Axial Bearings

For high speed main spindles

SCHAEFFLER GROUP
INDUSTRIAL

Axial bearings

Axial bearings

Features

The bearing arrangement of main spindles in machine tools are subjected to high demands. They must have high load carrying capacity and must at the same time also be suitable for high spindle speeds.

Increased load carrying capacity normally brings with it a reduction in the maximum speed. Through the use of the new axial bearings, it is now possible to unify both requirements.

The axial bearings:

- can support high axial loads
- have the speed capacity of main spindle bearings
- are highly rigid, see page 6
- can be subjected to axial loads only, not radial loads.

Figure 1
High speed axial bearing

Bearing design

The bearings correspond to the accuracy class P4S and are generally supplied as ready-to-fit sets of the arrangement DB in the preload classes L (light) and M (medium).

Cage

They are equipped with a cage made from laminated hard material.

Bore diameter

The possible bore diameters are between 50 mm and 200 mm.

Axial bearings BAX correspond in their diameter to bearings of size 70. They are thus matched to the diameters of cylindrical roller bearings N10 and NN30.

Contact angle

Axial bearings are available with a contact angle of 30° and, for even higher rigidities, also with a contact angle of 40°.

Hybrid bearings

In addition to the standard design with steel balls, the bearings are also available as a hybrid version with ceramic balls. This design has the series designation HCBAX. They can be used to achieve speed parameters up to 1 350 000 $min^{-1} \cdot mm$.

Bearing designations

The structure for axial bearings is shown in *Figure 2*.

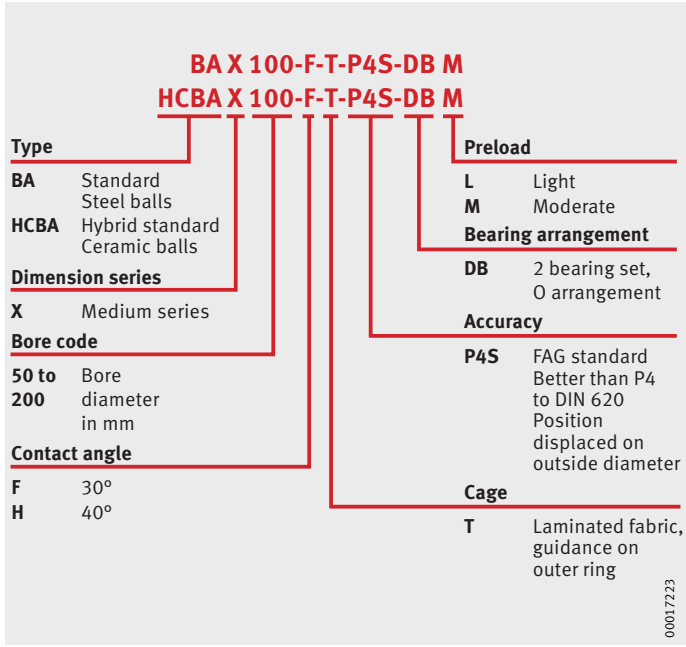


Figure 2
Bearing designations

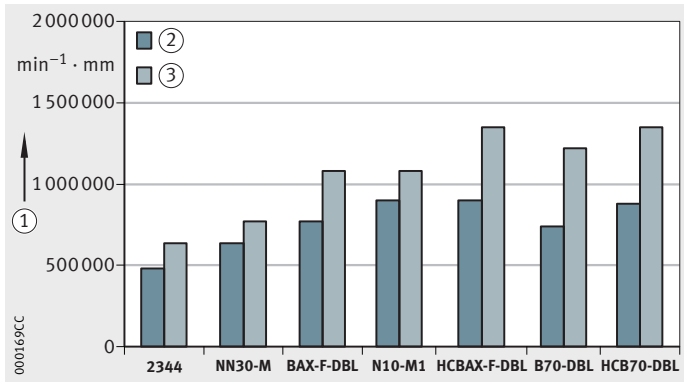
Advantages

In spindle bearing applications, axial bearings BAX facilitate excellent machining accuracies and very high cutting rates, ideally for milling spindles or machining centres.

