12.7 THRUST BALL BEARINGS

Design

From a design perspective, thrust ball bearings are divided into single direction and double direction. Rings have flat seating surfaces. The rings in smaller bearings may alternatively have a round seating faces (see fig. 12.7.1) for seating in the hub. Rings must be supported such that all of the balls or loaded equally. Bearings cannot carry radial forces. The bearings can be disassembled; consequently, the rings and axial cages with balls can be taken apart.

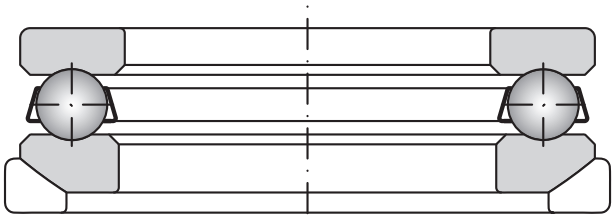


Fig. 12.7.1

Single direction thrust bearings

Standard single direction thrust ball bearings are composed of a shaft and hub ring with races and of balls guided by a cage (see fig. 12.7.2). Bearings only transfer axial loads in one direction.

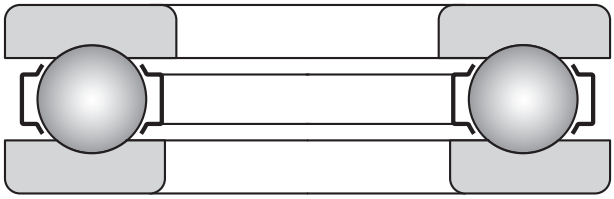


Fig. 12.7.2

Double direction thrust bearings

Standard double direction thrust ball bearings have two cages with balls between the centre shaft ring and two housing rings (see fig. 12.7.3). The shaft ring has races on both sides and is fastened on the journal. Bearings are only capable of transferring axial forces in both directions. Housing rings and cages with balls have identical components as single direction bearings of similar dimensions.

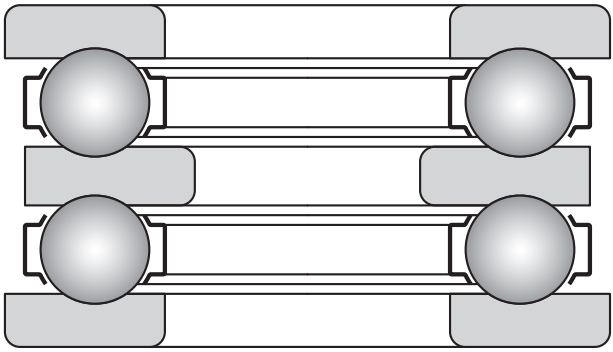


Fig. 12.7.3

Cages

Thrust ball bearings, in standard design, have a sheet metal cage according to fig. 12.7.4.

Larger size bearings use massive brass or steel cages (fig. 12.7.5).

In the rare exception, cages made from fibre-glass reinforced polyamide 6.6 are used.

Designation of the material and design is not specified in standard cages made from pressed steel sheeting. Any customer demands for special variations of cage structure and material must be consulted in advance with the supplier.

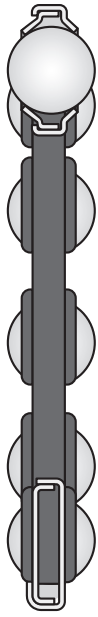


Fig. 12.7.4

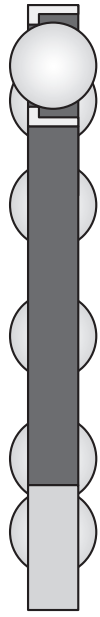


Fig. 12.7.5

Basic information

Dimensions

The main dimensions of bearings are consistent with standard ISO 104 and are listed for individual bearings in the tables of the publication.

Precision

Bearings are currently produced at a normal degree of precision P0, which is not marked. Bearings are also supplied for more demanding loading at higher degrees of precision, P6 and P5. The availability of precision P5 bearings must be discussed with the supplier.

The dimensional and operational precision tolerances are listed in tables 7.16a and 7.16b and are consistent with standard ISO 199.

