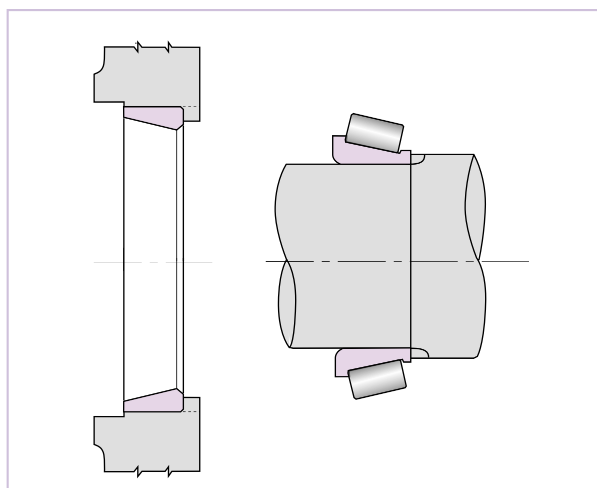


Fig. 4-7
Removal slots or puller grooves to ease removal.

2. Backing diameters

Backing diameters, fillet clearances and cage clearances are listed for each individual part number in the bearing tables. Backing shoulder diameters shown should be considered as minimum values for shafts and maximum values for housings.

WARNING: DO NOT USE A BACKING DIAMETER THAT PROVIDES LESS BACKING SURFACE THAN SUGGESTED.

3. Seating

3.1. Geometry

Two major causes of misalignment occur when the seats of cones and/or cups are machined out of square with the bearing axis or when the seats are parallel but out of alignment.

3.2. Surface finishes – standard bearings

For industrial applications, please refer to the following guidelines:

Ground shafts
All shaft seats should be ground to a surface finish of 1.6 µm (65 µin) R_a maximum wherever possible.

Turned shafts
When shaft seats are turned, a tighter heavy duty fit should be used. In this case the shaft diameter should be turned to a finish of 3.2 µm (125 µin) R_a maximum.

Housing bores
Housing bores should be finished to 3.2 µm (125 µin) R_a maximum.

3.4. Surface finishes - precision bearings

Precision class bearings should be mounted on shafts and in housings that are finished to at least the same precision limits as the bearing bore or outside diameter.

Furthermore, high quality surface finishes together with close machining tolerances of bearing seats must also be provided. The following tabulations give some guidelines for all these criteria:

SURFACE FINISH - R_a (µin - µm)

ALL SIZES	Bearing class			
	C 3	B 0	A 00	AA 000
Shaft	32 0.8	24 0.6	15 0.4	7 0.2
Housing	65 1.6	32 0.8	24 0.6	15 0.4

Correct fitting practice and precise bearing setting both affect bearing life, rigidity and, in the case of precision bearings, accuracy.

Improper fits will lead to problems such as poor machine performance including creeping of the cone on the spindle or the cup in the housing and lack of spindle stiffness.

C. Fitting guidelines

1. Introduction

The design of a tapered roller bearing permits the setting (endplay or preload) to be optimized during installation for the operation requirements. This is irrespective of the cone and cup fits on the shaft and housing and will allow the use of the widest possible machining tolerances for the shaft and housing, as well as the best possible fits for the cones and cups to match the duty of the bearing.

The choice of fitting practices will mainly depend upon the following parameters:

- Precision class of the bearing
- Rotating or stationary race
- Type of layout (single/double-row bearings)
- Type and direction of load (continuous/alternate rotating)
- Particular running conditions like shocks, vibrations, overloading or high speed
- Capability for machining the seats (grinding, turning or boring)
- Shaft and housing section and material
- Mounting and setting conditions
- Preadjusted bearings must be mounted with the recommended fit.

2. General guidelines

The design of a Timken tapered roller bearing allows the setting of bearing internal clearance during installation to optimize bearing operation.

General industrial application fitting practice standards for cones and cups are shown in the following tables. These tables apply to solid or heavy-sectioned steel shafts, heavy-sectioned ferrous housings, and normal operating conditions. To use the tables, it is necessary to determine if the member is rotating or stationary, the magnitude, direction, and type of loading, and the shaft finish.

Certain table fits may not be adequate for light shaft and housing sections, shafts other than steel, nonferrous housings, critical operation conditions such as high speed, unusual thermal or loading conditions, or a combination thereof. Also assembly procedures and the means and ease of obtaining the bearing setting may require special fits. In these cases, experience should be used as a guideline or a Timken Company sales engineer or representative should be consulted for review and suggestions.

