PRÄZISIONSLAGER
PRECISION BEARINGS

About CSC

Established in 1969 CSC Bearings is today as manufacturer of high-class bearings for the global market. On more than 130.000m² factory floor we produce a large product range of different of bearings.

Innovation & Quality

CSC is focused on technical high-level bearings. By permanent investing in the improvement of products and services CSC has numerous satisfied customers all over the world.

Our own research and design departments in Germany and China develop innovative and demand-driven bearings for almost every kind of application.

Own warehouses in Asia and Europe guarantee fast delivery times and maximum comfort for our customers.

Contents

1.1 Bearing Types

Because each application has a different operating condition, bearing selection must be done on a case by case basis. Various factors should be considered when selecting bearings, these include: load carrying capability, speed capability, lifetime and running accuracy. Machine tools require superior performance bearings that to support spindles and screw drives

CSC has developed a very comprehensive range of high-precision bearings for machine tool spindles, and other applications where high demands are placed on accuracy and speed capability.

Internal design is state-of-the art, and differs in many ways from that of a standard bearing. The design has been optimized for outstanding speed capability in combination with the highest possible stiffness. When designing a bearing arrangement it is necessary to consider a number of factors, i.e.:

- Accuracy
- Available space
- Load
- Required system rigidity
- Accommodation of axial displacements
- Speeds
- Heat generation

1.2 Bearing Materials

The performance and reliability required from high-precision bearings implies the use of adequate materials for rings, rolling elements and cages.

All-steel bearings

Steels used for high-precision bearing rings and rolling elements are capable of being adequately hardened and have high fatigue strength and wear resistance. Moreover they have the structural and dimensional stability to satisfy the spindle operating temperatures.

CSC high-precision bearing rings and rolling elements are generally made of through-hardened carbon chromium steel

Hybrid Bearings

Machine tools, especially machining centres, can have higher machining efficiencies and higher machining accuracies when operated at higher speeds. For this reason, there have been ever-greater demands for higher speed performance of their spindle bearings. If the performance required is close to all-steel bearing limits, or if higher rigidity or longer life are needed, hybrid high precision bearings can be used. Hybrid high-precision bearings consist of outer and inner rings made of bearing steel and ceramic (silicon nitride Si_3N_4) rolling elements.

All-steel bearings

Comparing with steel rolling elements, ceramic rolling elements has following benefit :

- Lower heat generation
- Having density as light as 40% of bearing steel, thus centrifugal forces of rolling elements is reduced
- The thermal expansion is lower.
- Having a great rigidity, which is more suitable for machine tools
- Having better resistance to damage

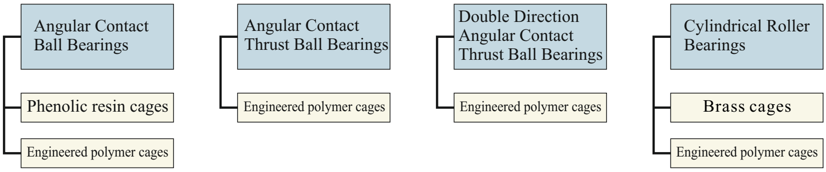
Hybrid Bearing

Due to these reasons, the service life of the bearings is extended, and

Material for cages

The main purpose of the cage is to keep the rolling elements at an appropriate distance from each other and to prevent immediate contact between two neighbouring rolling elements, in order to keep friction and consequently heat generation at a minimum. Materials and the shape of cages for high-precision bearings have been developed parallel to the development of the bearings and to the requirements they have to satisfy.

High-precision bearing cages are mechanically stressed by frictional strain and inertia forces. They might also be subjected to chemical action of certain lubricants and the influence of usage temperature. Thus, the design and choice of material are of paramount importance for the performance of the cage, as well as for the operational reliability of the bearing as a whole.



Features of each cage

Phenolic resin cage

1.This material is lightweight resulting in minimal centrifugal forces and having the capability of retaining part of the lubricant, ensuring optimum lubrication. Fabric reinforced phenolic resin cages should not be used at temperatures exceeding 80℃ for a long term. It can be able to bear the instantaneous temperatuce of 120degrees.

2.High-speed capability

Engineered polymers

1.High temperature resistance

2.Having good self-lubricating property and lower friction

1.3 Available space

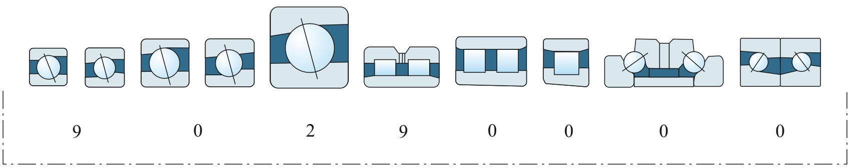
High-precision applications generally call for bearings with a low cross section, due to limited space and high requirements for rigidity and running accuracy. Bearings with a low cross section are able to accommodate relatively large diameter shafts to provide the necessary rigidity and turning accuracy within a relatively small bearing envelope.

Angular contact ball bearings, cylindrical roller bearings and angular contact thrust ball bearings commonly used in machine tool applications are almost exclusively bearings in the ISO 9 and 0 Diameter Series

By selecting suitable combinations of bearings it is thus possible to achieve an optimum bearing arrangement for specific requirements within the same radial space. For bearing arrangements where less radial space is available, angular contact ball bearings and cylindrical roller bearings belonging to ISO Diameter Series 9 can be used. Angular contact ball bearings to the ISO Diameter Series 2, despite being rarely chosen for new designs, are still common in existing applications.

To illustrate the space required, fig 1 shows cross-sections of the most common machine tool spindle bearings belonging to the different Diameter Series.

Fig.1 High-precision bearings cross section for different Diameter Series



2.1 Angular contact ball bearings for spindle

2.1.1 Feature

High Precision Angular Contact Ball Bearings

Standard series

- 719XX, 70XX, 72XX series
- Two kinds of contact angle: 15°(C), 25°(AC)
- Two kinds of cage design: Select either Phenolic (TA) or Plastic (TN) depending on application requirements
- Two types of ball material: Select either steel or ceramic depending on application requirements.
- Two kinds of design: Select either Open or Sealed depending on lubricating system of machines.

In order to use more conveniently and suitable for miantenance of machine tool spindles, lubricating the suitable type and amount of arease within the seals.

High-speed Angular Contact Ball Bearings but HS series

High-speed, Lower Heat generation and High rigidity

- 719XX, 70XX series
- Two types of contact angle: 15°（C）, 25°（AC）
- Two kinds of cage design: Select either Phenolic (TA) or Engineered polymer (TN) depending on application requirements
- Two types of ball material: Select either steel or Ceramic depending on application requirements.
- Two kinds of design: Select either open or sealed depending on lubricating system of machines

In order to use more conveniently and suitable for miantenance of machine tool spindles, lubricating the suitable type and amount of arease within the seals.

2.1.2 Numbering system

Numbering system of CSC High Precision Angular Contact Ball Bearings

7 0 10 C – 2RZ TA / HQ1 P4 DB A

Bearing type symbol

7 — Angular Contact Ball Bearings

Dimension symbol

18 — Extra light series
19 — Light series
0 — Medium series
2 — Heavy series

Bore symbol

00 — 10mm
01 — 12mm
02 — 15mm
03 — 17mm
04 — 4×5=20mm

Contact angle symbol

C — 15°
AC — 25°

Seal symbol

No symbol— open type
2RZ—Two sides of the bearing with non contact frame-rubber seals

Cage symbol

TA—Outer ring guided phenolic resin cage
TN—Ball guided Engineered polymer cage

Preload symbol

A—Light preload
B—Medium preload
C—Heavy preload
G— Special preload, Unit: N

Arrangement symbol

DB—No symbol-single bearing
Two bearings arranged back-to-back
DF—Two bearings arranged face-to-face
DT—Two bearings arranged in tandem
TBT—Three bearings arranged back-to-back and tandem
TFT—Three bearings arranged face-to-face and tandem
QBC—Four bearings arranged tandem back-to-back
QFC—Four bearings arranged tandem face-to-face
U—Universal bearings

Accuracy symbol

P5 — Dimensional and running accordance with ISO tolerance class 5
P4——Dimensional and running accordance with ISO tolerance class 4
P2——Dimensional and running accordance with ISO tolerance class 2
P4A——Rotating accuracy is better than P4

Ball material symbol

No symbol——Carbon chromium steel
HQ1—— silicon nitride Si3N4 (Ceramic)

Numbering system of CSC High-speed Angular Contact Ball Bearings

HS S 7 0 10 C TA / HQ1 P4 DB A

Bearing type symbol

HS - Super high speed

Seal symbol

No symbol— open type

S — both side sealing

Bearing type symbol

7 — Angular Contact Ball Bearings

Dimension symbol

18 — Extra light series

19 — Light series

0 — Medium series

Bore symbol

00 — 10mm

01 — 12mm

02 — 15mm

03 — 17mm

04 — 4×5=20mm

Contact angle symbol

C — 15°

AC — 25°

Cage symbol

TA—Outer ring guided phenolic resin cage

TN—Ball guided Engineered polymer cage

Preload symbol

A—Light preload

B—Medium preload

C—Heavy preload

G— Special preload, Unit: N

Arrangement symbol

DB—No symbol-single bearing

Two bearings arranged back-to-back

DF—Two bearings arranged face-to-face

DT—Two bearings arranged in tandem

TBT—Three bearings arranged back-to-back and tandem

TFT—Three bearings arranged face-to-face and tandem

QBC—Four bearings arranged tandem back-to-back

QFC—Four bearings arranged tandem face-to-face

U—Universal bearings

Accuracy symbol

P2——Dimensional and running accordance with ISO tolerance class 2

P4A——Rotating accuracy is better than P4

Ball material symbol

No symbol——Carbon chromium steel

HQ1—— silicon nitride Si_3N_4 (Ceramic)

2

Comparison Table of CSC Bearings with other makes

Manufacturer	CSC	SKF	FAG	SNFA	NSK
Bearing type symbol					
719	719	719	B719	SEB	79
70	70	70	B70	EX	70
72	72	72	B72	E2	72
HS	HS				
Contact angle symbol					
15°	C	CD	C	1	C
25°	AC	ACD	E	3	A5
Cage symbol					
Phenolic	T(TA)	TA	T(TPA)	CE	T
Polyamide	TN	TNH	TVP		TYN
Universal arrangement symbol					
single row	U	G	U	U	SU
double row	DU	DG	DU	DU	DU
Arrangement symbol					
2 bearing O	DB	DB	DB	DD	DB
2 bearing X	DF	DF	DF	FF	DF
2 bearing T	DT	DT	DT	T	DT
3 bearing T-O	TBT	TBT	TBT	TD	DBD
3 bearing T-X	TFT	TFT	TFT	TF	DFD
3 bearing T	TT		TT		
4 bearing T-O-T	QBC	QBC	QBC	TDT	DBB
4 bearing T-X-T	QFC	QFC	QFC	TFT	DFF
4 bearing 3T-O	QBT	QBT	QBT	3TD	DBT
4 bearing 3T-X	QFT	QFT	QFT	3TF	DFT
4 bearing T	QT	QT	QT		
Preload symbol					
Light preload	A	A	L	L	L
Medium preload	B	B	M	M	M
Heavy preload	C	C	H	F	H
Accuracy symbol					
P4	P4	P4A	P4	-7	P4
P2	P2	PA9A	P2	-9	P2

2

2.1.3 Arrangement

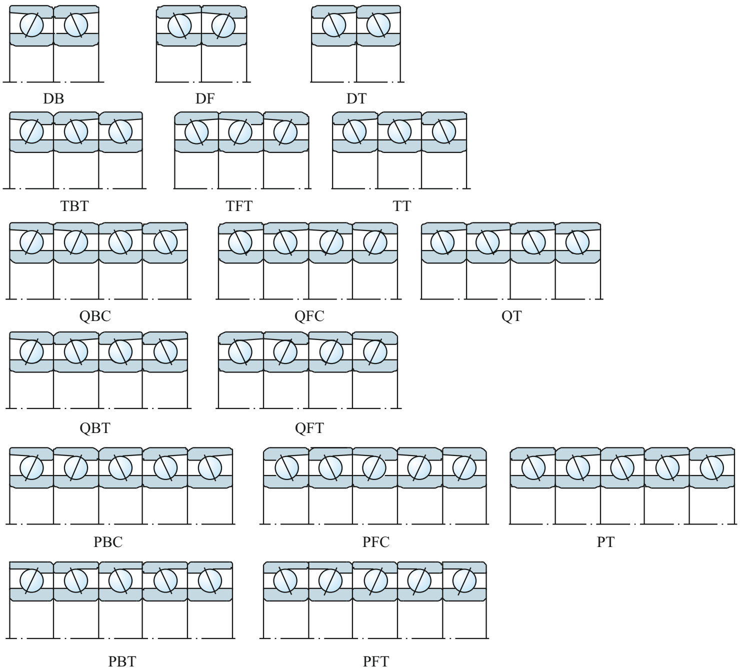
CSC Axial angular contact ball bearings can be supplied as required in complete sets of two, three or four matched bearings in the arrangements

The bearings of a set are matched in production so that when they are mounted immediately adjacent to each other in the prescribed order, a given preload will be obtained or the load will be evenly distributed. The bore and outside diameters of the bearings of a set differ from each other by one third of the permissible diameter tolerance.

In a back-to-back bearing arrangement, the load lines diverge toward the bearing axis. Axial loads acting in both directions can be accommodated, but only by one bearing or bearing set in one direction each. Bearings mounted back-to-back provide a relatively rigid bearing arrangement that can also accommodate tilting moments.

In a face-to-face bearing arrangement, the load lines converge toward the bearing axis. Axial loads acting in both directions can be accommodated, but only by one bearing or bearing set in one direction each. Face-to-face arrangements can accommodate small amounts of deflection.

In a tandem bearing arrangement, the load lines are parallel so that radial and axial loads are shared equally by the bearings in the set. The bearing set can only accommodate axial loads acting in one direction. For higher loads or requirements for high rigidities, bearings are assembled and installed in sets of 3 or 4. 2 or 3 of them are installed in Tandem arrangement.



Marking

A "V-shaped" marking on outside surface of the outer rings of matched bearings set. The "V" should point in the direction in which the axial load will act on the inner ring. As shown in the figure 2

A "V-shaped" is marked on outer diameter surface of universal combination bearings that indicate the direction of contact angle and ensure correct matching when they are mounted by customer. As shown in the figure 3

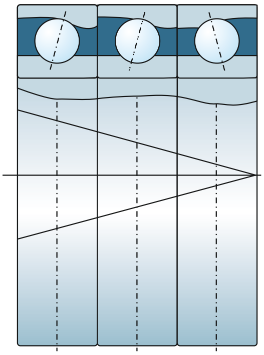


Figure 2

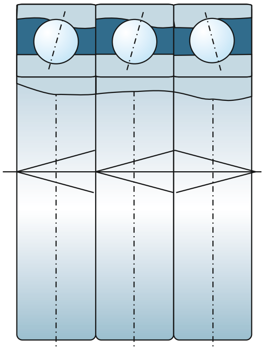


Figure 3

2

Each high-precision angular contact ball bearing is marked with "O" on one side face of the inner ring and outer ring indicated the max. point of radial runout Kia and Kea. As shown in thefigure 4

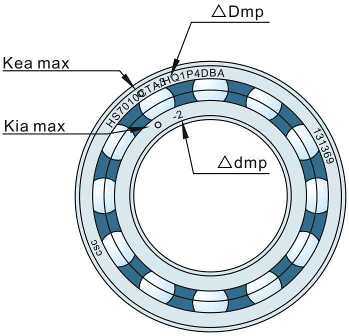
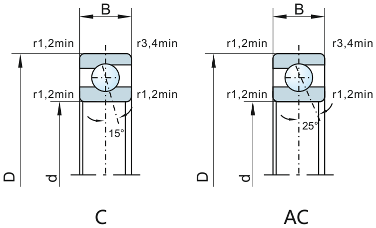


Figure 4

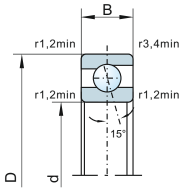
2.1.4 Dimension Tables

Dimension table of High-precision Angular Contact Ball Bearings



d	D	B	r1,r2	r3,r4	Cr	Cor	Oil	Grease	Mass	Code
	Dimensions				Basic load rating		Speed limit			
mm			min		kN		r/min		kg	——
15	28	7	0.3	0.1	4.36	2.4	85000	56000	0.015	71902CTA
	28	7	0.3	0.1	4.16	2.28	75000	50000	0.015	71902ACTA
	32	9	0.3	0.1	6.24	3.45	75000	50000	0.028	7002CTA
	32	9	0.3	0.1	5.92	3.25	67000	45000	0.028	7002ACTA
	35	11	0.6	0.3	7.41	3.65	70000	48000	0.043	7202CTA
	35	11	0.6	0.3	7.15	3.55	63000	43000	0.043	7202ACTA
17	30	7	0.3	0.1	4.49	2.65	75000	50000	0.017	71903CTA
	30	7	0.3	0.1	4.36	2.5	67000	45000	0.017	71903ACTA
	35	10	0.3	0.1	6.5	3.8	70000	48000	0.037	7003CTA
	35	10	0.3	0.1	6.18	3.65	60000	40000	0.037	7003ACTA
	40	12	0.6	0.3	9.23	4.65	63000	43000	0.062	7203CTA
	40	12	0.6	0.3	8.84	4.5	56000	38000	0.062	7203ACTA
20	37	9	0.3	0.15	6.63	4.05	63000	43000	0.035	71904CTA
	37	9	0.3	0.15	6.24	3.9	56000	38000	0.035	71904ACTA
	42	12	0.6	0.3	10.4	6.1	56000	38000	0.065	7004CTA
	42	12	0.6	0.3	9.95	5.85	50000	34000	0.065	7004ACTA
	47	14	1	0.3	12.4	6.55	53000	36000	0.1	7204CTA
	47	14	1	0.3	11.9	6.2	48000	32000	0.1	7204ACTA
25	42	9	0.3	0.15	7.02	4.8	53000	36000	0.042	71905CTA
	42	9	0.3	0.15	6.63	4.55	48000	32000	0.042	71905ACTA
	47	12	0.6	0.3	11.4	7.35	50000	34000	0.075	7005CTA
	47	12	0.6	0.3	10.8	7.1	43000	28000	0.075	7005ACTA
	52	15	1	0.3	14	8.15	45000	30000	0.14	7205CTA
	52	15	1	0.3	13.5	7.8	40000	26000	0.14	7205ACTA
30	47	9	0.3	0.15	7.15	5.2	45000	30000	0.048	71906CTA
	47	9	0.3	0.15	6.76	4.9	40000	26000	0.048	71906ACTA
	55	13	1	0.3	14.6	10	43000	28000	0.11	7006CTA
	55	13	1	0.3	14	9.65	38000	24000	0.11	7006ACTA
	62	16	1	0.3	24.2	16	38000	24000	0.19	7206CTA
	62	16	1	0.3	23.4	15.3	34000	20000	0.19	7206ACTA
35	55	10	0.6	0.15	9.75	6.55	40000	26000	0.074	71907CTA
	55	10	0.6	0.15	9.23	6.2	36000	22000	0.074	71907ACTA
	62	14	1	0.3	15.6	9.5	36000	22000	0.15	7007CTA
	62	14	1	0.3	14.8	9	32000	19000	0.15	7007ACTA
	72	17	1.1	0.3	31.9	21.6	34000	20000	0.28	7207CTA
	72	17	1.1	0.3	30.7	20.8	30000	18000	0.28	7207ACTA

Dimension table of High-precision Angular Contact Ball Bearings



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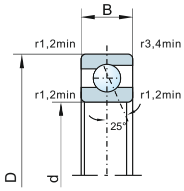
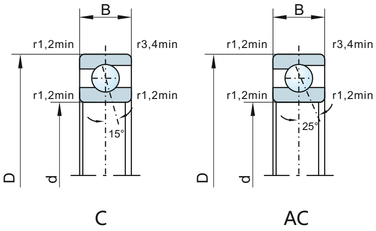