Self-alignment ability

Bearings require that seating surface alignment tolerances be respected, because misalignment causes increased stress during contact of the balls with raceways. Thrust ball bearings with a flat housing ring face therefore should not be used, where conditions of alignment cannot be secured.

Bearings with a round housing ring face can be used for compensating misalignment (not for axial displacement) of axial bearing rings. Bearings are then installed with a spherical housing ring, and can thus compensate the above specified misalignment – see fig. 12.7.6.

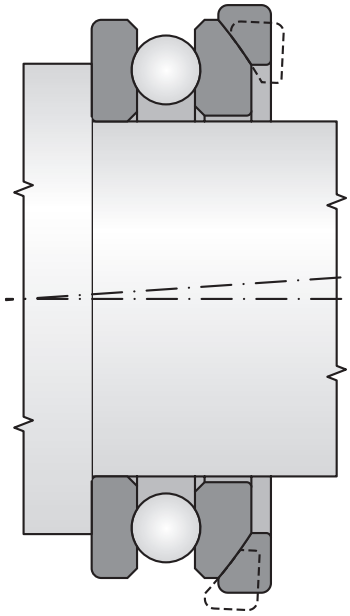


Fig. 12.7.6

Minimal load

Balls may slide between the ring raceways at higher speeds or during sudden changes in rotation. These slippages, which damage the bearings, are caused by centrifugal or inertial forces. In order to prevent damage, the axial load F_a must not drop during operation below the permitted value. We can calculate the permitted value $F_{a\,min}$ from the equation:

$$F_{a\,min} = M \left[\frac{n_{max}}{1000} \right]^2$$

$F_{a\,min}$ .... minimal axial load [kN]

n_{max} .... maximum rotation speed [min^{-1}]

M ..... coefficient of minimum axial load

The values are provided in the tables of the publication.

If it should occur that the value of the axial load drops below the value $F_{a\,min}$, which can occur e.g. wherever there is unloading of the bearing during operation, e.g. of one row of balls in a double direction bearing or one bearing when using a pair of single direction thrust bearings, resp., minimal loading must be secured, e.g. by the use of springs.

Bearing equivalent dynamic load capacity

$$P_a = F_a$$

Bearing equivalent static load capacity

$$P_{oa} = F_a$$

Additional markings

Labelling of standard bearings is specified in the tables of the publication. Divergence from the standard design is marked by additional characters.

F . . . . . Massive steel cage, guided by rolling elements

M . . . . . Massive brass cage, guided by rolling elements

P6 . . . . . Increased precision of dimensions and operation compared to the standard version (ISO 199)

P5 . . . . . Increased precision of dimensions and operation compared to P6 (ISO 199)

TNG . . . . Injected cage made from fibreglass reinforced polyamide 6.6, ball-guided

Structure of related components

As specified earlier in the article on structure, smaller bearings may have housing rings with a spherical seating surface. Housing ring with a spherical surface that carry a load between the housing ring and the bearings - "U" rings, can also be supplied for these bearings – See fig. 12.7.7.

The availability of these rings must be consulted with the supplier. Rings are made from bearing steel and are unhardened. At request and subject to approval by the supplier, hardened rings can also be supplied.

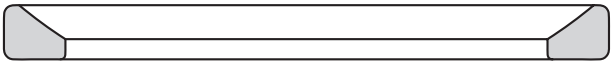
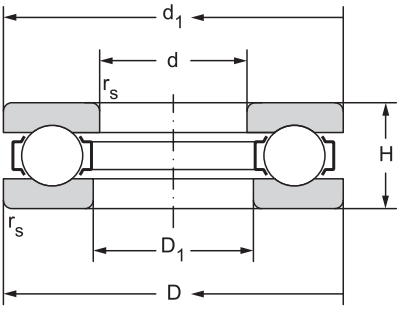


