NIBC

NRB-IBC BEARINGS PVT. LTD.

Super Precision Bearings

Super Precision Bearings

TI-101-01-15

Date of this version: April 2015

Table of contents

1. Introduction

NRB - IBC Bearings Pvt. Ltd. (NIBC) is a joint venture of NRB Industrial Bearings Ltd, India and IBC Walzlager GMBH, Industrial Bearings and Components, Germany / IBC Industrial Bearings and Components AG, Switzerland.

IBC, has an experience of more than 40 years in the business of high precision bearings. Production facilities of IBC are in Germany and Switzerland.

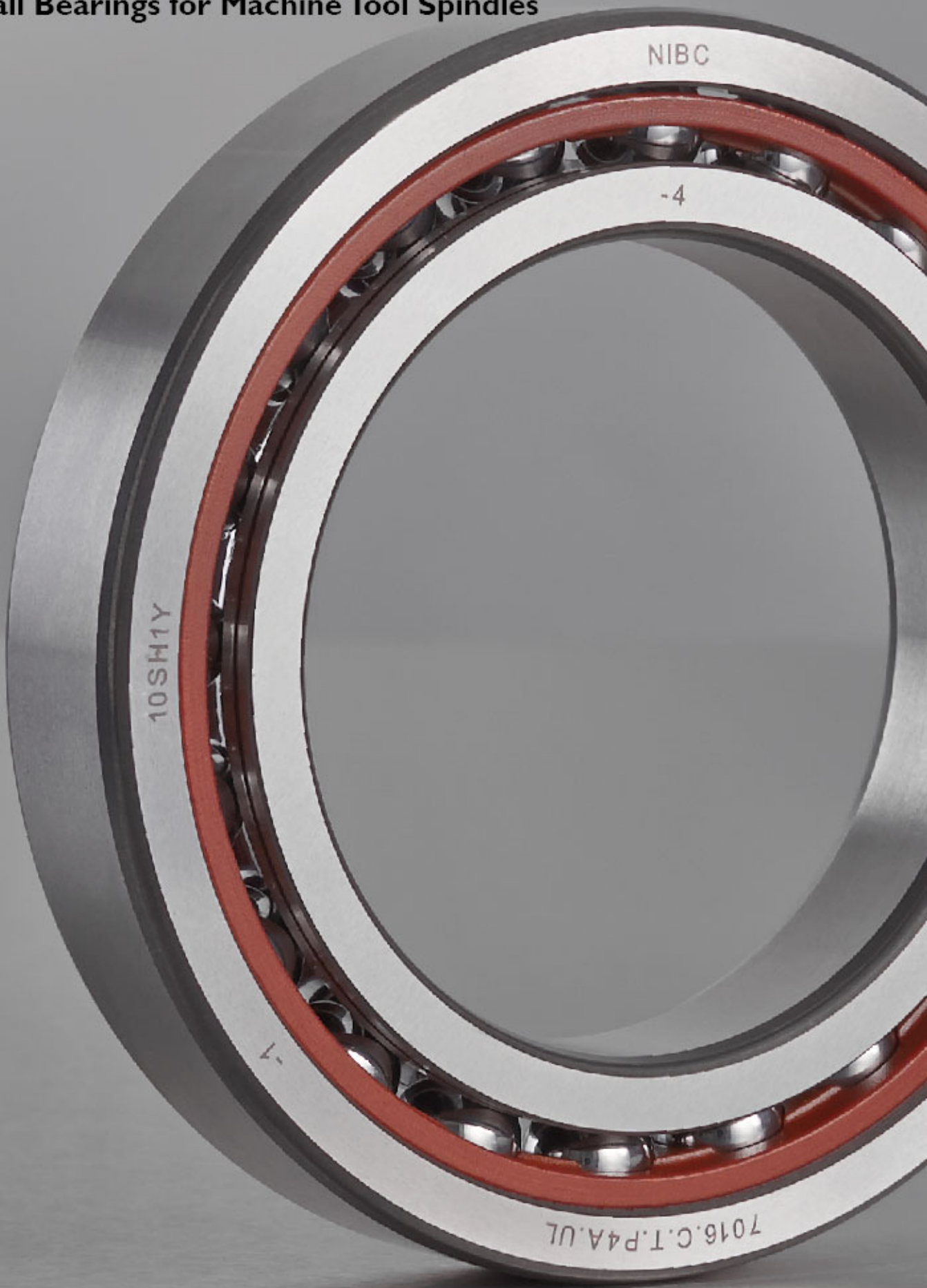
NIBC has a state of the art production facility in Shendra (Aurangabad), India which is equipped with the latest machinery and inspection technology from Europe.

NIBC is the first Indian company manufacturing Super Precision Angular Contact Ball Bearings with the aim to fulfil the demand on the Indian Machine Tool Industry with these Super Precision Spindle Bearings and Super Precision Ball Screw Support Bearings.

NIBC is focused on development and production of Super Precision Bearings of the highest quality. Continuous quality control instruments like Six Sigma and Kaizen are part of our manufacturing processes. Our efficient quality management system has been implemented and certified according ISO 9001:2008 for the engineering, design, development, manufacturing and sales of high precision bearings.

NIBC is committed and responsible towards compliance with safety and environmental aspects to guarantee the consistently high quality of the products.

2. NIBC Super Precision Angular Contact Ball Bearings for Machine Tool Spindles



2. NIBC Super Precision Angular Contact Ball Bearings for Machine Tool Spindles

NIBC Super precision angular contact ball bearings are designed for all roller bearing applications with great requirements on reliability, stiffness, speed capability and running accuracy; either as a single requirement or as a combination of the above.

The NIBC product range allows spindle manufacturers across different sectors of industry as well as special-purpose machine designers to optimise their spindles by focusing on the aspects that are most important to them.

To achieve improved performance and reduced costs for rolling bearings, the specific requirements for running accuracy, load carrying capacity, rotational capacity, stiffness, vibration characteristics and installation space a wide variety of bearing is needed. Each series of Super Precision Bearings offers different solutions and dimensions and has different design characteristics.

Dimensional series

The NIBC product range contains many different variations of single-row Super precision angular contact ball bearings.

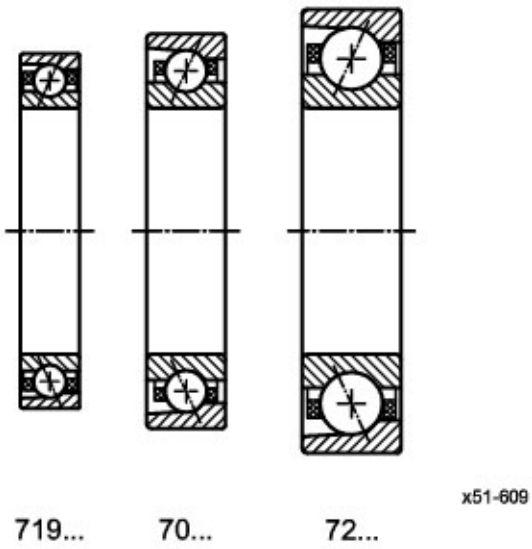


Fig.1: Dimensional series for NIBC Super Precision Angular Contact Ball Bearings

According to the German standard DIN 616 each type is assigned a dimensional series that consists of a diameter series and a width series. The dimensional series defines the outside diameter D, the bearing width B and the corner radii 'r'.

The identification number for the dimensional series is prefixed by the code "7",which means angular contact ball bearing. Each dimensional series has special characteristics that make the bearing suitable to different applications.

The dimensional series 719… and 70… are used for higher speed or small radial cross-sections, whereas dimensional series 72…is used for high loads with relatively low speeds. If there are great requirements on the stiffness of rolling bearings, it is usually best to choose Super Precision Angular Contact Ball Bearings from dimensional series 719…. This series has the greatest possible number of rolling elements and give the designer the opportunity for large shaft diameters with a given outside diameter.

Contact angle

The contact angle is defined as the angle between an imaginary straight line joining the contact points of the rolling elements with the raceways and a line perpendicular to the rotational axis.

NIBC has tailored the internal design of its Super Precision Angular Contact Ball Bearings according to the diverse requirements of the machine tool building industry. NIBC therefore offers as standard Super precision angular contact ball bearings with two different contact angles. Each dimensional series is designed with a contact angle of 15° (suffix C) or 25° (suffix E).

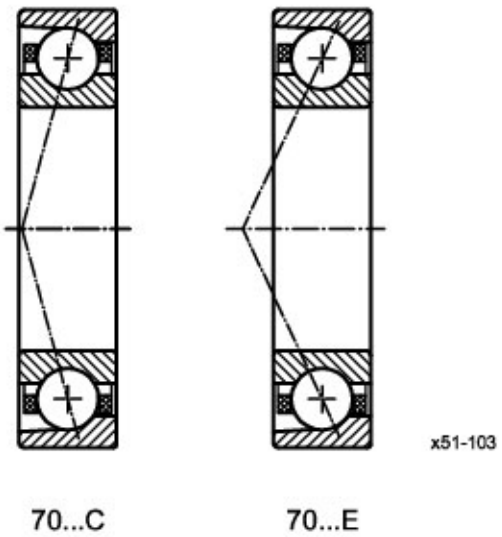


Fig.2: Contact angles for NIBC Super Precision Angular Contact Ball Bearings

The different contact angles meet individual requirements for combined loads with regard to stiffness and rotational speed characteristics.

Designs

As an option NIBC Super precision angular contact ball bearings can be supplied with ceramic rolling elements in order to achieve higher speeds.

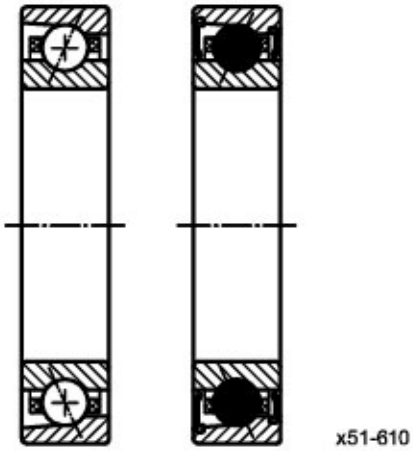


Fig.3:Standard design and design with ceramic rolling elements of the same dimensional series

The so-called hybrid bearings retain the original bearing geometry but are equipped with ceramic rolling elements.

Hybrid bearings equipped with ceramic rolling elements and rings made of bearing steel are used not only in high-speed applications.They have many advantages like reliability and extended grease service life. Ceramic rolling elements are harder and lighter and therefore reducing the rolling bearing's heat output and the wear of the lubricant. They also improve rolling conditions in an unfavourable lubrication enviroment and provide insulation to prevent electrical current flowing through the bearing. This reduces the system costs.

Bearing materials

Rolling bearing rings and rolling elements are generally manufactured from vacuum degassed bearing steel 100Cr6 (1.3505). Ceramic rolling elements are also available in the ceramic material silicon nitride Si_3N_4.

Heat treatment

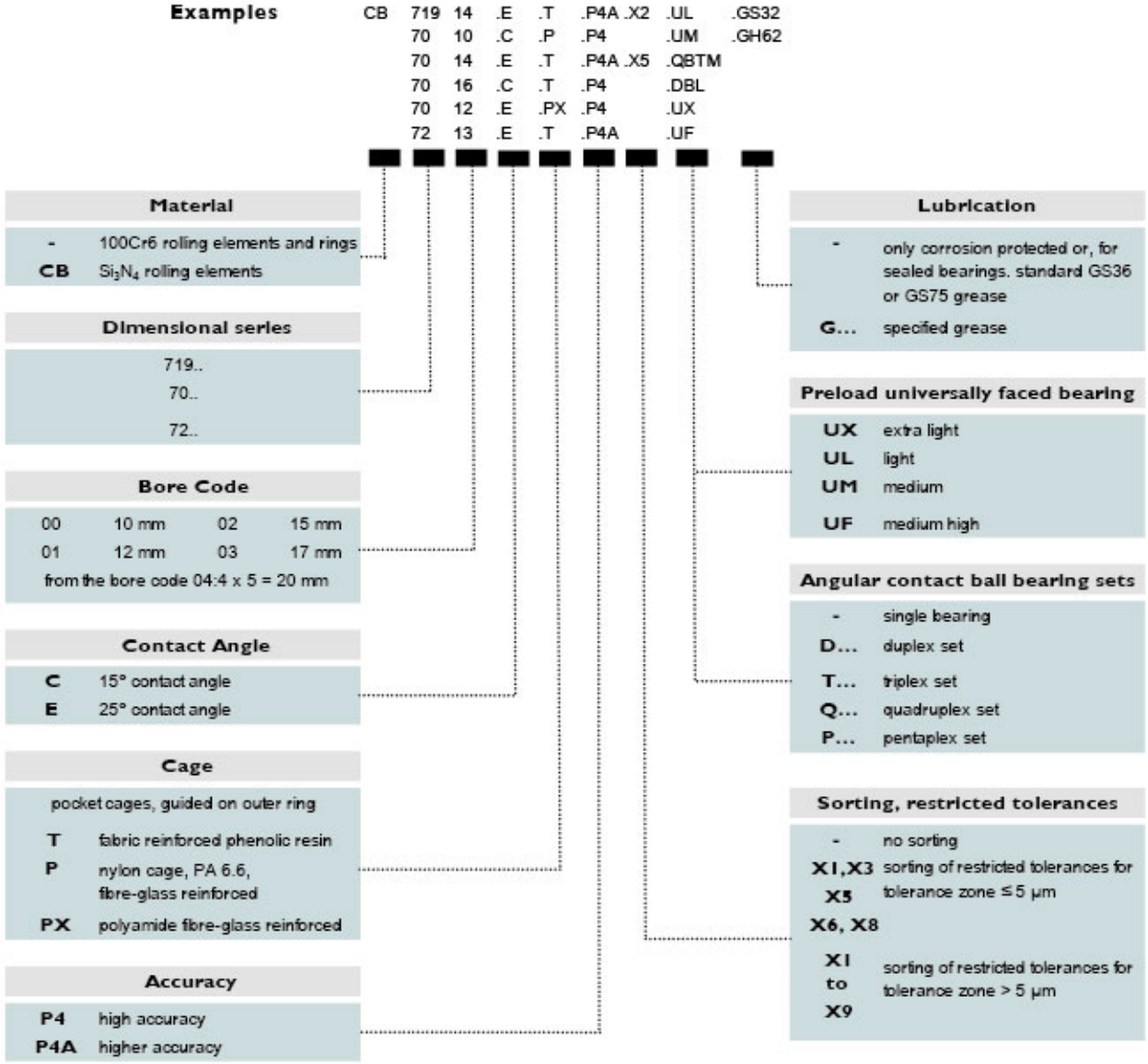
The bearing rings are, as standard, stabilised up to a service temperature of 150 °C.

Cages

As standard, NIBC Super precision angular contact ball bearings are equipped with a fabric reinforced phenolic resin cage that already meets the requirements of many applications.

The NIBC Super precision angular contact ball bearings in the range 7004 to 7009 are also available with Polyamide (PA6) cage.

2.1 Designation system

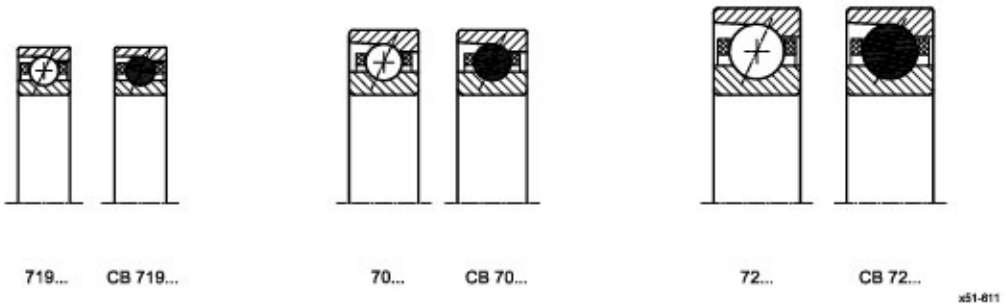


2.2 Product range

719...
CB 719...

70...
CB 70...

72...
CB 72...