AC

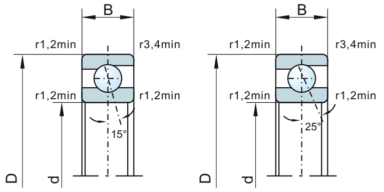
		Dimensions			Basic load rating		Speed limit			
d	D	B	r1,r2	r3,r4	Cr	Cor	Oil	Grease	Mass	Code
mm			min		kN		r/min		kg	——
40	62	12	0.6	0.15	12.4	8.5	34000	20000	0.11	71908CTA
	62	12	0.6	0.15	11.7	8	30000	18000	0.11	71908ACTA
	68	15	1	0.3	16.8	11	32000	19000	0.19	7008CTA
	68	15	1	0.3	15.9	10.4	30000	18000	0.19	7008ACTA
	80	18	1.1	0.6	41	28	30000	18000	0.36	7208CTA
	80	18	1.1	0.6	39	27	26000	16000	0.36	7208ACTA
45	68	12	0.6	0.15	13	9.5	32000	19000	0.13	71909CTA
	68	12	0.6	0.15	12.4	9	28000	17000	0.13	71909ACTA
	75	16	1	0.3	28.6	22.4	30000	18000	0.23	7009CTA
	75	16	1	0.3	27.6	21.6	26000	16000	0.23	7009ACTA
	85	19	1.1	0.6	42.3	31	28000	17000	0.41	7209CTA
	85	19	1.1	0.6	41	30	24000	15000	0.41	7209ACTA
50	72	12	0.6	0.15	13.5	10.4	28000	17000	0.13	71910CTA
	72	12	0.6	0.15	12.7	9.8	26000	16000	0.13	71910ACTA
	80	16	1	0.3	29.6	24	28000	17000	0.25	7010CTA
	80	16	1	0.3	28.1	23.2	24000	15000	0.25	7010ACTA
	90	20	1.1	0.6	44.9	34	26000	16000	0.46	7210CTA
	90	20	1.1	0.6	42.3	32.5	22000	14000	0.46	7210ACTA
55	80	13	1	0.3	19.5	14.6	26000	16000	0.18	71911CTA
	80	13	1	0.3	18.2	13.7	24000	15000	0.18	71911ACTA
	90	18	1.1	0.6	39.7	32.5	24000	15000	0.37	7011CTA
	90	18	1.1	0.6	37.1	31	22000	14000	0.37	7011ACTA
	100	21	1.5	0.6	55.3	43	22000	14000	0.61	7211CTA
	100	21	1.5	0.6	52.7	40.5	20000	13000	0.61	7211ACTA
60	85	13	1	0.3	19.9	15.3	24000	15000	0.19	71912CTA
	85	13	1	0.3	18.6	14.6	22000	14000	0.19	71912ACTA
	95	18	1.1	0.6	40.3	34.5	22000	14000	0.4	7012CTA
	95	18	1.1	0.6	39	33.5	20000	13000	0.4	7012ACTA
	110	22	1.5	0.6	67.6	53	20000	13000	0.8	7212CTA
	110	22	1.5	0.6	63.7	50	18000	11000	0.8	7212ACTA
65	90	13	1	0.3	20.8	17	22000	14000	0.21	71913CTA
	90	13	1	0.3	19.5	16	20000	13000	0.21	71913ACTA
	100	18	1.1	0.6	41.6	37.5	22000	14000	0.42	7013CTA
	100	18	1.1	0.6	39	35.5	19000	12000	0.42	7013ACTA
	120	23	1.5	0.6	76.1	60	19000	12000	1	7213CTA
	120	23	1.5	0.6	72.8	57	17000	10000	1	7213ACTA

Dimension table of High-precision Angular Contact Ball Bearings



d	D	B	r1,r2	r3,r4	Cr	Cor	Oil	Grease	Mass	Code
	Dimensions				Basic load rating		Speed limit			
mm			min		kN		r/min		kg	——
70	100	16	1	0.3	34.5	34	20000	13000	0.33	71914CTA
	100	16	1	0.3	32.5	32.5	18000	11000	0.33	71914ACTA
	110	20	1.1	0.6	52	45.5	19000	12000	0.59	7014CTA
	110	20	1.1	0.6	48.8	44	17000	10000	0.59	7014ACTA
	125	24	1.5	0.6	79.3	64	18000	11000	1.1	7214CTA
	125	24	1.5	0.6	76.1	62	16000	9500	1.1	7214ACTA
75	105	16	1	0.3	35.8	37.5	19000	12000	0.35	71915CTA
	105	16	1	0.3	33.8	35.5	17000	10000	0.35	71915ACTA
	115	20	1.1	0.6	52.7	49	18000	11000	0.62	7015CTA
	115	20	1.1	0.6	49.4	46.5	16000	9500	0.62	7015ACTA
	130	25	1.5	0.6	83.2	69.5	17000	10000	1.2	7215CTA
	130	25	1.5	0.6	79.3	67	15000	9000	1.2	7215ACTA
80	110	16	1	0.3	36.4	39	18000	11000	0.37	71916CTA
	110	16	1	0.3	34.5	36.5	16000	9500	0.37	71916ACTA
	125	22	1.1	0.6	65	61	17000	10000	0.85	7016CTA
	125	22	1.1	0.6	62.4	58.5	15000	9000	0.85	7016ACTA
	140	26	2	1	97.5	81.5	16000	9500	1.45	7216CTA
	140	26	2	1	92.3	78	14000	8500	1.45	7216ACTA
85	120	18	1.1	0.6	46.2	48	17000	10000	0.53	71917CTA
	120	18	1.1	0.6	43.6	45.5	15000	9000	0.53	71917ACTA
	130	22	1.1	0.6	67.6	65.5	16000	9500	0.89	7017CTA
	130	22	2	1	63.7	62	14000	8500	0.89	7017ACTA
	150	28	1.1	0.6	99.5	88	15000	9000	1.8	7217CTA
	150	28	1.1	0.6	95.6	85	13000	8000	1.8	7217ACTA
90	125	18	1.1	0.6	47.5	51	16000	9500	0.55	71918CTA
	125	18	1.1	0.6	44.2	48	14000	8500	0.55	71918ACTA
	140	24	1.5	0.6	79.3	76.5	15000	9000	1.15	7018CTA
	140	24	2	1	74.1	72	13000	8000	1.15	7018ACTA
	160	30	2	1	127	112	14000	8500	2.25	7218CTA
	160	30	2	1	121	106	12000	7500	2.25	7218ACTA
95	130	18	1.1	0.6	49.4	55	15000	9000	0.58	71919CTA
	130	18	1.1	0.6	46.2	52	14000	8500	0.58	71919ACTA
	145	24	1.5	0.6	81.9	80	14000	8500	1.2	7019CTA
	145	24	1.5	0.6	76.1	76.5	13000	8000	1.2	7019ACTA
	170	32	2.1	1.1	138	120	13000	8000	2.7	7219CTA
	170	32	2.1	1.1	133	114	12000	7500	2.7	7219ACTA

Dimension table of High-precision Angular Contact Ball Bearings

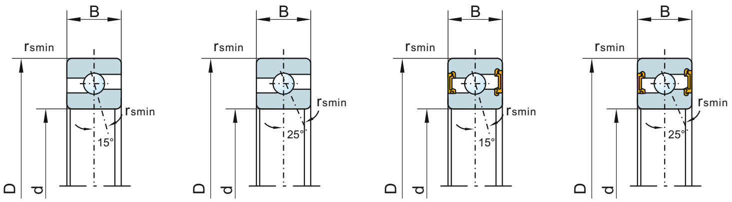


C AC

d	D	B	r1,r2	r3,r4	Cr	Cor	Oil	Grease	Mass	Code
	Dimensions				Basic load rating		Speed limit			
mm			min		kN		r/min		kg	——
100	140	20	1.1	0.6	60.5	65.5	14000	8500	0.8	71920CTA
	140	20	1.1	0.6	57.2	63	13000	8000	0.8	71920ACTA
	150	24	1.5	0.6	83.2	85	14000	8500	1.25	7020CTA
	150	24	1.5	0.6	79.3	80	12000	7500	1.25	7020ACTA
	180	34	2.1	1.1	156	137	12000	7500	3.25	7220CTA
	180	34	2.1	1.1	148	129	11000	7000	3.25	7220ACTA
105	145	20	1.1	0.6	61.8	69.5	14000	8500	0.82	71921CTA
	145	20	1.1	0.6	57.2	65.5	12000	7500	0.82	71921ACTA
	160	26	2	1	95.6	96.5	13000	8000	1.6	7021CTA
	160	26	2	1	90.4	93	12000	7500	1.6	7021ACTA
	190	36	2.1	1.1	172	153	12000	7500	3.85	7221CTA
	190	36	2.1	1.1	163	146	10000	6700	3.85	7221ACTA
110	150	20	1.1	0.6	62.4	72	13000	8000	0.86	71922CTA
	150	20	1.1	0.6	58.5	68	12000	7500	0.86	71922ACTA
	170	28	2	1	111	108	12000	7500	1.95	7022CTA
	170	28	2	1	104	104	11000	7000	1.95	7022ACTA
	200	38	2.1	1.1	178	166	11000	7000	4.55	7222CTA
	200	38	2.1	1.1	168	160	10000	6700	4.55	7222ACTA
120	165	22	1.1	0.6	78	91.5	12000	7500	1.15	71924CTA
	165	22	1.1	0.6	72.8	86.5	11000	7000	1.15	71924ACTA
	180	28	2	1	114	122	11000	7000	2.1	7024CTA
	180	28	2	1	111	116	10000	6700	2.1	7024ACTA
	215	40	2.1	1.1	199	193	10000	6700	5.4	7224CTA
	215	40	2.1	1.1	190	183	9000	6000	5.4	7224ACTA
130	180	24	1.5	0.6	92.3	108	11000	7000	1.55	71926CTA
	180	24	1.5	0.6	87.1	102	10000	6700	1.55	71926ACTA
	200	33	2	1	148	156	10000	6700	3.2	7026CTA
	200	33	2	1	140	150	9000	6000	3.2	7026ACTA

Using the nylon cage, bearing limit rotational speed please consult technical center.

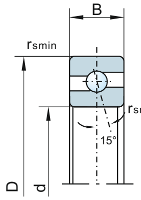
High-speed Angular Contact Ball Bearings



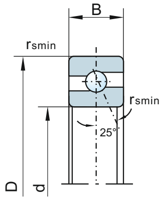
HS...C | HS...AC | HSS...C 7...C-2RZ | HSS...AC 7...AC-2RZ

d	D	B	r1,r2	r3,r4	Cr	Cor	Oil	Grease	Mass	Code
	Dimensions				Basic load rating		Speed limit			
mm			min		kN		r/min		kg	—
17	30	7	0.3		2.90	1.90	90000	60000	0.02	HS 71903CTA
	30	7	0.3		2.70	1.80	75000	50000	0.02	HS 71903ACTA
	35	10	0.3		3.80	2.65	80000	53000	0.04	HS 7003CTA
	35	10	0.3		3.65	2.50	67000	45000	0.04	HS 7003ACTA
20	37	9	0.3		3.90	2.85	75000	50000	0.04	HS 71904CTA
	37	9	0.3		3.75	2.70	63000	43000	0.04	HS 71904ACTA
	42	12	0.6		6.20	4.55	67000	45000	0.08	HS 7004CTA
	42	12	0.6		5.85	4.30	56000	38000	0.08	HS 7004ACTA
25	42	9	0.3		4.25	3.35	63000	43000	0.05	HS 71905CTA
	42	9	0.3		4.00	3.15	53000	36000	0.05	HS 71905ACTA
	47	12	0.6		6.30	4.90	56000	38000	0.09	HS 7005CTA
	47	12	0.6		6.00	4.65	50000	34000	0.09	HS 7005ACTA
30	47	9	0.3		6.40	5.20	53000	36000	0.05	HS 71906CTA
	47	9	0.3		6.00	4.90	48000	32000	0.05	HS 71906ACTA
	55	13	1		8.80	7.10	48000	32000	0.13	HS 7006CTA
	55	13	1		8.30	6.70	43000	28000	0.13	HS 7006ACTA
35	55	10	0.6		6.95	6.20	48000	32000	0.08	HS 71907CTA
	55	10	0.6		6.55	5.85	40000	26000	0.08	HS 71907ACTA
	62	14	1		9.30	8.30	43000	28000	0.17	HS 7007CTA
	62	14	1		8.80	7.80	38000	24000	0.17	HS 7007ACTA
40	62	12	0.6		7.20	6.95	43000	28000	0.13	HS 71908CTA
	62	12	0.6		6.80	6.40	38000	24000	0.13	HS 71908ACTA
	68	15	1		10.00	9.30	40000	26000	0.22	HS 7008CTA
	68	15	1		9.30	8.65	36000	22000	0.22	HS 7008ACTA
45	68	12	0.6		10.00	9.65	38000	26000	0.14	HS 71909CTA
	68	12	0.6		9.50	9.00	36000	22000	0.14	HS 71909ACTA
	75	16	1		12.90	12.20	38000	26000	0.27	HS 7009CTA
	75	16	1		12.20	11.40	34000	20000	0.27	HS 7009ACTA
50	72	12	0.6		10.40	10.20	36000	24000	0.15	HS 71910CTA
	72	12	0.6		9.80	9.65	34000	20000	0.15	HS 71910ACTA
	80	16	1		13.40	13.20	36000	22000	0.29	HS 7010CTA
	80	16	1		12.50	12.20	30000	18000	0.29	HS 7010ACTA

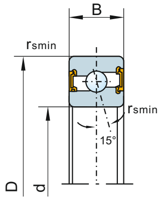
High-speed Angular Contact Ball Bearings



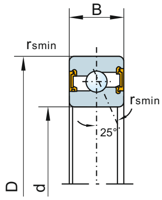
HS...C



HS...AC



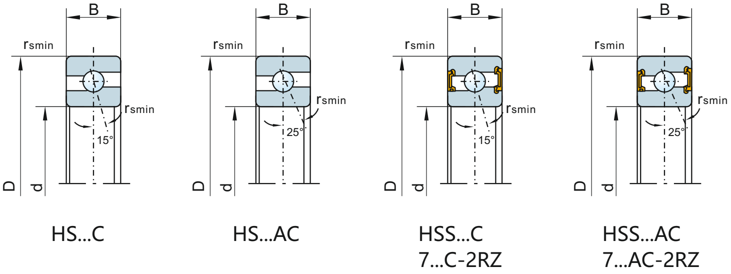
HSS...C
7...C-2RZ



HSS...AC
7...AC-2RZ

	Dimensions				Basic load rating		Speed limit			
d	D	B	r1,r2	r3,r4	Cr	Cor	Oil	Grease	Mass	Code
mm			min		kN		r/min		kg	——
55	80	13	1		13.40	13.70	34000	22000	0.2	HS 71911CTA
	80	13	1		12.70	12.70	30000	18000	0.2	HS 71911ACTA
	90	18	1.1		18.60	19.00	32000	20000	0.43	HS 7011CTA
	90	18	1.1		17.60	17.60	28000	17000	0.43	HS 7011ACTA
60	85	13	1		14.00	14.60	32000	20000	0.21	HS 71912CTA
	85	13	1		13.20	13.40	28000	17000	0.21	HS 71912ACTA
	95	18	1.1		19.30	20.00	30000	19000	0.46	HS 7012CTA
	95	18	1.1		18.30	19.00	24000	15000	0.46	HS 7012ACTA
65	90	13	1		14.30	15.30	30000	19000	0.23	HS 71913CTA
	90	13	1		13.40	14.30	24000	15000	0.23	HS 71913ACTA
	100	18	1.1		20.00	21.60	28000	17000	0.48	HS 7013CTA
	100	18	1.1		19.00	20.00	24000	15000	0.48	HS 7013ACTA
70	100	16	1		18.30	20.00	26000	16000	0.37	HS 71914CTA
	100	16	1		17.30	18.60	22000	14000	0.37	HS 71914ACTA
	110	20	1.1		26.00	28.00	26000	16000	0.67	HS 7014CTA
	110	20	1.1		24.50	26.00	20000	13000	0.67	HS 7014ACTA
75	105	16	1		19.00	21.20	26000	16000	0.4	HS 71915CTA
	105	16	1		17.60	20.00	20000	13000	0.4	HS 71915ACTA
	115	20	1.1		26.50	29.00	24000	15000	0.71	HS 7015CTA
	115	20	1.1		25.00	27.00	20000	13000	0.71	HS 7015ACTA
80	110	16	1		21.20	24.00	24000	15000	0.41	HS 71916CTA
	110	16	1		19.60	22.40	20000	13000	0.41	HS 71916ACTA
	125	22	1.1		31.50	34.50	22000	14000	0.96	HS 7016CTA
	125	22	1.1		30.00	32.50	19000	12000	0.96	HS 7016ACTA
85	120	18	1.1		22.00	26.00	22000	14000	0.61	HS 71917CTA
	120	18	1.1		20.40	24.50	19000	12000	0.61	HS 71917ACTA
	130	22	1.1		32.00	36.00	20000	13000	0.99	HS 7017CTA
	130	22	1.1		30.00	33.50	18000	11000	0.99	HS 7017ACTA
90	125	18	1.1		23.60	28.50	20000	13000	0.63	HS 71918CTA
	125	18	1.1		22.40	26.50	18000	11000	0.63	HS 71918ACTA
	140	24	1.5		37.50	43.00	19000	12000	1.31	HS 7018CTA
	140	24	1.5		35.50	40.00	17000	10000	1.31	HS 7018ACTA
95	130	18	1.1		24.50	30.00	19000	13000	0.66	HS 71919CTA
	130	18	1.1		22.80	28.00	17000	10000	0.66	HS 71919ACTA
	145	24	1.5		38.00	44.00	18000	12000	1.34	HS 7019CTA
	145	24	1.5		35.50	41.50	16000	9500	1.34	HS 7019ACTA

High-speed Angular Contact Ball Bearings



d	Dimensions D	B	r1,r2	r3,r4	Basic load rating Cr	Cor	Speed limit Oil	Grease	Mass	Code
mm			min		kN		r/min		kg	—
100	140	20	1.1		29.00	36.00	18000	11000	0.9	HS 71920CTA
	140	20	1.1		27.50	33.50	16000	9500	0.9	HS 71920ACTA
	150	24	1.5		38.00	45.50	18000	12000	1.4	HS 7020CTA
	150	24	1.5		36.00	42.50	15000	9000	1.4	HS 7020ACTA
105	145	20	1.1		30.00	38.00	18000	12000	0.9	HS 71921CTA
	145	20	1.1		28.00	35.50	15000	9000	0.9	HS 71921ACTA
	160	26	2		49.00	58.50	17000	10000	1.8	HS 7021CTA
	160	26	2		46.50	54.00	14000	8500	1.8	HS 7021ACTA
110	150	20	1.1		34.50	44.00	17000	10000	1	HS 71922CTA
	150	20	1.1		32.50	40.50	14000	8500	1	HS 71922ACTA
	170	28	2		50.00	60.00	16000	9500	2.2	HS 7022CTA
	170	28	2		46.50	56.00	13000	8000	2.2	HS 7022ACTA
120	165	22	1.1		36.50	48.00	15000	9000	1.3	HS 71924CTA
	165	22	1.1		34.00	45.00	13000	8000	1.3	HS 71924ACTA
	180	28	2		51.00	63.00	14000	8500	2.3	HS 7024CTA
	180	28	2		48.00	58.50	12000	7500	2.3	HS 7024ACTA
130	180	24	1.5		41.50	56.00	14000	8500	1.8	HS 71926CTA
	180	24	1.5		39.00	52.00	11000	7000	1.8	HS 71926ACTA
	200	33	2		65.50	83.00	12000	7500	3.7	HS 7026CTA
	200	33	2		62.00	78.00	10000	6700	3.7	HS 7026ACTA

Using the nylon cage, bearing limit rotational speed please consult technical center.

