ABM
PRECISION BEARINGS

2020 Third Edition
Published by **ABM**

No. 36, Ln. 465, Sec. 9,
Xiangshang Rd., Wuqi Dist.,
Taichung City 435055,
Taiwan

TEL : 886-4-26390616
FAX : 886-4-26390989

Email : abm.twn@msa.hinet.net

www.abm-bearings.com

ADVANCED BEARING MANUFACTURING CO.,LTD.

ABM
PRECISION BEARINGS

BS SERIES

SUPER PRECISION
BALL SCREW SUPPORT BEARINGS

INDEX

Introduction

ABM specializes in developing leading-edge super precision angular contact ball bearing series for modern machine tool spindles, precision instruments, and other devices carrying high load at utmost rotation speed.

While CNC control system has become the main stream of the machine tool industry, ABM's ball screw support bearing series are specifically designed to meet this demand. These bearings are designated as BS... series. BS series have a 60-degree contact angle and are manufactured to meet P4A tolerance, yet with an even higher P2A tolerance axial runout restriction. Each ball in bearing is separated by a one piece, glass fiber, reinforced nylon molded cage. These bearings are designed to have maximum axial rigidity, low drag torque and supreme axial running accuracy. The later developed rubber seal BS series bearings have a better water-resistant characteristic than non-seal version.