Production series

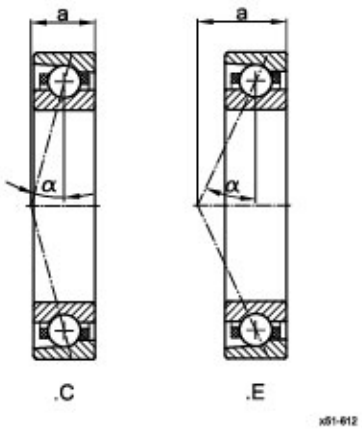
d	719...			70...			72...		
		D	B		D	B		D	B
mm		mm			mm			mm	
17							7203	40	12
20	71904	37	9	7004	42	12	7204	47	14
25	71905	42	9	7005	47	12	7205	52	15
30	71906	47	9	7006	55	13	7206	62	16
35	71907	55	10	7007	62	14	7207	72	17
40	71908	62	12	7008	68	15	7208	80	18
45	71909	68	12	7009	75	16	7209	85	19
50	71910	72	12	7010	80	16	7210	90	20
55	71911	80	13	7011	90	18	7211	100	21
60	71912	85	13	7012	95	18	7212	110	22
65	71913	90	13	7013	100	18	7213	120	23
70	71914	100	16	7014	110	20	7214	125	24
75	71915	105	16	7015	115	20			
80	71916	110	16	7016	125	22			
85	71917	120	18	7017	130	22			
90	71918	125	18	7018	140	24			
95	71919	130	18						
100	71920	140	20						

2.3 Product range and technical data

719 C / E
CB 719 C / E

70 C / E
CB 70 C / E

72 C / E
CB 72 C / E

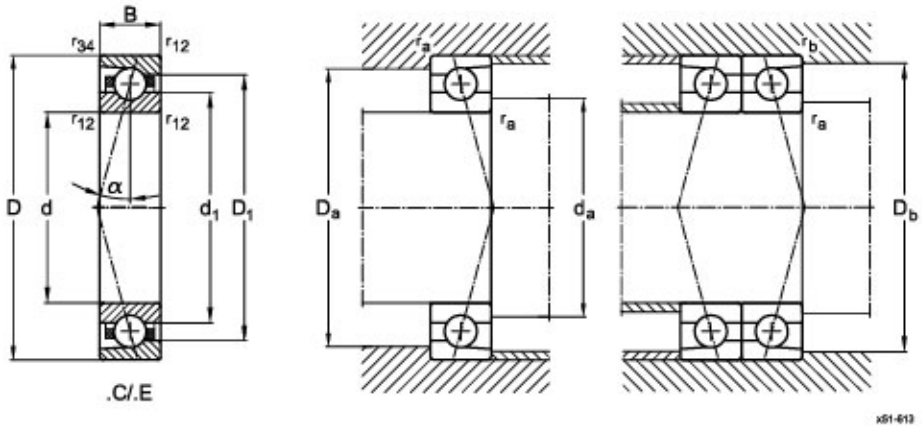


Basic dimensions			Basic designation	Load ratings			Speed		Injection diameter	Effective load centre	Precision locknut
				dyn.	stat.	fatigue load	grease	oil/air			
d	D	B		C	C_0	C_u (radial)	n_G	n_O	d_{pi}	a	
mm				N			min^{-1}		mm		
17	40	12	**7203.C**	11.000	6.000	222	39.000	57.000	24.8	10.0	MMR 17
			CB 7203.C	11.000	4.200	156	50.700	74.100			
			7203.E	10.500	5.800	215	35.100	51.300	24.8	13.0	
			CB 7203.E	10.500	4.000	148	45.700	66.700			
20	37	9	**71904.C**	7.200	4.400	163	41.000	62.500	26.1	8.0	MBA 20
			CB 71904.C	7.200	3.000	111	53.300	81.300			
			71904.E	6.800	4.200	156	36.900	56.300	26.1	11.0	
			CB 71904.E	6.800	2.900	107	48.000	73.200			
	42	12	**7004.C**	10.600	6.200	230	36.500	54.000	27.4	10.0	MBA 20
			CB 7004.C	10.600	4.300	159	47.500	70.200			
			7004.E	10.200	5.900	219	32.900	48.600	28.2	13.0	
			CB 7004.E	10.200	4.100	152	42.800	63.200			
	47	14	**7204.C**	15.000	8.500	315	31.500	47.300	30.4	12.0	MBA 20
			CB 7204.C	15.000	5.900	219	41.000	61.500			
			7204.E	14.500	8.000	296	28.400	42.600	30.4	15.0	
			CB 7204.E	14.500	5.600	207	37.000	55.400			
25	42	9	**71905.C**	8.000	5.600	207	36.000	53.000	31.1	9.0	MBA 25
			CB 71905.C	8.000	3.900	144	46.800	68.900			
			71905.E	7.700	5.300	196	32.400	47.700	31.1	12.0	
			CB 71905.E	7.700	3.700	137	42.200	62.100			
	47	12	**7005.C**	15.000	9.300	344	31.000	46.000	33.,6	11.0	MBA 25
			CB 7005.C	15.000	6.500	241	40.300	59.800			
			7005.E	14.000	9.000	333	27.900	41.400	32.9	15.0	
			CB 7005.E	14.000	6.300	233	36.300	53.900			
	52	15	**7205.C**	15.800	9.500	352	28.500	41.000	36.1	13.0	MBA 25
			CB 7205.C	15.800	6.600	244	37.100	53.300			
			7205.E	15.200	9.200	341	25.700	36.900	36.1	17.0	
			CB 7205.E	15.200	6.400	237	33.500	48.000			

719 C / E
CB 719 C / E

70 C / E
CB 70 C / E

72 C / E
CB 72 C / E

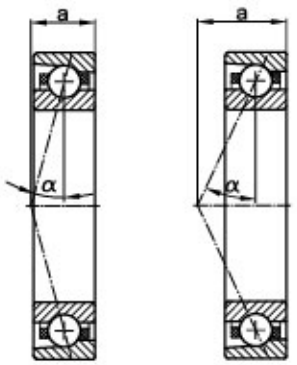


Basic dimensions			Basic designation	Dimensions				Weight	Mounting Dimensions				
d	D	B		d_1	D_1	r_{12min}	r_{34min}	m	$d_{a.min}$	$D_{a.max}$	$D_{b.max}$	$r_{a.max}$	$r_{b.max}$
mm				mm				kg	mm				
17	40	12	**7203.C**	23.8	32.0	0.6	0.3	0.060	22.4	34.3	34.0	0.6	0.3
			CB 7203.C					0.055					
			7203.E	23.8	32.0	0.6	0.3	0.060	22.4	34.3	34.0	0.6	0.3
			CB 7203.E					0.055					
20	37	9	**71904.C**	25.3	31.8	0.3	0.15	0.036	24.0	34.5	35.7	0.3	0.15
			CB 71904.C					0.033					
			71904.E	25.3	31.8	0.3	0.15	0.036	24.0	34.5	35.7	0.3	0.15
			CB 71904.E					0.033					
	42	12	**7004.C**	26.6	35.5	0.6	0.3	0.065	25.0	37.0	39.5	0.6	0.3
			CB 7004.C					0.060					
			7004.E	26.6	35.5	0.6	0.3	0.065	25.0	37.0	39.5	0.6	0.3
			CB 7004.E					0.060					
	47	14	**7204.C**	29.2	37.9	0.6	0.3	0.106	26.4	40.4	40.2	0.6	0.3
			CB 7204.C					0.098					
			7204.E	29.2	37.9	0.6	0.3	0.106	26.4	40.4	40.2	0.6	0.3
			CB 7204.E					0.098					
25	42	9	**71905.C**	30.3	37.0	0.3	0.15	0.042	29.0	39.5	40.7	0.3	0.15
			CB 71905.C					0.039					
			71905.E	30.3	37.0	0.3	0.15	0.042	29.0	39.5	40.7	0.3	0.15
			CB 71905.E					0.039					
	47	12	**7005.C**	32.6	41.3	0.6	0.3	0.075	30.0	42.0	44.5	0.6	0.3
			CB 7005.C					0.069					
			7005.E	32.6	41.3	0.6	0.3	0.075	30.0	42.0	44.5	0.6	0.3
			CB 7005.E					0.069					
	52	15	**7205.C**	34.7	43.3	1.0	0.6	0.128	31.4	45.4	45.2	1.0	0.6
			CB 7205.C					0.118					
			7205.E	34.7	43.3	1.0	0.6	0.128	31.4	45.4	45.2	1.0	0.6
			CB 7205.E					0.118					

719 C / E
CB 719 C / E

70 C / E
CB 70 C / E

72 C / E
CB 72 C / E

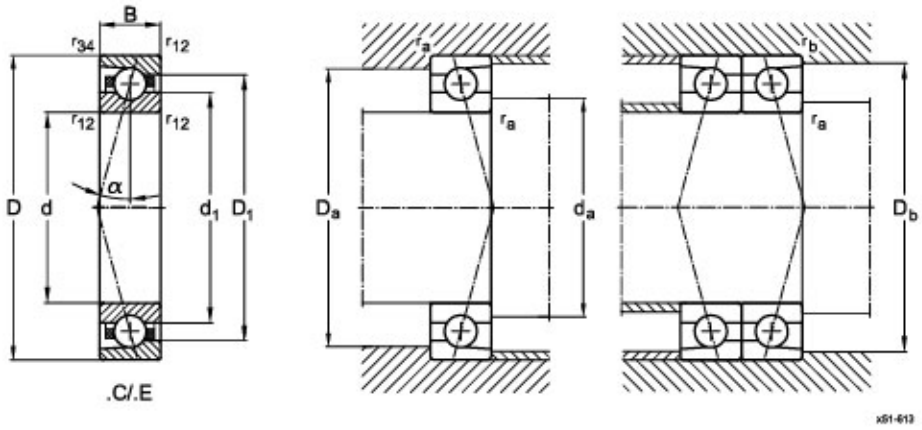


Basic dimensions			Basic designation	Load ratings			Speed		Injection diameter	Effective load centre	Precision locknut
				dyn.	stat.	fatigue load	grease	oil/air			
d	D	B		C	C_0	C_u (radial)	n_G	n_O	d_{pi}	a	
mm				N			min^{-1}		mm		
30	47	9	**71906.C**	8.500	6.400	237	31.000	47.000	36.1	10.0	MBA 30
			CB 71906.C	8.500	4.400	163	40.300	61.100			
			71906.E	8.000	6.100	226	27.900	42.300	36.1	14.0	
			CB 71906.E	8.000	4.200	156	36.300	55.000			
	55	13	**7006.C**	15.000	10.300	381	26.300	40.500	39.6	12.0	MBA 30
			CB 7006.C	15.000	7.200	267	34.200	52.700			
			7006.E	14.500	10.000	370	23.700	36.500	39.5	17.0	
			CB 7006.E	14.500	7.000	259	30.900	47.500			
	62	16	**7206.C**	23.500	14.900	552	24.000	38.500	42.9	14.0	MBA 30
			CB 7206.C	23.500	10.400	385	31.200	50.100			
			7206.E	22.200	14.300	530	21.600	34.700	42.9	19.0	
			CB 7206.E	22.200	10.000	370	28.100	45.200			
35	55	10	**71907.C**	12.500	10.000	370	26.000	39.500	42.6	11	MBA 35
			CB 71907.C	12.500	7.000	259	33.800	51.400			
			71907.E	12.000	9.500	352	23.400	35.600	42.6	16	
			CB 71907.E	12.000	6.600	244	30.500	46.300			
	62	14	**7007.C**	18.800	13.500	500	22.600	37.200	45.8	14	MBA 35
			CB 7007.C	18.800	9.400	348	29.400	48.400			
			7007.E	18.100	12.700	470	20.400	33.500	44.6	19	
			CB 7007.E	18.100	8.800	326	26.600	43.600			
	72	17	**7207.C**	25.600	18.100	670	21.000	35.000	49.9	16	MBA 35
			CB 7207.C	25.600	12.600	467	27.300	45.500			
			7207.E	24.600	17.100	633	18.900	31.500	49.9	21	
			CB 7207.E	24.600	11.900	441	24.600	41.000			

719 C / E
CB 719 C / E

70 C / E
CB 70 C / E

72 C / E
CB 72 C / E

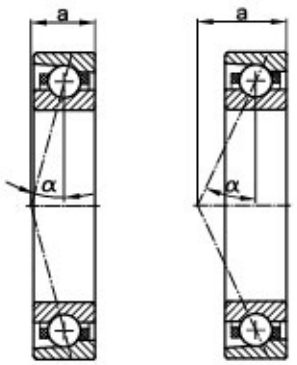


Basic dimensions			Basic designation	Dimensions				Weight	Mounting Dimensions				
d	D	B		d_1	D_1	r_{12min}	r_{34min}	m	$d_{a.min}$	$D_{a.max}$	$D_{b.max}$	$r_{a.max}$	$r_{b.max}$
mm				mm				kg	mm				
30	47	9	71906.C	35.30	41.80	0.3	0.15	0.048	34.0	44.5	45.7	0.3	0.15
			CB 71906.C					0.044					
			71906.E	35.30	41.80	0.3	0.15	0.048	34.0	44.5	45.7	0.3	0.15
			CB 71906.E					0.044					
	55	13	7006.C	38.50	46.40	1.0	0.3	0.118	36.0	49.0	50.0	1.0	0.3
			CB 7006.C					0.109					
			7006.E	38.50	46.40	1.0	0.3	0.118	36.0	49.0	50.0	1.0	0.3
			CB 7006.E					0.109					
	62	16	7206.C	41.20	51.80	1.0	0.6	0.197	37.6	54.6	54.4	1.0	0.6
			CB 7206.C					0.181					
			7206.E	41.20	51.80	1.0	0.6	0.197	37.6	54.6	54.4	1.0	0.6
			CB 7206.E					0.181					
35	55	10	71907.C	41.5	48.6	0.6	0.15	0.076	40.0	50.0	52.3	0.6	0.15
			CB 71907.C					0.070					
			71907.E	41.5	48.6	0.6	0.15	0.076	40.0	50.0	52.3	0.6	0.15
			CB 71907.E					0.070					
	62	14	7007.C	44.5	53.0	1.0	0.3	0.154	41.0	41.0	55.8	1.0	0.3
			CB 7007.C					0.142					
			7007.E	44.5	53.0	1.0	0.3	0.154	41.0	41.0	55.8	1.0	0.3
			CB 7007.E					0.142					
	72	17	7207.C	47.9	59.7	1.1	0.6	0.290	44.2	63.2	63.0	1.1	0.6
			CB 7207.C					0.267					
			7207.E	47.9	59.7	1.1	0.6	0.290	44.2	63.2	63.0	1.1	0.6
			CB 7207.E					0.267					

719 C / E
CB 719 C / E

70 C / E
CB 70 C / E

72 C / E
CB 72 C / E

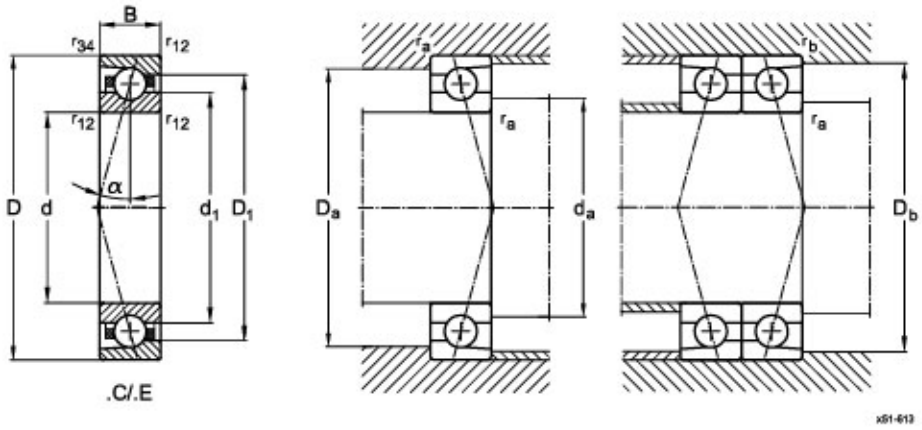


Basic dimensions			Basic designation	Load ratings			Speed		Injection diameter	Effective load centre	Precision locknut
				dyn.	stat.	fatigue load	grease	oil/air			
d	D	B		C	C_0	C_u (radial)	n_G	n_O	d_{pi}	a	
mm				N			min^{-1}		mm		
40	62	12	**71908.C**	15.800	12.000	444	23.000	35.000	47.9	13	MBA 40
			CB 71908.C	15.800	8.400	311	29.900	45.500			
			71908.E	15.000	11.600	430	20.700	31.500	47.9	18	
			CB 71908.E	15.000	8.100	300	27.000	41.000			
	68	15	**7008.C**	20.500	16.100	596	20.300	35.000	51.2	15	MBA 40
			CB 7008.C	20.500	11.200	415	26.400	45.500			
			7008.E	20.000	15.300	567	18.300	31.500	51.2	20	
			CB 7008.E	20.000	10.700	396	23.800	41.000			
	80	18	**7208.C**	32.300	22.500	833	18.500	31.000	55.6	17	MBA 40
			CB 7208.C	32.300	15.700	581	24.100	40.300			
			7208.E	31.000	21.900	811	16.700	27.900	55.5	23	
			CB 7208.E	31.000	15.300	567	21.800	36.300			
45	68	12	**71909.C**	16.200	13.500	500	20.700	31.500	53.4	14	MBA 45
			CB 71909.C	16.200	9.400	348	27.000	41.000			
			71909.E	15.200	12.900	478	18.700	28.400	53.4	19	
			CB 71909.E	15.200	9.000	333	24.400	37.000			
	75	15	**7009.C**	27.600	21.500	796	17.000	28.000	57.0	16	MBA 45
			CB 7009.C	27.600	15.000	556	22.100	36.400			
			7009.E	26.400	20.300	752	15.300	25.200	57.0	22	
			CB 7009.E	26.400	14.200	526	19.900	32.800			
	85	19	**7209.C**	41.000	30.000	1.111	18.000	27.000	59.9	18	MBA 45
			CB 7209.C	41.000	21.000	778	23.400	35.100			
			7209.E	39.000	27.600	1.022	16.200	24.300	60.2	25	
			CB 7209.E	39.000	19.300	715	21.100	31.600			