2.2 Unidirectional Angular Contact Thrust Ball Bearings for Screw Drives

2.2.1 Features

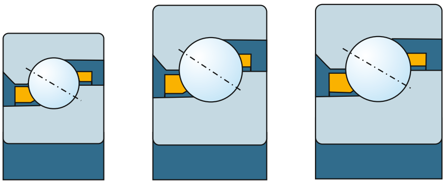
- High axial load carrying capacity
- High axial stiffness
- Very high running accuracy
- Ability to accommodate high speeds and accelerations
- Low frictional moment

76 series (Standard Series)

- 7602 series and 7603 series
- Engineered polymer cages
- Select either Open or Sealed depending on application

BSB Series(for Screw Drives)

- Engineered polymer cages
- Select either Open or Sealed depending on application



2.2.2 Numbering system

76series angular contact thrust ball bearings

76 | 02 | 04 – 2RZ | TN / P4 | DB | A

Bearing type symbol

76— 60°contact angle
Angular Contact Thrust Ball Bearing

Dimension symbol

0—Width series 0

2—Diameter series 2

Bore symbol

00 — 10mm

01 — 12mm

02 — 15mm

03 — 17mm

04 — 4×5=20mm

Contact angle symbol

No symbol— open type

2RZ—Non-Contact Rubber seal

2RS—Contact Rubber seal

Cage symbol

TN—Ball guided Engineered polymer cage

Preload symbol

A—Light preload

B—Medium preload

C—Heavy preload

G— Special preload, Unit: N

Arrangement symbol

DB—No symbol-single bearing
Two bearings arranged back-to-back

DF—Two bearings arranged face-to-face

DT—Two bearings arranged in tandem

TBT—Three bearings arranged back-to-back and tandem

TFT—Three bearings arranged face-to-face and tandem

QBC—Four bearings arranged tandem back-to-back

QFC—Four bearings arranged tandem face-to-face

U—Universal bearings

Accuracy symbol

P5 — Dimensional and running accordance with ISO tolerance class 5

P4——Dimensional and running accordance with ISO tolerance class 4

2

2.2.2 Numbering system

BSB 025 062-2RZ TN / P4 DB A

Bearing type symbol

BSB—60°contact angle
Angular Contact Thrust Ball Bearing(Screw Drives)

Dimension symbol

Inner dimension 25mm

Outside diameter symbol

Outside diameter is 62mm

Seal symbol

No symbol— open type

2RZ—Non-Contact Rubber seal

2RS—Contact Rubber seal

Cage symbol

TN—Ball guided Engineered polymer cage

Preload symbol

A—Light preload

B—Medium preload

C—Heavy preload

G— Special preload, Unit: N

Arrangement symbol

DB—No symbol-single bearing
Two bearings arranged back-to-back

DF—Two bearings arranged face-to-face

DT—Two bearings arranged in tandem

TBT—Three bearings arranged back-to-back and tandem

TFT—Three bearings arranged face-to-face and tandem

QBC—Four bearings arranged tandem back-to-back

QFC—Four bearings arranged tandem face-to-face

U—Universal bearings

Accuracy symbol

P5 — Dimensional and running accordance with ISO tolerance class 5

P4——Dimensional and running accordance with ISO tolerance class 4

Comparison Table of CSC Bearings with other makes

Manufacturer	CSC	SKF	FAG	SNFA	NSK
Bearing type symbol					
ISO 02	76	BSA		BS 2	
Special	BSB	BSD		BS	TAC.B

Marking:

The max. point of axial runout "Sia" and "Sea" is marked on one side face of inner ring and outer ring of each combination bearings, As shown in the figure 5

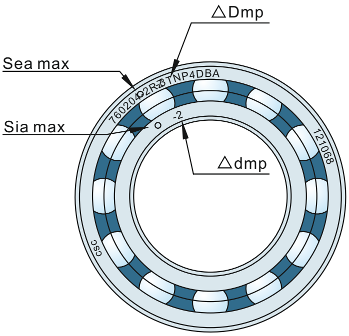
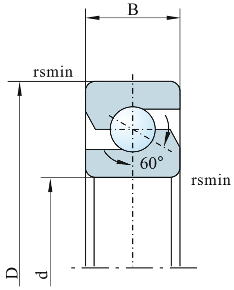


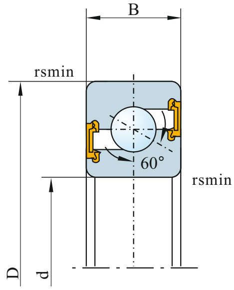
Figure 5

Notes: The type of arrangement structure and the mark after arranging need to be same with angular contact ball bearing requirement.Refer to P10(figure 2、figure 3)

2.2.3 Dimension table of 76 series angular contact thrust ball bearing



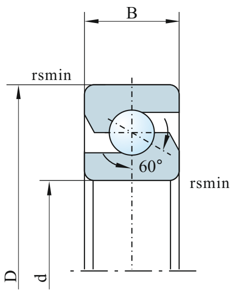
76



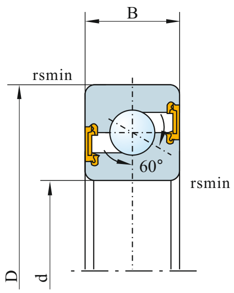
76...-2RZ

d	D	B	rsmin	Ca	Coa	Oil	Grease	Mass	Code
	Dimensions			Basic load rating		Speed limit			
mm			mm	kN		r/min		kg	——
15	35	11	0.6	12.50	15.00	10000	8000	0.05	760202TN
17	40	12	0.6	16.60	20.00	8800	7100	0.07	760203TN
20	47	14	1	19.30	25.00	7500	6000	0.13	760204TN
	52	15	1.1	24.50	32.00	7000	5600	0.17	760304TN
25	52	15	1	22.00	30.50	6500	5200	0.16	760205TN
	62	17	1.1	28.50	41.50	5800	4600	0.28	760305TN
30	62	16	1	26.00	39.00	5500	4400	0.24	760206TN
	72	19	1.1	34.50	55.00	5000	4000	0.41	760306TN
35	72	17	1.1	30.00	50.00	4700	3800	0.34	760207TN
	80	21	1.5	36.50	61.00	4400	3500	0.55	760307TN
40	80	18	1.1	37.50	64.00	4200	3400	0.44	760208TN
	90	23	1.5	50.00	83.00	3900	3100	0.76	760308TN
45	85	19	1.1	38.00	68.00	3900	3100	0.5	760209TN
	100	25	1.5	58.50	104.00	3500	2800	1.02	760309TN
50	90	20	1.1	39.00	75.00	3600	2900	0.57	760210TN
	110	27	2	69.50	127.00	3200	2500	1.33	760310TN
55	100	21	1.5	40.50	81.50	3300	2600	0.75	760211TN
	120	29	2	78.00	146.00	2900	2300	1.69	760311TN
60	110	22	1.5	56.00	112.00	3000	2400	0.96	760212TN
	130	31	2.1	88.00	166.00	2700	2200	2.12	760312TN
65	120	23	1.5	57.00	122.00	2800	2200	1.2	760213TN
	140	33	2.1	100.00	196.00	2500	2000	2.6	760313TN
70	125	24	1.5	65.50	137.00	2600	2100	1.32	760214TN
	150	35	2.1	110.00	220.00	2300	1900	3.16	760314TN
75	130	25	1.5	67.00	150.00	2500	2000	1.45	760215TN
	160	37	2.1	125.00	255.00	2200	1800	3.79	760315TN
80	140	26	2.0	76.50	175.00	2300	1900	1.76	760216TN
	170	39	2.1	137.00	285.00	2000	1600	4.5	760316TN

Dimension table of BSB series



BSB



BSB...-2RZ

2

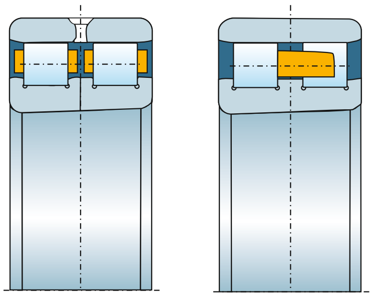
d	Dimensions D	B	rsmin	Basic load rating Ca	Coa	Speed limit Oil	Grease	Mass	Code
mm			mm	kN		r/min		kg	——
15	47	15	1	21.50	27.00	8000	6000	0.13	BSB 015047
17	47	15	1	21.50	27.00	8000	6000	0.14	BSB 017047
20	47	15	1	21.50	27.00	8000	6000	0.13	BSB 020047
25	62	15	1	28.50	41.50	6000	4500	0.24	BSB 025062
30	62	15	1	26.00	39.00	5600	4300	0.23	BSB 030062
35	72	15	1	30.00	50.00	5000	3600	0.3	BSB 035072
40	72	15	1	28.00	49.00	4800	3600	0.26	BSB 040072
	90	20	1.5	50.00	83.00	4000	3000	0.65	BSB 040090
45	75	15	1	28.50	52.00	4300	3200	0.26	BSB 045075
	100	20	1.5	58.80	104.00	3600	2600	0.81	BSB 045100
50	100	20	1.5	58.50	104.00	3400	2600	0.75	BSB 050100
55	90	15	1	32.50	65.50	3400	2600	0.38	BSB 055090
	100	20	1	40.50	81.50	3400	2600	0.75	BSB 055100
	120	20	2	60.00	116.00	3000	2200	1.18	BSB 055120
60	120	20	1.5	61.00	120.00	3000	2200	1.11	BSB 060120

2.3 Double-Row Cylindrical Roller Bearings in the NN Series

2.3.1 Feature

CSC double-row cylindrical roller bearings are available with either a cylindrical or a tapered bore (taper 1:12). In machine tool applications, cylindrical roller bearings with a tapered bore are preferred, because the taper enables more accurate adjustment of clearance or preload during installation.

In order to facilitate efficient lubrication, the bearings in the NN series have an annular groove and three lubrication holes in the outer ring. CSC double-row cylindrical roller bearings are fitted, depending on the size with either machined brass cage or engineered polymer cage.



2.3.2 Numbering system of Double-row cylindrical roller bearings in the NN series

NN 30 18 K TN / P4 [ ] W33

Bearing type symbol

NN—Double-row cylindrical roller bearing

Dimension symbol

30—30 series

Bore symbol

05 - 5×5=25mm

18- 18×5=90mm

Internal symbol

K- 1/12 tapered bore

Cage symbol

M—Brass

TN—Engineered polymer

Suffixes

W33 - Lubricating groove and three holes in the outer ring

Radial clearance symbol

C0 - standard clearance

C9 - special clearance

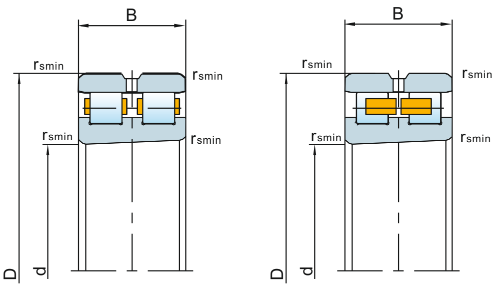
Accuracy symbol

P4—Dimensional and running accordance with ISO tolerance class 4

SP—Rotating accuracy is better than P5

UP—Rotating accuracy is better than P4

2.3.3 Dimension table of NN-Double-row cylindrical roller bearings



d	Dimensions D	B	rsmin	Basic load rating Cr	Cor	Speed limit Oil	Grease	Mass	Code
mm			mm	kN		r/min		kg	——
25	47	16	0.6	25.80	30.00	25000	20900	0.127	NN3005K
30	55	19	1	31.00	37.00	23600	20000	0.172	NN3006K
35	62	20	1	39.50	50.00	20700	17600	0.224	NN3007K
40	68	21	1	43.50	55.50	18600	15800	0.283	NN3008K
45	75	23	1	52.00	68.50	16700	14200	0.373	NN3009K
50	80	23	1	53.00	72.50	15400	13100	0.402	NN3010K
55	90	26	1.1	69.50	96.50	13800	11800	0.592	NN3011K
60	95	26	1.1	73.50	106.00	13000	11000	0.635	NN3012K
65	100	26	1.1	77.00	116.00	12200	10400	0.681	NN3013K
70	110	30	1.1	94.50	143.00	11200	9500	0.988	NN3014K
75	115	30	1.1	96.50	149.00	10600	9000	1.03	NN3015K
80	125	34	1.1	119.00	186.00	9800	8300	1.44	NN3016K
85	130	34	1.1	122.00	194.00	9400	8000	1.52	NN3017K
90	140	37	1.5	143.00	228.00	8700	7400	1.93	NN3018K
95	145	37	1.5	146.00	238.00	8400	7100	2.03	NN3019K
100	150	37	1.5	149.00	247.00	8000	6800	2.12	NN3020K
105	160	41	2	192.00	310.00	7600	6500	2.69	NN3021K
110	170	45	2	222.00	360.00	7200	6100	3.44	NN3022K
120	180	46	2	233.00	390.00	6700	5700	3.75	NN3024K
130	200	52	2	284.00	475.00	6300	5300	5.2	NN3026K

2.4 Double Direction Angular Contact Thrust Ball Bearings in the BTM Series

2.4.1 Features

Bearings in the BTM series (fig. 3) conform in design to two non-separable single row angular contact ball bearings arranged back-to-back, to carry thrust loads in both directions. When mounted, the bearings become preloaded.

These high-speed design bearings are available with fitted with 30° contact angle or 40° contact angle.

They have the same bore and outside diameter as bearings in the 2344(00) series, but a 25 % lower bearing height, which makes them particularly suitable for very compact arrangements. They do not have the same high load carrying capacity and axial stiffness as bearings in the 2344(00) series, but can operate at higher speeds.

BTM series bearings are capable of high-speed operations and lower heat generation whiles maintaining high rigidity.BTM series bearings with the special width dimension bearing spacer can be successful indicated for the 2344 series bearings in case of unchanged with shaft and bearing housing.As shown in the figure 6

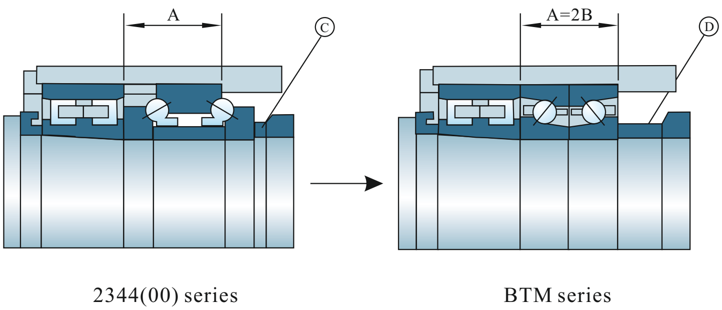


Figure 6

2.4.2 Numbering system

BTM 90 A / HQ1 P4C DB A

Bearing type symbol

BTM—Double direction angular contact thrust ball bearings, high speed

Bore symbol

60 — 60mm

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130 — 130MM

Contact angle symbol

A — 30°

B — 40°

Preload symbol

A - Light preload (only for BTM - A series)

B - Medium preload (only for BTM -B series)

G - Special preload unit: N

Arrangement symbol

DB - standard arrangement Back-to-Back

Accuracy symbol

P4C -special accuracy

Rolling element symbol

No symbol - Carbon chromium steel

HQ1 - Si3N4 (Ceramic)

2

Comparison Table of CSC Bearings with other makes

CSC	SKF	FAG	SNFA	NSK
BTM-A BTM-B	BTM-A BTM-B			BAR BTR

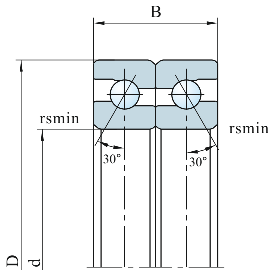
Dimension precision P4C

D(mm) Over	Incl.	△Dmp、△Ds Upper deviation	Lower deviation	VDp max	VDmp	Kea	SD	Sea	VCs
—	80	-30	-37	5	3.5	5	4	5	3
80	120	-40	-48	6	4	6	5	6	4
120	150	-50	-59	7	5	7	5	7	5
150	180	-50	-60	8	5	8	5	8	5
180	250	-50	-61	8	6	10	7	10	7
250	315	-60	-73	10	7	11	8	10	7

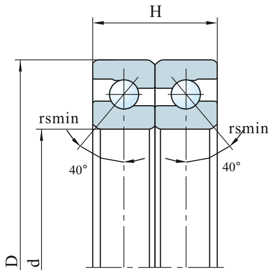
Note: P4C is CSC standard, equal to ISO 4 except outsider diameter of outer ring.

2

2.4.3 Dimension Table of Double direction angular contact thrust ball bearings



BTM-A



BTM-B

d	Dimensions D	B	rsmin	Basic load rating Ca	Coa	Speed limit Oil	Grease	Mass	Code
mm			mm	kN		r/min		kg	——
50	80	28.5	1	14.70	27.70	14700	11600	0.27	BTM 50A/DB
	80	28.5	1	17.40	31.50	13100	10000	0.27	BTM 50B/DB
55	90	33	1.1	18.20	35.00	13200	10400	0.40	BTM 55A/DB
	90	33	1.1	21.60	40.00	11800	9000	0.40	BTM 55B/DB
60	95	33	1.1	18.90	38.00	12300	9700	0.42	BTM 60A/DB
	95	33	1.1	22.40	43.50	11000	8400	0.42	BTM 60B/DB
65	100	33	1.1	19.50	41.50	11600	9100	0.44	BTM 65A/DB
	100	33	1.1	23.10	47.00	10400	7900	0.44	BTM 65B/DB
70	110	36	1.1	26.90	55.00	10600	8400	0.60	BTM 70A/DB
	110	36	1.1	32.00	63.00	9500	7300	0.60	BTM 70B/DB
75	115	36	1.1	27.30	58.00	10000	7900	0.63	BTM 75A/DB
	115	36	1.1	32.50	65.50	9000	6900	0.63	BTM 75B/DB
80	125	40.5	1.1	32.00	68.50	9300	7400	0.85	BTM 80A/DB
	125	40.5	1.1	38.00	78.00	8300	6400	0.85	BTM 80B/DB
85	130	40.5	1.1	32.50	71.50	8900	7000	0.95	BTM 85A/DB
	130	40.5	1.1	38.50	81.50	8000	6100	0.95	BTM 85B/DB
90	140	22.5	1.5	42.50	92.50	8300	6600	1.10	BTM 90A/DB
	140	22.5	1.5	50.00	105.00	7400	5700	1.10	BTM 90B/DB
95	145	45	1.5	43.00	96.50	8000	6300	1.32	BTM 95A/DB
	145	45	1.5	51.00	110.00	7100	5500	1.32	BTM 95B/DB
100	150	22.5	1.5	43.50	100.00	7600	6000	1.39	BTM 100A/DB
	150	22.5	1.5	51.50	114.00	6800	5200	1.39	BTM 100B/DB
105	160	49.5	2	49.50	115.00	7200	5700	1.70	BTM 105A/DB
	160	49.5	2	58.50	131.00	6500	5000	1.70	BTM 105B/DB
110	170	27	2	55.50	131.00	6800	5400	2.10	BTM 110A/DB
	170	27	2	66.00	148.00	6100	4700	2.10	BTM 110B/DB
120	180	27	2	57.00	141.00	6400	5000	2.30	BTM 120A/DB
	180	27	2	68.00	160.00	5700	4400	2.30	BTM 120B/DB
130	200	31.5	2	72.50	172.00	5800	4600	3.30	BTM 130A/DB
	200	31.5	2	86.00	195.00	5200	4000	3.30	BTM 130B/DB

2.5 Axial Angular Contact Ball Bearings ZKLF...-2RS Series

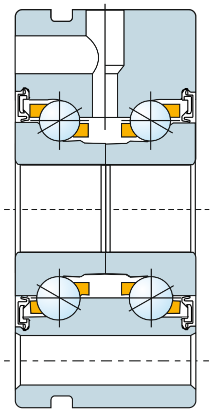
2.5.1 Features:

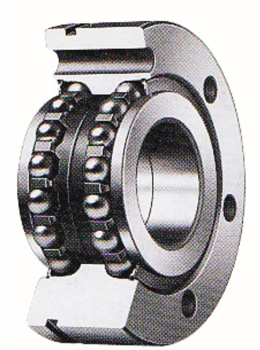
High load carrying capacity, high rigidity, high preload capability.

Relubrication is possible via radial and an axial threaded hole

ZKLF···2RS series can be forced from both sides with heavy load, with high rigidity and low cross section. Due to these elements, ZKLF···2RS miss all the accuracy requirements of modern precision machine. The bearings don' t need any set parts and adjustment during fitting because of flange.

The lubrication holes are sealed by countersunk bolt and in order to dismount easily there has a groove on the surface of outer ring.