Rotating cones generally should be applied with an interference fit. In special cases loose fits may be considered if it has been determined by test or experience they will perform satisfactorily. The term "rotating cone" describes a condition in which the cone rotates relative to the load. This may occur with a rotating cone under a stationary load or a stationary cone with a rotating load. Loose fits will permit the cones to creep and wear the shaft and the backing shoulder. This will result in excessive bearing looseness and possible bearing and shaft damage.

Stationary cone fitting practice depends on the application. Under conditions of high speed, heavy loads or shock, interference fits using heavy-duty fitting practice should be used. With cones mounted on unground shafts subjected to moderate loads (no shock) and moderate speeds, a metal-to-metal or near zero average fit is used. In sheave and wheel applications using unground shafts, or in cases using ground shafts with moderate loads (no shock), a minimum fit near zero to a maximum looseness which varies with the cone bore size is suggested. In stationary cone applications requiring hardened and ground spindles, a slightly looser fit may be satisfactory. Special fits may also be necessary on installations such as multiple sheave crane blocks.

Rotating cup applications where the cup rotates relative to the load should always use an interference fit.

Stationary, nonadjustable and fixed single-row cup applications should be applied with a tight fit wherever practical. Generally, adjustable fits may by used where the bearing setup is obtained by sliding the cup axially in the housing bore. However, in certain heavy-duty, high-load applications, tight fits are necessary to prevent pounding and plastic deformation of the housing. Tightly fitted cups mounted in carriers can be used. Tight fits are recommended when the load rotates relative to the cup.

To permit through-boring when the outside diameters of single-row bearings mounted at each end of a shaft are equal and one is adjustable and the other fixed, it is suggested that the same adjustable fit be used at both ends. However, tight fits should be used if cups are backed against snap rings, to prevent excessive dishing of snap rings, groove wear and possible loss of ring retention. Only cups with a maximum housing fillet radius requirement of 1.3 mm (0.05 in) or less should be considered for a snap ring backing.

Two-row stationary double cups are generally mounted with loose fits to permit assembly and disassembly. The loose fit also permits float when a floating bearing is mounted in conjunction with an axially fixed bearing on the other end of the shaft.

The fitting practice tables that follow have been prepared for both metric and inch dimensions.

For the inch system bearings, classes 4 and 2 (standard) and classes 3, 0, and 00 (precision) have been included.

The metric system bearings that have been included are: classes K and N (metric system standard bearings) and classes C, B, and A (metric system precision bearings).

Precision class bearings should be mounted on shafts and in housings which are similarly finished to at least the same precision limits as the bearing bore and OD. High quality surface finishes should also be provided.

For more information on precision bearings, consult the *Timken Bearings for Machine Tools* brochure.

Two-row and four-row bearings, which are provided with spacers and shipped as matched assemblies, have been preset to a specific bench end play. The specific endplay setting is determined from a study of the bearing mounting and expected environment. It is dependent on the fitting practice and the required mounted bearing settings. Failure to use the designated fitting practice in the bearing application can result in improper bearing performance or sudden malfunction of the bearing, which may cause damage to machinery in which the bearing is a component.

For rolling mill neck fitting practice, contact a Timken Company Sales Engineer or Representative. For all other equipment associated with the rolling mill industry, the fitting practice suggestions in the tables that follow should be used.

In addition to all other axial tolerances and the overall bearing width tolerance, the width increase due to tight fits of the cone or cup, or both, must be considered when axial tolerance summation calculations are made. By knowing the fit range, the minimum and maximum bearing width increase can be determined to establish the initial design dimensions. For instance, all tolerances plus the bearing width increase range due to tight fits must be known in order to calculate the shim gap range that would occur on a cup adjusted, direct-mounting design.

In a factory preset bearing or a SET-RIGHT™ mounting where bearing width is not permitted to change, even though tight fits are involved, the cone expansion or cup contraction due to tight fits reduces the internal clearance (endplay) within the bearing.

End Play Removed for Single Cone

$$= 0.5 \left(\frac{K}{0.30}\right) \left(\frac{d}{d_o}\right) \delta$$

The other equations under *Normal Sections* and *Thin Wall Sections* can be used to calculate end play removed in a similar manner.

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