719 C / E
CB 719 C / E

70 C / E
CB 70 C / E

72 C / E
CB 72 C / E

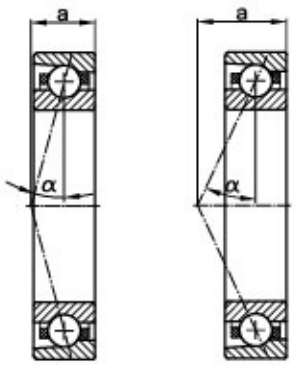


Basic dimensions			Basic designation	Dimensions				Weight	Mounting Dimensions				
d	D	B		d_1	D_1	r_{12min}	r_{34min}	m	$d_{a.min}$	$D_{a.max}$	$D_{b.max}$	$r_{a.max}$	$r_{b.max}$
mm				mm				kg	mm				
40	62	12	**71908.C**	46.7	55.6	0.6	0.15	0.108	45.0	57.0	59.3	0.6	0.15
			CB 71908.C					0.099					
			71908.E	46.7	55.6	0.6	0.15	0.108	45.0	57.0	59.3	0.6	0.15
			CB 71908.E					0.099					
	68	15	**7008.C**	49.7	58.5	1.0	0.3	0.194	46.0	61.8	62.8	1.0	0.3
			CB 7008.C					0.178					
			7008.E	49.7	58.5	1.0	0.3	0.194	46.0	61.8	62.8	1.0	0.3
			CB 7008.E					0.178					
	80	18	**7208.C**	53.4	66.8	1.1	0.6	0.363	48.2	71.8	71.0	1.1	0.6
			CB 7208.C					0.334					
			7208.E	53.4	66.8	1.1	0.6	0.363	48.2	71.8	71.0	1.1	0.6
			CB 7208.E					0.334					
45	68	12	**71909.C**	52.2	61.1	0.6	0.15	0.128	50.0	63.0	65.4	0.6	0.15
			CB 71909.C					0.118					
			71909.E	52.2	61.1	0.6	0.15	0.128	50.0	63.0	65.4	0.6	0.15
			CB 71909.E					0.118					
	75	15	**7009.C**	55.3	64.7	1.0	0.3	0.245	51.0	68.8	70.0	1.0	0.3
			CB 7009.C					0.225					
			7009.E	55.3	64.7	1.0	0.3	0.245	51.0	68.8	70.0	1.0	0.3
			CB 7009.E					0.225					
	85	19	**7209.C**	57.5	72.4	1.1	0.6	0.408	52.7	77.8	77.0	1.1	0.6
			CB 7209.C					0.375					
			7209.E	57.5	72.4	1.1	0.6	0.408	52.7	77.8	77.0	1.1	0.6
			CB 7209.E					0.375					

719 C / E
CB 719 C / E

70 C / E
CB 70 C / E

72 C / E
CB 72 C / E

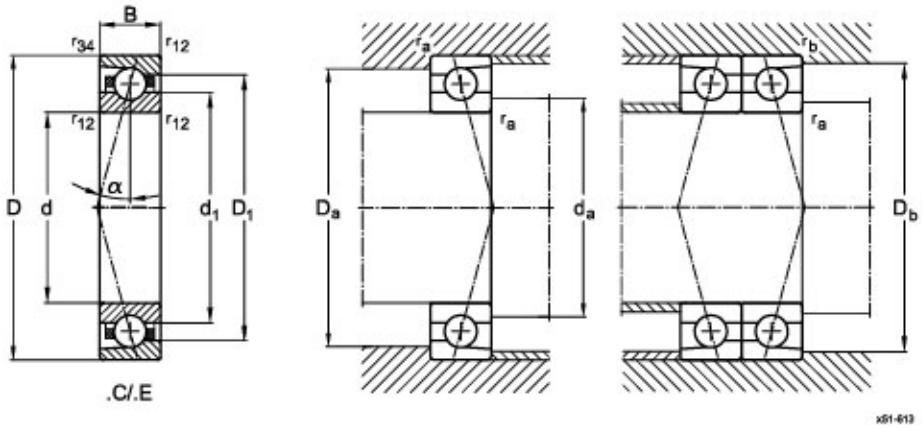


Basic dimensions			Basic designation	Load ratings			Speed		Injection diameter	Effective load centre	Precision locknut
				dyn.	stat.	fatigue load	grease	oil/air			
d	D	B		C	C_0	C_u (radial)	n_G	n_O	d_{pi}	a	
mm				N			min^{-1}		mm		
50	72	12	**71910.C**	17.000	15.000	556	19.000	29.000	57.9	14	MBA 50
			CB 71910.C	17.000	10.500	389	24.700	37.700			
			71910.E	16.000	14.500	537	17.100	26.100	57.9	20	
			CB 71910.E	16.000	10.100	374	22.300	34.000			
	80	16	**7010.C**	28.700	23.000	852	16.800	27.600	62.3	17	MBA 50
			CB 7010.C	28.700	16.100	596	21.900	35.900			
			7010.E	27.000	21.800	807	15.200	24.900	62.3	23	
			CB 7010.E	27.000	15.200	563	19.800	32.400			
	90	20	**7210.C**	43.000	31.500	1.167	16.800	25.500	66.2	20	MBA 50
			CB 7210.C	43.000	22.000	815	21.900	33.200			
			7210.E	41.000	30.500	1.130	15.200	23.000	65.2	27	
			CB 7210.E	41.000	21.300	789	19.800	29.900			
55	80	13	**71911.C**	19.300	18.000	667	17.500	26.300	65.0	16	MBA 55
			CB 71911.C	19.300	12.600	467	22.800	34.200			
			71911.E	18.300	17.000	630	15.800	23.700	65.0	22	
			CB 71911.E	18.300	11.900	441	20.600	30.900			
	90	18	**7011.C**	37.800	31.000	1.148	15.200	25.000	69.4	19	MBA 55
			CB 7011.C	37.800	21.700	804	19.800	32.500			
			7011.E	36.500	29.300	1.085	13.700	22.500	69.4	26	
			CB 7011.E	36.500	20.500	759	17.900	29.300			
	100	21	**7211.C**	53.000	4.000	148	15.300	22.800	73.1	21	MBA 55
			CB 7211.C	53.000	2.800	104	19.900	29.700			
			7211.E	51.000	38.500	1.426	13.800	20.600	72.0	29	
			CB 7211.E	51.000	26.900	996	18.000	26.800			

719 C / E
CB 719 C / E

70 C / E
CB 70 C / E

72 C / E
CB 72 C / E

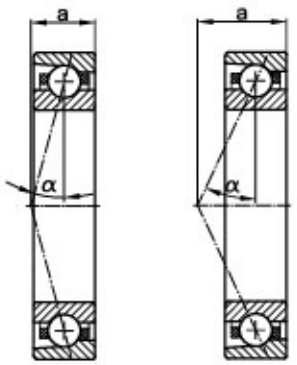


Basic dimensions			Basic designation	Dimensions				Weight	Mounting Dimensions				
d	D	B		d_1	D_1	r_{12min}	r_{34min}	m	$d_{a.min}$	$D_{a.max}$	$D_{b.max}$	$r_{a.max}$	$r_{b.max}$
mm				mm				kg	mm				
50	72	12	**71910.C**	56.7	65.5	0.6	0.15	0.129	55.0	67.0	69.4	0.6	0.15
			CB 71910.C					0.119					
			71910.E	56.7	65.5	0.6	0.15	0.129	55.0	67.0	69.4	0.6	0.15
			CB 71910.E					0.119					
	80	16	**7010.C**	60.5	70.0	1.0	0.3	0.264	56.0	74.0	74.8	1.0	0.3
			CB 7010.C					0.243					
			7010.E	60.5	70.0	1.0	0.3	0.264	56.0	74.0	74.8	1.0	0.3
			CB 7010.E					0.243					
	90	20	**7210.C**	63.5	76.8	1.1	0.6	0.476	57.2	82.8	82	1.1	0.6
			CB 7210.C					0.438					
			7210.E	63.5	76.8	1.1	0.6	0.476	57.2	82.8	82	1.1	0.6
			CB 7210.E					0.438					
55	80	13	**71911.C**	63.7	71.6	0.6	0.3	0.186	60.0	74.0	75.0	0.6	0.3
			CB 71911.C					0.171					
			71911.E	63.7	71.6	0.6	0.3	0.186	60.0	74.0	75.0	0.6	0.3
			CB 71911.E					0.171					
	90	18	**7011.C**	67.4	78.5	1.1	0.6	0.390	61.0	82.8	84.8	1.1	0.6
			CB 7011.C					0.359					
			7011.E	67.4	78.5	1.1	0.6	0.390	61.0	82.8	84.8	1.1	0.6
			CB 7011.E					0.359					
	100	21	**7211.C**	70.1	85	1.5	1.0	0.630	63.3	91.7	91.7	1.5	1.0
			CB 7211.C					0.580					
			7211.E	70.1	85	1.5	1.0	0.630	63.3	91.7	91.7	1.5	1.0
			CB 7211.E					0.580					

719 C / E
CB 719 C / E

70 C / E
CB 70 C / E

72 C / E
CB 72 C / E

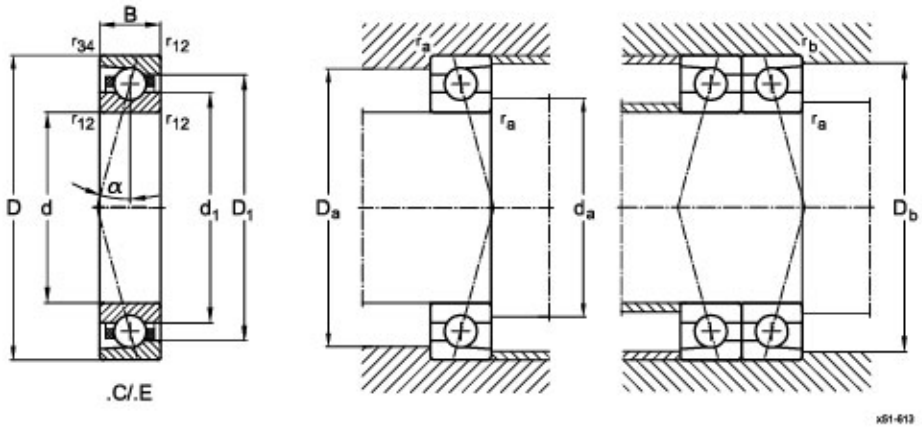


Basic dimensions			Basic designation	Load ratings			Speed		Injection diameter	Effective load centre	Precision locknut
				dyn.	stat.	fatigue load	grease	oil/air			
d	D	B		C	C_0	C_u (radial)	n_G	n_O	d_{pi}	a	
mm				N			min^{-1}		mm		
60	85	13	**71912.C**	19.500	18.800	696	16.000	24.500	70.3	16	MBA 60
			CB 71912.C	19.500	13.100	485	20.800	31.900			
			71912.E	18.500	17.900	663	14.400	22.100	70.3	23	
			CB 71912.E	18.500	12.500	463	18.800	28.800			
	95	18	**7012.C**	39.000	33.700	1.248	14.000	23.000	74.3	20	MBA 60
			CB 7012.C	39.000	23.500	870	18.200	29.900			
			7012.E	36.500	31.800	1.178	12.600	20.700	74.3	27	
			CB 7012.E	36.500	22.200	822	16.400	27.000			
	110	22	**7212.C**	64.000	49.000	1.815	13.800	20.600	80.1	23	MBA 60
			CB 7212.C	64.000	34.300	1.270	18.000	26.800			
			7212.E	61.000	47.000	1.741	12.500	18.600	79.0	31	
			CB 7212.E	61.000	32.900	1.219	16.300	24.200			
65	90	13	**71913.C**	20.500	20.800	770	15.000	23.000	75.2	17	MBA 65
			CB 71913.C	20.500	14.500	537	19.500	29.900			
			71913.E	19.500	19.800	733	13.500	20.700	75.2	25	
			CB 71913.E	19.500	13.800	511	17.600	27.000			
	100	18	**7013.C**	40.300	35.800	1.326	13.000	20.000	79.5	20	MBA 65
			CB 7013.C	40.300	25.000	926	16.900	26.000			
			7013.E	38.000	33.600	1.244	11.700	18.000	79.5	28	
			CB 7013.E	38.000	23.500	870	15.300	23.400			
	120	23	**7213.C**	73.200	58.800	2.178	12.700	19.500	88.0	24	MBA 65
			CB 7213.C	73.200	41.100	1.522	16.600	25.400			
			7213.E	70.000	56.500	2.093	11.500	17.600	86.2	33	
			CB 7213.E	70.000	39.500	1.463	15.000	22.900			

719 C / E
CB 719 C / E

70 C / E
CB 70 C / E

72 C / E
CB 72 C / E

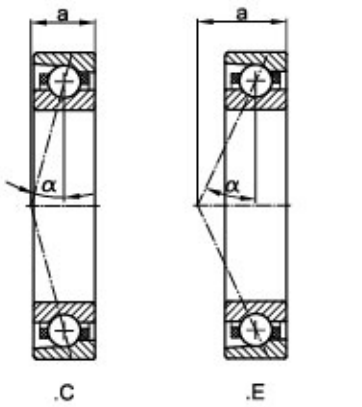


Basic dimensions			Basic designation	Dimensions				Weight	Mounting Dimensions				
d	D	B		d_1	D_1	r_{12min}	r_{34min}	m	$d_{a.min}$	$D_{a.max}$	$D_{b.max}$	$r_{a.max}$	$r_{b.max}$
mm				mm				kg	mm				
60	85	13	71912.C	68.7	76.6	0.6	0.3	0.205	65.0	79.0	80.0	0.6	0.3
			CB 71912.C					0.189					
			71912.E	68.7	76.6	0.6	0.3	0.205	65.0	79.0	80.0	0.6	0.3
			CB 71912.E					0.189					
	95	18	7012.C	72.1	83.1	1.1	0.6	0.420	67.0	88.0	90.0	1.1	0.6
			CB 7012.C					0.386					
			7012.E	72.1	83.1	1.1	0.6	0.420	67.0	88.0	90.0	1.1	0.6
			CB 7012.E					0.386					
	110	22	7212.C	76.8	93.4	1.5	1.0	0.800	69.7	101.2	100.2	1.5	1.0
			CB 7212.C					0.736					
			7212.E	76.8	93.4	1.5	1.0	0.800	69.7	101.2	100.2	1.5	1.0
			CB 7212.E					0.736					
65	90	13	71913.C	73.7	81.5	0.6	0.3	0.215	70.0	84.0	84.8	0.6	0.3
			CB 71913.C					0.198					
			71913.E	73.7	81.5	0.6	0.3	0.215	70.0	84.0	84.8	0.6	0.3
			CB 71913.E					0.198					
	100	18	7013.C	77.2	88.3	1.1	0.6	0.445	72.0	92.9	95.1	1.1	0.6
			CB 7013.C					0.409					
			7013.E	77.2	88.3	1.1	0.6	0.445	72.0	92.9	95.1	1.1	0.6
			CB 7013.E					0.409					
	120	23	7213.C	84.4	101.8	1.5	1.0	1.010	75.8	109.2	109	1.5	1.0
			CB 7213.C					0.929					
			7213.E	84.4	101.8	1.5	1.0	1.010	75.8	109.2	109	1.5	1.0
			CB 7213.E					0.929					

719 C / E
CB 719 C / E

70 C / E
CB 70 C / E

72 C / E
CB 72 C / E

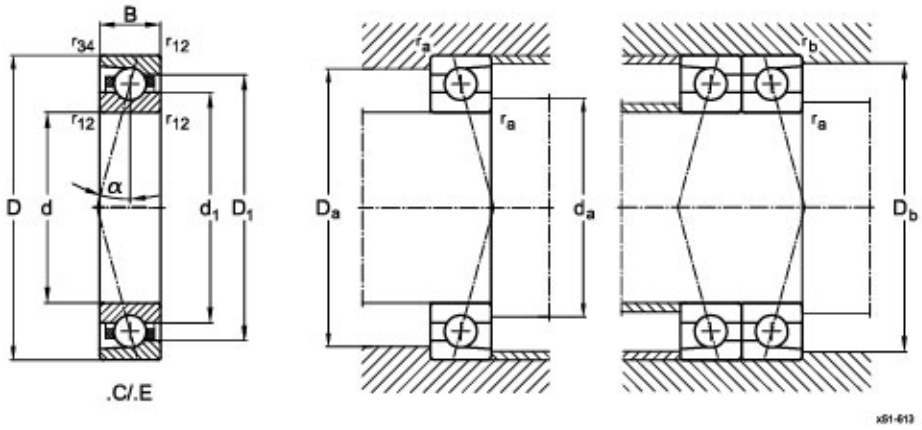


Basic dimensions			Basic designation	Load ratings			Speed		Injection diameter	Effective load centre	Precision locknut
				dyn.	stat.	fatigue load	grease	oil/air			
d	D	B		C	C_0	C_u (radial)	n_G	n_O	d_{pi}	a	
mm				N			min^{-1}		mm		
70	100	16	**71914.C**	28.500	28.000	1.037	13.800	21.000	77.5	19	MBA 70
			CB 71914.C	28.500	19.600	726	18.000	27.300			
			71914.E	26.800	26.500	981	12.500	18.900	77.5	28	
			CB 71914.E	26.800	18.500	685	16.300	24.600			
	110	20	**7014.C**	50.500	43.500	1.611	12.500	19.800	86.3	22	MBA 70
			CB 7014.C	50.500	30.400	1.126	16.300	25.800			
			7014.E	46.500	41.500	1.537	11.300	17.900	86.3	31	
			CB 7014.E	46.500	29.000	1.074	14.700	23.300			
	125	24	**7214.C**	79.300	64.800	2.400	12.200	19.000	92.2	25	MBA 70
			CB 7214.C	79.300	45.300	1.678	15.900	24.700			
			7214.E	76.300	61.800	2.289	11.000	17.100	90.9	35	
			CB 7214.E	76.300	43.200	1.600	14.300	22.300			
75	105	16	**71915.C**	29.000	29.500	1.093	13.000	19.800	87.2	20	MBA 75
			CB 71915.C	29.000	20.600	763	16.900	25.800			
			71915.E	27.000	28.000	1.037	11.700	17.900	87.2	29	
			CB 71915.E	27.000	19.600	726	15.300	23.300			
	115	20	**7015.C**	51.000	46.500	1.722	12.500	19.000	91.8	23	MBA 75
			CB 7015.C	51.000	32.500	1.204	16.300	24.700			
			7015.E	48.000	44.000	1.630	11.300	17.100	91.8	32	
			CB 7015.E	48.000	30.800	1.141	14.700	22.300			
80	110	16	**71916.C**	29.500	31.000	1.148	12.500	18.800	92.3	21	MBA 80
			CB 71916.C	29.500	21.700	804	16.300	24.500			
			71916.E	27.500	29.300	1.085	11.300	17.000	92.3	30	
			CB 71916.E	27.500	20.500	759	14.700	22.100			
	125	22	**7016.C**	62.500	58.000	2.148	11.300	18.000	98.4	25	MBA 80
			CB 7016.C	62.500	40.600	1.504	14.700	23.400			
			7016.E	59.500	55.000	2.037	10.200	16.200	98.4	35	
			CB 7016.E	59.500	38.500	1.426	13.300	21.100			