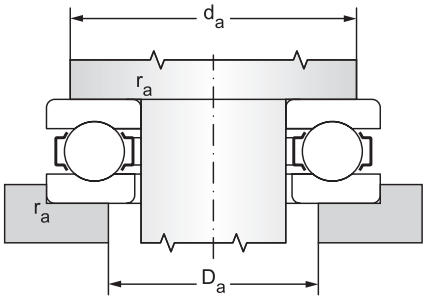
Fig. 12.7.7

Single direction thrust ball bearings d = 160 to 630 mm

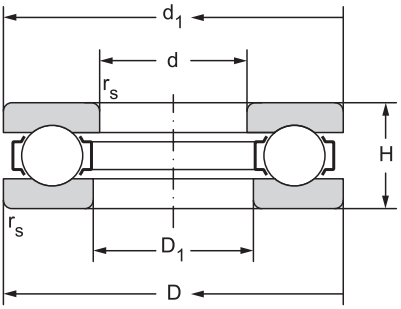


Main dimensions						Basic load rating		Fatique load limit	Limiting speed for lubrication with	
						dynamic	static			
d	D	d_1	D_1	H	r_s	C_a	C_{oa}	P_u	grease	oil
					min					
mm						kN		kN	min^{-1}	
10	24	24	11	9	0,3	11,2	14,0	0,64	7900	10600
12	26	26	13	9	0,3	11,5	15,4	0,70	7500	10000
15	28	28	16	9	0,3	11,8	16,8	0,76	7100	9400
	32	13	17	12	0,6	17,3	24,4	1,11	6000	7900
17	30	30	18	9	0,3	12,7	19,6	0,89	7100	9400
	35	35	19	12	0,6	17,8	26,6	1,21	5600	7500
20	35	35	21	10	0,3	16,8	26,6	1,21	6300	8400
	40	40	22	14	0,6	24,5	37,7	1,71	5000	6700
25	42	42	26	11	0,6	20,3	35,5	1,61	5300	7100
	47	47	27	15	0,6	30,6	50,5	2,30	4500	6000
	52	52	27	18	1,0	38,9	61,5	2,80	3800	5000
	60	60	27	24	1,0	60,5	89,4	4,06	3200	4200
30	47	47	32	11	0,6	21,1	39,9	1,81	5000	6700
	52	52	32	16	0,6	30,3	58,2	2,65	4000	5300
	60	60	32	21	1,0	44,8	78,7	3,58	3300	4500
	70	70	32	28	1,0	79,2	126,0	5,73	2700	3500
35	52	52	37	12	0,6	22,5	46,6	2,12	4700	6300
	62	62	37	18	1,0	41,8	78,2	3,55	3500	4700
	68	68	37	24	1,0	58,8	105,0	4,77	2800	3800
	80	80	37	32	1,1	94,7	155,0	7,05	2200	3000
40	60	60	42	13	0,6	30,1	62,9	2,86	4200	5600
	68	68	42	19	1,0	48,4	92,4	4,20	3200	4200
	78	78	42	26	1,0	73,5	135,0	6,14	2700	3500
	90	90	42	36	1,1	122,1	205,0	9,32	2000	2700
45	65	65	47	14	0,6	31,3	69,2	3,15	4000	5300
	73	73	47	20	1,0	47,0	105,0	4,77	3000	4000
	85	85	47	28	1,0	87,2	164,0	7,45	2400	3200
	100	100	47	39	1,1	141,7	243,0	11,1	1900	2500
50	70	70	52	14	0,6	32,3	75,5	3,43	3800	5000
	78	78	52	22	1,0	51,9	111,0	5,05	2800	3800

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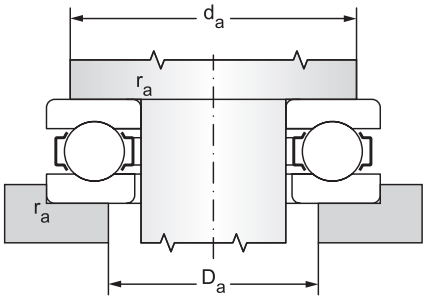