Speeds

The high cutting output in machine tools is based on the excellent speed suitability of the axial bearings, both in the steel as well as in the hybrid version, *Figure 3*.

The achievable speeds of the axial bearings BAX are at the level of the corresponding spindle bearings. The hybrid version HCBAX-F-DBL can be used, in combination with single row cylindrical roller bearings, to achieve bearing arrangements for speed parameters up to 1 350 000 $min^{-1} \cdot mm$ with high rigidity.



① Speed parameter
② Grease lubrication
③ Minimal oil quantity lubrication

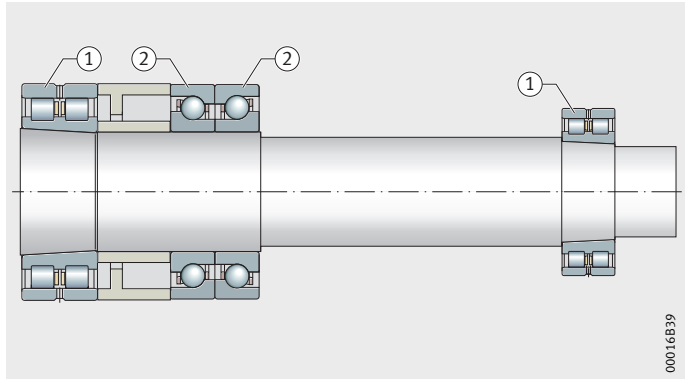
Figure 3
Comparison of speed suitability

Axial bearings

Combination with cylindrical roller bearings

In particular, combination with modern, high speed cylindrical roller bearings N10 and NN30 gives an especially robust spindle bearing arrangement, *Figure 4*.

A combined load does not impair the kinematics, since it is not necessary to support tilting moments.



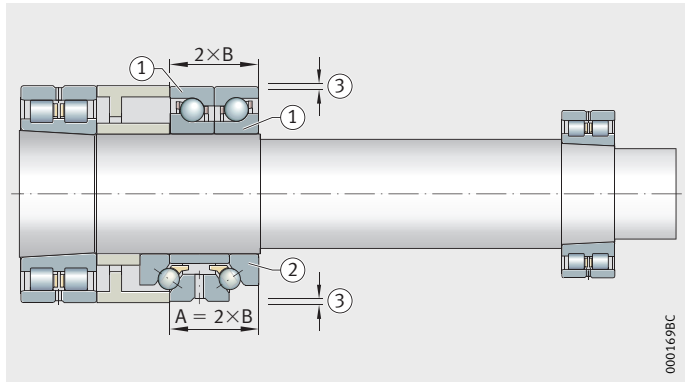
① Cylindrical roller bearing NN30
② Axial bearing BAX

Figure 4
Spindle bearing arrangement

Compatibility

Axial bearings BAX are dimensionally compatible with double direction axial angular contact ball bearings of series 2344, *Figure 5*. They are, in the same way as double direction axial angular contact ball bearings, not radially retained and thus can only support axial loads.

Substitution is possible with only slight changes to adjacent components and without changes to the shaft and housing.



A = contact width of axial angular contact ball bearing
B = width of an axial bearing BAX
① Axial bearing BAX
② Double direction axial angular contact ball bearing 2344
③ Not radially retained

Figure 5
Interchangeability

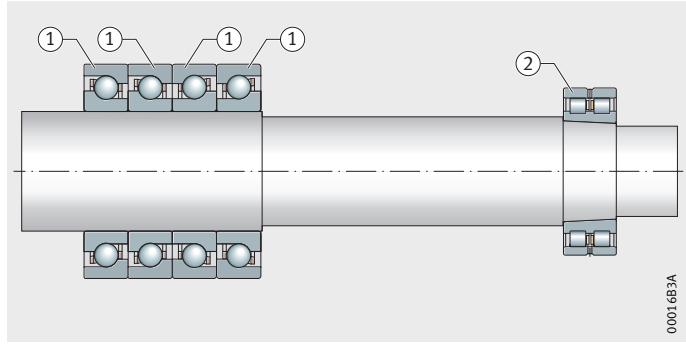
Comparison between different spindle bearing arrangements

A comparison is presented of three different spindle bearing arrangements in relation to radial and axial rigidity, see page 6, and speed suitability, see page 7.