719 C / E
CB 719 C / E

70 C / E
CB 70 C / E

72 C / E
CB 72 C / E

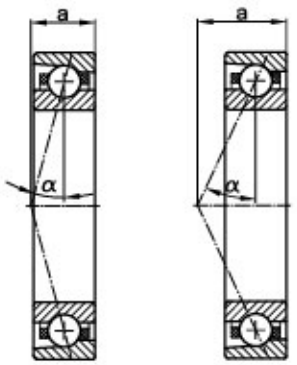


Basic dimensions			Basic designation	Dimensions				Weight	Mounting Dimensions				
d	D	B		d_1	D_1	r_{12min}	r_{34min}	m	$d_{a.min}$	$D_{a.max}$	$D_{b.max}$	$r_{a.max}$	$r_{b.max}$
mm				mm				kg	mm				
70	100	16	71914.C	80.4	89.8	0.6	0.3	0.345	76.0	94.0	94.8	0.6	0.3
			CB 71914.C					0.317					
			71914.E	80.4	89.8	0.6	0.3	0.345	76.0	94.0	94.8	0.6	0.3
			CB 71914.E					0.317					
	110	20	7014.C	83.8	96.4	1.1	0.6	0.620	77.0	102.7	105.1	1.1	0.6
			CB 7014.C					0.570					
			7014.E	83.8	96.4	1.1	0.6	0.620	77.0	102.7	105.1	1.1	0.6
			CB 7014.E					0.570					
	125	24	7214.C	88.4	106.6	1.5	1.0	1.110	80.3	114.7	114	1.5	1.0
			CB 7214.C					1.021					
			7214.E	88.4	106.6	1.5	1.0	1.110	80.3	114.7	114	1.5	1.0
			CB 7214.E					1.021					
75	105	16	71915.C	85.4	94.8	1.0	0.3	0.370	81.0	99.0	99.9	1.0	0.3
			CB 71915.C					0.340					
			71915.E	85.4	94.8	1.0	0.3	0.370	81.0	99.0	99.9	1.0	0.3
			CB 71915.E					0.340					
	115	20	7015.C	89.1	101.8	1.1	0.6	0.660	82.0	108.1	110.0	1.1	0.6
			CB 7015.C					0.607					
			7015.E	89.1	101.8	1.1	0.6	0.660	82.0	108.1	110.0	1.1	0.6
			CB 7015.E					0.607					
80	110	16	71916.C	90.4	99.7	1.0	0.3	0.390	86.0	104.0	104.8	1.0	0.3
			CB 71916.C					0.359					
			71916.E	90.4	99.7	1.0	0.3	0.390	86.0	104.0	104.8	1.0	0.3
			CB 71916.E					0.359					
	125	22	7016.C	95.5	109.7	1.1	0.6	0.880	88.0	118.0	120.0	1.1	0.6
			CB 7016.C					0.810					
			7016.E	95.5	109.7	1.1	0.6	0.880	88.0	118.0	120.0	1.1	0.6
			CB 7016.E					0.810					

719 C / E
CB 719 C / E

70 C / E
CB 70 C / E

72 C / E
CB 72 C / E



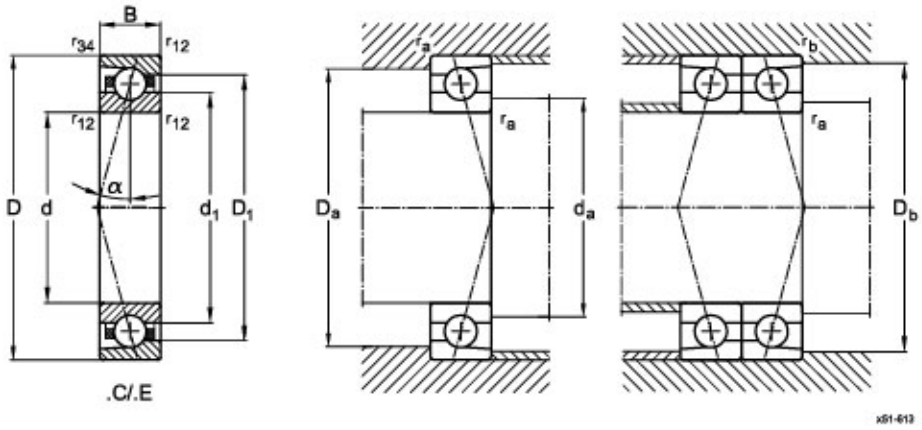
x51-612

Basic dimensions			Basic designation	Load ratings			Speed		Injection diameter	Effective load centre	Precision locknut
				dyn.	stat.	fatigue load	grease	oil/air			
d	D	B		C	C_0	C_u (radial)	n_G	n_O	d_{pi}	a	
mm				N			min^{-1}		mm		
85	120	18	**71917.C**	39.500	41.000	1.519	11.800	17.500	99.1	23	MBA 85
			CB 71917.C	39.500	28.700	1.063	15.400	22.800			
			71917.E	37.000	39.000	1.444	10.700	15.800	99.1	33	
			CB 71917.E	37.000	27.300	1.011	14.000	20.600			
	130	22	**7017.C**	62.000	60.000	2.222	11.000	16.800	104.1	26	MBA 85
			CB 7017.C	62.000	42.000	1.556	14.300	21.900			
			7017.E	59.000	57.000	2.111	9.900	15.200	104.1	36	
			CB 7017.E	59.000	39.900	1.478	12.900	19.800			
90	125	18	**71918.C**	42.000	46.500	1.722	11.000	16.500	104.5	23	MBA 90
			CB 71918.C	42.000	32.500	1.204	14.300	21.500			
			71918.E	40.000	44.000	1.630	9.900	14.900	104.5	34	
			CB 71918.E	40.000	30.800	1.141	12.900	19.400			
	140	24	**7018.C**	76.300	71.800	2.659	9.600	16.500	111.4	28	MBA 90
			CB 7018.C	76.300	50.200	1.859	12.500	21.500			
			7018.E	72.500	68.000	2.519	8.700	14.900	111.4	39	
			CB 7018.E	72.500	47.600	1.763	11.400	19.400			
95	130	18	**71919.C**	43.000	48.500	1.796	10.800	16.000	109.6	24	MBA 95
			CB 71919.C	43.000	33.900	1.256	14.100	20.800			
			71919.E	40.500	46.000	1.704	9.800	14.400	109.6	35	
			CB 71919.E	40.500	32.200	1.193	12.800	18.800			
100	140	20	**71920.C**	51.000	55.000	2.037	10.000	15.000	116.2	26	MBA 100
			CB 71920.C	51.000	38.500	1.426	13.000	19.500			
			71920.E	48.000	52.000	1.926	9.000	13.500	116.2	38	
			CB 71920.E	48.000	36.400	1.348	11.700	17.600			

719 C / E
CB 719 C / E

70 C / E
CB 70 C / E

72 C / E
CB 72 C / E



Basic dimensions			Basic designation	Dimensions				Weight	Mounting Dimensions				
d	D	B		d_1	D_1	r_{12min}	r_{34min}	m	$d_{a.min}$	$D_{a.max}$	$D_{b.max}$	$r_{a.max}$	$r_{b.max}$
mm				mm				kg	mm				
85	120	18	**71917.C**	97.1	108.2	1.1	0.6	0.555	92.0	113.0	114.8	1.1	0.6
			CB 71917.C					0.511					
			71917.E	97.1	108.2	1.1	0.6	0.555	92.0	113.0	114.8	1.1	0.6
			CB 71917.E					0.511					
	130	22	**7017.C**	101.0	115.3	1.1	0.6	0.920	93.0	122.8	124.8	1.1	0.6
			CB 7017.C					0.846					
			7017.E	101.0	115.3	1.1	0.6	0.920	93.0	122.8	124.8	1.1	0.6
			CB 7017.E					0.846					
90	125	18	**71918.C**	102.1	113.1	1.1	0.6	0.590	97.0	118.0	119.7	1.1	0.6
			CB 71918.C					0.543					
			71918.E	102.1	113.1	1.1	0.6	0.590	97.0	118.0	119.7	1.1	0.6
			CB 71918.E					0.543					
	140	24	**7018.C**	108.1	124.0	1.5	0.6	1.190	100.0	131.1	134.2	1.5	0.6
			CB 7018.C					1.095					
			7018.E	108.1	124.0	1.5	0.6	1.190	100.0	131.1	134.2	1.5	0.6
			CB 7018.E					1.095					
95	130	18	**71919.C**	107.1	118.1	1.1	0.6	0.620	102.0	123.0	124.7	1.1	0.6
			CB 71919.C					0.570					
			71919.E	107.1	118.1	1.1	0.6	0.620	102.0	123.0	124.7	1.1	0.6
			CB 71919.E					0.570					
100	140	20	**71920.C**	113.8	126.4	1.1	0.6	0.830	107.0	133.0	134.7	1.1	0.6
			CB 71920.C					0.764					
			71920.E	113.8	126.4	1.1	0.6	0.830	107.0	133.0	134.7	1.1	0.6
			CB 71920.E					0.764					

2.4 Preload and stiffness

In most cases machine tools are not single-purpose machines. To correspond with these requirements, the spindle of a machine tool must be designed according to one out of various conditions.

If Super Precision Angular Contact Ball Bearings are mounted in sets, the ground-in preload essentially determines the characteristics of speed, stiffness and heat. High speed and great stiffness are contradictory characteristics. So the best possible compromise must be accomplished.

To fulfil the various requirements NIBC Super Precision Angular Contact Ball Bearings have been developed not only with different-sized rolling elements and different load ratings, but also with different preloads. The preloads are marked with X for extra light, L for light, M for medium, and F for medium high preloads. With this range of preloads most applications for machine tools are covered.

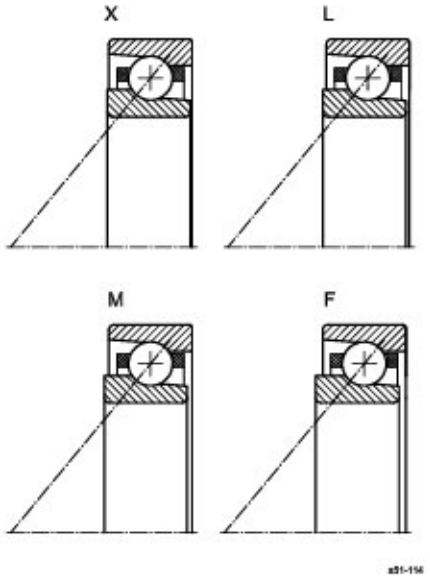


Fig.4: Overview about the different preloads

The preload of a Super Precision Angular Contact Ball Bearing is defined as the axial force that must be applied in order to align the faces of inner and outer ring.The faces of the inner and the outer rings are slightly offset against each other when the single bearing is in unloaded state.While loaded the bearing thereby becomes elastically deformed without, sustaining damage.

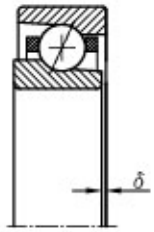
The reciprocal of bearing elasticity is stiffness. Stiffness [N/µm] indicates the resisting force [N] of a preloaded bearing in its elastic range, indicated in µm. Preload and stiffness are correlating with each other. The stiffness of spindle bearings is not proportional to the preload. Axial and radial stiffness of a pair of NIBC Super Precision Universal Angular Contact Ball Bearings depends on the preload and the contact angle. The preload stresses the super precision bearings in the same way as outside axial forces do.

The table from page 26 to 32. shows the values for the axial stiffness S_a and the radial stiffness S_r for each individual angular contact ball bearing. The same values apply for a pair of angular contact ball bearings of the same type faced against each other.

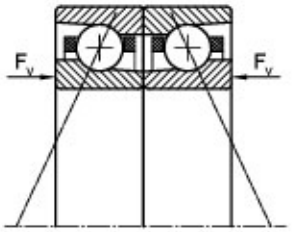
In the selection process for the rolling bearings, quite often a good balance must be found between preload and stiffness on one hand and speed and lifetime on the other.

Due to the lower static load-carrying capacity of the ceramic rolling elements compared to steel rolling elements of the same geometry, Super Precision Hybrid Rolling Bearing have slightly lower preloads. But the stiffness of Super Precision Hybrid Bearings are still significantly higher at identical preload, due to the hardness of the ceramic rolling elements.

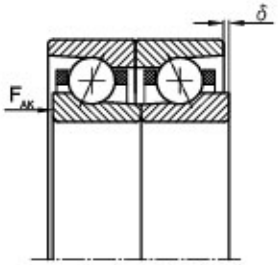
The values for axial and radial stiffness contain parameters that are affected by tolerances related to the manufacturing process. The actual stiffness of a rolling bearing may only be determined when it is fitted in its individual mounting situation. For this reason the values in the tables have been rounded; the values are only meant to be used to compare the different kinds of Super Precision rolling bearings with each other.



excess end
δ



pre-load
F_V



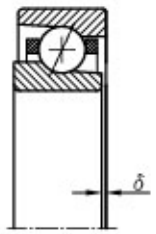
relief force
F_{AK}

e91-110

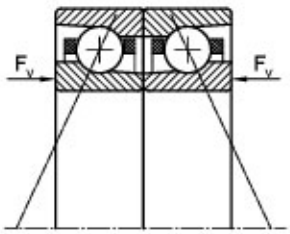
Preloads and stiffness

Basic designation	X					L					M					F				
	F_V N	d µm	S_a N/µm	S_r N/µm	F_{AK} N	F_V N	d µm	S_a N/µm	S_r N/µm	F_{AK} N	F_V N	d µm	S_a N/µm	S_r N/µm	F_{AK} N	F_V N	d µm	S_a N/µm	S_r N/µm	F_{AK} N
7203.C	22	5	16	100	60	40	8	22	130	120	95	12	30	150	270	120	14	35	165	360
CB 7203.C	14	3	14	95	40	30	5	20	120	85	65	8	30	150	190	90	9	35	165	255
7203.E	30	3	40	75	85	60	4	50	100	170	140	7	65	130	390	180	8	75	145	510
CB 7203.E	22	2	35	65	60	45	3	45	90	120	95	5	65	130	270	135	5	75	145	360
71904.C	14	3	18	120	40	30	4	24	140	80	65	8	35	180	180	90	9	40	200	240
CB 71904.C	7	2	16	100	20	14	3	22	130	40	30	5	30	160	90	40	6	35	180	120
71904.E	20	2	45	90	55	40	3	60	120	110	85	5	80	160	240	120	6	90	180	330
CB 71904.E	10	1	40	85	25	20	2	55	110	55	45	3	75	150	120	60	4	85	165	165
7004.C	18	5	20	130	50	35	7	25	160	100	80	12	35	190	230	105	14	40	210	300
CB 7004.C	9	3	18	110	25	18	5	24	150	50	40	8	35	170	120	55	9	40	190	150
7004.E	24	3	40	85	65	45	4	55	110	130	110	7	75	150	300	135	8	85	165	390
CB 7004.E	12	2	35	75	35	24	3	50	100	65	55	5	75	150	150	70	5	85	165	195
7204.C	25	5	18	120	75	50	8	25	150	150	120	12	35	180	330	150	14	40	200	450
CB 7204.C	18	3	18	110	50	35	5	24	150	100	80	8	35	170	230	105	9	40	190	300
7204.E	35	3	45	90	100	70	5	55	110	200	160	8	80	160	460	210	9	90	180	600
CB 7204.E	25	2	40	80	70	50	3	55	110	140	110	5	75	150	320	150	6	85	165	420
71905.C	16	3	22	150	50	35	4	30	180	95	75	8	45	220	210	105	10	50	245	285
CB 71905.C	8	2	20	130	24	16	3	25	160	50	40	5	40	190	110	50	6	45	210	150
71905.E	22	2	55	110	65	45	3	75	150	130	100	5	100	200	290	135	6	115	220	390
CB 71905.E	12	1	50	100	30	22	2	70	140	65	50	3	90	180	140	65	4	105	200	195
7005.C	24	5	25	160	65	45	8	35	200	130	100	14	45	230	300	135	16	50	255	390
CB 7005.C	12	3	22	140	35	24	5	30	180	65	50	9	45	220	150	70	10	50	245	195
7005.E	30	3	55	110	90	65	5	70	140	180	140	8	95	190	410	195	9	110	210	540
CB 7005.E	16	2	45	95	45	30	3	65	130	90	70	5	90	180	200	90	6	105	200	270
7205.C	35	6	24	150	100	70	9	30	190	200	160	14	45	220	450	210	16	50	245	600
CB 7205.C	24	4	22	140	70	50	6	30	180	140	110	9	45	220	310	150	10	50	245	420
7205.E	50	3	55	110	140	95	5	70	140	270	220	8	100	200	610	285	10	115	220	810
CB 7205.E	35	2	50	100	95	65	3	65	130	190	150	5	95	190	430	195	6	110	210	570