Bearing designation	Abutment and fillet dimensions			Weight	Minimum axial load factor
	d_a	D_a	r_a	~	
	min	max	max		
	mm			kg	
51100**	19	15	0,3	0,020	0,001
51101**	21	17	0,3	0,020	0,002
51102**	23	20	0,3	0,020	0,002
51202**	25	22	0,6	0,050	0,004
51103**	25	22	0,3	0,030	0,003
51203**	28	24	0,6	0,050	0,004
51104**	29	26	0,3	0,040	0,004
51204**	32	28	0,6	0,080	0,008
51105**	35	32	0,6	0,060	0,006
51205**	38	34	0,6	0,12	0,015
51305**	41	36	1,0	0,18	0,020
51405**	46	39	1,0	0,34	0,035
51106**	40	37	0,6	0,070	0,008
51206**	43	39	0,6	0,14	0,018
51306**	48	42	1,0	0,27	0,030
51406**	54	46	1,0	0,53	0,085
51107**	45	42	0,6	0,080	0,012
51207**	51	46	1,0	0,22	0,032
51307**	55	48	1,0	0,39	0,050
51407**	62	53	1,0	0,79	0,120
51108**	52	48	0,6	0,12	0,018
51208**	57	51	1,0	0,27	0,047
51308**	63	55	1,0	0,55	0,095
51408TNGN**	70	60	1,0	1,14	0,190
51109**	57	53	0,6	0,15	0,025
51209**	62	56	1,0	0,32	0,060
51309**	69	61	1,0	0,69	0,130
51409**	78	67	1,0	1,47	0,350
51110**	62	58	0,6	0,16	0,035
51210**	67	61	1,0	0,39	0,082

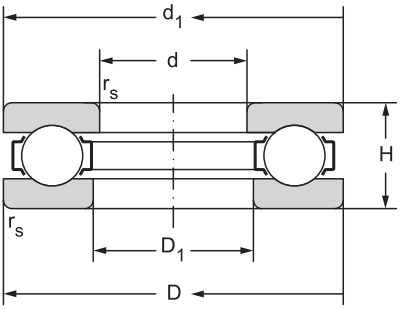


Main dimensions						Basic load rating		Fatique load limit	Limiting speed for lubrication with	
						dynamic	static			
d	D	d_1	D_1	H	r_s	C_a	C_{oa}	P_u	grease	oil
					min					
mm						kN		kN	min^{-1}	
55	78	78	57	16	0,6	36,5	93,2	4,24	3300	4500
	90	90	57	25	1,0	73,6	159,0	7,23	2500	3300
	105	105	57	35	1,1	122,6	246,0	11,2	1900	2500
	120	120	57	48	1,5	214,2	397,0	18,1	1600	2100
60	85	85	62	17	1,0	46,4	113,0	5,14	3200	4200
	110	110	62	35	1,1	125,2	270,0	12,3	1900	2500
65	90	90	67	18	1,0	44,6	117,0	5,32	2300	3400
	100	100	67	27	1,0	76,4	189,0	8,59	2400	3200
	115	115	67	36	1,1	129,3	287,0	13,1	1800	2400
70	95	95	72	18	1,0	46,6	127,0	5,77	2800	3800
	105	105	72	27	1,0	76,9	199,0	9,05	2200	3000
	125	125	72	40	1,1	158,4	340,0	15,5	1700	2200
	150	150	73	60	2,0	272,5	553,0	24,0	1200	1600
75	100	100	77	19	1,0	49,8	136,0	6,18	2700	3500
	110	110	77	27	1,0	81,2	209,0	9,50	2200	3000
	135	135	77	44	1,5	193,2	426,0	18,9	1600	2100
80	105	105	82	19	1,0	50,0	141,0	6,41	2700	3500
	115	115	82	28	1,0	86,4	219,0	9,95	2000	2700
	170	170	83	68	2,1	326,5	751,0	30,5	890	1200
85	110	110	87	19	1,0	51,5	150,0	6,82	2700	3500
	125	125	88	31	1,0	104,9	264,0	11,7	2000	2700
	150	150	88	49	1,5	227,5	517,0	21,7	1300	1800
90	120	120	92	22	1,0	66,9	190,0	8,43	2000	2700
	155	155	93	50	1,5	236,6	556,0	22,8	1100	1500
	190	187	93	77	2,1	384,8	970,0	37,3	790	1060
100	135	135	102	25	1,0	95,3	268,0	11,2	2000	2700
	170	170	103	55	1,5	266,1	628,0	24,6	1060	1400
	210	205	103	85	3,0	453,5	1220,0	44,5	750	1000
	210	205	103	85	3,0	453,5	1220,0	44,5	750	1000