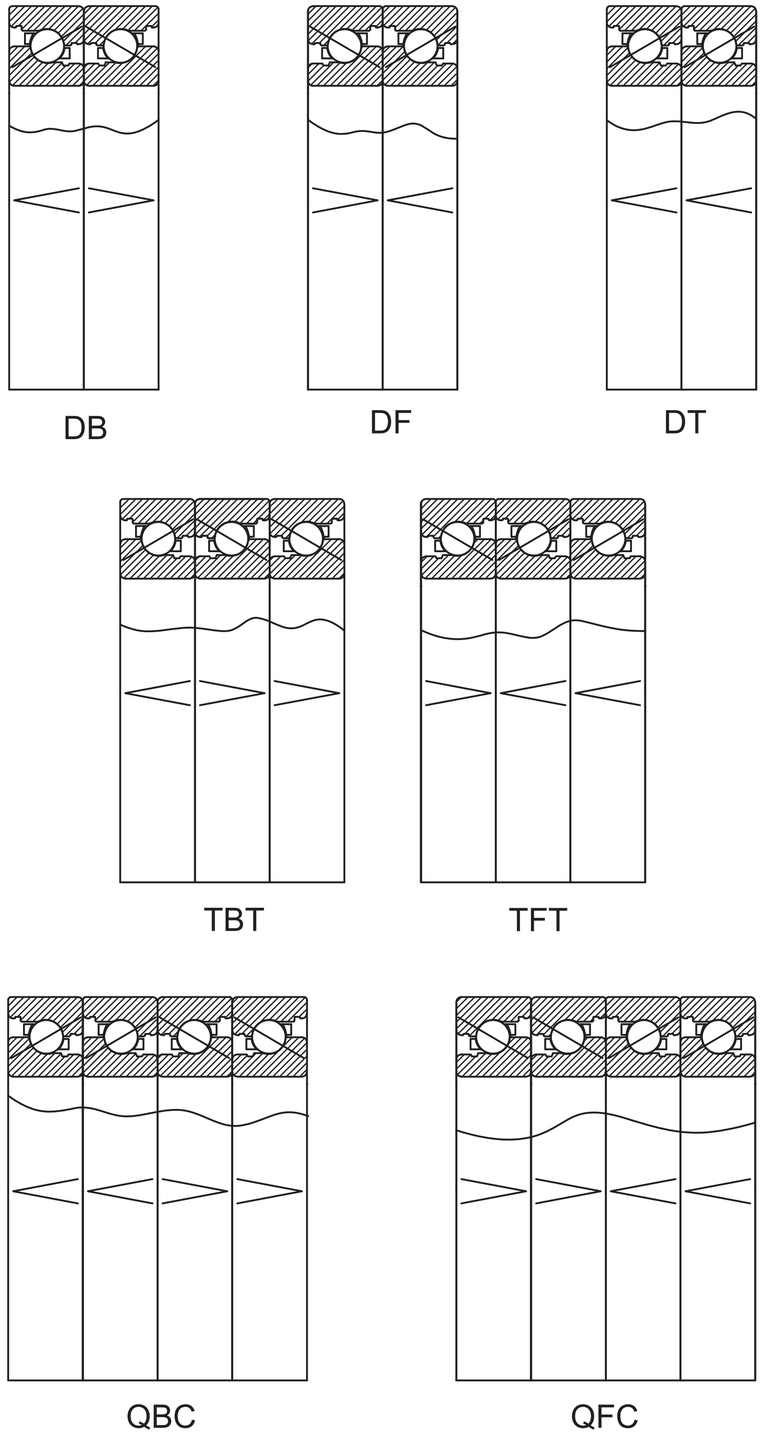
Preload and Axial Stiffness

BS series bearings are manufactured in three preload classes:
▸▸▸ L= light preload, M= Medium preload, H=Heavy preload.
Refer preload and axial stiffness values of duplex bearings to page 8. Preload and axial stiffness values should be doubled for quadruplex sets.
For some machine tool applications with high speed, designers might have the need to request a preload which is even lighter than our standard light preload, ABM can fulfill the special request to meet your need.
Note: Our XL preload represents a preload which is 50% of L preload.

Arrangements

BS series bearings are normally supplied in standard factory matched duplex pair, triplex set, and quadruplex set. Although these bearings are packed as DB, TBT and QBC arrangements in every individual box as our standard packaging, they are suitable for many different arrangements shown below.

Seal version BS bearing



Lubrication

All BS series bearings, both seal and non-seal versions, are 50% pre-greased with "Petamo GHY 133N" and vacuum-packed in a nylon plastic bag to extend the shelf life of the grease.
Petamo GHY 133N, a lubrication grease with high performance, has following advantages:

- Good resistance to oxidation
- Good wear protection at high temperature
- Good corrosion protection and water resistance