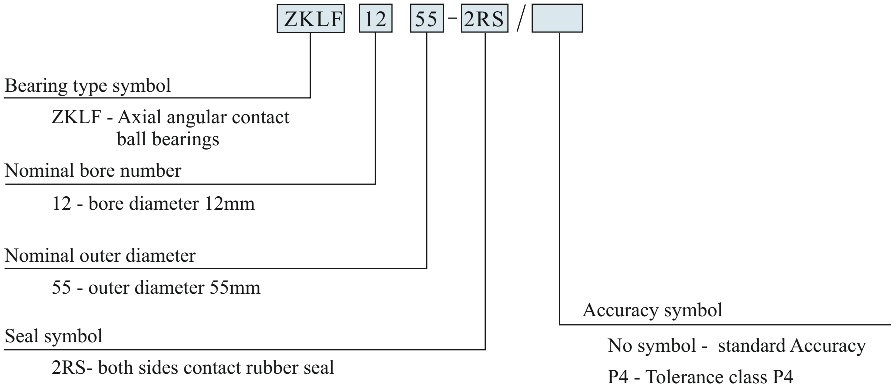
Accuracy

Unit:μm

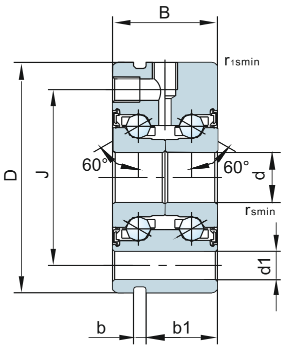
Nominal Bore diameter mm	Side Run-out	Bore diameter deviation △dmp	Outer diameter deviation △Dmp	Width deviation △Bs
≤25 ＞25	2 2.5	0 , -5	0 , -10	0 , -250

Note. Tolerance in accordance with ISO 4

2.5.2 Numbering system



2.5.3 Dimension table



ZKLF...-2RS

d	Dimensions D	B	rsmin	r1smin	J	d1	b	b1
mm								
12	55	25	0.3	0.6	42	6.5	3	17
15	60	25	0.3	0.6	46	6.5	3	17
17	62	25	0.3	0.6	48	6.5	3	17
20	68	28	0.3	0.6	53	6.5	3	19
25	75	28	0.3	0.6	58	6.5	3	19
30	80	28	0.3	0.6	63	6.5	3	19
40	100	34	0.3	0.6	80	8.5	3	25
50	115	34	0.3	0.6	94	8.5	3	25

fixing screws		Basic load rating		Speed limit		
		Ca	Coa	Oil	Mass	Code
Size	Quantity	kN		r/min	kg	——
M6	3	13.60	16.20	3800	0.37	ZKLF 1255-2RS
M6	3	14.40	18.30	3500	0.43	ZKLF 1560-2RS
M6	3	15.10	20.40	3300	0.45	ZKLF 1762-2RS
M6	4	20.80	30.50	3000	0.61	ZKLF 2068-2RS
M6	4	22.10	36.00	2600	0.72	ZKLF 2575-2RS
M6	6	23.40	41.50	2200	0.78	ZKLF 3080-2RS
M8	4	34.50	66.00	1800	1.46	ZKLF 40100-2RS
M8	6	37.50	82.00	1500	1.86	ZKLF 50115-2RS

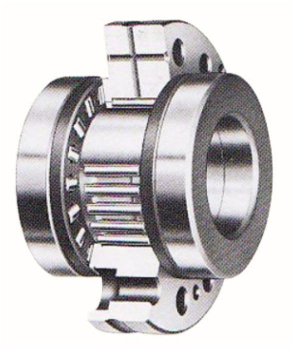
2.6 ZARF Series

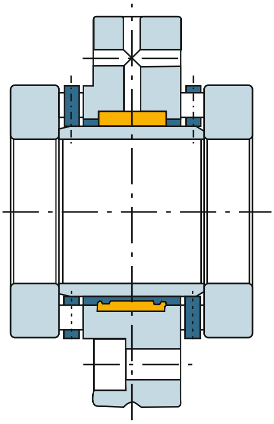
Application: Screw drives

2.6.1 Features

Needle roller / axial cylindrical roller bearing, ZARF. Centre washer suitable for flange mounting. The outside surface of ther outer ring has a lubrication groove and three lubrication holes. The outside surface of both shaft locating washers are machined free from spiral marks so they are suitable for use as running surfaces for rotary shaft seals. Their lubrication holes are arranged differently. Threaded holes are provided for fixing the seal carrier assembly DRS

2





Accuracy

Unit: μ m

Bore diameter d mm	Side Run-out μm	Radial Run-out μm	dimension and geometrical accuracy Axial	Radial
≤70 > 70	1 2	C2	P4	P6

Note. Customer request on accuracy is available.

2.6.2 Numbering System

ZARF 30 80 – TN / [ ]

Bearing type symbol

ZARF —Needle roller axial cylindrical roller bearings

Bore symbol

30—Bore diameter 30mm

Outside diameter symbol

80 — outsider diameter 80mm

Cage symbol

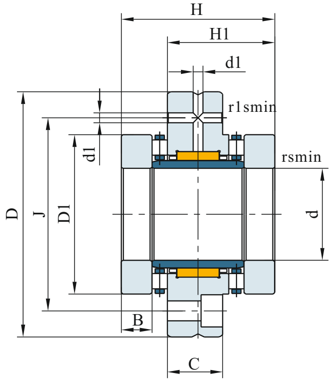
TN - Engineered polymer

Accuracy symbol

No symbol - standard accuracy

2

2.6.3 Dimension Table



ZARF

d	Dimensions D	H	H1	C	D1	B	rsmin	r1smin	d1	J	Fixing screws Size	Quantity
mm												
15	60	40	26	14	35	7.5	0.3	0.6	3.2	46	M6	6
17	62	43	27.5	14	38	9	0.3	0.6	3.2	48	M6	6
20	68	46	29	14	42	10	0.3	0.6	3.2	53	M6	8
25	75	50	33	18	47	10	0.3	0.6	3.2	58	M6	8
30	80	50	33	18	52	10	0.3	0.6	3.2	63	M6	12
35	90	54	35	18	60	11	0.3	0.6	3.2	73	M6	12
40	100	54	35	18	65	11	0.3	0.6	3.2	80	M8	8
45	105	60	40	22.5	70	11.5	0.3	0.6	6	85	M8	8
50	115	60	40	22.5	78	11.5	0.3	0.6	6	94	M8	12

Basic axial load rating		Basic radial load rating		Speed limit			
Ca	Coa	Cr	Cor	Oil	Grease	Mass	Code
kN				r/min		kg	——
24.90	53.00	13.00	17.50	8500	2200	0.42	ZARF 1560 TN
26.00	57.00	14.00	19.90	7800	2100	0.49	ZARF 1762 TN
33.50	76.00	14.90	22.40	7000	2000	0.56	ZARF 2068 TN
35.50	86.00	22.60	36.00	6000	1900	0.78	ZARF 2575 TN
39.00	101.00	24.30	41.50	5500	1800	0.85	ZARF 3080 TN
56.00	148.00	26.00	47.00	4800	1700	1.12	ZARF 3590 TN
59.00	163.00	27.50	53.00	4400	1600	1.35	ZARF 40100 TN
61.00	177.00	38.00	74.00	4000	1500	1.70	ZARF 45105 TN
90.00	300.00	40.00	82.00	3600	1200	2.10	ZARF 50115 TN

2.7 YRT series

Application: Spindles of machine tools, bearings for rotary tables

2.7.1 Features:

Axial / Radial bearings YRT series are large, double direction axial bearings with a radial guidance bearing. Holes are provided in the outer ring. Geometrical tolerances are within tolerance class ISO 4 Combination of two axial needle roller bearings and one radial cylindrical roller bearing.

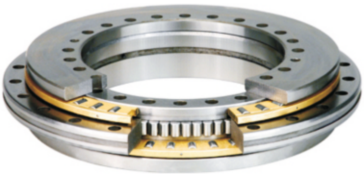
The axial component consists of two axial needle roller and cage assemblies .

The radial component of the bearing is full complement and lightly preloaded.

They can be relubricated through the outer ring and the L-section ring. The number of lubrication holes is determined by the bearings size.

Arrangement Tolerance

Center ring usually be tightened to the machine. In order to locate the center correctly, the inner and outer supporting housing should miss the tolerance range of h6 and J7.All the screws need to be cross tightened by torque spanner.



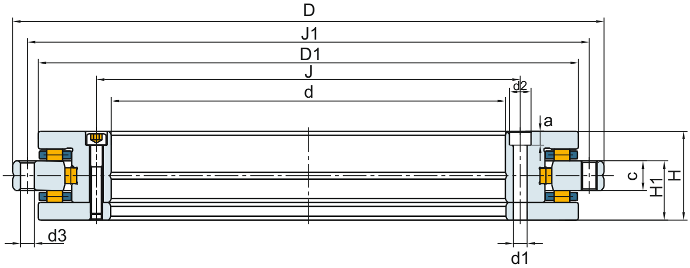
2.7.2 Numbering System

YRT 150

Bearing type symbol
YRT - Thrust - Radial Bearings

Bore symbol
150 - Bore diameter 150mm

2.7.3 Dimension Table



YRT

2

Dimensions												
d	D	H	H1	C	D1	J	J1	d1	d2	a	Number	d3
mm												
80	146	35	23.35	12	130	92	138	5.6	10	4	12	4.6
100	185	38	25	12	160	112	170	5.6	10	5.4	15	5.6
120	210	40	26	12	184	135	195	7	11	6.2	21	7
150	240	40	26	12	214	165	225	7	11	6.2	33	7
180	280	43	29	15	244	194	260	7	11	6.2	45	7
200	300	45	30	15	274	215	285	7	11	6.2	45	7

Number	Basic axial load rating Ca	Coa	Basic radial load rating Cr	Cor	Speed limit Oil	Mass	Code
	kN				r/min	kg	——
12	38.50	158.00	36.50	47.00	350	2.40	YRT 80
15	72.00	370.00	54.00	115.00	280	4.10	YRT 100
21	79.00	430.00	70.00	148.00	230	5.30	YRT 120
33	85.00	510.00	77.00	179.00	210	6.20	YRT 150
45	92.00	580.00	83.00	208.00	190	7.70	YRT 180
45	98.00	650.00	88.00	235.00	170	9.70	YRT 200

3.1 Preload

Preload purpose, types and Preloading methods

Depending on the application, it is necessary to have a positive or a negative operational clearance in a bearing arrangement. In the majority of high precision bearing applications a negative operational clearance i.e. a preload is desirable in order to enhance the stiffness of the bearing arrangement, or to increase the running accuracy. The application of a preload is also recommended where bearings are to operate without load, or under very light load and at high speeds. In such cases the preload serves to guarantee a minimum load on the bearing and thus prevents bearing damage resulting from sliding movements.

Depending on the type of bearing the preload may be either radial or axial. Cylindrical roller bearings can only be radial preloaded and thrust ball bearings can only be axially preloaded.

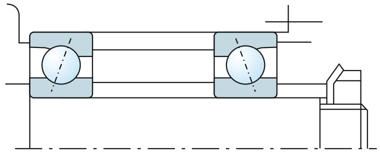
The distance between the pressure centres of two angular contact ball bearings is longer when the bearings are arranged back-to-back and shorter when they are arranged face-to-face. This means that the bearings arranged back-to-back can accommodate large tilting moments even if the distance between bearing centres is relatively short.

Purpose of preload

- Enhance stiffness
- Reduce running noise
- Enhance the accuracy of shaft guidance
- Compensate for wear and settling (bedding down) processes in operation
- Give a long service life.

The bearings with preload are good for the spindle of machine tool.

Preloading methods

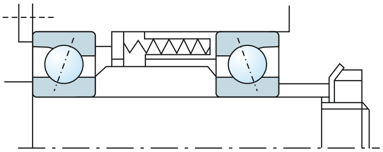


● **Position preload**

A position preload is achieved by fixing two axially opposed bearings in a position that remains unchanged while in operation. a) preload

b) By using a spacer to obtain the required spacing and preload

c)Fastening is the way to adjust the screw and the nut. The action of measuring starting friction torque and adjusting must be down at the same time to get a suitable preload. But it is hard to control the preload and may generate inclination for the method to fit the spindle of machine tool.



● **Constant pressure preload**

A constant pressure preload is achieved using a cylinder spring or belleville spring.

Even if the relative position of the bearings changes during it operation, the magnitude of the preload remains relatively constant. It's generally used in angular contact Ball Bearings for high rotation speed

Preload Adjustment

Adjustment of axial clearance depends on the spacer width. For back-to-back arrangement, increasing preload indicate the decrease of the spacer width of inner ring; Decreasing preload indicate the decrease of the spacer width of outer ring.

3.2 Bearing rigidity

Rigidity means the elastic deformation in the bearing under load. Bearing rigidity influences the rigidity of a bearing arrangement and thus the rigidity of the complete spindle/bearing system. It is of particular importance in machine tool applications, as the magnitude of the deflection under load determines the machining accuracy of a machine tool.

Apart from the bearings, other components might influence the rigidity of a system i.e. bending of the spindle itself, position and number of support bearings, and tool overhang. The stiffness of a bearing depends on its type and size. The most important parameters are

- Type of rolling elements (balls or rollers)
- Number and size of rolling elements
- Contact angle.

Roller bearings are stiffer than ball bearings because of the contact conditions between the rolling elements and raceways. The influence due to number of rolling element

3

To enhance the rigidity of the bearing arrangement, or to increase running accuracy, bearings can be preloaded. These are two important reasons why machine tool spindles are almost always fitted with preloaded bearings or bearing sets.

3.3 Preload and Stiffness

Angular contact ball bearings-- DB DF combination

7900C series

Basic Type	L		A		B		C	
	Preload	Axial stiffness	Preload	Axial stiffness	Preload	Axial stiffness	Preload	Axial stiffness
71902	12	14	25	20	49	26	100	38
71903	12	15	25	20	59	30	120	43
71904	19	19	39	26	78	35	150	48
71905	19	21	39	28	100	43	200	61
71906	24	25	49	33	100	45	200	65
71907	34	29	69	39	150	55	290	78
71908	39	32	78	42	200	63	390	88
71909	50	37	100	50	200	66	390	94
71910	50	39	100	51	250	78	490	111
71911	60	45	120	58	290	90	590	127
71912	60	46	120	60	290	93	590	128
71913	75	53	150	71	340	104	690	146

Basic Type	L		A		B		C	
	Preload	Axial stiffness	Preload	Axial stiffness	Preload	Axial stiffness	Preload	Axial stiffness
71914	100	59	200	79	490	119	980	168
71915	100	61	200	79	490	120	980	171
71916	100	62	200	80	490	124	980	173
71917	145	73	290	98	640	138	1270	191
71918	145	79	290	102	740	156	1470	219
71919	145	81	290	105	780	165	1570	231
71920	195	83	390	112	880	164	1770	231
71921	195	86	390	116	880	167	1770	235
71922	195	89	390	120	930	173	1860	244
71924	270	102	540	135	1270	200	2550	278
71926	320	108	640	148	1470	214	2940	302

7900AC series

Basic Type	L		A		B		C	
	Preload	Axial stiffness	Preload	Axial stiffness	Preload	Axial stiffness	Preload	Axial stiffness
71902	16	33	39	46	78	60	150	76
71903	19	34	39	46	78	62	150	81
71904	29	43	59	60	120	75	250	103
71905	34	56	69	70	150	95	290	123
71906	39	61	78	77	150	99	290	131
71907	50	70	100	94	250	127	4901	170
71908	60	72	120	97	290	139	590	182
71909	75	87	150	114	340	160	690	207
71910	75	94	150	124	390	175	780	235
71911	100	112	200	144	440	198	880	264
71912	100	117	200	150	440	198	880	267
71913	100	125	200	161	490	223	980	289
71914	145	138	290	183	690	249	1370	334
71915	145	142	290	188	740	267	1470	347
71916	170	156	340	203	780	274	1570	367
71917	220	172	440	229	980	306	1960	396
71918	245	188	490	253	1080	340	2160	449
71919	245	195	4901	262	1180	363	2350	475
71920	295	197	590	266	1270	346	2550	463
71921	295	203	590	264	1370	368	2750	490
71922	320	222	640	284	1470	391	2940	517
71924	440	244	880	328	1960	441	3920	580
71926	490	262	980	346	2160	460	4310	611

7000C series

Basic Type	L		A		B		C	
	Preload	Axial stiffness	Preload	Axial stiffness	Preload	Axial stiffness	Preload	Axial stiffness
7002	14	16	29	20	69	29	150	43
7003	14	16	29	21	69	31	150	45
7004	24	21	49	28	120	42	250	59
7005	29	24	59	32	150	48	290	68
7006	39	29	78	39	200	59	390	83
7007	60	36	120	49	250	68	490	94
7008	60	39	120	51	290	77	590	110
7009	75	43	150	58	340	85	690	121
7010	75	46	150	63	390	96	780	136
7011	100	51	200	69	490	102	980	145
7012	100	53	200	70	540	110	1080	158
7013	125	61	250	82	540	117	1080	164
7014	145	68	290	88	740	135	1470	190
7015	145	70	290	92	780	144	1570	202
7016	195	76	390	103	930	152	1860	216
7017	195	78	390	106	980	161	1960	225
7018	245	87	490	117	1180	172	2350	242
7019	270	93	540	124	1180	176	2350	246
7020	270	97	540	127	1270	187	2550	264
7021	320	103	640	134	1470	198	2940	277
7022	370	104	740	137	1770	203	3530	286
7024	415	116	830	153	1960	225	3920	317
7026	490	126	980	167	2260	244	4510	344

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7000AC series

Basic Type	L		A		B		C	
	Preload	Axial stiffness	Preload	Axial stiffness	Preload	Axial stiffness	Preload	Axial stiffness
7002	19	33	39	43	100	65	200	84
7003	24	41	49	52	120	75	250	99
7004	39	51	78	68	200	97	390	128
7005	50	61	100	79	200	99	390	133
7006	60	68	120	89	290	129	590	171
7007	75	78	150	107	390	149	780	198
7008	100	95	200	127	440	168	880	223
7009	100	99	200	132	490	181	980	238
7010	120	118	250	154	590	208	1180	278
7011	170	127	340	170	780	235	1570	307

Basic Type	L		A		B		C	
	Preload	Axial stiffness	Preload	Axial stiffness	Preload	Axial stiffness	Preload	Axial stiffness
7012	170	134	340	179	780	241	1570	317
7013	195	157	390	196	880	272	1770	356
7014	245	170	490	218	1080	293	2160	390
7015	245	179	490	229	1180	316	2350	418
7016	320	187	640	245	1470	343	2940	448
7017	320	196	640	257	1470	352	2940	462
7018	390	218	780	275	1770	374	3530	494
7019	415	227	830	287	1860	392	3730	525
7020	415	235	830	299	1960	417	3920	548
7021	490	246	980	317	2260	430	4510	571
7022	590	258	1180	330	2650	447	5300	588
7024	635	281	1270	361	2940	491	5880	654
7026	785	305	1570	396	3430	536	6860	710

7200C series

Basic Type	L		A		B		C	
	Preload	Axial stiffness	Preload	Axial stiffness	Preload	Axial stiffness	Preload	Axial stiffness
7202	19	17	39	23	100	34	200	48
7203	24	19	49	25	150	42	290	59
7204	34	23	69	30	200	49	390	70
7205	39	26	78	36	200	53	390	76
7206	60	32	120	43	290	66	590	94
7207	75	37	150	50	390	75	780	108
7208	100	44	200	60	490	90	980	126
7209	125	49	250	67	540	94	1080	132
7210	125	52	250	69	590	102	1180	143
7211	145	56	290	74	780	117	1570	163
7212	195	64	390	86	930	126	1860	179
7213	220	71	440	95	1080	141	2160	200
7214	245	75	490	100	1180	148	2350	210
7215	270	81	540	108	1230	157	2450	220
7216	295	83	590	109	1370	159	2750	224
7217	345	88	690	120	1670	177	3330	251
7218	390	97	780	126	1860	187	3730	263
7219	440	98	880	130	2060	192	4120	271
7220	490	101	980	137	2350	202	4710	285
7221	540	108	1080	144	2650	216	5300	305
7222	635	117	1270	156	2940	228	5880	321
7224	700	128	1400	170	3210	247	6350	345