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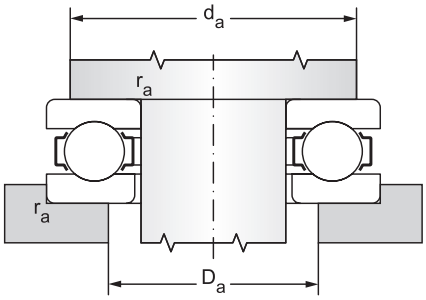


Bearing designation	Abutment and fillet dimensions			Weight	Minimum axial load factor
	d_a	D_a	r_a	~	
	min	max	max		
	mm			kg	
51111**	69	64	0,6	0,24	0,040
51211**	76	69	1,0	0,61	0,110
51311**	85	75	1,0	1,34	0,270
51411**	94	81	1,5	2,64	0,650
51112**	75	70	1,0	0,29	0,066
51312**	90	80	1,0	1,43	0,350
51113**	80	75	1,0	0,33	0,086
51213**	86	79	1,0	0,77	0,170
51313**	95	85	1,0	1,57	0,450
51114**	85	80	1,0	0,36	0,110
51214**	91	84	1,0	0,81	0,210
51314**	103	92	1,0	2,06	0,540
51414**	118	102	2,0	5,48	1,600
51115**	90	85	1,0	0,42	0,120
51215**	96	89	1,0	0,86	0,270
51315**	111	99	1,5	2,68	0,760
51116**	95	90	1,0	0,43	0,150
51216**	101	94	1,0	0,95	0,350
51416**	133	117	2,0	7,97	2,700
51117**	100	95	1,0	0,46	0,180
51217**	109	101	1,0	1,29	0,430
51317**	123	111	1,5	3,66	1,200
51118**	108	102	1,0	0,68	0,260
51318**	129	116	1,5	3,88	1,500
51418**	149	131	2,0	11,2	4,100
51120**	121	114	1,0	0,99	0,340
51320**	142	128	1,5	5,11	2,000
51420 M**	165	145	2,5	15,6	7,700
51420 F**	165	145	2,5	15,0	6,200