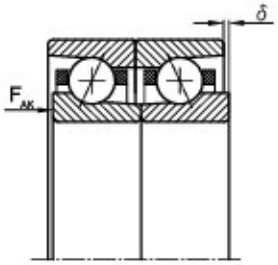
F_v
S_a
S_r
F_{AK}



excess end
δ



pre-load
F_V

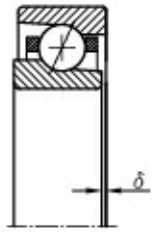


relief force
F_{AK}

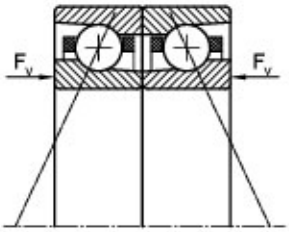
e91-110

Preloads and stiffness

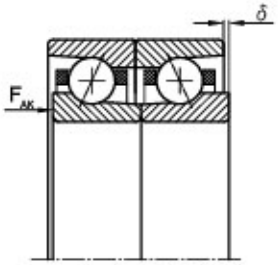
Basic designation	X					L					M					F				
	F_V	d	S_a	S_r	F_{AK}	F_V	d	S_a	S_r	F_{AK}	F_V	d	S_a	S_r	F_{AK}	F_V	d	S_a	S_r	F_{AK}
	N	µm	N/µm		N	N	µm	N/µm		N	N	µm	N/µm		N	N	µm	N/µm		N
71906.C	20	3	25	180	60	40	5	35	220	120	95	9	55	260	260	120	10	65	290	360
CB 71906.C	10	2	24	150	30	20	3	30	190	60	45	6	45	230	130	60	7	50	255	180
71906.E	30	2	70	140	80	55	3	90	180	160	120	6	120	240	350	165	6	140	265	480
CB 71906.E	14	1	60	120	40	30	2	80	160	80	60	4	110	220	180	90	4	125	245	240
7006.C	30	5	30	200	85	60	8	40	240	170	130	14	55	280	380	180	16	65	310	510
CB 7006.C	14	3	25	170	40	30	5	35	220	85	65	9	50	260	190	90	11	60	290	255
7006.E	40	3	65	130	120	85	5	80	160	240	190	8	110	220	540	255	9	125	245	720
CB 7006.E	22	2	55	110	60	40	3	75	150	120	95	5	110	220	270	120	6	125	245	360
7206.C	45	6	30	180	130	95	9	40	230	260	210	14	55	260	590	285	16	65	290	780
CB 7206.C	35	4	25	170	95	65	6	35	220	190	150	10	50	260	420	195	11	60	290	570
7206.E	65	4	65	130	180	130	5	85	170	360	280	9	120	230	800	390	10	140	255	1080
CB 7206.E	45	2	60	120	120	90	4	80	160	250	200	6	110	230	560	270	7	125	255	750
71907.C	25	3	30	200	70	50	5	40	250	140	110	9	60	310	320	150	11	70	345	420
CB 71907.C	12	2	30	180	35	25	3	40	230	70	55	6	55	270	160	75	7	65	300	210
71907.E	35	2	80	160	95	70	3	100	200	190	150	6	140	280	440	210	7	160	310	570
CB 71907.E	18	1	70	140	50	35	2	95	190	95	75	4	130	260	220	105	4	150	290	285
7007.C	40	6	35	230	110	75	9	45	280	210	170	14	65	330	480	225	16	75	365	630
CB 7007.C	18	4	30	200	55	40	6	40	250	110	85	10	60	300	240	120	11	70	335	330
7007.E	55	3	75	150	150	110	5	95	190	310	240	9	130	260	690	330	10	150	290	930
CB 7007.E	25	2	65	130	75	55	3	90	180	150	120	6	130	250	350	165	7	150	280	450
7207.C	60	7	35	210	170	120	10	45	260	340	270	16	60	310	770	360	18	70	345	1020
CB 7207.C	40	4	30	200	120	85	6	40	250	240	190	10	60	300	540	255	12	70	335	720
7207.E	80	4	75	150	230	160	6	100	200	460	370	10	140	270	1030	480	11	160	300	1380
CB 7207.E	55	2	70	140	160	110	4	95	190	320	260	6	130	270	720	330	7	150	300	960



excess end
δ



pre-load
F_V

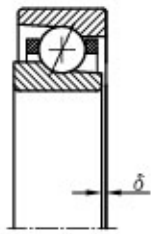


relief force
F_{AK}

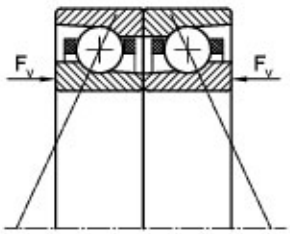
e01-110

Preloads and stiffness

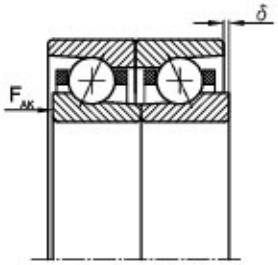
Basic designation	X					L					M					F				
	F_V N	d µm	S_a N/µm	S_r N/µm	F_{AK} N	F_V N	d µm	S_a N/µm	S_r N/µm	F_{AK} N	F_V N	d µm	S_a N/µm	S_r N/µm	F_{AK} N	F_V N	d µm	S_a N/µm	S_r N/µm	F_{AK} N
71908.C	30	3	35	230	85	60	5	50	290	170	140	10	70	350	390	180	12	80	390	510
CB 71908.C	16	2	30	210	45	30	3	45	260	85	70	7	60	310	200	90	8	70	345	255
71908.E	40	2	90	180	120	85	4	120	230	240	190	6	160	320	530	255	7	185	355	720
CB 71908.E	22	1	85	170	60	40	2	110	220	120	95	4	150	290	270	120	5	175	320	360
7008.C	45	6	40	260	130	95	9	55	320	270	210	16	75	370	600	285	18	85	410	810
CB 7008.C	24	4	35	230	65	45	6	50	290	130	110	10	70	350	300	135	12	80	390	390
7008.E	70	4	85	170	190	140	5	110	220	390	310	9	150	300	870	420	11	175	335	1170
CB 7008.E	35	2	75	150	95	70	4	100	200	190	150	6	150	290	440	210	7	175	320	570
7208.C	75	7	40	240	220	150	10	50	300	430	350	16	70	350	980	450	18	80	390	1290
CB 7208.C	55	5	35	230	150	110	7	50	290	300	240	12	70	350	680	330	14	80	390	900
7208.E	100	4	90	180	290	210	6	110	230	580	460	10	160	310	1310	630	12	185	345	1740
CB 7208.E	70	3	80	160	200	140	4	110	210	410	320	7	150	310	910	420	8	175	345	1230
71909.C	35	4	40	260	110	75	5	55	320	210	170	10	80	390	480	225	12	90	435	630
CB 71909.C	18	2	35	230	55	35	4	50	290	110	85	7	70	350	240	105	8	80	390	330
71909.E	50	2	100	200	140	100	4	130	260	290	230	7	180	360	650	300	8	205	400	870
CB 71909.E	25	2	95	190	70	50	2	120	240	140	120	4	170	330	330	150	5	195	365	420
7009.C	60	6	45	290	170	120	10	60	360	330	260	16	85	420	740	360	18	100	465	990
CB 7009.C	30	4	40	260	85	60	6	55	330	170	130	10	80	390	370	180	12	90	435	510
7009.E	85	4	95	190	240	170	6	120	240	480	380	10	170	330	1080	510	11	195	365	1440
CB 7009.E	40	2	85	170	120	85	4	110	230	240	190	6	160	330	540	255	7	185	365	720
7209.C	95	7	40	270	270	190	12	55	340	540	430	18	80	390	1210	570	21	90	435	1620
CB 7209.C	65	5	40	250	190	130	7	55	330	380	300	12	80	390	850	390	14	90	435	1140
7209.E	130	4	100	200	360	250	7	130	260	720	570	12	180	350	1620	750	14	205	390	2160
CB 7209.E	90	3	90	180	250	180	4	120	240	500	400	7	170	340	1130	540	8	195	375	1500



excess end
δ



pre-load
F_V

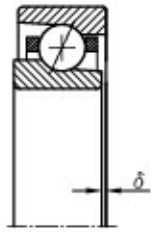


relief force
F_{AK}

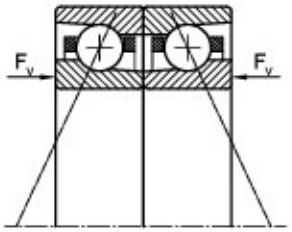
e91-110

Preloads and stiffness

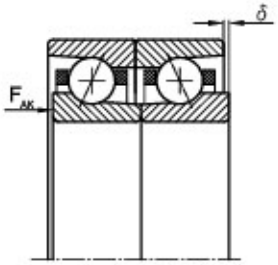
Basic designation	X					L					M					F				
	F_V	d	S_a	S_r	F_{AK}	F_V	d	S_a	S_r	F_{AK}	F_V	d	S_a	S_r	F_{AK}	F_V	d	S_a	S_r	F_{AK}
	N	µm	N/µm		N	N	µm	N/µm		N	N	µm	N/µm		N	N	µm	N/µm		N
71910.C	45	4	45	290	130	90	6	60	360	250	200	12	90	440	570	270	14	105	490	750
CB 71910.C	22	2	40	260	65	45	4	55	320	130	100	7	80	390	290	135	8	90	435	390
71910.E	60	3	110	230	170	120	4	150	290	350	280	7	200	400	790	360	8	230	445	1050
CB 71910.E	30	2	100	210	85	60	3	140	270	170	140	4	180	370	390	180	5	205	410	510
7010.C	70	7	50	330	200	140	10	65	400	400	320	18	95	470	900	420	21	110	520	1200
CB 7010.C	35	4	45	290	100	70	7	60	360	200	160	12	85	430	450	210	14	100	475	600
7010.E	100	4	110	210	290	200	6	140	270	580	460	10	190	370	1300	600	12	220	410	1740
CB 7010.E	50	3	95	190	140	100	4	130	250	290	230	7	180	360	650	300	8	205	400	870
7210.C	120	8	45	310	330	230	12	65	380	660	520	20	90	440	1480	690	23	105	490	1980
CB 7210.C	80	5	45	280	230	160	8	60	360	460	360	12	85	430	1030	480	14	100	475	1380
7210.E	160	5	110	220	440	310	7	140	290	880	700	12	200	390	1970	930	14	230	435	2640
CB 7210.E	110	3	100	200	310	220	5	130	270	610	490	8	190	380	1380	660	9	220	420	1830
71911.C	55	4	50	320	150	110	6	65	400	300	240	12	95	480	680	330	14	110	535	900
CB 71911.C	25	3	45	280	75	55	4	60	360	150	120	8	85	430	340	165	9	100	475	450
71911.E	75	3	120	250	210	150	4	160	320	420	330	7	220	440	940	450	8	255	490	1260
CB 71911.E	35	2	110	230	100	75	3	150	300	210	170	5	200	400	470	225	5	230	445	630
7011.C	85	7	55	360	240	170	10	75	440	480	380	18	100	510	1080	510	21	115	565	1440
CB 7011.C	45	5	50	310	120	85	7	65	400	240	190	12	95	480	540	255	14	110	535	720
7011.E	120	4	120	230	350	240	6	150	300	690	550	10	200	410	1550	720	12	230	455	2070
CB 7011.E	60	3	100	200	170	120	4	140	280	350	270	7	200	400	780	360	8	230	445	1050
7211.C	140	8	50	340	390	280	12	70	410	790	620	20	95	480	1770	840	23	110	535	2370
CB 7211.C	95	5	50	310	270	190	8	65	400	550	440	14	95	480	1240	570	16	110	535	1650
7211.E	190	5	120	240	530	370	7	160	320	1050	840	12	210	430	2370	1110	14	240	475	3150
CB 7211.E	130	3	110	210	370	260	5	150	290	740	590	8	210	420	1660	780	9	240	465	2220



excess end
δ



pre-load
F_V

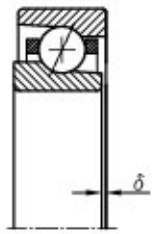


relief force
F_{AK}

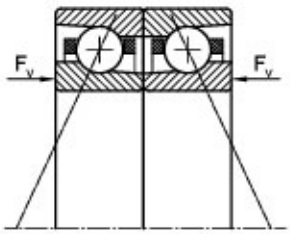
e91-110

Preloads and stiffness

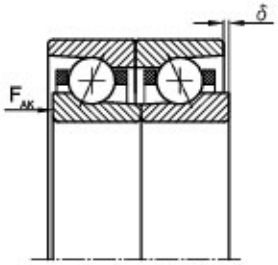
Basic designation	X					L					M					F				
	F_V N	d µm	S_a N/µm	S_r N/µm	F_{AK} N	F_V N	d µm	S_a N/µm	S_r N/µm	F_{AK} N	F_V N	d µm	S_a N/µm	S_r N/µm	F_{AK} N	F_V N	d µm	S_a N/µm	S_r N/µm	F_{AK} N
71912.C	65	4	55	350	180	130	6	70	430	360	280	12	110	530	800	390	14	125	590	1080
CB 71912.C	30	3	45	310	90	65	4	65	390	180	140	8	95	470	400	195	9	110	520	540
71912.E	85	3	140	270	250	170	4	180	350	490	390	8	240	480	1110	510	9	275	535	1470
CB 71912.E	45	2	120	250	120	85	3	160	320	250	200	5	220	440	550	255	6	255	490	750
7012.C	100	7	60	390	280	200	12	80	480	570	450	18	110	560	1280	600	21	125	620	1710
CB 7012.C	50	5	55	340	140	100	7	75	440	280	230	12	100	520	640	300	14	115	575	840
7012.E	140	4	130	250	410	290	7	160	330	810	650	12	220	440	1830	870	14	255	490	2430
CB 7012.E	70	3	110	220	200	140	4	150	300	410	320	7	220	440	910	420	8	255	490	1230
7212.C	160	9	55	370	460	330	14	75	450	930	740	22	110	530	2090	990	25	125	590	2790
CB 7212.C	110	6	50	340	320	230	9	75	440	650	520	14	100	520	1460	690	16	115	575	1950
7212.E	220	5	130	270	620	440	8	170	340	1250	990	14	230	470	2800	1320	16	265	520	3750
CB 7212.E	150	3	120	230	440	310	5	160	320	870	690	9	230	460	1960	930	10	265	510	2610
71913.C	75	4	60	380	210	150	7	80	470	410	330	14	110	570	930	450	16	125	635	1230
CB 71913.C	35	3	50	330	100	75	4	70	420	210	160	9	100	500	470	225	10	115	555	630
71913.E	100	3	150	290	290	200	5	190	380	580	460	8	260	520	1290	600	9	300	575	1740
CB 71913.E	50	2	130	270	140	100	3	180	350	290	230	5	240	480	650	300	6	275	535	870
7013.C	120	8	65	420	330	240	12	85	520	670	530	20	120	610	1500	720	23	140	675	2010
CB 7013.C	60	5	55	370	170	120	8	80	470	330	260	12	110	560	750	360	14	125	620	990
7013.E	170	5	140	270	470	330	7	180	350	940	750	12	240	480	2130	990	14	275	535	2820
CB 7013.E	85	3	120	240	240	170	5	170	330	470	380	8	240	470	1060	510	9	275	520	1410
7213.C	190	9	60	400	540	380	14	80	490	1080	860	22	110	570	2440	1140	25	125	635	3240
CB 7213.C	130	6	55	370	380	270	9	80	470	760	600	14	110	560	1710	810	16	125	620	2280
7213.E	260	5	140	290	730	520	8	190	370	1460	1160	14	250	510	3280	1560	16	290	565	4380
CB 7213.E	180	3	130	250	510	360	5	170	350	1020	810	9	250	500	2300	1080	10	290	555	3060