7200AC series

Basic Type	L		A		B		C	
	Preload	Axial stiffness	Preload	Axial stiffness	Preload	Axial stiffness	Preload	Axial stiffness
7202	34	43	69	57	200	83	390	111
7203	39	46	78	60	200	87	390	116
7204	60	59	120	73	290	104	590	140
7205	75	68	150	90	340	124	690	167
7206	100	85	200	107	440	147	880	192
7207	125	95	250	118	590	167	1180	218
7208	145	104	290	136	740	195	1470	258
7209	170	115	340	147	880	212	1770	280
7210	195	129	390	163	980	233	1960	306
7211	245	141	490	181	1180	255	2350	337
7212	295	155	590	202	1470	281	2940	374
7213	345	177	690	221	1670	314	3330	414
7214	390	188	780	238	1860	331	3730	438
7215	415	199	830	253	1960	352	3920	466
7216	465	200	930	258	2160	356	4310	472
7217	540	217	1080	283	2450	383	4900	507
7218	635	239	1270	304	2940	416	5880	556
7219	685	240	1370	308	3140	419	6280	557
7220	785	251	1570	325	3530	441	7060	587
7221	885	267	1770	348	3920	471	7850	624
7222	980	280	1960	368	4410	496	8830	676
7224	1140	315	2280	409	5180	559	10350	736

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HS7900C series

Basic Type	A		B		C	
	Preload	Axial stiffness	Preload	Axial stiffness	Preload	Axial stiffness
HS71902	18	18	60	29	120	41
HS71903	18	19	70	34	140	47
HS71904	25	22	80	35	160	49
HS71905	25	24	94	42	188	58
HS71906	25	26	100	46	200	64
HS71907	50	38	140	59	280	82
HS71908	50	36	140	54	280	74
HS71909	50	38	150	60	300	81
HS71910	50	40	160	64	320	87
HS71911	50	40	170	64	340	87

Basic Type	A		B		C	
	Preload	Axial stiffness	Preload	Axial stiffness	Preload	Axial stiffness
HS71912	50	42	170	67	340	90
HS71913	50	44	180	71	360	96
HS71914	50	46	180	74	360	101
HS71915	50	48	180	77	460	116
HS71916	50	49	190	82	474	122
HS71917	50	52	190	87	646	148
HS71918	100	62	280	93	709	138
HS71919	100	64	290	96	768	147
HS71920	100	71	330	115	870	174
HS71921	100	72	330	116	898	180
HS71922	100	73	400	126	925	184
HS71924	100	78	410	135	1275	222
HS71926	100	75	712	162	1408	225

HS7900AC series

Basic Type	A		B		C	
	Preload	Axial stiffness	Preload	Axial stiffness	Preload	Axial stiffness
HS71902	18	36	90	63	180	83
HS71903	18	39	110	73	220	97
HS71904	25	45	125	79	250	104
HS71905	25	50	150	94	300	124
HS71906	25	55	160	105	320	139
HS71907	50	77	210	130	420	171
HS71908	50	75	220	126	440	165
HS71909	50	81	240	141	480	182
HS71910	50	85	250	150	500	193
HS71911	50	87	260	153	520	198
HS71912	50	91	270	161	540	209
HS71913	50	95	290	173	580	223
HS71914	50	99	290	182	598	239
HS71915	50	103	300	189	619	250
HS71916	50	107	310	200	639	262
HS71917	50	113	310	211	889	312
HS71918	100	133	430	220	968	306
HS71919	100	138	440	232	996	318
HS71920	100	154	520	272	1131	361
HS71921	100	154	530	279	1169	373
HS71922	100	158	550	284	1206	379
HS71924	100	169	680	330	1743	468
HS71926	100	167	972	371	1880	464

HS7000C series

Basic Type	A		B		C	
	Preload	Axial stiffness	Preload	Axial stiffness	Preload	Axial stiffness
HS7002	18	17	60	28	120	38
HS7003	18	17	70	28	140	38
HS7004	25	20	80	30	160	41
HS7005	25	21	90	35	180	46
HS7006	50	30	110	41	220	55
HS7007	50	30	110	41	220	54
HS7008	50	32	110	43	220	58
HS7009	50	33	110	45	220	59
HS7010	50	34	120	47	249	63
HS7011	50	40	120	55	302	81
HS7012	50	41	130	58	345	87
HS7013	50	42	130	60	364	92
HS7014	50	46	230	82	505	116
HS7015	50	48	240	87	520	121
HS7016	100	64	330	102	606	135
HS7017	100	60	330	95	622	124
HS7018	100	62	340	99	823	144
HS7019	100	64	350	102	846	152
HS7020	100	65	350	105	870	155
HS7021	100	66	420	115	1054	169
HS7022	100	69	540	131	1144	185
HS7024	100	70	560	134	1208	186
HS7026	100	71	732	148	1508	205

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HS7000AC series

Basic Type	A		B		C	
	Preload	Axial stiffness	Preload	Axial stiffness	Preload	Axial stiffness
HS7002	18	36	120	70	240	92
HS7003	18	35	140	71	280	93
HS7004	25	42	160	79	320	103
HS7005	25	46	180	90	360	117
HS7006	50	64	220	107	440	138
HS7007	50	65	240	111	480	143

Basic Type	A		B		C	
	Preload	Axial stiffness	Preload	Axial stiffness	Preload	Axial stiffness
HS7008	50	69	250	121	500	157
HS7009	50	72	250	124	500	160
HS7010	50	74	270	132	540	171
HS7011	50	86	350	169	700	215
HS7012	50	88	380	179	760	230
HS7013	50	91	400	186	800	242
HS7014	50	99	400	202	800	263
HS7015	50	104	510	231	1020	299
HS7016	100	137	620	260	1240	339
HS7017	100	129	640	248	1280	322
HS7018	100	134	650	257	1300	325
HS7019	100	139	670	266	1340	339
HS7020	100	141	690	276	1380	354
HS7021	100	144	910	305	1820	389
HS7022	100	154	930	330	1860	441
HS7024	100	155	980	333	1960	422
HS7026	100	156	1002	341	2004	450

The radial stiffness of DB or DF combination of angular contact ball bearings

$Cr = Ca \times K$

Type:

Cr: radial stiffness, N/µm

Ca: axial stiffness , N/µm

K: Coefficient

Contact angle	Preload			
	L	A	B	C
15	6.5	6	5	4.5
25	2	2	2	2

Angular Contact Thrust Ball Bearings--DB、DF Combination

760 series

Basic Type	A		B		C	
	Preload	Axial stiffness	Preload	Axial stiffness	Preload	Axial stiffness
760202	750	492	1500	623	3000	793
760203	850	508	1700	642	3400	815
760204	1150	617	2300	781	4600	996
760205	1250	677	2500	856	5000	1089
760207	1650	862	3300	1088	6600	1385
760208	2150	969	4300	1225	8600	1557
760209	2250	1020	4500	1289	9000	1644
760210	2450	1087	4900	1374	9800	1752
760211	2300	1128	4600	1431	9200	1810
760212	3250	1248	6500	1579	13000	2020
760213	3500	1372	7000	1725	14000	2203
760214	3500	1405	7000	1778	14000	2256
760215	3800	1542	7600	1938	15200	2475
760216	4450	1682	8900	2104	17800	2696

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760 series

Basic Type	A		B		C	
	Preload	Axial stiffness	Preload	Axial stiffness	Preload	Axial stiffness
760304	1450	644	2900	815	5800	1038
760305	1650	730	3300	924	6600	1175
760306	2150	862	4300	1090	8600	1393
760307	2400	960	4800	1211	9600	1549
760309	3500	1166	7000	1484	14000	1887
760310	3800	1260	7600	1606	15200	2025
760311	4400	1364	8800	1735	17600	2210
760312	5000	1448	10000	1840	20000	2364
760313	6000	1621	12000	2087	24000	2620
760314	6000	1683	12000	2143	24000	2747
760315	7500	1837	15000	2330	30000	2963
760316	8000	1912	16000	2441	32000	3132

TAC series

Basic Type	A		B	
	Preload	Axial stiffness	Preload	Axial stiffness
15TAC47B	1000	590	2150	764
17TAC47B	1000	590	2150	764
20TAC47B	1000	590	2150	764
25TAC62B	1490	774	3150	998
35TAC72B	1785	1003	3800	1299
40TAC72B	1860	1018	3900	1312
40TAC90B	2370	1065	5000	1376
45TAC75B	2010	1015	4100	1295
45TAC100B	2880	1217	5900	1555
50TAC100B	3010	1275	6100	1622
55TAC90B	2200	1201	4400	1520
55TAC100B	3010	1316	6100	1668
55TAC120B	3520	1504	6650	1869
60TAC120B	3520	1504	6650	1869

BTM-A series

Basic Type	A		B	
	Preload	Axial stiffness	Preload	Axial stiffness
BTM50A	220	170	460	220
BTM55A	230	180	600	250
BTM60A	240	190	650	270
BTM65A	250	200	690	290
BTM75A	260	210	940	330
BTM80A	340	240	1100	360
BTM85A	350	240	1130	370
BTM90A	360	250	1660	430
BTM95A	360	260	1720	450
BTM100A	370	270	1770	460
BTM105A	380	280	1820	470
BTM110A	390	280	1870	490
BTM120A	390	300	1980	520
BTM130A	390	300	2530	550

BTM-B series

Basic Type	A		B	
	Preload	Axial stiffness	Preload	Axial stiffness
BTM50B	330	290	760	390
BTM55B	350	310	800	410
BTM60B	370	330	860	440
BTM65B	390	350	910	470
BTM75B	400	360	1610	590
BTM80B	510	400	1820	630
BTM85B	520	420	1880	650
BTM90B	530	430	2830	770
BTM95B	550	450	2930	790
BTM100B	560	460	3030	820
BTM105B	570	470	3120	850
BTM110B	580	490	3210	870
BTM120B	610	520	3420	930
BTM130B	610	520	4410	980

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3.4 The preload and stiffness of several rows angular contace ball bearings

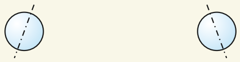
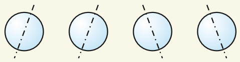
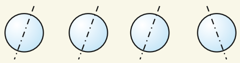
Matching Type	Preload	Axial stiffness	径向刚度
DB	Fa	Ca	Cr
TBT	1.36×Fa	1.44×Ca	1.54×Cr
QBC	2×Fa	2×Ca	2×Cr
QBT	1.57×Fa	1.8×Ca	1.93×Cr
PBC	2.42×Fa	2.46×Ca	2.57×Cr

3.5 Unloading Force

The bearing will have deformation when the combination of angular contact ball bearings is under an exial force from the axis. The bearing which from the opposite direction to the direction of the load will be unload ,and it will be failure soon.

The unloading force of bearing combination

Unit N

Matching Type	Matching	卸载力
DB		3Fv
TBT		6Fv
QBC		6Fv
QBT		9Fv
PBC		9Fv

Fv:Preload

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3.6 Limiting speeds

The limiting speeds listed in the bearing dimensional tables are guideline values. They are based on a single bearing that is lightly preloaded by means of a spring and subjected to relatively light loads with good heat dissipation.

The attainable speeds for oil-air lubrication can be used to estimate attainable speeds for other oil lubrication methods. For batch lubrication, a reduction factor of 0.3 to 0.4 should be considered. For fog lubrication, a reduction factor of 0.95 is adequate.

In situations where the lubricating oil is used as a means to remove heat, higher speed can be achieved, however a large amount of oil must be pressure fed through the bearing, so there is a significant loss of power.

When single bearings are used in two, three or four row combinations, or the preload is increased to improve spindle rigidity, limiting speeds will be lower than those listed.

Speed ratings

The limiting speed of a matched bearing set operating under position preload conditions is calculated by multiplying the limiting speed of a single bearing in the set by the appropriate adjustment factor listed in table.As shown in the figure 7

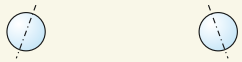
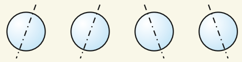
Bearing arrangement		Bearing preload			
		L	A	B	C
DB		0.85	0.80	0.65	0.55
QBC		0.80	0.75	0.60	0.45
TBT		0.75	0.70	0.55	0.40

Figure 7

Factors influencing Limiting Speeds

The limiting speed of the bearing, inside of the spindle, is affected by the following operating conditions.

1) Lubrication method

The thickness of the lubricating film created by the oil-air oil mist lubrication replenishment method is larger compared to the thickness created by the grease lubrication method. Therefore the limiting speed is higher when the oil-air or oil mist lubrication method is used.

In the case of jet lubrication, the large volume of oil supplied into the bearing for lubrication also removes heat efficiently so that much higher operating speeds are possible.

2) Combination

If bearings are used as multiple bearing sets, the number of bearings in the set affects the limiting speed. As the number is increased, the limiting speed becomes lower because the ability to dissipate that heat becomes lower.

3) Preload

If the preload after mounted is high, the contact surface pressure between the rolling elements and raceways increases, which causes extra heat generation. As a result of this heat, the preload during operation increase further and the risk of bearing failure will be higher. To avoid this type of bearing failure, the limiting speed is reduced. Also in case of cylindrical roller bearing, when the radial clearance is reduced and the preload increases during operation, the limiting speed is reduced.

4) Drive method

The limiting speed of a bearing will also change depending on the spindle drive system.

In the case of motor built-in spindles the heat inside if the spindle is higher. If there is also a jacket-cooling system, the temperature difference between the inner ring and the outer ring becomes higher, so the preload is increased and the limiting speed becomes lower. Jacket cooling also affects the clearance between the bearing and the housing. Therefore, the clearance between the bearing and the housing could become negative, in which case the preload would be increased.

3.7 Bearing arrangement

General

The classic application field for high precision bearings is machine tools spindles, which may have different requirements depending on the working operations they are designed for. Generally, lathe spindles are used to cut metals at rather low speeds and in combination with relatively large cutting loads. Such types of spindles usually have the driving torque transmitted through a pulley or toothed gears. This means that loads at the rear side of the shaft are also rather heavy. For such applications, the requirements in terms of speed are not so tough; the more important parameters are rigidity and load carrying capacity. It is quite common to have, at the front side of the spindle, a double row cylindrical roller bearing in combination with a double row angular contact thrust ball bearing, while having a double row cylindrical roller bearing at the rear end of the shaft. This type of arrangement ensures a long calculated life and an excellent rigidity, so that a good quality of the work piece is obtained. Also, from a kinematic point of view, the bearings run in a stable way, as there are two types of bearing (radial and axial) that carry independently, the loads applied on the shaft (in fact, to avoid that angular contact thrust ball bearings carry radial loads, the outer ring outside diameter has a special tolerance so that it is never in contact with the housing). When designing these types of spindles (this applies in general when rather heavy loads are involved) a good rule of thumb concerning the position of the bearings along the shaft, is to have the distance between the centre of the front and rear support in the range of 3–3.5 times the bearing inner diameter.

When higher speeds are requested (i.e. high-speed machining centre or internal grinding) different bearing solutions need to be found. Obviously, in such cases something has to be paid in terms of rigidity, as well as carrying capacity. High-speed applications usually have direct-driven spindles driven by direct coupling and/or electrical motors (i.e. the so called motorised spindles).

There are no loads due to transmission of power and consequently single row angular contact ball bearings paired in sets or single (for extremely high speed) and single row cylindrical roller bearings are frequently adopted, if enhanced performances are required, equipped with silicon nitride rolling elements. The front side bearing set is axially located, whilst mounting a cylindrical roller bearing at the rear side permits axial displacement, due to spindle elongation.

When very high speeds are involved (n dm factor over 2 million) it is quite common to see angular contact ball bearings on both sides, preloaded by springs. This is done to control the heat generation. If sets of angular contact ball bearings arranged in a constant position are chosen, preload would increase with the speed, and at high speed produce an amount of heat which is not sustainable.

Conversely, spring preload remains constant with the speed, thus ensuring a more correct kinematic behaviour and a limited amount of heat generation.

An even better solution is represented by the possibility to preload the bearings (angular contact) by a hydraulic system. In such a case, the amount of preload can be adjusted according to the speed of the spindle, thus reaching the best possible combination among rigidity, heat generation and theoretical life of the bearings.

3

Radial location of bearings

In order to work properly, bearings must have their rings or washers fully supported around their complete circumference and across the whole width of the raceway. The support must be firm and even, and can be provided by a cylindrical or tapered seating or, for thrust bearing washers, by a flat (plane) support surface. This means that the seatings must be made with adequate accuracy and that their surface should be uninterrupted by grooves, holes or other features. This is particularly important with high-precision bearings since they have relatively thin-walled rings, which adapt themselves to the form of the shaft or housing bore. In addition, the bearing rings must be reliably secured to prevent them from turning on or in their seatings under load.

A satisfactory radial location and an adequate support can generally be obtained when the rings are mounted

with an appropriate degree of interference. Inadequately or incorrectly secured bearing rings generally cause damage to the bearings and associated components. However, when easy mounting and dismounting are

desirable, or when axial displacement is required with a non-locating bearing, an interference fit cannot be used. In certain cases where a loose fit is employed it is necessary to take special precautions to limit the inevitable wear, for example, surface hardening of the seating and abutments.

Axial location of bearings

General

An interference fit alone, is inadequate for the axial location of a bearing ring. As a rule, therefore, some suitable means of axially securing the ring is needed. Both rings of locating bearings should be axially secured at both sides. For non-locating bearings, on the other hand, where they are of a non-separable design, it is sufficient if the ring having the tighter fit- usually the inner ring-is axially secured; the other ring must be free to move axially with respect to its seating.

In machine tool applications, usually, the work side bearings ensure the shaft location to support the axial load transmission from the shaft to the housing. Generally, then, work side bearings are axially located, while rear side supports are axially free.

Methods of location

Bearing rings having an interference fit are generally mounted so that the ring abuts a shoulder on the shaft or in the housing at one side. At the opposite side, inner rings are normally secured using a lock nut. Outer rings are usually retained by a housing end cover.

Instead of integral shaft or housing shoulders, it is frequently more convenient to use spacer sleeves or collars between the bearing rings or between a bearing ring and an adjacent component, e.g. a gear.

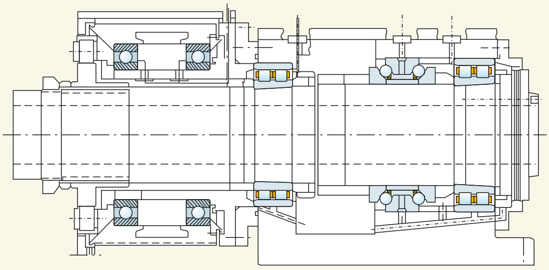
Other methods of axial location which are suitable, above all, for high precision bearing arrangements involve the use of press fits, e.g. in the form of stepped sleeve arrangements.

Bearings with a tapered bore, mounted directly on tapered journals, are generally secured on the shaft by lock nuts.

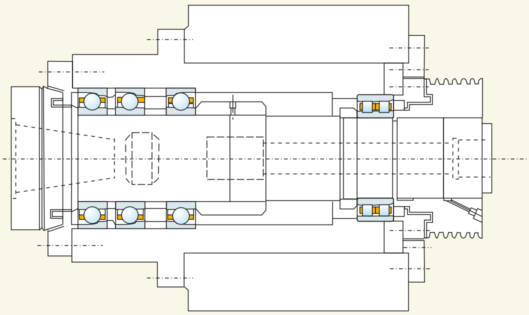
Application examples

Spindle arrangements for heavy machining, CNC lathes and conventional milling machines (figs 8, 9 and 10).