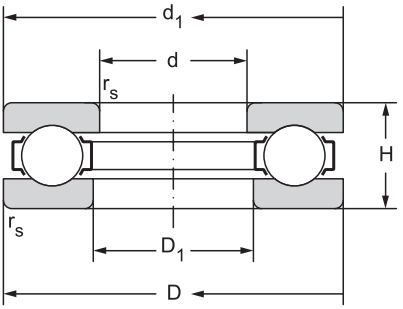


12.71

Main dimensions						Basic load rating		Fatique load limit	Limiting speed for lubrication with	
						dynamic	static			
d	D	d_1	D_1	H	r_s	C_a	C_{oa}	P_u	grease	oil
					min					
mm						kN		kN	min^{-1}	
110	145	145	112	25	1,0	97,8	288,0	11,6	1900	2500
	190	187	113	63	2,0	323,3	807,0	30,0	890	1200
	190	187	113	63	2,0	280,0	744,0	27,6	890	1200
	230	225	113	95	3,0	495,9	1400,0	48,8	670	890
	230	225	113	95	3,0	495,9	1400,0	48,8	670	890
120	155	155	122	25	1,0	95,1	308,0	11,9	1600	2100
	210	205	123	70	2,1	368,9	977,0	34,6	790	1060
	250	245	123	102	4,0	566,0	1590,0	53,1	630	840
	250	245	123	102	4,0	566,0	1590,0	53,1	630	840
130	170	170	132	30	1,0	127,3	406,0	15,1	1400	1900
	190	187	133	45	1,5	183,8	537,4	19,3	1170	1600
	225	220	134	75	2,1	389,0	1070,0	36,5	750	1000
	225	220	134	75	2,1	389,0	1070,0	36,5	750	1000
	225	220	134	75	2,1	358,0	1050,0	35,8	830	1100
	270	265	134	110	4,0	643,4	2010,0	64,6	560	750
	270	265	134	110	4,0	643,4	2010,0	64,6	560	750
140	240	235	144	80	2,1	438,8	1260,0	41,6	710	940
	240	235	144	80	2,1	438,8	1260,0	41,6	710	940
	240	235	144	80	2,1	407,0	1250,0	41,2	790	1040
150	190	188	152	31	1,0	131,6	448,0	15,6	1300	1800
	190	188	152	31	1,0	117,4	420,2	14,6	1250	1700
	190	188	152	31	1,0	117,4	420,2	14,6	1250	1700
	215	212	153	50	1,5	281,8	835,0	28,1	900	1300
	215	212	153	50	1,5	235,6	733,3	24,7	970	1400
	250	245	154	80	2,1	454,7	1360,0	43,7	670	900
	250	245	154	80	2,1	454,7	1360,0	43,7	670	900
	250	245	154	80	2,1	419,0	1340,0	43,1	750	1000
160	200	198	162	31	1,0	133,8	476,0	16,1	1300	1800
	200	198	162	31	1,0	120,6	448,2	15,2	1250	1700
	200	198	162	31	1,0	120,6	448,2	15,2	1250	1700
	225	222	163	51	1,5	288,8	874,0	28,6	890	1200
	225	222	163	51	1,5	239,2	768,2	25,2	1040	1400

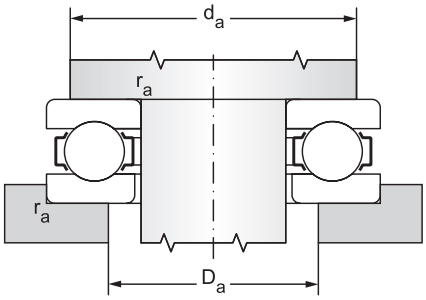


Bearing designation	Abutment and fillet dimensions			Weight	Minimum axial load factor
	d_a	D_a	r_a	~	
	min	max	max		
	mm			kg	
51122**	131	124	1,0	1,08	0,420
51322**	158	142	2,0	7,87	2,800
51322 M	158	142	2,0	7,83	3,100
51422 M**	181	159	2,5	20,2	9,000
51422 F**	181	159	2,5	20,2	9,000
51124**	141	134	1,0	1,16	0,530
51324**	173	157	2,0	10,9	4,100
51424 M**	197	173	3,0	25,5	13,000
51424 F**	197	173	3,0	25,5	13,000
51126**	154	146	1,0	1,87	0,650
51226 **	167	153	1,5	3,91	1,700
51326 M**	186	169	2,0	13,3	6,200
51326 F**	186	169	2,0	13,3	6,200
51326 M	186	168	2,0	12,9	6,000
51426 M**	213	187	3,0	32,0	18,000
51426 F**	213	187	3,0	32,0	18,000
51328 M**	199	181	2,0	15,9	8,000
51328 F**	199	181	2,0	15,9	8,000
51328 M	199	181	2,0	15,6	8,400
51130**	174	166	1,0	2,20	0,950
51130 M**	174	166	1,0	2,33	1,000
51130 F**	174	166	1,0	2,33	1,000
51230**	189	176	1,5	6,10	2,800
51230 M	189	176	1,5	6,10	3,000
51330 M**	209	191	2	16,5	10,000
51330 F**	209	191	2	16,5	10,000
51330 M	209	191	2,0	16,2	9,400
51132**	184	176	1,0	2,33	1,200
51132 M**	199	186	1,5	2,29	1,200
51132 F**	199	186	1,5	2,29	1,200
51232**	199	186	1,5	6,67	3,200
51232 M	199	186	1,5	6,49	3,300