Design of bearing arrangements

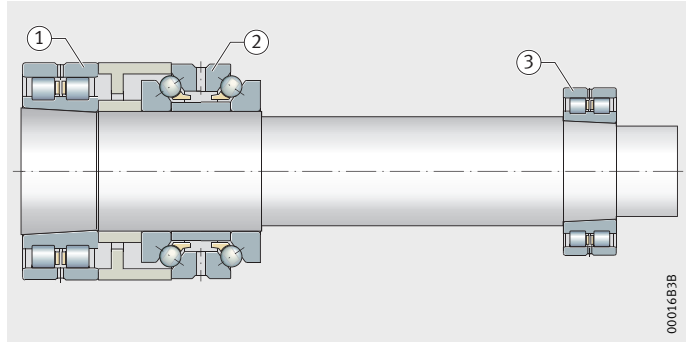
Bearing combination and arrangement:

- four spindle bearings in a tandem-O-tandem arrangement and a double row cylindrical roller bearing, *Figure 6*
- a double direction axial angular contact bearing and two double row cylindrical roller bearings, *Figure 7*
- two axial bearings and two double row cylindrical roller bearings, *Figure 8*.



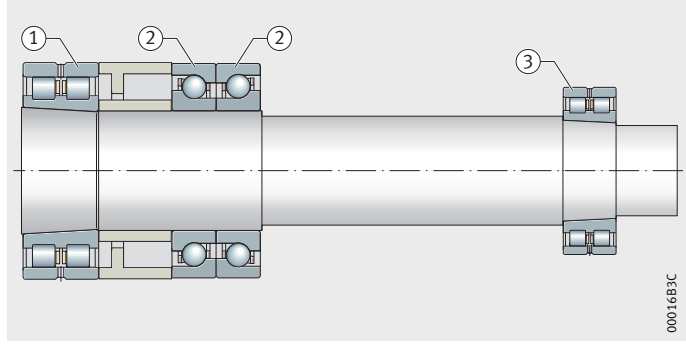
① Spindle bearing B7014-E-T-P4S-UL
② Cylindrical roller bearing NN3011-ASK-M-SP

Figure 6
Bearing arrangement with spindle bearings B70



① Cylindrical roller bearing NN3014-ASK-M-SP
② Double direction axial angular contact ball bearing 234414-M-SP
③ Cylindrical roller bearing NN3011-ASK-M-SP

Figure 7
Bearing arrangement with axial angular contact ball bearing 2344



① Cylindrical roller bearing NN3014-ASK-M-SP
② Axial bearing BAX70-F-T-P4S-UM
③ Cylindrical roller bearing NN3011-ASK-M-SP

Figure 8
Bearing arrangement with axial bearings BAX

Axial bearings

Axial and radial rigidity

The bearing arrangement in machine tools is subjected to frequently changing requirements. In order to achieve the highest possible machining accuracy, high basic rigidity values are an important target.

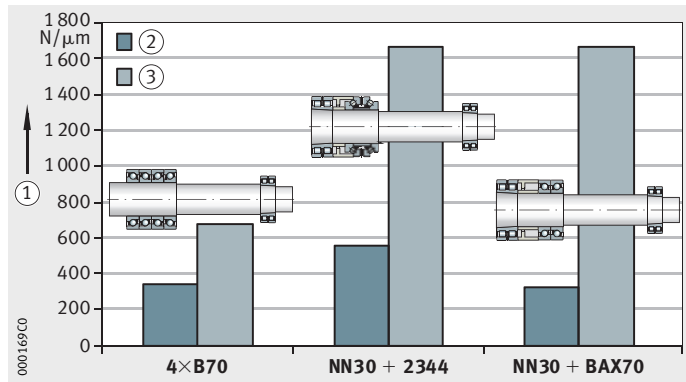
Increased radial rigidity

When using cylindrical roller bearings NN30, this gives the arrangement with axial angular contact ball bearings 2344 and the arrangement with axial bearings BAX a rigidity approximately 2,5 times greater than in the case of four spindle bearings B70 of the same size, *Figure 9*.