excess end
δ



pre-load
F_V

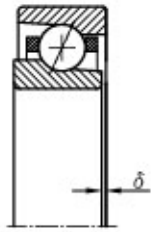


relief force
F_{AK}

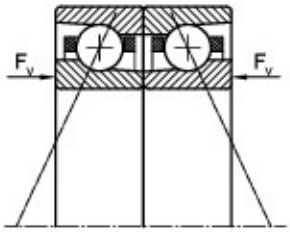
e01-110

Preloads and stiffness

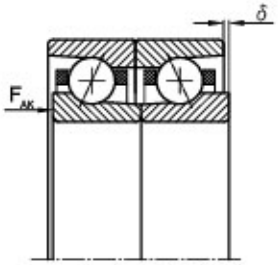
Basic designation	X					L					M					F				
	F_V	d	S_a	S_r	F_{AK}	F_V	d	S_a	S_r	F_{AK}	F_V	d	S_a	S_r	F_{AK}	F_V	d	S_a	S_r	F_{AK}
	N	µm	N/µm		N	N	µm	N/µm		N	N	µm	N/µm		N	N	µm	N/µm		N
71914.C	85	5	65	410	240	170	7	85	500	480	380	14	120	610	1080	510	16	140	675	1440
CB 71914.C	40	3	55	360	120	85	5	75	450	240	190	9	110	540	540	255	10	125	600	720
71914.E	120	3	160	320	330	240	5	200	410	670	530	8	280	560	1500	720	10	320	620	2010
CB 71914.E	60	2	140	290	170	120	3	190	380	330	260	5	260	510	750	360	6	300	565	990
7014.C	140	8	70	460	390	270	12	95	560	770	610	20	130	650	1730	810	23	150	720	2310
CB 7014.C	70	5	60	400	190	140	8	85	510	390	310	14	120	610	870	420	16	140	675	1170
7014.E	190	5	150	290	540	380	7	190	380	1090	870	12	260	520	2450	1140	14	300	575	3270
CB 7014.E	95	3	130	260	270	190	5	180	360	540	430	8	250	510	1220	570	9	290	565	1620
7214.C	220	10	65	430	630	440	14	90	530	1250	990	24	120	610	2810	1320	28	140	675	3750
CB 7214.C	150	6	60	400	440	310	10	85	510	880	700	16	120	610	1970	930	18	140	675	2640
7214.E	300	6	150	310	840	600	9	200	400	1690	1340	14	270	550	3800	1800	16	310	610	5070
CB 7214.E	210	4	140	270	590	420	6	190	380	1180	940	9	270	540	2660	1260	11	310	600	3540
71915.C	95	5	70	440	270	190	7	90	540	550	440	14	130	660	1230	570	16	150	735	1650
CB 71915.C	50	3	60	390	140	95	5	80	490	270	220	9	120	580	620	285	11	140	645	810
71915.E	140	3	170	340	380	270	5	220	440	770	610	9	300	600	1720	810	10	345	665	2310
CB 71915.E	70	2	160	310	190	140	3	200	410	380	300	6	280	550	860	420	6	320	610	1140
7015.C	160	8	75	490	440	310	12	100	600	880	700	22	140	700	1990	930	25	160	775	2640
CB 7015.C	80	5	65	430	220	160	8	90	540	440	350	14	130	650	990	480	16	150	720	1320
7015.E	220	5	160	320	620	440	8	200	410	1240	990	12	280	560	2790	1320	14	320	620	3720
CB 7015.E	110	3	140	280	310	220	5	190	380	620	490	8	270	540	1400	660	10	310	600	1860
71916.C	110	5	70	470	310	220	8	95	580	620	500	14	140	700	1400	660	16	160	775	1860
CB 71916.C	55	3	65	410	160	110	5	85	520	310	250	10	120	620	700	330	11	140	690	930
71916.E	150	3	180	360	440	310	5	230	470	870	690	9	320	640	1960	930	10	370	710	2610
CB 71916.E	75	2	170	330	220	150	3	220	430	440	350	6	290	590	980	450	7	335	655	1320
7016.C	180	9	80	520	500	360	14	110	640	1010	800	22	150	750	2260	1080	25	175	835	3030
CB 7016.C	90	6	70	460	250	180	9	95	580	500	400	14	140	690	1130	540	16	160	765	1500
7016.E	250	5	170	340	700	500	8	220	440	1410	1120	14	300	590	3160	1500	16	345	655	4230
CB 7016.E	120	3	150	300	350	250	5	200	410	700	560	9	290	580	1580	750	10	335	645	2100



excess end
δ



pre-load
F_V

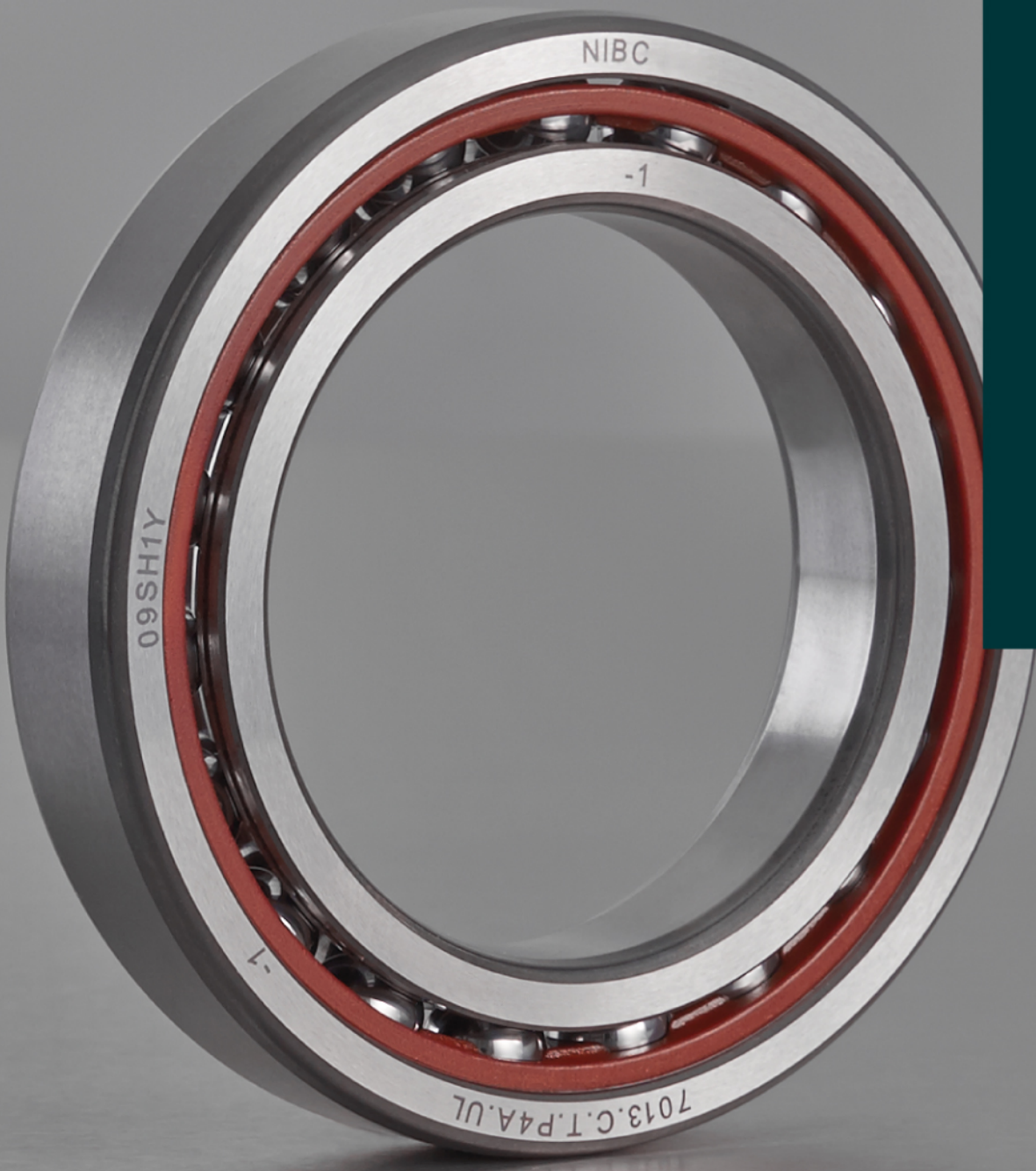


relief force
F_{AK}

e61-110

Preloads and stiffness

Basic designation	X					L					M					F				
	F_V N	d µm	S_a N/µm	S_r N/µm	F_{AK} N	F_V N	d µm	S_a N/µm	S_r N/µm	F_{AK} N	F_V N	d µm	S_a N/µm	S_r N/µm	F_{AK} N	F_V N	d µm	S_a N/µm	S_r N/µm	F_{AK} N
71917.C	120	5	75	500	350	250	8	100	610	700	560	16	150	740	1580	750	18	175	820	2100
CB 71917.C	60	3	65	440	180	120	5	90	550	350	280	10	130	660	790	360	12	150	735	1050
71917.E	170	3	190	380	490	350	5	250	500	990	780	9	340	670	2220	1050	11	390	745	2970
CB 71917.E	85	2	180	350	250	170	3	230	460	490	390	6	310	620	1110	510	7	355	690	1470
7017.C	200	9	85	550	570	400	14	110	680	1140	900	24	160	790	2560	1200	28	185	875	3420
CB 7017.C	100	6	75	490	280	200	9	100	620	570	450	14	150	740	1280	600	16	175	820	1710
7017.E	280	5	180	360	790	560	8	230	460	1580	1260	14	310	630	3560	1680	16	355	700	4740
CB 7017.E	140	3	160	310	400	280	5	220	430	790	630	9	310	620	1780	840	10	355	690	2370
71918.C	140	5	80	530	390	280	8	110	650	790	630	16	160	790	1780	840	18	185	875	2370
CB 71918.C	70	3	70	460	200	140	5	95	580	390	310	10	140	700	890	420	12	160	775	1170
71918.E	200	4	200	410	550	390	6	260	530	1110	880	10	360	710	2490	1170	11	415	790	3330
CB 71918.E	100	2	190	370	280	200	4	240	490	550	440	6	330	660	1250	600	7	380	735	1650
7018.C	230	9	90	590	640	450	14	120	720	1280	1010	24	170	840	2870	1350	28	195	930	3840
CB 7018.C	110	6	80	510	320	230	9	110	650	640	510	16	160	780	1440	690	18	185	865	1920
7018.E	310	5	190	380	880	620	8	240	490	1770	1410	14	330	670	3980	1860	16	380	745	5310
CB 7018.E	160	4	170	330	440	310	5	230	460	880	700	9	330	650	1990	930	11	380	720	2640
71919.C	160	6	85	560	440	310	8	110	680	880	700	16	170	830	1980	930	18	195	920	2640
CB 71919.C	80	4	75	490	220	160	6	100	620	440	350	10	150	740	990	480	12	175	820	1320
71919.E	220	4	210	430	620	440	6	280	550	1240	980	10	380	750	2780	1320	12	435	835	3720
CB 71919.E	110	2	200	390	310	220	4	260	510	620	490	7	350	700	1390	660	8	405	775	1860
71920.C	170	6	90	590	490	350	9	120	720	980	780	18	180	880	2200	1050	21	205	975	2940
CB 71920.C	85	4	80	510	240	170	6	110	650	490	390	12	160	780	1100	510	14	185	865	1470
71920.E	240	4	230	450	690	490	6	290	580	1380	1090	10	400	790	3090	1470	12	460	875	4140
CB 71920.E	120	3	210	410	340	240	4	270	540	690	550	7	370	730	1550	720	8	425	810	2070


NIBC
-1
09SH1Y
-7
7013.C.T.P4A.UL

The basic dimensions of a NIBC Super precision angular contact ball bearing are bore diameter d, outside diameter D and its width B. The basic dimensions also include the tolerances for the bore diameter Δ_{dmp} as well as the tolerances for the outside diameter Δ_{Dmp}. The tolerance for the width Δ_{Bs} depends on the bore diameter of the inner ring and is applicable to both bearing rings.

The running accuracy of a rolling bearing is also subject to defined tolerances. Besides the desired rotation about the central axis unwanted displacements and tilting movements occur in both axial and radial directions. There are maximum values and/or limit values for these effects too. In most mounting situations, the maximum radial runout of the inner ring K_{ia} is especially important. NIBC Super Precision Angular Contact Ball Bearings are manufactured as standard to conform to tolerance classes P4 and P4A.

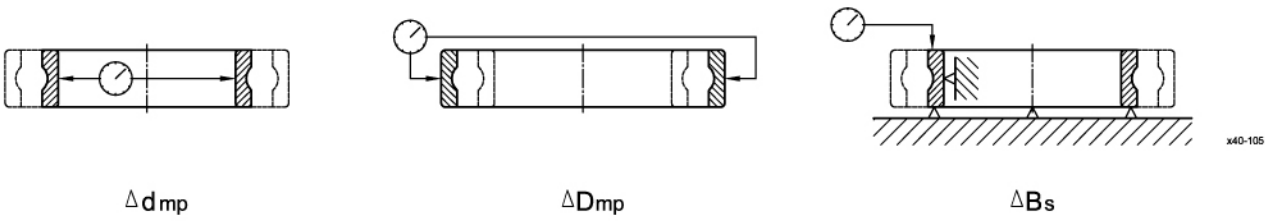


Fig.5: Dimensional tolerances

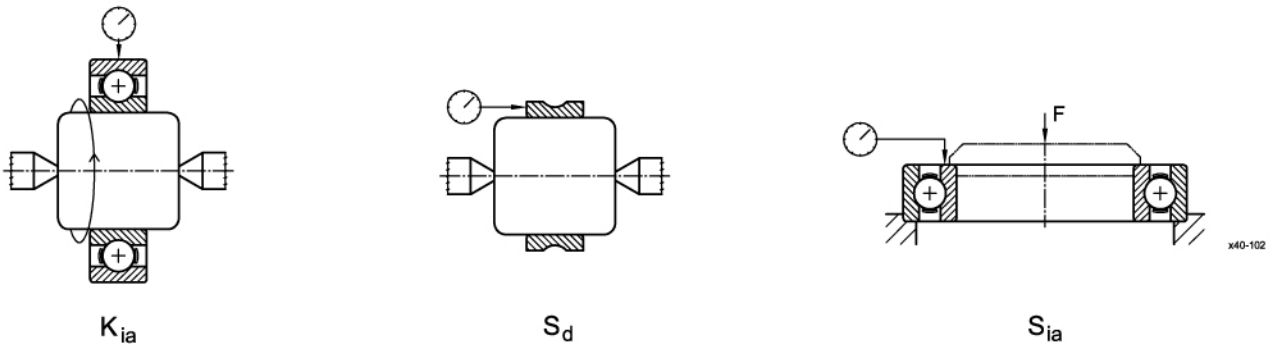


Fig.6: Running tolerances on the inner ring

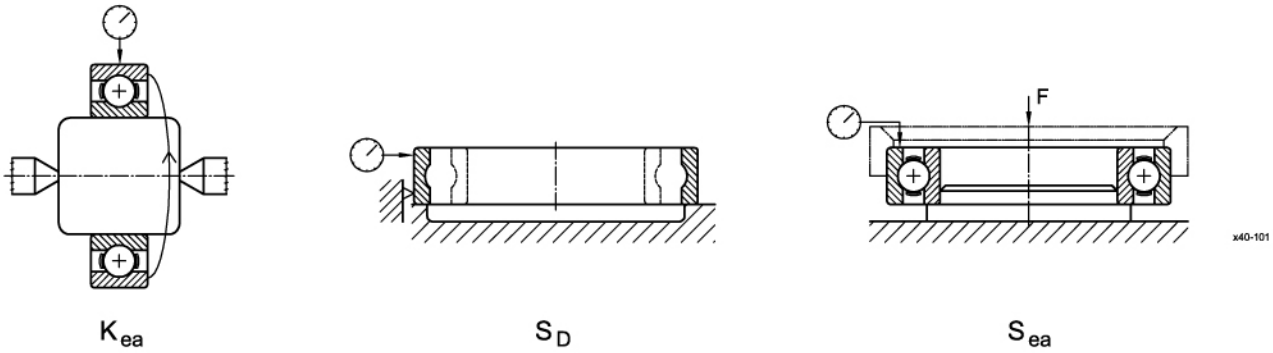


Fig.7: Running tolerances on the outer ring

2.6 Tolerance classes

Tolerance classes
The request for rolling bearings with ever greater precision has led to the introduction of a range of tolerance classes with an increasing number of subdivisions. Various tolerance classes have been established and are currently in use, each with its own designation.

Description of tolerance classes
Existing tolerance classes have been described by various organisations. The designation of the tolerance classes differs according to the manufacturer.