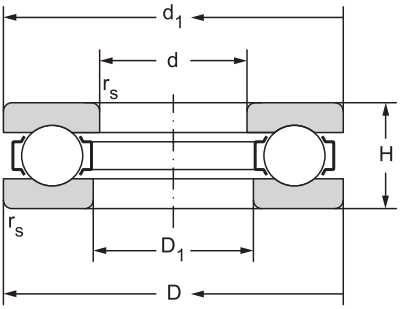


12.71

Main dimensions						Basic load rating		Fatique load limit	Limiting speed for lubrication with	
						dynamic	static			
d	D	d_1	D_1	H	r_s	C_a	C_{oa}	P_u	grease	oil
					min					
mm						kN		kN	min^{-1}	
170	215	213	172	34	1,1	160,1	582,0	19,1	1200	1600
	215	213	172	34	1,1	153,9	563,3	18,5	1100	1500
	215	213	172	34	1,1	153,9	563,3	18,5	1100	1500
	240	237	173	55	1,5	300,7	897,0	28,5	840	1100
	240	237	173	55	1,5	283,2	929,6	29,5	920	1200
180	225	222	185	34	1,1	165,6	639,0	20,4	1100	1500
	225	222	185	34	1,1	151,6	563,3	18,0	1030	1400
	225	222	185	34	1,1	151,6	563,3	18,0	1030	1400
	250	247	183	56	1,5	325,3	1030,0	31,9	840	1100
	250	245	183	56	1,5	302,6	1031,6	32,0	920	1200
	250	247	183	56	1,5	293,8	986,8	30,6	770	1050
	250	247	183	56	1,5	293,8	986,8	30,6	770	1050
190	240	237	193	37	1,1	200,1	715,0	22,2	1060	1400
	270	267	194	62	2,0	382,0	1240,0	37,2	750	1000
	270	267	194	62	2,0	382,0	1240,0	37,2	750	1000
	270	265	194	62	2,0	334,0	1170,0	35,1	830	1100
200	250	247	203	37	1,1	197,4	738,0	22,4	1060	1400
	250	247	203	37	1,1	184,2	715,1	21,7	950	1300
	250	247	203	37	1,1	184,2	715,1	21,7	950	1300
	280	277	204	62	2,0	376,6	1240,0	36,4	750	1000
	280	277	204	62	2,0	376,6	1240,0	36,4	750	1000
	280	275	204	62	2,0	339,0	1220	35,8	830	1100
220	270	267	223	37	1,1	200,1	804,5	23,4	1000	1300
	270	267	223	37	1,1	187,2	759,8	22,1	880	1200
	270	267	223	37	1,1	187,2	759,8	22,1	880	1200
240	300	297	243	45	1,5	277,1	1040,0	28,8	840	1100
	300	297	243	45	1,5	277,1	1040,0	38,6	840	1100
	340	335	244	78	2,1	460,8	2000,0	53,4	600	800
260	320	317	263	45	1,5	271,6	1120,0	29,9	800	1100
	360	355	264	79	2,1	470,5	2160,0	55,8	560	750
280	350	347	283	53	1,5	312,3	1460,0	37,4	700	950
	380	375	284	80	2,1	483,1	2320,0	58,1	560	750