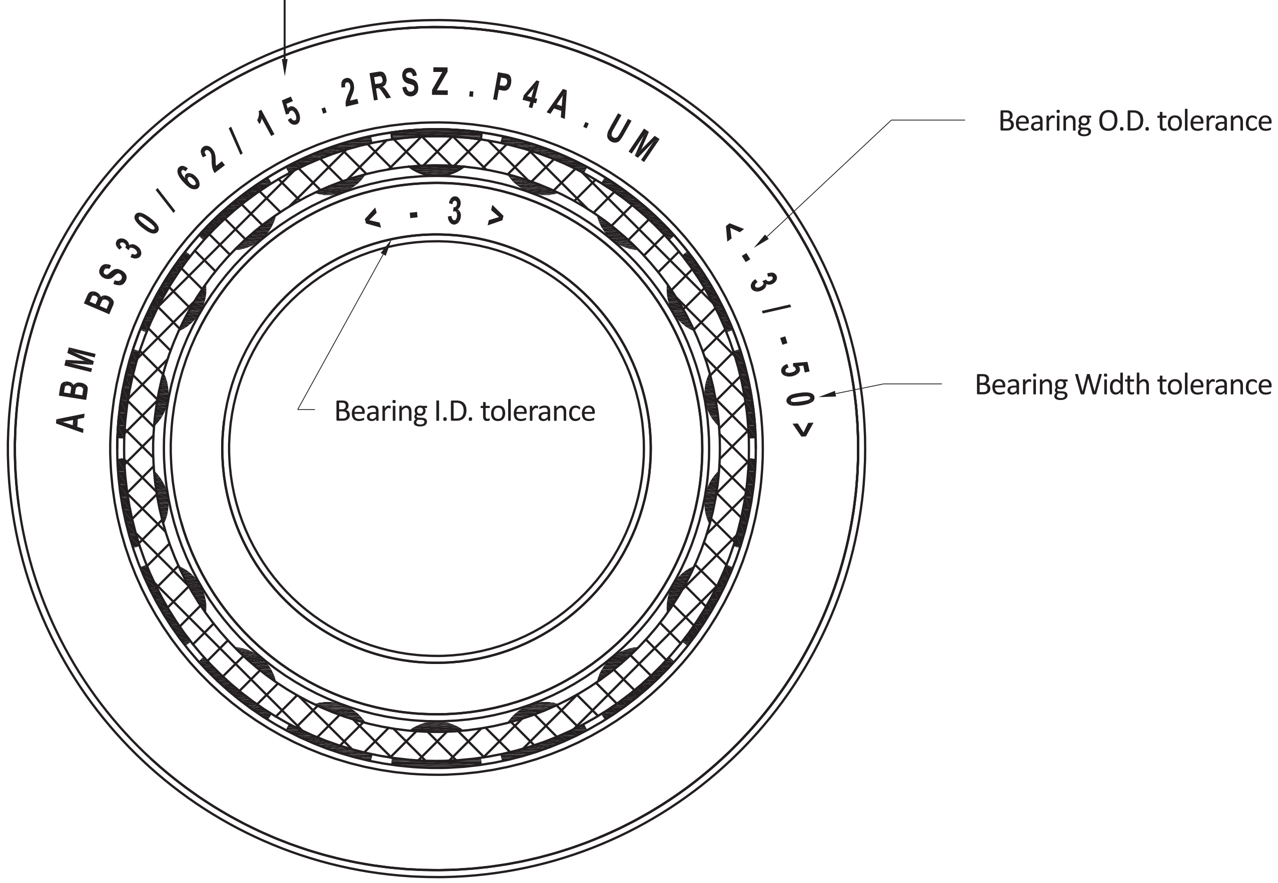
Data of Petamo GHY 133N

Base oil/ thickener	Mineral oil, synthetic hydrocarbon oil, polyurea
Service temperature range, DIN 51 825/51 821/2, °C, approx.	-30 to 160
Flow pressure, DIN 51 805, at -30 °C, mbar, approx.	<1400
Low-temperature torque in acc. with IP 186/85 at -30 °C Starting torque, N-mm Running torque, N-mm	 <1000 <100
Base oil viscosity, DIN 51 561 at 40°C, mm^2/s, approx. at 100°C, mm^2/s, approx.	 150 18
Worked penetration, DIN ISO 2137, at 25 °C; 0.1 mm	265 -295
Speed factor (n × dm), mm × min^{-1}, approx.	500,000
Drop point, DIN ISO 2176, °C	>250
Density, DIN 51 757 at 20°C, g/cm^3, approx.	0.88
Color	beige

If the users, for any reason, intend to remove the grease from the bearings, the bearings should be carefully washed in filtered kerosene, naphatha or other suitable fluid.
Our suggestion for installation:
Keep the plastic bag sealed and unopened until installation to minimize the risk of exposing bearings to surrounding contaminations.

Designation System of BS Series Bearings

BS: Ball screw support bearing
30: Bore size in mm
62: O.D. size in mm
15: Bearing width in mm
2RSZ : Seal version
_: Non seal version
P4A: Precision grade
_: Single bearing (D: Duplex pair T: Triplex set Q: Quadruplex Set)
U: Universal
M: Medium preload (XL: Extra light L: Light H: Heavy)



Tolerance for BS Series Bearings

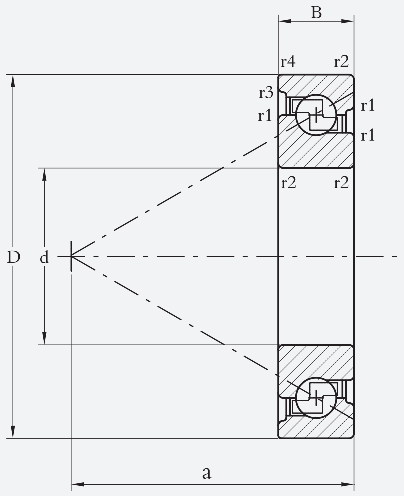
Unit: µm

	Inner ring	class	over ⌀ including	10 18	18 30	30 50	50 80	80 120
Δdmp	Deviation of mean bore diameter	P4A		-5	-5	-6	-7	-8
Kia	Radial runout of an assembled bearing inner ring	P4A		2.5	2.5	2.5	2.5	2.5
Sd	Axial runout of inner ring face against bore	P2A		1.3	1.3	1.3	1.3	2.5
Sia	Axial runout of inner ring face against raceway	P2A		1.3	2.5	2.5	2.5	2.5
ΔBs	Deviation of a single inner ring width against nominal dimension	P4A,P2A		-200	-200	-200	-250	-320
V_{Bs}	Width variation between inner ring and its mating outer ring	P4A		2.5	2.5	2.5	4	4

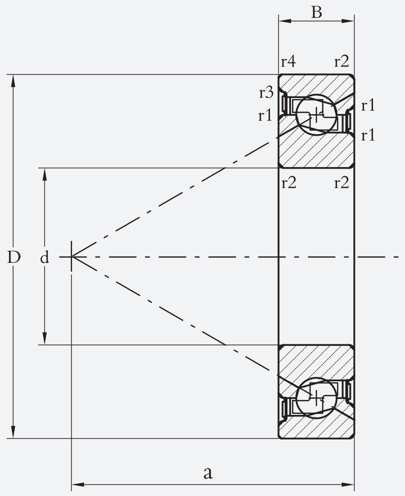
	Outer ring	class	over ⌀ including	30 50	50 80	80 120	120 150	150 180
ΔDmp	Deviation of mean outside diameter	P4A,P2H		-6	-7	-8	-9	-10
Kea	Radial runout of an assembled bearing outer ring	P4A		5	5	5	7	7.5
S_D	Outside diameter runout against reference face	P2A		1.3	1.3	2.5	2.5	2.5
Sea	Raceway groove runout against reterence face	P2A		2	3	3	4	4

Note: The width deviation of inner ring and outer ring are identical in a bearing.