Uniform axial rigidity

The axial rigidity with axial bearings BAX is at the level of the bearing arrangement variants with the spindle bearings.

The advantage when using the double direction axial angular contact ball bearings is 60%, *Figure 9*.



① Rigidity
② Axial
③ Radial

Figure 9
Axial and radial rigidity

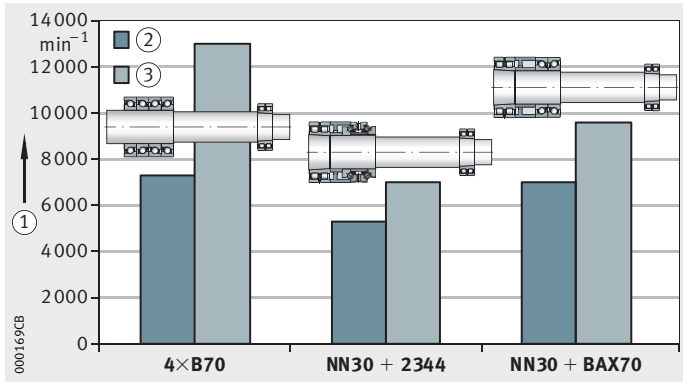
Speed suitability

In order that machine tools can achieve high cutting output, the bearing arrangement of the main spindle must be suitable for high speeds.

Increased machine speed

The bearing designs with axial bearings (NN30 + BAX70) achieve significantly higher maximum speeds in comparison with the bearing design utilising the axial angular contact ball bearing (NN30 + 2344). This is valid in the case of grease lubrication as well as in the case of minimal oil quantity lubrication.

In comparison with the design with the spindle bearings (4×B70), the maximum speed of the bearing arrangement with axial bearings (NN30 + BAX70) when using grease lubrication is at the same level. When using minimal oil quantity lubrication, however, the achievable speed capacity is lower. This is due to the lower speed suitability of the cylindrical roller bearings NN30, *Figure 10*.