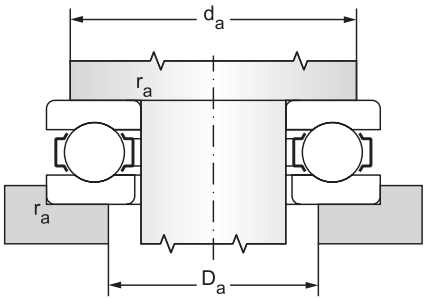


Bearing designation	Abutment and fillet dimensions			Weight	Minimum axial load factor
	d_a	D_a	r_a	~	
	min	max	max		
	mm			kg	
51134**	197	188	1,0	3,31	1,500
51134 M**	212	198	1,5	2,98	1,800
51134 F**	212	198	1,5	2,98	1,800
51234**	212	198	1,5	8,28	4,600
51234 M	212	198	1,5	8,03	4,600
51136**	207	198	1,0	3,04	1,900
51136 M**	207	198	1,0	3,11	1,900
51136 F**	207	198	1,0	3,11	1,900
51236**	222	208	1,5	8,29	5,500
51236 M**	220	208	1,5	8,51	5,500
51236 F**	222	208	1,5	8,73	5,300
51236 M	222	208	1,5	8,73	5,300
51138**	220	210	1,0	4,06	2,400
51238 M**	238	222	2,0	11,9	8,400
51238 F**	238	222	2,0	11,9	7,500
51238 M	236	222	2,0	11,6	7,300
51140**	230	220	1,0	4,00	3,100
51140 M**	230	220	1,0	4,20	2,900
51140 F**	230	220	1,0	4,20	2,900
51240 M**	248	232	2,0	12,4	9,500
51240 F**	248	232	2,0	12,4	9,500
51240 M	246	232	2,0	12,1	8,000
51144**	250	240	1,0	4,40	4,600
51144 M**	250	240	1,0	4,56	3,300
51144 F**	250	240	1,0	4,56	3,300
51148 M**	276	264	1,5	7,55	6,500
51148 F**	276	264	1,5	7,55	6,500
51248M	299	281	2,0	23,0	23,000
51152M	296	284	1,5	8,10	6,800
51285M	319	301	2,0	25,0	26,000
51156M	322	308	1,5	12,0	12,000
51256M	339	321	2,0	26,5	30,000



Main dimensions						Basic load rating		Fatique load limit	Limiting speed for lubrication with	
						dynamic	static			
d	D	d_1	D_1	H	r_s	C_a	C_{oa}	P_u	grease	oil
					min					
mm						kN		kN	min^{-1}	
300	380	376	304	62	2,0	358,9	1770,0	43,6	630	850
	420	415	304	95	3,0	589,8	3010,0	72,1	480	630
320	400	396	324	63	2,0	363,8	1860,0	44,6	600	800
	440	435	325	95	3,0	577,2	3010,0	70,2	450	600
340	420	416	344	64	2,0	368,6	1990,0	46,4	600	800
	460	456	345	96	3,0	606,3	3280,0	74,5	450	600
360	440	436	364	65	2,0	378,3	2080,0	47,3	560	750
	500	495	365	110	4,0	727,5	4200,0	92,1	400	530
380	460	456	384	65	2,0	383,2	2200,0	48,8	550	740
	520	515	385	112	4,0	704,2	4120,0	88,3	380	500
400	480	476	404	65	2,0	410,0	2300,0	49,8	530	700
420	500	496	424	65	2,0	412,0	2410,0	51,1	510	680
440	540	536	444	80	2,1	525,0	3200,0	65,7	450	600
460	560	556	464	80	2,1	530,0	3230,0	65,0	440	580
480	580	576	484	80	2,1	540,0	3290,0	65,0	430	560
500	600	596	504	80	2,1	560,0	3370,0	65,3	420	550
530	640	636	534	85	3,0	645,0	4380,0	82,3	400	530
560	670	666	564	85	3,0	665,0	4660,0	85,4	380	500
600	710	706	604	85	3,0	663,0	4800,0	85,3	370	490
630	750	746	634	95	3,0	730,0	5430,0	94,0	340	450
670	800	795	675	105	4,0	850,0	6680,0	112,0	300	400

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Bearing designation	Abutment and fillet dimensions			Weight	Minimum axial load factor
	d_a	D_a	r_a	~	
	min	max	max		
	mm			kg	
51160M	348	332	2,0	17,5	17,000
51260M	371	349	2,5	42,0	49,000
51164M	368	352	2,0	19,0	20,000
51264M	391	369	2,5	45,5	49,000
51168M	388	372	2,0	20,5	22,000
51268M	411	389	2,5	48,5	54,000
51172M	408	392	2,0	22,0	27,000
51272M	443	417	3,0	70,0	93,000
51176M	428	412	2,0	23,0	29,000
51276M	463	437	3,0	73,0	93,000
51180M**	448	432	2,0	24,0	30,000
51184M**	468	452	2,0	25,5	33,000
51188M**	499	481	2,0	42,0	59,000
51192M**	519	501	2,0	43,5	60,000
51196M**	539	521	2,0	45,5	68,000
511/500M**	559	541	2,0	46,5	70,000
511/530M**	595	575	2,5	58,5	105,000
511/560M**	625	606	2,5	61,0	116,000
511/600M**	665	645	2,5	65,0	124,000
511/630M**	701	679	2,5	84,0	158,000
511/670M**	747	723	3,0	105	234,000