IBC Designation **Descriptive organisation**	**P5**	**P4**	**P4A**
DIN (German Standards Institute)	P5	P4	P4S
AFBMA STD 20 (Anti-Friction Bearing Manufacturers Association)	ABEC5	ABEC7	
ISO 492 (International Standards Organisation)	Class 5	Class 4	
BS 292 (British Standards Institution)	EP5	EP7	
Comparison between manufacturers			
FAG	P5	P4	P4S
NSK	P5	P4	P3
SKF	P5	P4	P4A

Table 1: Tolerance classes and descriptive organisation

Tolerance characteristics			
Abbreviation according to ISO	**Inner ring characteristic**	**P4**	**P4A**
Δ_{dmp}	Deviation of the mean bore diameter from the nominal	P4	P4
K_{ia}	Radial runout of assembled bearing inner ring	P4	P2
S_d	Side face runout with reference to bore of the inner ring	P4	P2
S_{ia}	Side face runout of assembled bearing inner ring	P4	P2
V_{Bs}/V_{Cs}	Ring width variation	P4	P4
Δ_{Bs}/Δ_{Cs}	Deviataion of the inner ring width	P4	P4
Abbreviation according to ISO	**Outer ring characteristic**	**P4**	**P4A**
Δ_{Dmp}	Deviation of the mean outside diameter from the nominal	P4	P4
K_{ea}	Radial runout of assembled bearing outer ring	P4	P2
S_D	Variation in inclination of outside cylindrical surface to outer ring side face	P4	P2
S_{ea}	Side face runout with reference to raceway of assembled bearing outer ring	P4	P2

Table 2: Allocation to tolerance classes according to DIN 620

	Characteristic	Tolerance class	Inner ring ø 0,6 to 10	10 18	18 30	30 50	50 80	80 120	120 150	150 180	180 250	250 315
Δ_{dmp}	Deviation of the mean bore diameter from the nominal	P4, P4A	-4	-4	-5	-6	-7	-8	-10	-10	-12	-15
V_{dp}	Variation in the bore diameter in a radial plane	P4	3	3	4	5	5	6	8	9	-	-
		P4A	2	2	2	2,5	3	3	4	4	5	6
V_{Bs}	Inner ring width variation	P4	2	2	2,5	3	4	4	5	5	6	8
		P4A	1,5	1,5	1,5	1,5	1,5	2,5	2,5	4	5	6
K_{ia}	Radial runout of assembled bearing inner ring	P4	2,5	2,5	3	4	4	5	6	6	8	9
		P4A	1,5	1,5	2,5	2,5	2,5	2,5	2,5	3	4	5
S_d	Side face runout with reference to bore of the inner ring	P4	2,5	2,5	3	3	4	4	5	5	7	8
		P4A	1,5	1,5	1,5	1,5	1,5	2,5	2,5	4	5	6
S_{ia}	Side face runout with reference to the raceway of assembled bearing inner ring	P4	3	3	4	4	5	5	6	6	8	10
		P4A	1,5	1,5	2,5	2,5	2,5	2,5	2,5	5	5	7
Δ_{Bs}	Deviataion of the inner ring width	P4, P4A	-250	-250	-250	-250	-250	-380	-380	-500	-500	-630

Table 3: Dimensional and running tolerances for the inner ring, specified in µm.

	Characteristic	Tolerance class	Outer ring ø 18 to 30	30 50	50 80	80 120	120 150	150 180	180 250	250 315	315 400
Δ_{Dmp}	Deviation of the mean outside diameter from the nominal	P4, P4A	-5	-6	-7	-8	-9	-10	-11	-13	-15
V_{Dp}	Variation in the outside diameter in a radial plane	P4	4	5	5	6	7	8	8	10	11
		P4A	2	2,5	3	3	4	4	5	6	6
V_{Cs}	Outer ring width variation	P4	2,5	2,5	3	4	5	5	7	7	8
		P4A	1,5	1,5	1,5	2,5	2,5	2,5	4	5	7
K_{ea}	Radial runout of assembled bearing outer ring	P4	4	5	5	6	7	8	10	11	13
		P4A	2	2,5	3	3	4	4	5	6	6
S_D	Variation in inclination of outside cylindrical surface to outer ring side face	P4	3	3	3	4	5	5	7	7	10
		P4A	1,5	1,5	1,5	2,5	2,5	2,5	4	5	7
S_{ea}	Side runout with reference to raceway of assembled bearing outer ring	P4	4	4	5	6	7	8	10	10	13
		P4A	2,5	2,5	4	5	5	5	7	7	8

Table 4: Dimensional and running tolerances for the outer ring, specified in µm.

2.8 Sorting and chamfer dimensions

Sorting

The dimensional tolerances of the bearing, along with the dimensional tolerances of the housing, determine the exact and reproducible fitting of a fixed or floating bearing.

In order to simplify the allocation of high precision rolling bearings and sets of bearings to shafts and housings, the diameter deviations of NIBC Super precision angular contact bearings are sorted by bore diameter and outside diameter. Additionally a group mean value is given for each group.

The classification of bearings according to the permissible overall tolerance for outside diameter Δ_{Dmp} and bore diameter Δ_{dmp} in 2 or 3 sorting group is done on the basis of diameter and quality (P4 and P4A). Up to a overall tolerance of 5 µm there are 2 groups; above that value there are 3 groups. This makes 5 respectively 9 sorting groups.

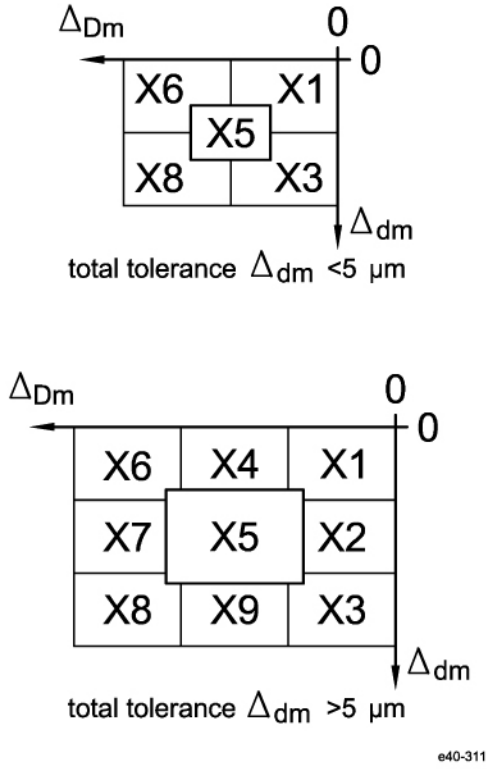


Fig.8: Sorting classes

Chamfer dimensions

The chamfer dimensions are standardised according to the table 5 for all rolling bearings. The chamfers of the adjacent parts, like shafts and housings, have to be manufactured accordingly.

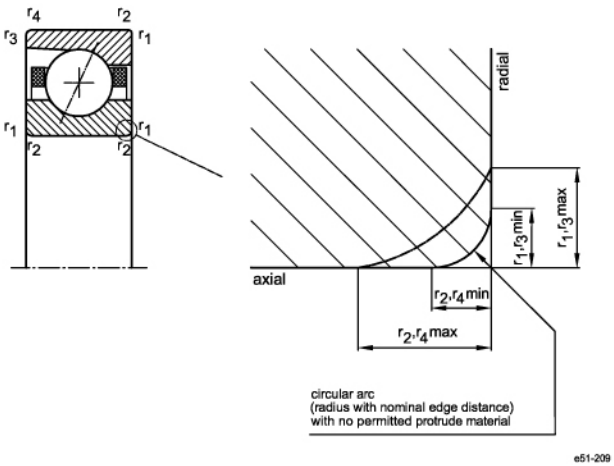


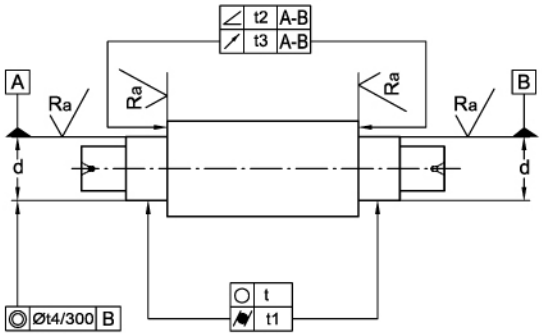
Fig.9: Dimensional drawing of chamfer dimensions according to DIN 620, Part 6

Nominal chamfer dimensions r_{min}, r_{12}, r_{34} mm	Bore diameter d over mm	to mm	Tolerance of chamfer dimensions radial r_1, r_3 min. mm	max. mm	axial r_2, r_4 min. mm	max. mm
0.2	-	-	0.2	0.5	0.2	0.8
0.3	-	40	0.3	0.6	0.3	1.0
	40	-	0.3	0.8	0.3	1.0
0.6	-	40	0.6	1.0	0.6	2.0
	40	-	0.6	1.3	0.6	2.0
1.0	-	50	1.0	1.5	1.0	3.0
	50	-	1.0	1.9	1.0	3.0
1.1	-	120	1.1	2.0	1.1	3.5
	120	-	1.1	2.5	1.1	4.0
1.5	-	120	1.5	2.3	1.5	4.0
	120	-	1.5	3.0	1.5	5.0
2.0	-	80	2.0	3.0	2.0	4.5
	80	220	2.0	3.5	2.0	5.0
2.1	-	280	2.1	4.0	2.1	6.5
2.5	-	100	2.5	3.8	2.5	6.0
	100	280	2.5	4.5	2.5	6.0
3.0	-	280	3.0	5.0	3.0	8.0

Table 5: Values for chamfer dimensions according to DIN 620, Part 6

2.9 Tolerances of adjacent parts

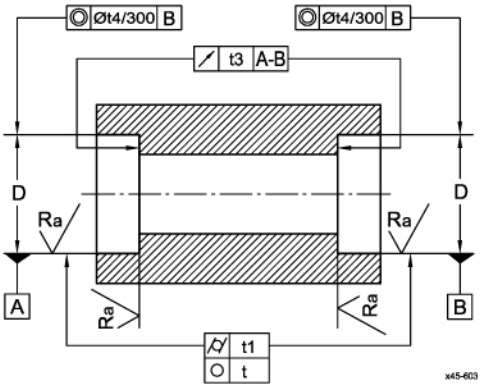
Form accuracy for shafts



Characteristic	Tolerance Symbol	Tolerance Designation	Accuracy of form, Tolerance grade, Roughness class for Tolerance class of bearings			
			PN	P6	P5	P4/P2
Circularity	○	t	IT5 2	IT4 2	IT3 2	IT2 2
Cylindicity	⌭	t1	IT5 2	IT4 2	IT3 2	IT2 2
Angularity	∠	t2	-	-	-	IT3 2
Runout	↗	t3	IT5	IT4	IT3	IT3
Coaxiality	◎	t4	IT6	IT6	IT5	IT4
Roughness R_a d≤ 80 mm		-	N6	N5	N4	N4
d > 80 mm		-	N7	N6	N5	N5

Table 6: Form accuracy for shafts

Form accuracy for housings



Characteristic	Tolerance Symbol	Tolerance Designation	Accuracy of form, Tolerance grade, Roughness class for Tolerance class of bearings			
			PN	P6	P5	P4/P2
Circularity	○	t	IT5 2	IT4 2	IT3 2	IT2 2
Cylindricity	⌭	t1	IT5 2	IT4 2	IT3 2	IT2 2
Angularity	∠	t3	IT5	IT4	IT3	IT3
Runout	↗	t4	IT7	IT6	IT5	IT4
Roughness R_a d≤ 80 mm		-	N7	N6	N5	N5
80 < D ≤ 250		-	N7	N7	N6	N6
D < 250 mm		-	N7	N7	N7	N7

Table 7: Form accuracy for housings

ISO Basic Tolerance Grades acc. To DIN 7151

Nominal diameter		Tolerance grades							
Over	incl.	IT0	IT1	IT2	IT3	IT4	IT5	IT6	IT7
mm		µm							
6	10	0,6	1	1,5	2,5	4	6	9	15
10	18	0,8	1,2	2	3	5	8	11	18
18	30	1	1,5	2,5	4	6	9	13	21
30	50	1	1,5	3	4	7	11	16	25
50	80	1,2	2	4	5	8	13	19	30
80	120	1,5	2,5	5	6	10	15	22	35
120	180	2	3,5	6	8	12	18	25	40
180	250	3	4,5	7	10	14	20	29	46
250	315	4	6	8	12	16	23	32	52
315	400	5	7	9	13	18	25	36	57
400	500	6	8	10	15	20	27	40	63

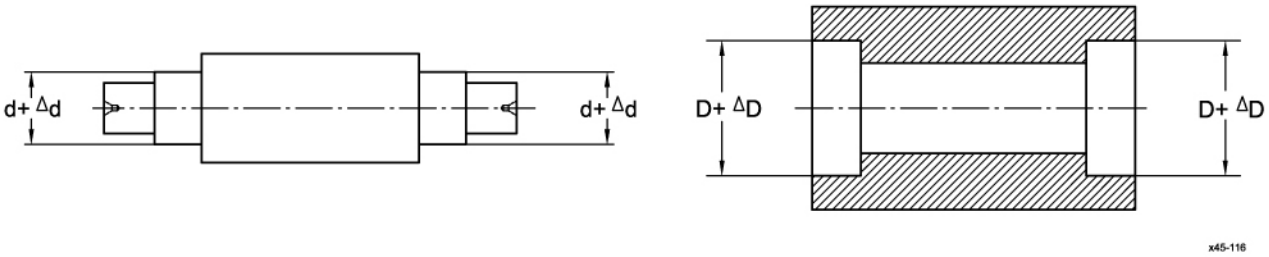
Table 8: Standard tolerances

Design of adjacent parts

The positional accuracy and form accuracy of the adjacent parts must be adjusted to the accuracy requirements of the Super precision angular contact ball bearings.Super Precision Angular Contact Ball Bearings adapt to the form deviations of the shaft and the housing. The selected fits depend on the rotational conditions of the considered bearing rings.

Surface Roughness Class	Roughness R_a µm
N3	0,1
N4	0,2
N5	0,4
N6	0,8
N7	1,6

Table 9: Roughness classes



Nominal shaft diameter d in mm	Tolerance class	from incl.	- 10	10 18	18 30	30 50	50 80	80 120	120 180
Bore diameter tolerance max. 0	P4, P4A	min.	-4	-4	-5	-6	-7	-8	-10
Shaft tolerance Δ d	P4, P4A	max.	+2	+2	+2	+2	+3	+4	+4
		min.	-2	-2	-2	-2	-2	-2	-3
Interference for mean fit sizes	P4, P4A	mean	+2	+2	+2	+3	+3	+3	+4

Nominal housing diameter D in mm	Tolerance class	from incl.	18 30	30 50	50 80	80 120	120 150	150 180	180 250
Bearing outside diameter tolerance max. 0	P4, P4A	min.	-5	-6	-7	-8	-10	-11	-13
Housing tolerance Δ D locating bearing	P4, P4A	max.	+5	+5	+5	+5	+7	+7	+7
		min.	0	0	0	-3	-3	-3	-3
Clearance for mean fit sizes	P4, P4A	mean	+5	+5	+5	+5	+7	+7	+7
Housing tolerance Δ D floating bearing	P4, P4A	max.	+7	+7	+7	+11	+17	+17	+19
		min.	+2	+2	+2	+3,5	+7	+7	+9
Clearance for mean fit sizes	P4, P4A	mean	+7	+7	+7	+11	+17	+17	+19

Table 10: Interference and/orclearance measurements that should be aimed for with adjacent parts with regard to NIBC Super precision angular contact ball bearings. Specifications in µm.

2.10 Universally ground

All NIBC Super Precision Angular Contact Ball Bearings are ground universally. This is the reason why the bearings could be used either as single bearings or as sets. Using universal angular contact ball bearings is a great advantage, especially from the point of view of stocks and the availability of components.

Universal angular contact ball bearings are manufactured as single bearings known as U, and as duplex sets known as DU. Single bearings are marked with a V-marking on the outer ring that shows the direction of axial force transmitted from the inner through the outer ring. The V-marking also indicates the point of maximum ring thickness.

Universal bearing as sets have the advantage that their bore diameter and outside diameter are sorted in the NIBC manufacturing process. In the manufacturing process, NIBC universal angular contact ball bearings are adjusted and matched in such a way that they can be mounted in any type of arrangement (O- or X-arrangement, or tandem mounting) and with any number of bearings positioned next to each other.

The bearing arrangement for single bearings is done by the customer according the small arrow. For sets of bearings f.e. DB, TBT, QBC an additional V-marking that runs on the outer rings indicates the mounting position.