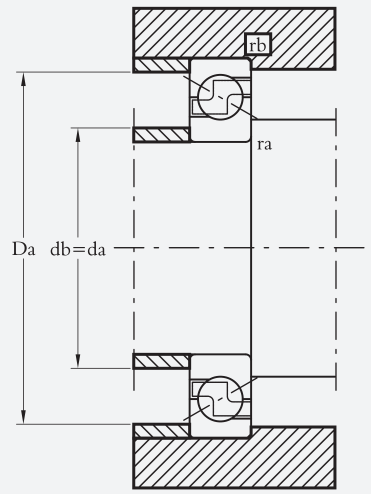
Bearing Data Table

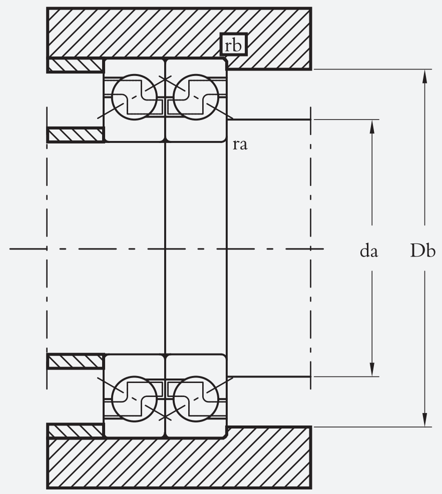


BS...



BS..2RSZ..





Primary Dimensions						Basic Bearing No.	Abutment and Fillet Dimension					Axial Load Ratings		Weight
d	D	B	$r_{1,2}$	$r_{3,4}$	a		r_{amax}	r_{bmax}	d_{amin}	D_{amax}	D_{bmax}	C_a(dynamic)	C_{oa}(static)	
mm			min	min	~		mm					N		Kg
15	42	13	1.0	0.6	18.6	BS 15/42/13	1.0	0.6	21	36	38	13000	6700	0.08
15	47	15	1.0	0.6	36.5	BS 15/47/15*	1.0	0.6	21	41	42	25000	32100	0.13
17	47	15	1.0	0.6	36.5	BS 17/47/15*	1.0	0.6	23	41	42	25000	32100	0.13
20	47	15	1.0	0.6	36.5	BS 20/47/15*	1.0	0.6	25	41	42	25000	32100	0.14
25	52	15	1.0	0.6	39.0	BS 25/52/15*	1.0	0.6	32	44	45	26500	37000	0.22
25	62	15	1.0	0.6	46.5	BS 25/62/15*	1.0	0.6	32	56	57	29200	42800	0.27
30	62	15	1.0	0.6	46.5	BS 30/62/15*	1.0	0.6	36	56	57	29200	42800	0.25
30	72	15	1.0	0.6	56.0	BS 30/72/15*	1.0	0.6	37	66	67	35600	55000	0.32
35	72	15	1.0	0.6	56.0	BS 35/72/15*	1.0	0.6	42	66	67	35600	55000	0.29
35	100	20	1.0	0.6	75.0	BS 35/100/20	1.0	0.6	47	91	92	70500	116000	1.05
40	72	15	1.0	0.6	56.0	BS 40/72/15*	1.0	0.6	48	66	67	35600	55000	0.28
40	90	20	1.0	0.6	71.5	BS 40/90/20	1.0	0.6	49	84	85	59000	90000	0.64
40	100	20	1.0	0.6	75.0	BS 40/100/20	1.0	0.6	49	91	92	70500	116000	1.00
45	75	15	1.0	0.6	60.0	BS 45/75/15	1.0	0.6	53	65	67	37900	61400	0.29
45	100	20	1.0	0.6	75.0	BS 45/100/20	1.0	0.6	54	91	92	70500	116000	0.95
50	90	20	1.0	0.6	71.5	BS 50/90/20	1.0	0.6	59	84	85	59000	90000	0.60
50	100	20	1.0	0.6	75.0	BS 50/100/20	1.0	0.6	59	91	92	70500	116000	0.89
55	100	20	1.0	0.6	75.0	BS 55/100/20	1.0	0.6	65	91	92	70500	116000	0.71
55	120	20	1.0	0.6	88.0	BS 55/120/20	1.0	0.6	65	111	112	80800	137000	1.43
60	120	20	1.0	0.6	88.0	BS 60/120/20	1.0	0.6	70	111	112	80800	137000	1.36