Bearing arrangement work side: NN 30-2344(00); drive side: NN 30 K Fig.8

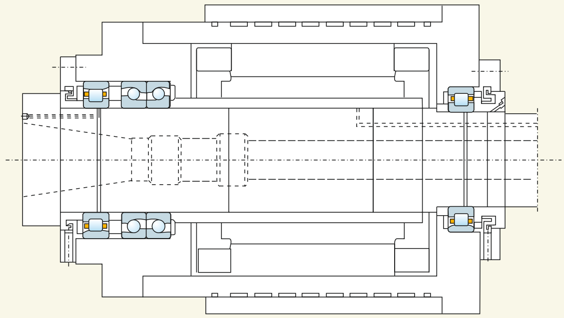


Bearing arrangement work side: 70 AC/P4 TBT; drive side NN 30 K Fig.9

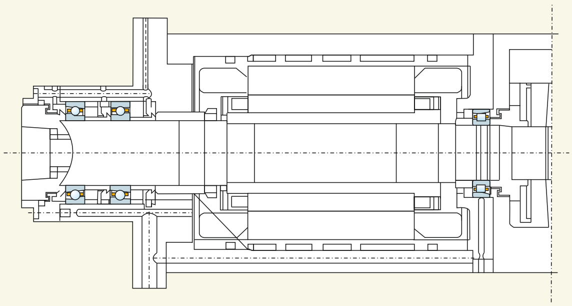


3

Bearing arrangement work side: N 10 K + BTM-A/HQ1; rear side N 10 K Fig.10

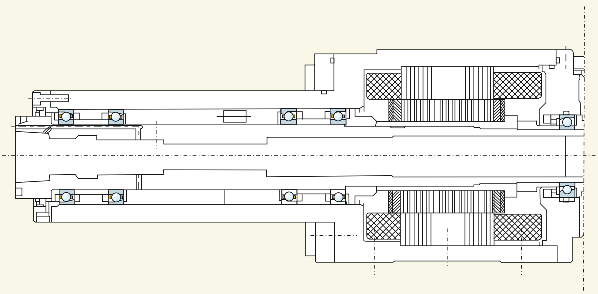


Bearing arrangement work side: 70 C/HQ1 P4 DB; rear side N 10 K Fig.11

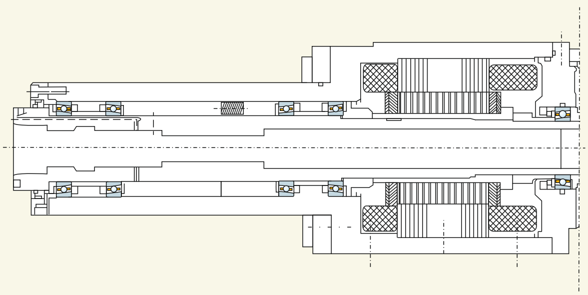


Spindle arrangements for great rigidity and high speed machining centres, high speed turning centres and high speed milling (figs 11, 12, 13 and 14)

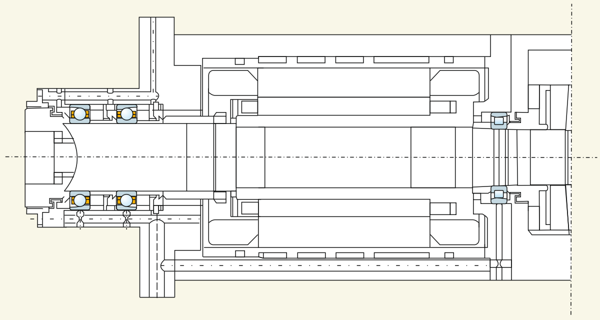
Bearing arrangement work side: 70 C/P4 QBC; rear side 70 C/P4 Fig.12



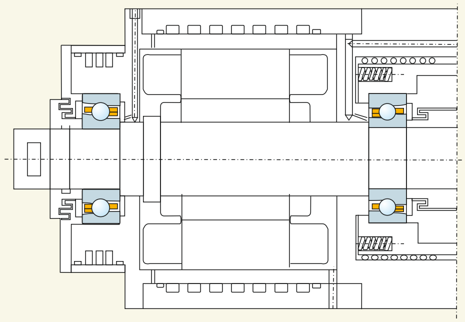
Bearing arrangement work side: 70 C/HQ1 P4 QBC; rear side 70 C/ P4 Fig.13



Bearing arrangement work side: 70 C/ P4DB; rear side N 10 K Fig.14



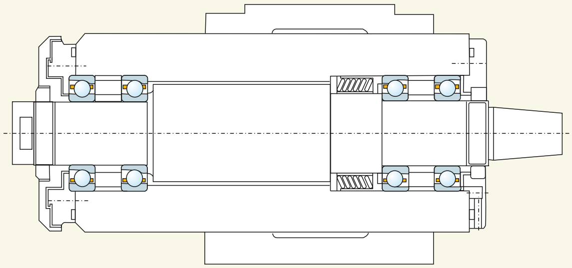
Bearing arrangement work side: 70 C/HQ1 P4; rear side 70 C/HQ1 P4 Fig.15



Spindle arrangements for grinding machines (figs 15 and 16).

3

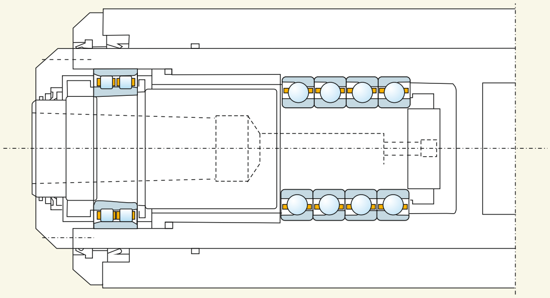
Bearing arrangement work side: 70 C/HQ1 P4DT; rear side 70 C/HQ1 P4DT Fig.16



Bearing arrangement for live centres (fig.17).

3

Bearing arrangement work side: NN 30 K; rear side 72 AC/P4 QBT Fig.17



3.8 Life

Bearing life

Aside from the failure of bearings to function due to natural deterioration, bearings may fail when conditions such as heat-seizure, fracture, wear of the seals, or other damage occurs. Conditions such as these should not be interpreted as normal bearing failure since they occur as a result of errors in bearing selection, improve design or manufacture of the bearing surroundings, incorrect mounting, or insufficient maintenance.

Usually, the rolling bearing life means fatigue life; fatigue life is the most important performance for roller bearings, fatigue life means working time for the bearing from start working until surface of bearings have scroll, or the bearings′ total speed. (10^6 For single bearing)

Rating fatigue life means bearing at the same type, same work condition not have fatigue peeling of total speed (mark to 10^6), or work in a certain rotation speed, will mark to L_{10}

Bearing life calculation

$$L_{10}=\left(\frac{C}{P}\right)^{\varepsilon}\ (10^6\text{rpm})\ \text{or}\ L_{10h}=\frac{10^6}{60n}\left(\frac{C}{P}\right)^{\varepsilon}\ (h)$$

Note:

L_{10}——Basic rating life

C ——N Basic dynamic load rating N

P ——N Equivalent dynamic load

ε ——Life index(ball bearingsε=3,roller bearingsε=10/3

n ——Rotational speed (r/min)

3.9 Accuracy

Accuracy class

The running accuracy of a bearing arrangement is governed by the accuracy of all the component parts of the arrangement. Where the bearings are concerned it is primarily determined by the accuracy of form and position of

the raceways on the bearing rings. When selecting the appropriate tolerance class for a particular bearing, the maximum radial runout of the inner ring (Kia) is generally the determining factor for most applications.

Table 1 gives values of different tolerance classes

CSC	ISO	ABMA	SKF	FAG	NSK
Tolerance Class					
P2	2	ABEC9	PA9A	P2	P2
P4	4	ABEC7	P4	P4	P4
P5	5	ABEC5	P5	P5	P5

Table 2 CSC tolerance class for high-precision bearings

CSC	Boundary dimension	Running accuracy
Tolerance Class	ISO ABMA	ISO ABMA
SP	P5 ABEC5	P4 ABEC7
UP	P4 ABEC7	P2 ABEC9
P4A	P4 ABEC7	P2 ABEC9[1)]

Note: SP and UP only for NN double row cylindrical roller bearings
Up to 120mm bore diameter, for large sizes, ABEC7 is better.

Tolerance classes and tolerance values

Tolerance for the boundary dimensions and running accuracy of CSC radial bearing are specified by the Accuracies of Rolling bearings in ISO492/199/1132-1, GB/T. CSC manufactures Angler contact ball bearing according to AMBA standard.

P5 tolerance refer to form 3 and 4

Table 3 Inner ring (P5 class)

Unit: μm

d(mm)		△dmp、△ds		Vdp Diameter series 9	0、2、3	Vdmp	Kia	Sd	Sia	△Bs		VBs
Exceed	To	Upper deviation	Lower deviation	max						Upper deviation	Lower Deviation	max
2.5	10	0	-5	5	4	3	4	7	7	0	-40	5
10	18	0	-5	5	4	3	4	7	7	0	-80	5
18	30	0	-6	6	5	3	4	8	8	0	-120	5
30	50	0	-8	8	6	4	5	8	8	0	-120	5
50	80	0	-9	9	7	5	5	8	8	0	-150	6
80	120	0	-10	10	8	5	6	9	9	0	-200	7
120	180	0	-13	13	10	7	8	10	10	0	-250	8
180	250	0	-15	15	12	8	10	11	13	0	-300	10
250	315	0	-18	18	14	9	13	13	15	0	-350	13
315	400	0	-23	23	18	12	15	15	20	0	-400	15

Table 4 Outer ring (P5 class)

Unit: μ m

D(mm)		△Dmp、△Ds		VDp Diameter series 9	VDp Diameter series 0、2、3	VDmp	Kea	SD	Sea	△Cs		VCs
Exceed	To	Upper deviation	Lower deviation	max						Upper deviation	Lower Deviation	max
6	18	0	-5	5	4	3	5	8	8	Equal to the value of inner ring (△Bs) of the same bearing number		5
18	30	0	-6	6	5	3	6	8	8			5
30	50	0	-7	7	5	4	7	8	8			5
50	80	0	-9	9	7	5	8	8	10			6
80	120	0	-10	10	8	5	10	9	11			8
120	150	0	-11	11	8	6	11	10	13			8
150	180	0	-13	13	10	7	13	10	14			8
180	250	0	-15	15	11	8	15	11	15			10
250	315	0	-18	18	14	9	18	13	18			11
315	400	0	-20	20	15	10	20	13	20			13
400	500	0	-23	23	17	12	23	15	23			15
500	630	0	-28	28	21	14	25	18	25			18
630	800	0	-35	35	26	18	30	20	30			20

3

P4 tolerance refer to form 5 and 6

Table 5 Inner ring

Unit: μ m

d(mm)		△dmp、△ds		Vdp Diameter series 9	Vdp Diameter series 0、2、3	Vdmp	Kia	Sd	Sia	△Bs		VBs
Exceed	To	Upper deviation	Lower deviation	max						Upper deviation	Lower Deviation	max
2.5	10	0	-4	4	3	2	2.5	3	3	0	-40	2.5
10	18	0	-4	4	3	2	2.5	3	3	0	-80	2.5
18	30	0	-5	5	4	2.5	3	4	4	0	-120	2.5
30	50	0	-6	6	5	3	4	4	4	0	-120	3
50	80	0	-7	7	5	3.5	4	5	5	0	-150	4
80	120	0	-8	8	6	4	5	5	5	0	-200	4
120	180	0	-10	10	8	5	6	6	7	0	-250	5
180	250	0	-12	12	9	6	8	7	8	0	-300	6

Table 6 outer ring

Unit: μ m

D(mm)		△Dmp、△Ds		VDp Diameter series 9	VDp Diameter series 0、2、3	VDmp	Kea	SD	Sea	△Cs		VCs
Exceed	To	Upper deviation	Lower deviation	max						Upper deviation	Lower Deviation	max
2.5	6	0	-4	4	3	2	3	4	5	Equal to the value of inner ring (△Bs) of the same bearing number		2.5
6	18	0	-4	4	3	2	3	4	5			2.5
18	30	0	-5	5	4	2.5	4	4	5			2.5
30	50	0	-6	6	5	3	5	4	5			2.5
50	80	0	-7	7	5	3.5	5	4	5			3
80	120	0	-8	8	6	4	6	5	6			4
120	150	0	-9	9	7	5	7	5	7			5
150	180	0	-10	10	8	5	8	5	8			5
180	250	0	-11	11	8	6	10	7	10			7
250	315	0	-13	13	10	7	11	8	10			7
315	400	0	-15	15	11	8	13	10	13			8

P4A tolerance refer to form 7 and 8

Table 7 Inner ring

Unit: μ m

d(mm)		△dmp、△ds		Vdp Diameter series		Vdmp	Kia	Sd	Sia	△Bs		VBs
				9	0、2、3							
Exceed	To	Upper deviation	Lower deviation	max						Upper deviation	Lower Deviation	max
2.5	10	0	-4	4	3	2	1.5	1.5	1.5	0	-40	2.5
10	18	0	-4	4	3	2	1.5	1.5	1.5	0	-80	2.5
18	30	0	-5	5	4	2.5	2.5	1.5	2.5	0	-120	2.5
30	50	0	-6	6	5	3	2.5	1.5	2.5	0	-120	3
50	80	0	-7	7	5	3.5	2.5	1.5	2.5	0	-150	4
80	120	0	-8	8	6	4	2.5	2.5	2.5	0	-200	4
120	180	0	-10	10	8	5	2.5	2.5	2.5	0	-250	5
180	250	0	-12	12	9	6	5	5	5	0	-300	6

3

Table 8 Outer ring

Unit: μ m

D(mm)		△Dmp、△Ds		VDp Diameter series		VDmp	Kea	SD	Sea	△Cs		VCs
				9	0、2、3							
Exceed	To	Upper deviation	Lower deviation	max						Upper deviation	Lower deviation	max
2.5	6	0	-4	4	3	2	1.5	1.5	1.5	Equal to the value of inner ring (△Bs) of the same bearing number		2.5
6	18	0	-4	4	3	2	1.5	1.5	1.5			2.5
18	30	0	-5	5	4	2.5	2.5	1.5	2.5			2.5
30	50	0	-6	6	5	3	2.5	1.5	2.5			2.5
50	80	0	-7	7	5	3.5	4	1.5	4			3
80	120	0	-8	8	6	4	5	2.5	5			4
120	150	0	-9	9	7	5	5	2.5	5			5
150	180	0	-10	10	8	5	5	2.5	5			5
180	250	0	-11	11	8	6	7	4	7			7
250	315	0	-13	13	10	7	7	5	7			7
315	400	0	-15	15	11	8	8	7	8			8

Note:P4A,bore of inner ring and outer diameter of outer ring are P4, the other rotation accuracy are P2.

P2 tolerance refer to form 9 and 10

Table 9 Inner ring

Unit: μ m

d(mm)		△dmp、△ds		Vdp	Vdmp	Kia	Sd	Sia	△Bs		VBs
Exceed	To	Upper deviation	Lower deviation	max					Upper deviation	Lower deviation	max
2.5	10	0	-2.5	2.5	1.5	1.5	1.5	1.5	0	-40	1.5
10	18	0	-2.5	2.5	1.5	1.5	1.5	1.5	0	-80	1.5
18	30	0	-2.5	2.5	1.5	2.5	1.5	2.5	0	-120	1.5
30	50	0	-2.5	2.5	1.5	2.5	1.5	2.5	0	-120	1.5
50	80	0	-4	4	2	2.5	1.5	2.5	0	-150	1.5
80	120	0	-5	5	2.5	2.5	2.5	2.5	0	-200	2.5
120	150	0	-7	7	3.5	2.5	2.5	2.5	0	-250	2.5
150	180	0	-7	7	3.5	5	4	5	0	-250	4
180	250	0	-8	8	4	5	5	5	0	-300	5

Table 10 Outer ring

Unit: μ m

D(mm)		△Dmp、△Ds		VDp	VDmp	Kea	SD	Sea	△Cs		VCs
Exceed	To	Upper deviation	Lower deviation	max					Upper deviation	Lower deviation	max
2.5	6	0	-2.5	2.5	1.5	1.5	1.5	1.5			1.5
6	18	0	-2.5	2.5	1.5	1.5	1.5	1.5			1.5
18	30	0	-4	4	2	2.5	1.5	2.5			1.5
30	50	0	-4	4	2	2.5	1.5	2.5			1.5
50	80	0	-4	4	2	4	1.5	4	Equal to the value of inner ring (△Bs) of the same bearing number		1.5
80	120	0	-5	5	2.5	5	2.5	5			2.5
120	150	0	-5	5	2.5	5	2.5	5			2.5
150	180	0	-7	7	3.5	5	2.5	5			2.5
180	250	0	-8	8	4	7	4	7			4
250	315	0	-8	8	4	7	5	7			5
315	400	0	-10	10	5	8	7	8			7

Tolerance for Double Row Cylindrical Roller Bearings

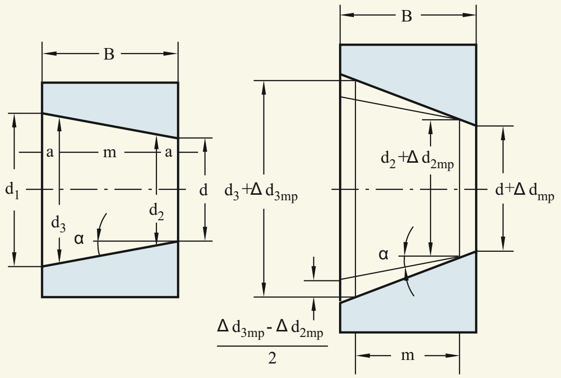
P5, P4 and P2 according to form 3-10

Bore accuracy of tapered bore

measuring of angular deviation

half cone angle α=22°3'9.4"

the theoretical maximum taper d1=d+1/12B



SP tolerance of bearing refer to form 11 and 12

Table 11 Inner ring

d(mm)		Cylindrical bore △ds,△dmp		Vdp,Vdmp	Tapered bore △ds,△dmp		Vdp
Exceed	To	Upper deviation	Lower deviation	max	Upper deviation	Lower deviation	max
—	18	0	-5	3	—	—	—
18	30	0	-6	3	+10	0	3
30	50	0	-8	4	+12	0	4
50	80	0	-9	5	+15	0	5
80	120	0	-10	5	+20	0	5
120	180	0	-13	7	+25	0	7
180	250	0	-15	8	+30	0	8
250	315	0	-18	9	+35	0	9
315	400	0	-23	12	+40	0	12
400	500	0	-28	14	+45	0	14

3

Table 12 Outer ring

D(mm)		△Ds,△Dmp		VDp,VDmp	Kea	SD	△Cs		VCs
Exceed	To	Upper deviation	Lower deviation	max			Upper deviation	Lower deviation	max
30	50	0	-7	4	5	8	Equal to the value of inner ring (△Bs and VBs) of the same bearing number		
50	80	0	-9	5	5	8			
80	120	0	-10	5	6	9			
120	150	0	-11	6	7	10			
150	180	0	-13	7	8	10			
180	250	0	-15	8	10	11			
250	315	0	-18	9	11	13			
315	400	0	-20	10	13	13			
400	500	0	-23	12	15	15			
500	630	0	-28	14	17	18			

△d1mp-△dmp		Kia	Sd	△Bs		VBs
Upper deviation	Lower deviation	max		Upper deviation	Lower deviation	max
—	—	3	8	0	-100	5
+4	0	3	8	0	-100	5
+6	0	4	8	0	-120	5
+6	0	4	8	0	-150	6
+8	0	5	9	0	-200	7
+8	0	6	10	0	-250	8
+10	0	8	11	0	-300	10
+12	0	10	13	0	-350	13
+13	0	12	15	0	-400	15
+15	0	12	18	0	-450	25

3

UP tolerance of bearing refer to form 13 and 14

Table 13 inner ring

d(mm)		Cylindrical bore △ds,△dmp		Vdp,Vdmp	Tapered bore △ds,△dmp		Vdp
Exceed	To	Upper deviation	Lower deviation	max	Upper deviation	Lower deviation	max
—	18	0	-4	2	—	—	—
18	30	0	-5	3	+6	0	3
30	50	0	-6	3	+8	0	3
50	80	0	-7	4	+9	0	4
80	120	0	-8	4	+10	0	4
120	180	0	-10	5	+13	0	5
180	250	0	-12	6	+15	0	6
250	315	0	-18	9	+18	0	9
315	400	0	-23	12	+23	0	12
400	500	0	-28	14	+28	0	14

3

Table 14 outer ring

D(mm)		△Ds,△Dmp		VDp,VDmp	Kea	SD	△Cs		VCs
Exceed	To	Upper deviation	Lower deviation	max			Upper deviation	Lower deviation	max
30	50	0	-5	3	3	2	Equal to the value of inner ring (△Bs and VBs) of the same bearing number		
50	80	0	-6	3	3	2			
80	120	0	-7	4	3	3			
120	150	0	-8	4	4	3			
150	180	0	-9	5	4	3			
180	250	0	-10	5	5	4			
250	315	0	-12	6	6	4			
315	400	0	-14	7	7	5			
400	500	0	-23	12	8	5			
500	630	0	-28	14	10	6			

△d1mp-△dmp		Kia	Sd	△Bs		VBs
Upper deviation	Lower deviation	max		Upper deviation	Lower deviation	max
—	—	1.5	2	0	-25	1.5
+2	0	1.5	3	0	-25	1.5
+3	0	2	3	0	-30	2
+3	0	2	4	0	-40	3
+4	0	3	4	0	-50	3
+5	0	3	5	0	-60	4
+7	0	4	6	0	-75	5
+8	0	5	6	0	-100	6
+9	0	6	8	0	-100	8
+10	0	7	9	0	-150	10

3.10 Fitting

Fitting tolerance of Shafts and Housings

It is almost importance that shafts and hosings are accurately and precisely mated in order to take full advantage of the precision bearing's capabilities, which includ rotational accuracy, high speed performance,and low heat generation.