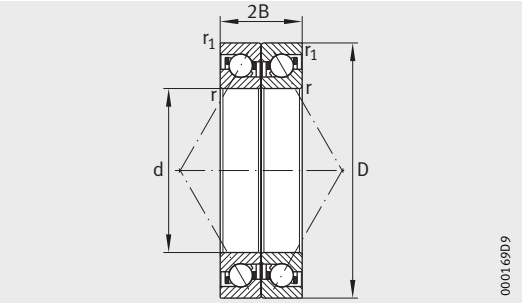


① Speed
② Grease
③ Minimal oil quantity

Figure 10
Maximum speeds of bearing designs

Axial bearings

Arrangement DB



BAX..-F-T-P4S-DB, BAX..-H-T-P4S-DB

Dimension table · Dimensions in mm

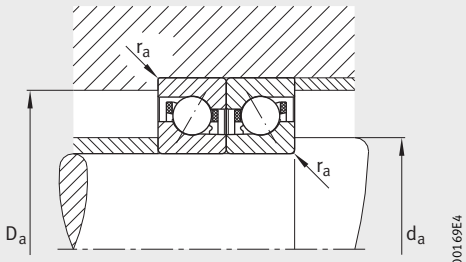
Designation	Mass	Dimensions					Contact angle	Mounting dimensions			
	m	d	D	2B	r	r_1	α	d_a h12	D_a H12	r_a	r_{a1}
	≈kg				min.	min.	°			max.	max.
BAX50-F-T-P4S-DB	0,5	**50**	80	28,5	1	0,6	30	57	73	1	0,6
BAX50-H-T-P4S-DB	0,5	**50**	80	28,5	1	0,6	40	57	73	1	0,6
BAX55-F-T-P4S-DB	0,74	**55**	90	33	1,1	0,6	30	63,5	81,5	1,1	0,6
BAX55-H-T-P4S-DB	0,74	**55**	90	33	1,1	0,6	40	63,5	81,5	1,1	0,6
BAX60-F-T-P4S-DB	0,8	**60**	95	33	1,1	0,6	30	68,5	86,5	1,1	0,6
BAX60-H-T-P4S-DB	0,8	**60**	95	33	1,1	0,6	40	68,5	86,5	1,1	0,6
BAX65-F-T-P4S-DB	0,84	**65**	100	33	1,1	0,6	30	73,5	91,5	1,1	0,6
BAX65-H-T-P4S-DB	0,84	**65**	100	33	1,1	0,6	40	73,5	91,5	1,1	0,6
BAX70-F-T-P4S-DB	1,18	**70**	110	36	1,1	0,6	30	80,5	99,5	1,1	0,6
BAX70-H-T-P4S-DB	1,18	**70**	110	36	1,1	0,6	40	80,5	99,5	1,1	0,6
BAX75-F-T-P4S-DB	1,24	**75**	115	36	1,1	0,6	30	85,5	104,5	1,1	0,6
BAX75-H-T-P4S-DB	1,24	**75**	115	36	1,1	0,6	40	85,5	104,5	1,1	0,6
BAX80-F-T-P4S-DB	1,68	**80**	125	40,5	1,1	0,6	30	91	113,5	1,1	0,6
BAX80-H-T-P4S-DB	1,68	**80**	125	40,5	1,1	0,6	40	91	113,5	1,1	0,6
BAX85-F-T-P4S-DB	1,98	**85**	130	40,5	1,1	0,6	30	96	118,5	1,1	0,6
BAX85-H-T-P4S-DB	1,98	**85**	130	40,5	1,1	0,6	40	96	118,5	1,1	0,6
BAX90-F-T-P4S-DB	2,3	**90**	140	45	1,5	0,6	30	102	128	1,5	0,6
BAX90-H-T-P4S-DB	2,3	**90**	140	45	1,5	0,6	40	102	128	1,5	0,6
BAX95-F-T-P4S-DB	2,4	**95**	145	45	1,5	0,6	30	107	133	1,5	0,6
BAX95-H-T-P4S-DB	2,4	**95**	145	45	1,5	0,6	40	107	133	1,5	0,6

All data apply to a bearing pair of the arrangement DB.

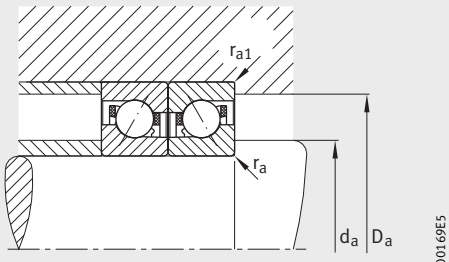
1) Minimal oil quantity lubrication.

2) L = light preload.

3) M = medium preload.