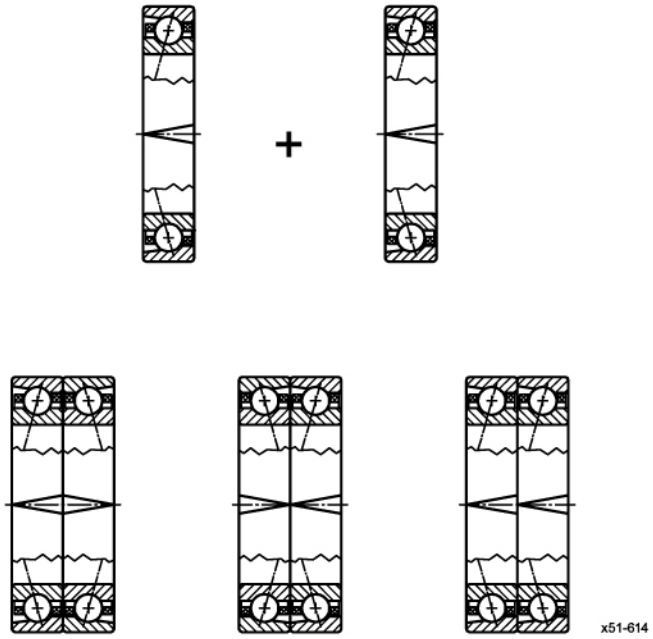
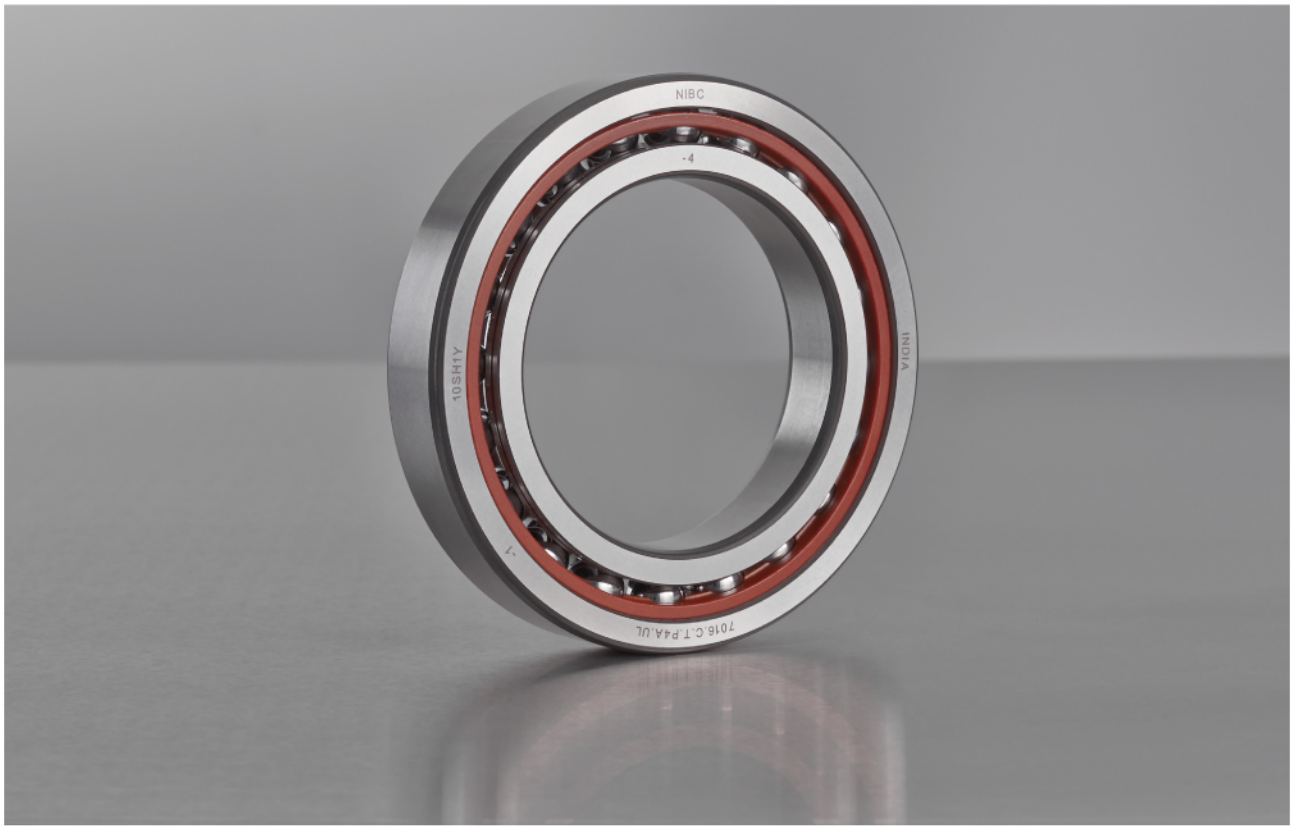


Fig.10: Universally ground NIBC Super Precision Angular Contact Ball Bearings in O-arrangement, X-arrangement and in tandem mounting



2.11 Matched sets

The basic mounting for a spindle is one Super Precision Angular Contact Ball Bearing on each side. Both bearings are therefore arranged at a suitable distance from each other. In this arrangement, the required preload adjustment is achieved with a defined torque by a suitable locknut or a ground flange cover.

The correct adjustment of the two individual Super Precision Angular Contact Ball Bearings is crucial for the successful operation of this type of bearing arrangement. If the adjustment is not carried out correctly, the lifetime of the bearing may be reduced through higher friction and associated higher operating temperatures.

If the load carrying capacity of a single bearing is insufficient, or the bearing must carry axial forces in both directions, then Super Precision Angular Contact Ball Bearings with universally ground preload can be used in sets.

NIBC Super Precision Angular Contact Ball Bearing sets are pre-adjusted and matched in such a way, that the predefined preload value of a single bearing remains in the set. The load is spread evenly across all individual bearings.

Arrangements

The O- and X-arrangements of two Super Precision Angular Contact Ball Bearings can carry axial loads in both directions. For high axial forces in one direction only, Super Precision Angular Contact Ball Bearings in tandem arrangement must be used.

Stronger forces can be carried by Super Precision Angular Contact Ball Bearing sets with more than two Super Precision Angular Contact Ball Bearings positioned in a single direction. The angular contact ball bearing set is therefore generally set against a further angular contact ball bearing, or a further set, that carries the axial load in the opposite load direction.

O-arrangements are better to absorb tilting moments, because the contact lines are touching the spindle axes outside the bearing. That`s the reason why angular contact ball bearing sets in O-arrangements are very stiff against tilting moments

In contrast to the O-arrangement, the contact lines in the X-arrangement are touching inside the set of bearings and therefore the set of bearings can not absorb such a high tilting moment as the the O-arrangement.

In the tandem arrangement, the contact lines run parallel to each other and at the same angle to the perpendicular line and the rotational axes of the angular contact ball bearing.

NIBC also offers further Super Precision Angular Contact Ball Bearing sets. It is possible to combine tandem mounting with an O- or X-arrangement when the design of the spindle does not allow to locate angular contact ball bearings in tandem mounting against a further contact ball bearing, or against another set of contact ball bearings. If there are special requirements to stiffness and load carrying capacity, then Super precision angular contact ball bearings in tandem arrangement with three or four angular contact ball bearings should be used.

Number of angular contact ball bearings		
D...		duplex set with 2 angular contact ball bearings
T...		triplex set with 3 angular contact ball bearings
Q...		quadruplex set with 4 angular contact ball bearings
P...		pentaplex set with 5 angular contact ball bearings
Arrangement of angular contact ball bearings		
		with 2 angular contact ball bearings in a set:
...B	< >	O-arrangement
...F	> <	X-arrangement
...T	>> or <<	tandem mounting
		with 3 or more angular contact ball bearings in a set:
...BT	<< >	tandem and O-arrangement
...FT	>> <	tandem and X-arrangement
...BC	<< >>	tandem-tandem in O-arrangement
...FC	>> <<	tandem-tandem in X-arrangement

Table 11: Designation system of NIBC Super precision angular contact ball bearings sets

Bearing sets and marking

Angular contact ball bearing sets with different combinations are used, according to the requirements. In order to meet these requirements, NIBC manufactures matched angular contact ball bearing sets in addition to single bearings. These sets are provided with a V-marking that spans the whole set, in addition to the individual V-marking on the single bearing.

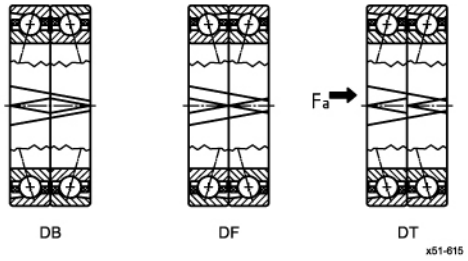


Fig.11: Arrangements with duplex sets

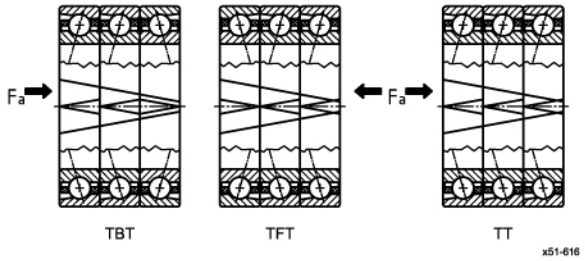


Fig.12: Arrangements with triplex sets

The sequence of the individual bearings is clearly defined by the marking within the set and the marking also indicates the main direction of axial load of the angular contact ball bearing set.

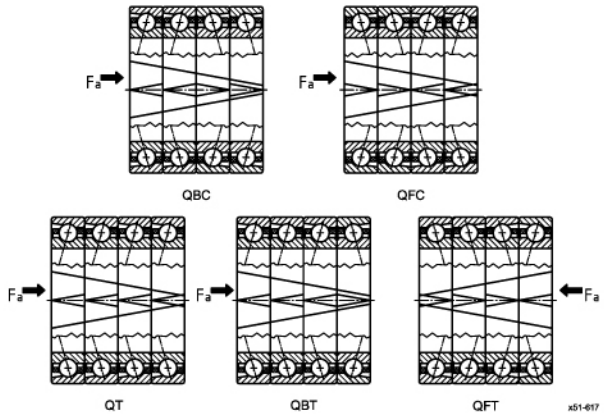


Fig.13: Arrangements with quadruplex sets

The correct mounting direction must be adhered in order to keep the function of the Super precision angular contact ball bearing set and to allow the adjustment of the required preload. With the V-marking the exact position can be checked, even after mounting. The marking also helps to reduce potential mounting errors

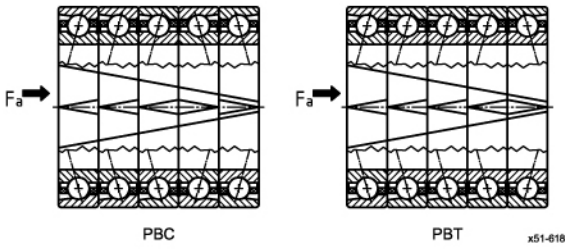


Fig.14: Arrangements with pentaplex sets

The inner ring faces are marked with a small circle “o” at the point of maximum ring thickness and/or maximum radial runout. During the installation of Super Precision Angular Contact Ball Bearing sets, care should be taken to ensure that the circles on both the outer and the inner ring are aligned. The best possible radial runout is achieved, when the outer ring marker is aligned with the point of the largest housing bore and the inner ring marker is aligned with the point of the smallest shaft diameter.

In order to achieve balanced load bearing characteristics for all the angular contact ball bearings within a set, Super Precision Angular Contact Ball Bearings with the same restricted outer and inner ring tolerance are combined. The measurements Δ_{Dmp} and / or Δ_{dmp} of these angular contact ball bearings are specified as average values D_{gm} and/or d_{gm} with regard to their tolerance classes and marked as such on the external packing and foil bag. Chapter on Tolerances contains detailed information on tolerances and their designation as well as their respective characteristics.

Rotational speed factors for angular contact ball bearing sets

The rotational speeds mentioned in the tables in chapter 2.3 (Technical data of NIBC Super precision angular contact ball bearings) are based on a single Super Precision Angular Contact Ball Bearing that is carrying a light load.

Preloaded Super Precision Angular Contact Ball Bearings that are combined to sets cannot be used according the mentioned speeds, because they are subject to self-heating. Various reduction factors apply to these sets, depending on the arrangement of the super precision bearings. Detailed information on rotational speed factors is contained in Chapter 2.12 (Speed coefficients for sets).

Preload and stiffness of bearing sets

The numerical values for preload and stiffness given in the tables are valid for the individual super precision angular contact ball bearing.
A significant change in axial stiffness will occur, however, depending on the way the angular contact ball bearings are arranged within the set and also depending on the direction of the force.

The radial stiffness of a set of angular contact ball bearings, calculated as the sum of the radial stiffness of all the individual bearings, is approximately valid only for those angular contact ball bearing sets in a symmetrical arrangement that also have an absolutely uniform load distribution between the angular contact ball bearings within the bearing set. Angular contact ball bearing sets in an asymmetrical arrangement are subject to a reduction in stiffness under radial load due to the effect of the slightly differing contact angles.

Table 12 below is valid for the different types of arrangements of angular contact ball bearings in bearing sets, and for both directions of axial force. The table specifies the factors for axial and radial stiffness as well as the factor that shows the axial force of angular contact ball bearings within the set that will cause a relief of load, when compared to the preload.

Load in main load direction	axial stiff-ness factor K_a	radial stiff-ness factor K_r	un-loading force $X \cdot F_v$	Opposite load direction	axial stiff-ness factor K_a	radial stiff-ness factor K_r	un-loading force $X \cdot F_v$
Fa Fa`	1.00	1.00	2.83	Fa` Fa	1.00	1.00	2.83
Fa Fa`	1.63	1.45	5.66	Fa` Fa	1.30	1.45	2.83
Fa Fa`	2.22	1.90	8.49	Fa` Fa	1.54	1.90	2.83
Fa Fa`	2.80	2.35	11.3	Fa` Fa	1.76	2.35	2.83
Fa Fa`	2.00	2.00	5.66	Fa` Fa	2.00	2.00	5.66
Fa Fa`	2.64	2.40	8.49	Fa` Fa	2.31	2.40	5.66
Fa Fa`	3.26	3.70	11.3	Fa` Fa	2.59	3.70	5.66
shaded inner ring: bearing loaded				light-coloured inner ring: bearing unloaded			

Table 12: Stiffness factors and deloading force for angular contact ball bearing sets

2.12 Speed coefficients for sets

The maximum operating speed under defined conditions depends on a number of different factors. Most of these factors are numerically known within certain tolerances. For new applications they must be determined and/or optimised by tests.

The maximum operating speed is achieved with a single bearing that is slightly preloaded with springs, has a load of P ≤ 0.06 • C and has good heat dissipation.

The operating speed is based on the basic speed rating n for a single high precision rolling bearing that is specified in the respective part of the table. The maximum operating speed is calculated by multiplying the basic speed rating specified in the bearing tables with the speed coefficients mentioned below.

$$N_B = n \cdot n_{av} \cdot n_f \cdot n_j \cdot n_r \quad [min^{-1}] \quad [2.1]$$

N_B	operating speed	$[min^{-1}]$
n	basic speed rating	$[min^{-1}]$
n_{av}	speed coefficient for preload and/or arrangement	
n_f	load-dependent speed coefficient	
n_j	speed coefficient of lubricant	
n_r	kinematic rolling coefficient	

Basic speed rating

This parameter is to be taken from the bearing tables, depending on the type of lubricant (grease or oil).

Speed coefficient for preload and arrangement

Reduced limiting speeds apply to high precision rolling bearings that are set against eachother in an arrangement; These limiting speeds can be determined in the following table.

Bearing Arrangement		Preload X	L	M	F
<	>	1.00	1.00	0.90	0.80
<<	>	0.95	0.90	0.80	0.70
<<	>>	1.00	0.95	0.85	0.75
<>	<>	0.95	0.85	0.75	0.70
<<>	<>	0.80	0.70	0.55	0.50
<<>>	<>	0.70	0.60	0.50	0.45

Table 13: Speed coefficients for preloading

The following speed coefficients apply to balanced NIBC Super Precision Angular Contact Ball Bearing sets:

Preload Combination			Speed coefficient	Preload Combination				Speed coefficient
X	X	L	0.95	X	X	X	M	0.65
L	L	M	0.90	L	L	L	F	0.60
M	M	F	0.65					

Table 14: Speed coefficient for preload combinations

Vertical shaft arrangement

For vertically arranged shafts, the values mentioned in the table above must be additionally multiplied by factor 0.8, because of the unfavourable lubrication condition and the altered cage guidance.

Load-dependent speed coefficient

The operating speed must be reduced for higher equivalent bearing loads. Diagram 1 is used to determine the load-dependent speed coefficient.

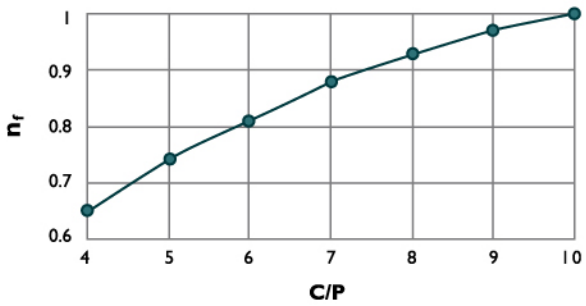


Diagram 1: Load-dependent speed coefficient

Speed coefficient of lubricant

If a grease filling quantity is used that deviates from the standard quantity, and if greases with an especially high or low viscosity are used, this will result in modified factors for the speed coefficient of lubricant.

The grease quantities for the standard greasing are specified in Table 24 in chapter 5.1 (Lubrication) with reference to each bearing type.

The speed coefficients for the various greases are also specified in Chapter 5.1 (Lubrication), in this case in table 23.

Kinematic rolling coefficient

The basic speed rating of high precision rolling bearings to be found in the tables applies to the rotating inner ring with a kinematic rolling coefficient of 1; for a rotating outer ring the kinematic rolling coefficient is 0.6.

Optimised spring preload

The centrifugal force acting on the rolling elements influences the contact angle of the inner and the outer ring in diffrent ways. Where as the centrifugal force tries to pull the rolling elements into the centre of the raceway of the outer ring, and thereby tries to reduce the contact angle, the rolling elements simultaneously rise towards the shoulder of the inner ring and there by widen the contact angle. The result is a bore rolling effect that encourages wear. An adapted spring preload may be used to counteract the rising up of the rolling elements at the inner ring.

The dependencies that are used to calculate the ideal spring preload are determined according the following formula:

$$F_{Feder} = k \cdot C_0^2 \cdot n_{max}^2 \cdot 10^{-15} \quad [N] \quad [2.2]$$

F_{Feder}	spring preload	[N]
k	contact angle dependant constant	
	k = 6.5 contact angle 15°	
	k = 13 contact angle 25°	
	k = 17 contact angle 30°	
C_0	static load rating	[N]
n_{max}	maximum service speed	[min^{-1}]

Only very seldom the preload of a mounted spindle can be adjusted later on. Therefore a compromise needs to be achieved in determining the preload, with the aim of guaranteeing operational safety for a variety of speed ranges.