When the inner ring or outer ring is mounted onto a shaft or into a housing with some interference, the shape of shaft or housing(out of roundness) is transferred to the bearing raceway surfaces and affects running accuracy. When multiple angular contact ball bearings are used ,cylindricality affects the distribution of preload for each bearing. Therefore,the mating parts should be as accurate as possoible .

Inaccurate mating of parts can cause the formation of peaks or ridges along the shaft of a precision lathe, which can affect the quality of finished work.

Table 15 Fits on Shafts ([1])

Bearing Type	Shaft Outer Diameter(mm)		Lerance of Shaft ([2]) Outer Diameter(mm)		Target Interference ([2]) ([3]) (mm)	
	Over	Incl	Min	Max	Min	Max
Machine tool spindle bearing	10	18	-0.003	0	0	0.002T
	18	50	-0.004	0	0	0.0025T
	50	80	-0.005	0	0	0.003T
	80	120	-0.003	0.003	0	0.004T
	120	180	-0.004	0.004	0	0.004T
	180	250	-0.005	0.005	0	0.005T
Angular contact thrust ball bearing for ball screw support	10	18	-0.008	0	—	—
	18	30	-0.009	0	—	—
	30	50	-0.011	0	—	—
	50	80	-0.013	0	—	—
	80	120	-0.015	0	—	—

3

Table 16 Fits on Housings ([1])

Bearing Type	Housing Bore Diameter(mm)		Tolerance of Housing ([2]) Bore Diameter(mm)		Target Interference ([2]) ([3]) (mm)	
	Over	Incl	Min	Max	Min	Max
Angular contact ball bearing (Fixes end)	18	50	-0.002	0.002	0.002L	0.006L
	50	80	-0.0025	0.0025	0.002L	0.006L
	80	120	-0.003	0.003	0.003L	0.008L
	120	180	-0.004	0.004	0.003L	0.008L
	180	250	-0.005	0.005	0.005L	0.010L
Angular contact ball bearing (Free end)	18	50	0	0.004	0.006L	0.011L
	50	80	0	0.005	0.006L	0.011L
	80	120	0	0.006	0.009L	0.015L
	120	180	0	0.008	0.009L	0.015L
	180	250	0	0.010	0.015L	0.022L
Cylindrical roller bearing	18	50	-0.006	0	0.002L	0.002L
	50	80	-0.007	0	0.002L	0.002L
	80	120	-0.008	0	0.002L	0.002L
	120	180	-0.009	0	0.002L	0.002L
	180	250	-0.011	0	0.002L	0.002L
Angular contact thrust ball bearing for ball screw support	10	18	—	—	—	—
	18	30	—	—	—	—
	30	50	0	0.016	—	—
	50	80	0	0.019	—	—
	80	120	0	0.022	—	—

注：([1]) The fitting data above provides general recommendations for machine tool spindles operating under normal conditions and for dmn values of less than 800,000. for high speeds, heavy loads, or outer ring rotation, please contact CSC for assistance.

([2]) Use the target interference when the bearing can be matched to the shaft or housing, Otherwise, use the shaft outer diamer and housing bore minimum and maximum for random matching.

([3]) T=Interference or tight fit
L=Clearance or loose fit

If the taper of the inner ring for a double row cylindrical roller bearing with a tapered bore does not match that of the shaft, the residual clearance will be different for two of the rows. Therefore, load will not be sustsined normally, and will impair rigidity or cause irregluar movemont of the rollers due to taper of the inner ring groove. We recommend that you gauge the tapered parts to be mated with bearings. Contact should cover more than 80% of the total surface area that is dyed blue. The recommended accuracy and surface roughness of bearing mounting seats are shown in following tables:

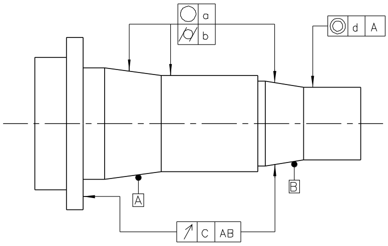


Table 17 Tolerance for and Mean Roughness of Shafts

Shaft Diameter(mm)		Tolerance Grades and Mean Roughness (um)					
		Out-of-roundness (○)		Cylindricity (⌭)		Runout (↗)	
		a		b		c	
		Bearing Accuracy					
Over	Incl	P5 , P4	P4A , P2	P5 , P4	P4A , P2	P5 , P4	P4A , P2
—	10	0.7	0.5	0.7	0.5	2	1.2
10	18	1	0.6	1	0.6	2.5	1.5
18	30	1.2	0.7	1.2	0.7	3	2
30	50	1.2	0.7	1.2	0.7	3.5	2
50	80	1.5	1	1.5	1	4	2.5
80	120	2	1.2	2	1.2	5	3
120	180	2.5	1.7	2.5	1.7	6	4
180	250	3.5	2.2	3.5	2.2	7	5
250	315	4	3	4	3	8	6

3

Coaxiality (⊚)		Roughness	
d		Ra	
P5，P4	P4A，P2	P5，P4	P4A，P2
4	2.5	0.2	0.1
5	3	0.2	0.1
6	4	0.2	0.1
7	4	0.2	0.1
8	5	0.2	0.1
10	6	0.4	0.2
12	8	0.4	0.2
14	10	0.4	0.2
16	12	0.4	0.2

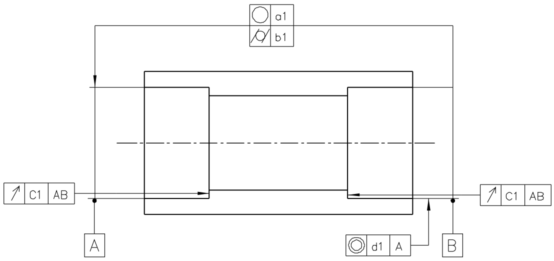


Table 18 Tolerance for and Mean Roughness of Housing

Housing Bore Diameter(mm)		Tolerance Grades and Mean Roughness (um)					
		Out-of-roundness (○)		Cylindricity (⌭)		Runout (↗)	
		a1		b1		c1	
		Bearing Accuracy					
Over	Incl	P5 , P4	P4A , P2	P5 , P4	P4A , P2	P5 , P4	P4A , P2
10	18	1	0.6	1	0.6	2.5	1.5
18	30	1.2	0.7	1.2	0.7	3	2
30	50	1.2	0.7	1.2	0.7	3.5	2
50	80	1.5	1	1.5	1	4	2.5
80	120	2	1.2	2	1.2	5	3
120	180	2.5	1.7	2.5	1.7	6	4
180	250	3.5	2.2	3.5	2.2	7	5
250	315	4	3	4	3	8	6
315	400	4.5	3.5	4.5	3.5	9	6.5

Coaxiality (⊚)		Roughness	
d1		Ra	
P5 , P4	P4A , P2	P5 , P4	P4A , P2
5	3	0.4	0.2
6	4	0.4	0.2
7	4	0.4	0.2
8	5	0.4	0.2
10	6	0.8	0.4
12	8	0.8	0.4
14	10	0.8	0.4
16	12	1.6	0.8
18	13	1.6	0.8

3

Chamfer Dimension

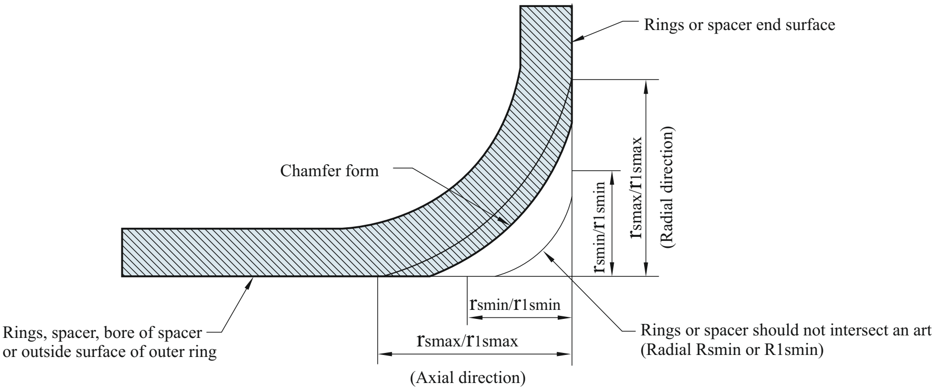


Table 19 Chamfer dimension limits of Radial bearings Unit: mm

r_{smin} [1)]	D Over	D Incl	r_{smax} Radial direction	r_{smax} Axial
0.05	—	—	0.1	0.2
0.08	—	—	0.16	0.3
0.1	—	—	0.2	0.4
0.15	—	—	0.3	0.6
0.2	—	—	0.5	0.8
0.3	—	40	0.6	1
	40	—	0.8	1
0.6	—	40	1	2
	40	—	1.3	2
1	—	50	1.5	3
	50	—	1.9	3
1.1	—	120	2	3.5
	120	—	2.5	4
1.5	—	120	2.3	4
	120	—	3	5
2	—	80	3	4.5
	80	220	3.5	5
	220	—	3.8	6
2.1	—	280	4	6.5
	280	—	4.5	7
2.5 [2)]	—	100	3.8	6
	100	280	4.5	6
	280	—	5	7
3	—	280	5	8
	280	—	5.5	8
4	—	—	6.5	9
5	—	—	8	10
6	—	—	10	13
7.5	—	—	12.5	17
9.5	—	—	15	19
12	—	—	18	24
15	—	—	21	30
19	—	—	25	38

Note:

1. Maximum chamfer dimension of shafts and housing refer to fitting chamfer dimension table
2. GB/T 273.3 has no requirement for chamfer dimension

3.11 Lubrication

Good lubricating is a basic condition for roller bearings. The analysis of bearing damage showed that about 40% damages are related to poor lubrication.

Seen from the results, oil lubrication is better than grease lubrication, but due to the complexity of lubrication system and device, the hardship of seal and the trouble with maintenance, the application of oil lubrication is limited in many occasion.

CSC precision bearing have open type and closed type for satisfy customer's requirement. CSC choose long life, low temperature grease in high rotation condition for spindle bearing.

Grease lubricating：

- Lubrication device is sample
- Not easy to leak, seal structure is sample
- Easy for maintenance
- Grease can prevent the dust water and other impurity from going into the bearings
- Increase cleanness

Oil lubrication：

Advantages:

- Suitable for high speed rotation
- Suitable for high temperature
- Have good heat dispersion
- Easy to remove wear and dust for bearing

4.1 Mounting and Dismounting

Mounting

Mounting Procedure

The method of mounting rolling bearings strongly affects their accuracy, life, and performance, it is recommended that the handling procedures for bearings be fully analyzed by designers and engineers and that standards be established with respect to the following items:

1.Cleaning the bearings and related parts.

2.Checking the dimensions and finish of related parts.

3.Mounting procedures

4.Inspection after mounting.

Bearings should not be unpacked until immediately before mounting. However, bearings for high speed operation must first be cleaned with clean filtered oil in order to remove the antirust agent. After the bearings are cleaned with filtered oil, they should be protected to prevent corrosion. Pre-lubricated bearings must be used without cleaning. Bearing mounting methods depend on the bearing type and type of fit. As bearings are usually used on rotating shafts, the inner rings require a tight fit. Bearings are usually mounted in housings with a loose fit. However, in cases where the outer ring has an interference fit, a press may be used.

Clean the Bearings and Related Parts

After opening the package, bearings need to be cleaned in order to remove the anti-corrosion agent.

Some bearings, such as sealed or pre-greased bearings, can be used without cleaning.

Cleaning method

Use kerosene or light oil to clean the bearings.

Use separate tanks for rough cleaning and final cleaning. Each tank should be equipped with wire rack to prevent direct contact of the bearings with any contamination that may have settled at the bottom.

In the rough cleaning tank, avoid rotating the bearings. After cleaning the outside surfaces with a brush, move the bearings to the final cleaning tank.

In the final cleaning tank, rotate the bearings with hand. Make sure that the cleaning fluid in the final cleaning tank is kept clean.

Remove excess cleaning fluid from the bearings after cleaning.

Bearings using ordinary grease lubrication need to be packing with grease. Oil lubricated bearings should be mounted on the machine tool spindle while taking care not to rotate the bearing. Prior to mounting, slightly coat the bearing inner and outer surface areas with a thin film of lubrication oil.

Checking Dimensions of Related Parts

Inspection of shaft and housing

Mating housing and shaft surfaces should be cleaned, scars, burrs and deckle edges are not allowed on the surfaces of bearings and spacers.

The dimensions of shafts and housing bores should be checked to confirm the matching fit with the bearing bore and outer diameter.

Take measurements and mount the bearings in a air conditioned room. Parts should be left until they have reached a constant and stable temperature. Using a micrometer or inside dial indicator, take measurements at several different points to confirm there are no significant differences in measurement values.

Inspection of spacers

For main spindle, a spacer parallelism of less than 0.003mm must be controlled, Spacer parallelism exceeding this recommendation will tilt the bearings, thus causing inaccuracies and bearing noise.

Mounting Procedures

Greased lubricated bearings and oil-air(oil-mist) lubricated bearings which are cleaned are mounted on the shaft and housing bore.

Procedures for mounting vary according to the fit requirements of the inner and outer rings. Primarily, it is the inner ring of machine tool bearing that rotates, thus bearings with cylindrical bores are usually mounted by heating them to expand the inner ring (shrink fit)

Outer rings are mounted with some clearance, so mounting tool are not usually required. The housing can be heated to make mounting much easier.

The bearings with tapered bores can be mounted directly onto a tapered shaft. For high speed operations, GN gauges are recommended for attaining accurate radial clearance when mounting. See p94-96.

Mounting of Bearings with Cylindrical Bores

1. Press fit

Fitting with a press is widely used for small bearings. Place a mounting tool against the inner rings as shown in Fig.18, apply steady pressure from the mounting tool to drive the bearing firmly the shoulder of the shaft. Avoid press fitting onto a shaft by applying pressure to the outer rings as this may damage the bearing.

In addition, apply a thin coat of oil to the mating surface before mounting. Also, avoid using a hammer when mounting precision bearings.

For separate bearings, such as cylindrical bearings, tapered roller bearings, the inner and outer rings can be mounted onto the shaft and into the housing as separate units. When assembling the two units, take extra care to align the inner and outer rings correctly. Careless or forced assembly may cause scratches on rolling contact surfaces.

2. Shrink fit

Since press fitting large bearings requires a great deal of force and bearings are difficult to mounting. The shrink fitting method is widely used. The bearings are first heated to expand the inner ring before mounting onto the shaft. This method prevents excessive force from being imposed on the bearings and enables mounting them in a short time.

The expansion of inner ring for various temperature differences and bearing sizes is shown in Fig.19.

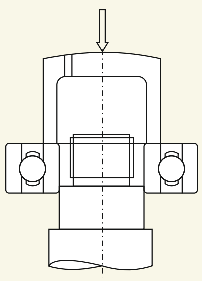
The following precautions need to be taken when shrink fitting.

a)Do not heat bearings to more than 120℃.

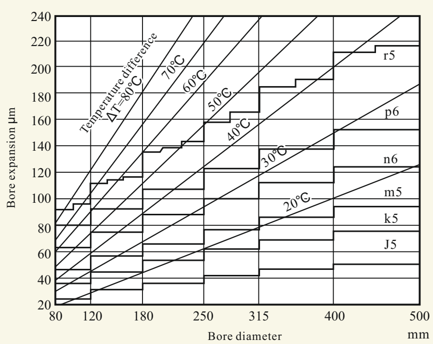
b)Heat the bearings to a temperature 20℃ to 30℃ higher than the lowest temperature required for mounting without interference since the inner ring will cool a little during mounting.

C)After mounting, the bearings will shrink in the axial direction while cooling, Therefore, drive the bearing firmly up against the shaft shoulder using locating methods to eliminate any clearance between the bearing and shoulder.

Press Fitting Inner Ring Fig.18



Temperature and Thermal Expansion of Inner Ring Fig.19



Precautions for Mounting Angular Contact Ball Bearings

Due to design restriction, an angular contact ball bearing can sustain loads in only one direction. Therefore, when mounting angular contact ball bearings onto shaft or into housing, it is important not to apply any load in the wrong direction.

Pay special attention to the order of mounting for combination bearings. Mounting onto the shaft and into the housing is different for Back-to-back and Face-to-face arrangements.

Back-to-Back Arrangement

a)Press the bearing onto the shaft.

b)Tighten the bearing locknut for preloading.

c)Insert the bearing and shaft into the housing, and attach the retaining cover.

Face-to-Face Arrangement

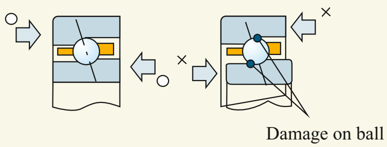
a)0Press the bearing into the housing.

b)Secure the clamping cover for preloading.

c)Insert shaft into the inner ring and tighten the bearing locknut.

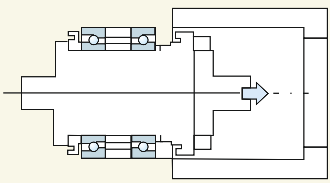
Reverse the order of each step for dismounting.

Direction of Load for Angular Contact Ball Bearings Fig.20

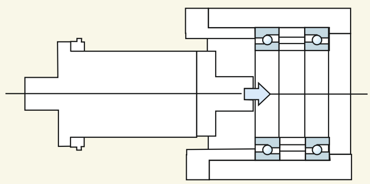


Load applied in direction "X"
results in damage to the ball

Mounting of Back-to-Back Arrangement Fig.21



Mounting of Face-to-Face Arrangement Fig.22



Securing the bearing

(1) Securing the inner ring

The inner ring is usually secured onto the shaft by tighten the bearing locknut, which explains why perpendicularity of the threads and end face are very important. Even if accuracy as a single component is good, the gap between shaft and locknut result in runout of the locknut, causing the shaft and bearing to bend. Therefore, making adjustments are necessary to ensure constant running accuracy. it is also important that the locknut be completely tightened so as to eliminate any possibility of it becoming loose. There is a risk of unbalance due to face and runout of the locknut or a minor inaccuracy of the mating parts. Here, sleeves are widely used in high speed, high precision machine tool spindles to secure the bearing to the shaft by a large interference fit between the shaft and sleeve bore. However, the sleeve tends to become loose after continuous operation, so it must be checked periodically.

When a wide spacer is used between combined angular contact ball bearings, and the seating torque of the locknut is excessive, the inner ring spacer may deformed and alter the preload to a level higher than expected. It is necessary to consider this deformation when the preload is set.

(2) Securing the outer ring

A retaining cover held by bolts is generally used to secure the bearing outer ring axially. If a bolt is tightened excessively or a combination of bolts is tightened unevenly, the bearing outer ring may become deformed.

When interference fit of the shaft increases under high speed operations, the amount of tightening torque applied to the locknut must also be increased.

The tightening force of angular contact thrust ball bearing for ball screw support should be 2.5-3.0 times of the preload.