Mounting dimensions

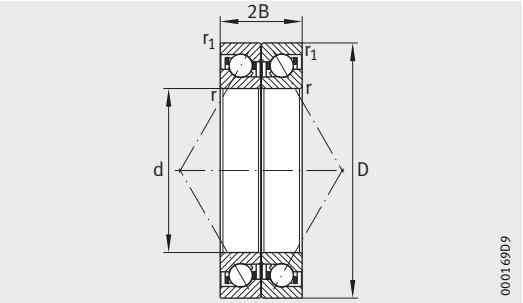


Mounting dimensions

Basic load ratings		Limiting speeds		Preload force F_v		Lift-off force K_{aE}		Axial rigidity c_a	
dyn. C_r	stat. C_{0r}	n_G grease	n_G oil[1]	L[2]	M[3]	L[2]	M[3]	L[2]	M[3]
N	N	min^{-1}	min^{-1}	N	N	N	N	N/µm	N/µm
34 000	26 200	13 000	18 000	88	436	252	1 269	129	226
31 000	23 600	11 000	15 000	116	645	330	1 850	217	391
36 000	32 400	11 000	16 000	93	457	265	1 326	135	236
37 000	29 200	9 500	14 000	156	804	445	2 306	248	435
42 000	34 200	11 000	15 000	117	545	334	1 583	148	254
38 000	30 800	9 000	13 000	159	818	452	2 345	252	442
44 000	37 600	10 000	14 000	126	580	359	1 681	155	264
39 000	33 800	8 500	12 000	168	859	476	2 459	263	459
51 000	44 000	9 000	13 000	157	692	447	2 005	171	288
46 000	39 600	7 500	11 000	211	1 024	599	2 929	292	501
52 000	46 200	8 500	12 000	156	699	446	2 024	176	297
47 000	41 000	7 500	10 000	211	1 036	600	2 964	300	517
68 000	60 000	8 000	11 000	227	945	648	2 738	204	337
61 000	54 000	6 700	9 500	323	1 436	917	4 110	355	591
69 000	63 000	7 500	11 000	230	964	657	2 791	211	348
62 000	56 000	6 300	9 000	322	1 446	915	4 137	364	608
86 000	75 000	7 000	10 000	313	1 235	896	3 581	231	375
76 000	68 000	6 000	8 500	441	1 844	1 253	5 279	400	653
87 000	79 000	6 700	9 500	309	1 243	885	3 610	245	401
77 000	71 000	5 600	8 000	435	1 857	1 236	5 321	424	697

Axial bearings

Arrangement DB



BAX..-F-T-P4S-DB, BAX..-H-T-P4S-DB

Dimension table (continued) · Dimensions in mm

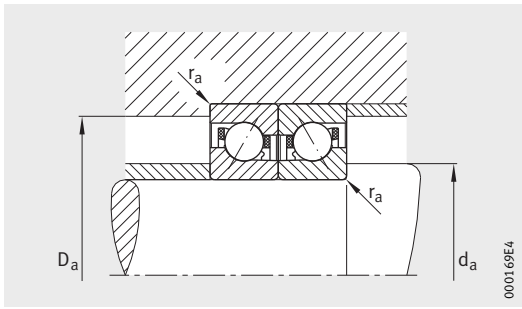
Designation	Mass	Dimensions					Contact angle	Mounting dimensions			
	m	d	D	2B	r	r_1	α	d_a h12	D_a H12	r_a	r_{a1}
	≈kg				min.	min.	°			max.	max.
BAX100-F-T-P4S-DB	2,52	**100**	150	45	1,5	0,6	30	112	138	1,5	0,6
BAX100-H-T-P4S-DB	2,52	**100**	150	45	1,5	0,6	40	112,	138	1,5	0,6
BAX105-F-T-P4S-DB	3,2	**105**	160	49,5	2	1	30	119,5	145,5	2	1
BAX105-H-T-P4S-DB	3,2	**105**	160	49,5	2	1	40	119,5	145,5	2	1
BAX110-F-T-P4S-DB	4	**110**	170	54	2	1	30	125,5	154,5	2	1
BAX110-H-T-P4S-DB	4	**110**	170	54	2	1	40	125,5	154,5	2	1
BAX120-F-T-P4S-DB	4,2	**120**	180	54	2	1	30	135,5	164,5	2	1
BAX120-H-T-P4S-DB	4,2	**120**	180	54	2	1	40	135,5	164,5	2	1
BAX130-F-T-P4S-DB	6,4	**130**	200	63	2	1	30	147,5	182,5	2	1
BAX130-H-T-P4S-DB	6,4	**130**	200	63	2	1	40	147,5	182,5	2	1
BAX140-F-T-P4S-DB	6,8	**140**	210	63	2	1	30	157,5	192,5	2	1
BAX140-H-T-P4S-DB	6,8	**140**	210	63	2	1	40	157,5	192,5	2	1
BAX150-F-T-P4S-DB	8,2	**150**	225	67,5	2,1	1,1	30	169	206	2,1	1,1
BAX150-H-T-P4S-DB	8,2	**150**	225	67,5	2,1	1,1	40	169	206	2,1	1,1
BAX160-F-T-P4S-DB	10,2	**160**	240	72	2,1	1,1	30	180,5	219,5	2,1	1,1
BAX160-H-T-P4S-DB	10,2	**160**	240	72	2,1	1,1	40	180,5	219,5	2,1	1,1
BAX170-F-T-P4S-DB	13,4	**170**	260	81	2,1	1,1	30	192,5	237,5	2,1	1,1
BAX170-H-T-P4S-DB	13,4	**170**	260	81	2,1	1,1	40	192,5	237,5	2,1	1,1
BAX180-F-T-P4S-DB	17,8	**180**	280	90	2,1	1,1	30	204	255,5	2,1	1,1
BAX180-H-T-P4S-DB	17,8	**180**	280	90	2,1	1,1	40	204	255,5	2,1	1,1
BAX190-F-T-P4S-DB	18,6	**190**	290	90	2,1	1,1	30	214	265,5	2,1	1,1
BAX190-H-T-P4S-DB	18,6	**190**	290	90	2,1	1,1	40	214	265,5	2,1	1,1
BAX200-F-T-P4S-DB	24	**200**	310	99	2,1	1,1	30	229	280,5	2,1	1,1
BAX200-H-T-P4S-DB	24	**200**	310	99	2,1	1,1	40	229	280,5	2,1	1

All data apply to a bearing pair of the arrangement DB.

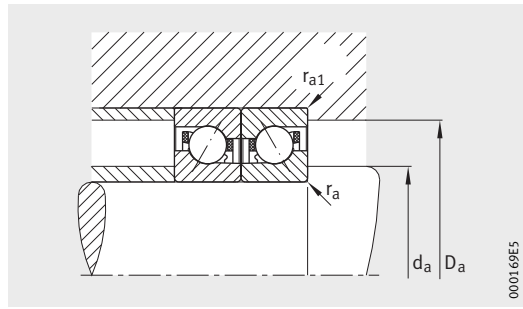
4) Minimal oil quantity lubrication.

5) L = light preload.

6) M = medium preload.



Mounting dimensions



Mounting dimensions

Basic load ratings		Limiting speeds		Preload force F_v		Lift-off force K_{aE}		Axial rigidity c_a	
dyn. C_r	stat. C_{0r}	n_G grease	n_G oil[4]	L[5]	M[6]	L[5]	M[6]	L[5]	M[6]
N	N	min^{-1}	min^{-1}	N	N	N	N	N/µm	N/µm
89 000	83 000	6 300	9 000	313	1 261	895	3 662	253	413
79 000	74 000	5 600	8 000	439	1 888	1 249	5 410	437	720
90 000	87 000	6 000	8 500	311	1 273	891	3 699	264	434
80 000	78 000	5 300	7 500	430	1 884	1 221	5 401	454	753
108 000	104 000	5 600	8 000	398	1 565	1 139	4 548	291	472
97 000	93 000	4 800	7 000	569	2 363	1 619	6 776	505	823
113 000	112 000	5 300	7 500	411	1 626	1 175	4 723	309	502
102 000	102 000	4 500	6 300	590	2 468	1 678	7 076	538	879
155 000	150 000	4 800	7 000	632	2 339	1 809	6 804	353	562
139 000	136 000	4 000	6 000	923	3 559	2 625	10 209	618	983
162 000	164 000	4 500	6 700	651	2 424	1 862	7 047	376	599
144 000	148 000	3 800	5 600	939	3 658	2 672	10 489	656	1 045
173 000	178 000	4 300	6 000	706	2 610	2 020	7 584	392	623
154 000	158 000	3 600	5 300	1 018	3 930	2 896	11 266	683	1 086
191 000	200 000	4 000	5 600	786	2 891	2 250	8 400	423	670
170 000	180 000	3 400	4 800	1 142	4 370	3 248	12 526	738	1 170
243 000	250 000	3 800	5 300	1 064	3 776	3 045	10 975	468	733
217 000	224 000	3 200	4 500	1 571	5 755	4 470	16 503	822	1 284
305 000	312 000	3 400	5 000	1 391	4 822	3 985	14 022	521	810
272 000	280 000	3 000	4 300	2 073	7 375	5 899	21 151	917	1 419
310 000	326 000	3 400	4 800	1 133	4 458	3 239	12 936	499	808
279 000	292 000	2 800	4 000	1 632	6 776	4 639	19 413	869	1 415
315 000	342 000	3 200	4 500	1 141	4 511	3 260	13 084	513	832
282 000	306 000	2 600	3 800	1 630	6 821	4 634	19 536	892	1 455

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