Mounting of Cylindrical Roller Bearings

Measuring radial clearance of cylindrical roller bearings. (Using GN gauge)

A GN gauge is an instrument for matching the tapered section of a shaft to the tapered bore of a bearing when mounting a cylindrical roller bearing with a tapered bore onto a matching tool spindle. After mounting, the GN gauge is used for precise control of the bearing's radial internal clearance. This instrument is especially effective when a cylindrical roller bearing is used with radial preload.

The GN gauge components shown as the Fig 23 .

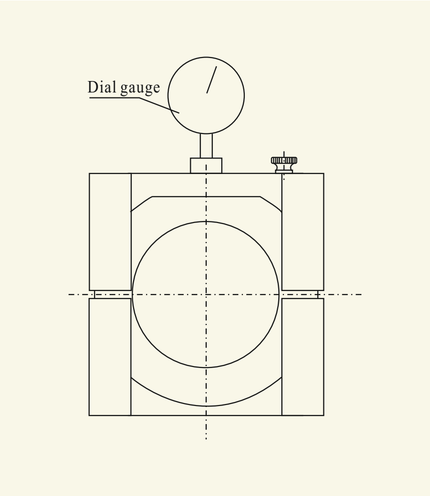


Figure 23

How to use a GN gauge

1)Insert outer ring into housing

The recommended fit between outer ring and housing is: clearance 2μm-interference 2μm

2)Zero setting of cylinder gauge

Confirm that the temperatures are the same for the outer ring(inserted into the housing), the inner ring, and the shaft. Then, measure the bore diameter of the outer ring at about four locations. Determine the average for the measurements and the cylinder gauge to zero

3)Adjust the inscribed diameter of GN gauge

Loosen the bolt of the main body fixture on the GN gauge. Apply the cylinder gauge to the inscribed diameter surface of the GN gauge and adjust the setscrew to the setting of the dial on the cylinder gauge to zero.(see step 2)

(use the GN gauge in an upright position to avoid inaccuracies due to its own weight)

4)Correction of GN gauge

Using the results of step 3,use the pointer control on the dial gauge to adjust the pointer on the GN gauge to the red mark for gauge correction. Confirm that short needle is near 2 on the dial.

(Gauge correction corrects for elastic deformation of the roller due to measuring pressure on the gauge. The amount of correction for each gauge is determined upon shipment a gauge.)

5)Mounting of inner ring

Mount the inner ring onto the shaft and tighten the locknut lightly. At this time, the bearings should be cleaned, but not yet coated with grease.

6)Setting of GN gauge

Adjust the setscrew on the GN gauge (0.2 mm to 0.3 mm on the dial face) to spread the dial on the GN gauge. The GN gauge is placed in the center of inner ring and the setscrew is loosened.

7)Reading of the scale.

Read the scale on the dial gauge of the GN gauge at this time. The shift value of the dial pointer from zero.

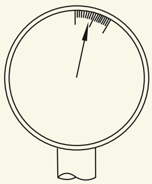
Example 1: A half-shift of the dial from zero in a clockwise direction indicates positive clearance.

Example 2: A half-shift of the dial from zero in a counter-clockwise direction indicates negative clearance

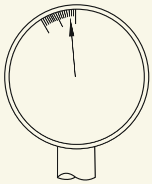
8) Adjustment

In addition to procedures given in step 6, use the screw to spread the dial of the GN gauge. Remove the gauge from inner ring and tighten the locknut. Repeat steps 6 through 8 until the scale of the dial gauge reaches the target clearance value.

9) Adjustment of spacer



Example 1: Point to "4" in a clockwise direction indicates a radial clearance of +0.002μm
Deviate in a clockwise direction, half reading is (plus) clearance



Example 2: Point to "2" in a counter-clockwise direction indicates a radial clearance of -0.001μm
Deviate in a counter-clockwise direction, half reading is (minus) clearance.

4

Grease Packing

Procedure for mounting grease after cleaning bearings

A rapid rise in temperature may occur during initial running-in due to improper mounting of grease. This can result in a long running-in period, or lead to seizure and bearing failure. Following proper procedures for mounting grease and using the correct amount of grease deserves careful attention. Recommended procedures are as follows:

Pre-inspection

Check to ensure there is no foreign matter in the bearing interior. Bearing for high speed spindle shafts should be cleaned, degreased, and packed with grease. For other applications, remove any anticorrosion agent adhering to interior surfaces of the bearings.

Grease dispensers

Use a grease dispenser, such as a plastic syringe for precision grease dispensing. If possible, use a dispenser that comes with a gauge for mounting accurate amounts of grease.

Recommended amounts of grease mounting for precision bearings:

- Angular contact ball bearings for high speed machine tool spindles: 15%±2% of internal space
- Cylindrical roller bearings for high speed machine tool spindle:10%±2% of internal space
- Ball bearings for motors: 20% to 30% of

Mounting method for ball bearings

(1) Pack Mount grease evenly between the balls. If an outer ring guided cage is used, such as a phenolic resin cage, apply a light coating of grease on the guided surface.

(2) Rotate the bearing by hand to spread grease evenly on the surfaces of the raceway, ball, and cage.

Mounting method for cylindrical roller bearings

(1) Coat about 80% of the grease amount evenly on roller rolling surface. Avoid putting too much grease on the cage bore. Grease on the cage bore is difficult to disperse during the running-in period, which can result in a rapid rise in temperature or a long running-in period.

(2) Coat roller surfaces with a thin film of grease, including the roller end faces, roller cage contact points, and along the face edges of each cage pocket.

(3) Using the remaining 20% of grease, apply a thin film of grease to the raceway surface of the outer ring.

Inspection after Mounting

Runout accuracy

Accurate mounting and related parts are indispensable to ensure precision and accuracy of the machine tool spindle.

(1)Assembled bearing outer ring face runout with raceway for angular contact bearings

Adjust to 0.002 mm or less by tapping on the outer ring end face.

(2)Tilt of angular contact ball bearings

Adjust to 0.005 mm or less tilting the locknut.

(3)Concentricity of rear side housing 0.010 mm or less.

If these accuracies cannot be met, disassemble the bearings and check the accuracies of parts again.

Control of preload after mounting of bearings

If the preload of rolling bearing is set larger, the rigidity of bearing is increased, but heat generation is also increased, and in extreme cases, seizure may occur. Therefore, it is necessary to control optimum preload carefully in response to operation condition. Measuring method of preload for angular contact ball bearing is introduced below.

Measuring of preload for angular contact ball bearings

There are three methods for checking preload of bearings after mounting onto the main shift starting torque method, thrust static rigidity method, and natural frequency method. Feature of this methods are summarized in Table 20

Table 20

	Starting torque method	Thrust static rigidity method
Advantage	Used for heavy preload If starting torque is high, measurement error is small	Used for light preload
Disadvantage	Not good for light preload If starting torque is small, variation of measurement is large.	Not good for heavy preload Loading equipment is too large scale. Affected easily by deformation of contact part other than bearing.

Starting torque method

High speed main shaft spindle bearings are often used with light preload so that start torque is low and measurement error is large.

Method

Start torque is obtained by measuring tangential force(see Fig 24).

Preload is obtained from the relationship between measured starting torque and preload.

When oil film formation in rolling contact area is unstable during measurement, sticking occurs (rotation does not start even under tangential force and rotation starts suddenly when tangential force is increased gradually). The torque at such occasion tends to higher than predicted calculated torque so that the excessive measurement result need to be excluded.

Starting torque method

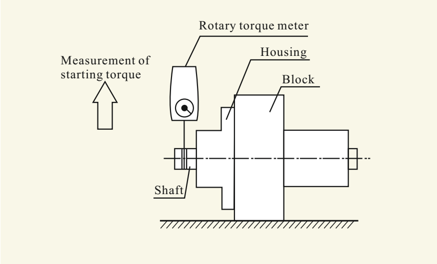


Figure 24

Thrust static rigidity method

When axial rigidity of the bearing is high, axial force necessary for measurement becomes very high and loading equipment is necessary (Example: if axial rigidity is 200N/μm, 2000N load is needed to generate 10 μm displacement). When measurement load is large, besides elaxtic deformation of bearing interior, effect of surface deformation of other related parts are added. Measured rigidity tends to be lower that theoretical value and error often occurs.

Method

Thrust load is applied to shaft and its axial displacement is measured for obtaining preload(see Fig 25).

Thrust static rigidity method

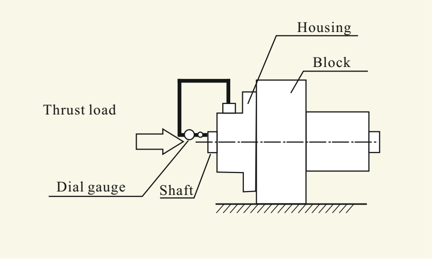


Figure 25

Dismounting

Proper maintenance of spindles is essential to their performance, and replacing the bearings in the correct way using the right tools is a major part of that maintenance.

Before disassembly begins, a suitable working area should be prepared and the proper tools made available.

The working area should be clean and away from areas where cutting and grinding operations take place. No traverses should pass over the working place. It is best to use a separate room if possible, one that is temperature controlled, dedicated to handling of accurate components and easy to keep clean.

Tool requirements differ depending on spindle design, but use of the correct tools makes the work easier and more efficient, and avoids damaging the components.

4.2 Bearing Failure Diagnosis

Maintenance, Inspection and Correcting Irregularities

In order to maintain the original performance of a bearing for as long as possible, proper maintenance and inspection should be performer. If proper procedures are used, many bearing problems can be avoided and the reliability, productivity, and operating costs of the equipment containing the bearings are all improved. It is suggested that periodic maintenance be done following the procedure specified. This periodic maintenance encompasses the supervision of operating conditions, the supply or replacement of lubricants, and regular periodic inspection.

Items that should be regularly checked during operation include bearing noise, vibration, temperature, and lubrication. If an irregularity is found during operation, the cause should be determined and the proper corrective actions should be taken.

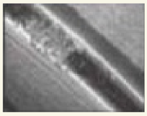
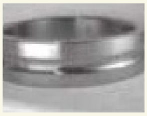
If necessary, the bearing should be dismounted and examined in detail.

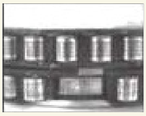
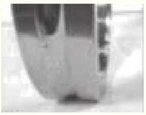
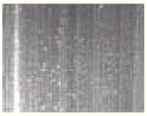
Bearing Failure and Countermeasures

In general, if rolling bearings are used correctly they will survive to their predicted fatigue life.

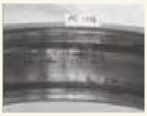
However, they often fail prematurely due to avoidable mistakes. In contrast to fatigue life, this premature failure is caused by improper mounting, handing or lubrication, entry of foreign matter, or abnormal heat generation. For instance, the causes of rib scoring, as one example, are the use of improper lubricant, faulty lubricant system, entry of foreign matter, bearing mounting error, excessive deflection of the shaft, or any combination of these. Thus, it is difficult to determine the real cause of some premature failures. If all the conditions at that time of failure and previous to the time of failure are known, including the application, the operating conditions, and environment; then by studying the nature of the failure and its probable causes, the possibility of similar future failures can be reduced. The most frequent types of bearing failure, along with their causes and corrective actions, are listed in Table 21.

Table 21 Causes and Countermeasures for Bearing Failures

Type of Failure	Irregularities	Photo	Probable Causes	Countermeasures
Flaking	Flaking on one side of the raceway of radial bearing.		Abnormal axial load (sliding failure of free-side bearing).	When mounting the outer ring of free-side bearings, it should be fitted loosely, to allow axial expansion of the shaft.
	Flaking pattern inclined relative to the raceway in radial ball bearings Flaking near the edge of the raceway and rolling surface in roller bearing.		Improper mounting, bending of shaft, inadequate centering, inadequate tolerances for shaft and housing.	Use care in mounting and centering, select a bearing with a large clearance, and correct the squareness of shaft and housing shoulder.
	Flaking of raceway with same spacing as rolling element.		Large shock load during mounting, rusting while bearing is out of operation for prolonged period, mounting flaws of cylindrical roller bearings.	Use care in mounting and apply a rust preventative when machine operation is suspended for a long time.
	Premature flaking of raceway and rolling element.		Insufficient clearance, excessive load, improper lubrication, rust, etc.	Select proper fit, bearing clearance, and lubricant.
	Premature flaking of combined bearings.		Excessive preload	Adjust the preload.
Scoring	Scoring or smearing between raceway and rolling surface.		Inadequate initial lubrication, excessively hard grease, high acceleration when starting operation.	Use a softer grease and avoid rapid acceleration.
	Scoring or smearing between the end face of the rollers and guide rib.		Inadequate lubrication, incorrect mounting and large axial load.	Select proper lubricant and modify the mounting.
Cracks	Crack in outer or inner ring.		Excessive shock load, excessive interference in fitting, poor shaft cylindricity, improper sleeve taper, large fillet radius, development of thermal cracks and increased flaking.	Examine the loading conditions, modify the fit of bearing and sleeve, improve accuracy in machining shaft and sleeve, collect fillet radius (the fillet radius must be smaller than the bearing chamber).

Type of Failure	Irregularities	Photo	Probable Causes	Countermeasures
Cracks	Crack in rolling element or broken rib.		Increased flaking, shock applied to rib during mounting or dropped during handing.	Use care in mounting and handing a bearing.
	Fracture of cage.		Abnormal loading on the cage due to incorrect mounting. Improper lubrication.	Correct mounting and examine the lubrication method and lubricant.
Indentations	Indentation on raceway with the same spacing as rolling element (Brinelling).		Shock load during mounting or excessive load when not rotating.	Use care in handing the bearing.
	Indentations on raceway and rolling elements.		Entry of foreign matter such as metallic particle and grit.	Clean the housing, improve the seals and use clean lubricant.
Abnormal wear	False brinelling (phenomenon similar to brinelling).		Vibration of the bearing without rotation when out of operation, such as during transport, or rocking motion of vibration.	Secure the shaft and housing, use oil as a lubricant and reduce vibration by applying preload.
	Fretting, Localized wear with reddish-brown wear dust at fitting surface.		Sliding wear at a minute gap in the fitting surface.	Increase interference and apply oil.
	Wearing on raceway, rolling elements, rib and cage.		Entry of foreign matter, incorrect lubrication and rust.	Improve sealing capabilities, clean the housing and use a clean lubricant.
	Creep, scoring wear at fitting surface.		Insufficient interference, insufficiently secured sleeve.	Modify the fitting and tighten the sleeve properly.

4

Type of Failure	Irregularities	Photo	Probable Causes	Countermeasures
Seizure	Discoloration and melting of raceway, rolling elements and ribs.		Insufficient clearance, incorrect lubrication, or improper mounting.	Examine the fitting and internal clearance of a bearing, supply an adequate amount of proper lubricant and examine the mounting method and quality of related parts.
Corrosion and Rust	Corrosion and rust at bearing interior or fitting surface.		Condensation of water from the air, or fretting, entry of corrosive substance (especially varnish gas).	Store carefully when in a moist or hot climate, take rust prevention measures before removing from operations for a long time, and select proper varnish and grease.

5.1 Definition of the Dimensional Lettering

d	nominal diameter of the bore
d_s	individual bore diameter
d_{sp}	individual bore diameter in an individual plane
Δ_{ds}	deviation of an individual bore diameter,difference between an individual bore diameter and the nominal diameter of a bore,$\Delta_{ds}=d_s-d$
V_{ds}	variation of the bore diameter,difference between the largest and smallest individual bore diameters of an individual ring,$V_{ds}=d_{smax}-d_{smin}$
d_m	mean bore diameter,arithmetic mean derived from the largest and smallest of the individual bore diameters of an individual ring,$d_m=(d_{smax}+d_{smin})/2$
Δ_{dm}	deviation of the mean bore diameter,difference between the mean bore diameter and the nominal diameter of the bore,$\Delta_{dm}=d_m-d$
d_{msp}	mean bore diameter in an individual plane,arithmetic mean derived from the largest and smallest individual bore diameters ascertainable in a radial plane.$d_{mp}=(d_{spmax}+d_{spmin})/2$
Δ_{dmp}	deviation of the mean bore diameter in an individual plane,difference between the mean bore diameter and the nominal diameter in a radial plane,$\Delta_{dmp}=d_{mp}-d$
V_{dp}	variation of an individual bore diameter in an individual plane,difference between the largest and smallest mean bore diameter ascertainable in a radial plane,$V_{dp}=d_{pmax}-d_{pmin}$
V_{dmp}	variation of the mean bore diameter,difference between the largest and

	smallest mean bore diameters respectively for an individual ring ascertainable in individual radial planes, $V_{dmp}=d_{mpmax}-d_{mpmin}$
D	nominal diameter of the jacket(outside diameter)
D_s	individual jacket diameter
D_{sp}	individual jacket diameter in an individual plane
Δ_{Ds}	deviation of the individual jacket diameter,difference between an individual jacket diameter and the nominal diameter of the jacket, $\Delta_{Ds}=D_s-D$
V_{DS}	variation of the jacket diameter,difference between the largest and smallest jacket diameters of an individual ring, $V_{ds}=D_{smax}-D_{smin}$
D_m	mean jacket diameter,arithmetic mean derived from the largest and smallest individual jacket diameters of an individual ring, $D_m=(D_{smax}+D_{smin})/2$
Δ_{Dm}	deviation of the mean jacket diameter,difference between the mean jacket diameter and the nominal diameter of the jacket, $\Delta_{Dm}=D_m-D$
D_{mp}	mean jacket diameter in an individual plane,arithmetic mean derived from the largest and smallest individual jacket diameters ascertainable in a radial plane, $D_{mp}=(D_{spmax}+D_{spmin})/2$
Δ_{Dmp}	deviation of the mean jacket diameter in an individual plane,difference between the mean jacket diameter and the nominal diameter of the jacket in an individual radial plane, $\Delta_{Dmp}=D_{mp}-D$
V_{Dsp}	variation of an individual jacket diameter in an individual plane,difference between the largest and smallest individual jacket diameters ascertainable

in an individual radial plane, $V_{Dp}=D_{pmax}-D_{pmin}$

V_{Dmp} — variation of the mean jacket diameter,difference between the largest and smallest mean jacket diameters ascertainable respectively in individual radial planes for and individual ring, $V_{Dmp}=D_{mpmax}-D_{mpmin}$

B — nominal width of the inner ring

C — nominal width of the outer ring

B_s — individual inner ring width

C_s — individual outer ring width

$\triangle_{Bs}$ — deviation of the individual inner ring width,difference between an individual inner ring width and the nominal width of the inner ring, $\triangle_{Bs}=B_s-B$

$\triangle_{Cs}$ — deviation of the individual outer ring width,difference between an individual outer ring width and the nominal width of the outer ring, $\triangle_{Cs}=C_s-C$

V_{Bs} — variation of the inner ring width,difference between the largest and smallest actual individual ring widths of an individual inner ring, $V_{Bs}=B_{smax}-B_{smin}$

V_{Cs} — variation of the outer ring width,difference between the largest and smallest actual individual ring widths of an individual outer ring, $V_{Cs}=C_{smax}-C_{smin}$

B_m — mean inner ring width,arithmetic mean derived from the largest and amallest individual ring widths ascertainable for an outer ring, $B_m=(B_{smax}+B_{smin})/2$

C_m	mean outer ring width,arithmetic mean of the largest and amallest individual ring widths ascertainable for an outer ring,$C_m=(C_{smax}+C_{smin})/2$
r	nominal bearing corner radius
r_s	individual bearing corner radius
r_{smin}	smallest individual bearing corner radius,smallest permissible radial and axial individual bearing corner radius of a ring
r_{smax}	largest individual bearing corner radius,largest permissible radial and axial individual bearing corner radius of a ring
K_i	variation of the wall thickness between inner ring tace and bore,difference between the largest and smallest radial gap between the bore surface and the race on the outer side of the inner ring,in the centre of the race
K_e	variation of the wall thickness between outer ring tace and outer ring jacket,difference between the largest and smallest distance between the jacket surface and the race on the inner side of the outer ring,in the centre of the race
K_{ia}	radial run-out of the inner ring on the assembled bearing,difference between the largest and smallest radial gap between the bore surface of

CSC Bearing Europe GmbH
Luitpoldstraße 6
97357 Prichsenstadt
Germany

Tel: +49 9383 873 9000
www.csc-bearing.eu