1. * means seal version available
2. BS 15/42/13 has 40° contact angle, and is designed for extreme high traverse speed application like P.C.B machining. All other BS series bearings are with 60° contact angle.

d	Preload			Axial Stiffness			Limiting Speeds			Drag Torque		
	L	M	H	L	M	H	L	M	H	L	M	H
mm	N			N/μm			rev/min			N-m/bearing		
15	360	—	—	250	—	—	10000	—	—	0.02	—	—
15	875	1750	3500	460	580	740	7150	6250	3100	0.04	0.08	0.16
17	875	1750	3500	460	580	740	7150	6250	3100	0.04	0.08	0.16
20	875	1750	3500	460	580	740	7150	6250	3100	0.04	0.08	0.16
25	1000	1900	3900	500	630	800	6250	5450	2700	0.05	0.09	0.18
25	1125	2250	4500	650	830	1050	5250	4550	2250	0.06	0.11	0.22
30	1125	2250	4500	650	830	1050	5250	4550	2250	0.06	0.11	0.22
30	1700	3400	6800	780	990	1260	4300	3750	1850	0.06	0.11	0.22
35	1700	3400	6800	780	990	1260	4300	3750	1850	0.06	0.11	0.22
35	3200	6400	12800	1090	1390	1760	3200	2800	1400	0.13	0.26	0.51
40	1700	3400	6800	780	990	1260	4300	3750	1850	0.06	0.11	0.22
40	2500	5000	10000	1035	1320	1680	3450	3000	1500	0.12	0.24	0.48
40	3200	6400	12800	1090	1390	1760	3200	2800	1400	0.13	0.26	0.51
45	1700	3400	6800	890	1090	1390	4000	3500	1750	0.07	0.14	0.28
45	3200	6400	12800	1090	1390	1760	3200	2800	1400	0.13	0.26	0.51
50	2500	5000	10000	1035	1320	1680	3450	3000	1500	0.12	0.24	0.48
50	3200	6400	12800	1090	1390	1760	3200	2800	1400	0.13	0.26	0.51
55	3200	6400	12800	1090	1390	1760	3200	2800	1400	0.13	0.26	0.51
55	3900	7800	15600	1340	1690	2150	2650	2300	1150	0.17	0.34	0.68
60	3900	7800	15600	1340	1690	2150	2650	2300	1150	0.17	0.34	0.68

3. ABM reserves the right to modify and/or discontinue any product specifications within our product lines at any time without notice.

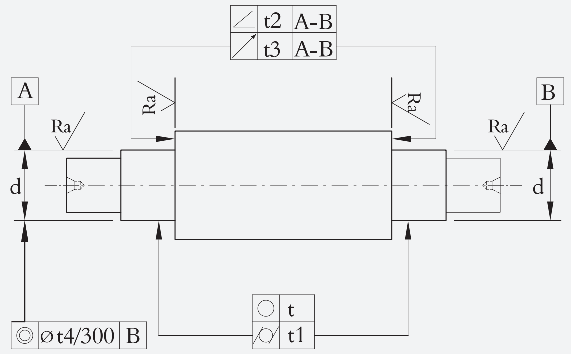
ABM
PRECISION BEARINGS

Recommended Shaft and Housing Dimensions for BS Series Bearings

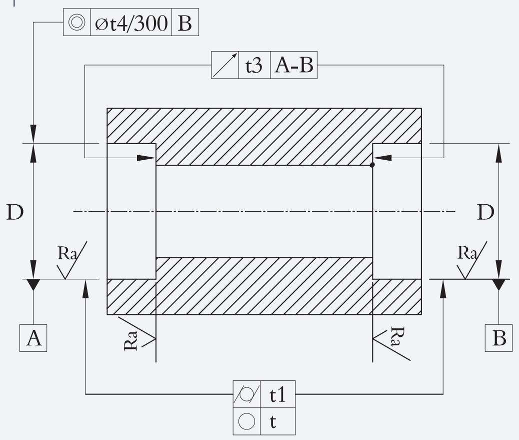
Bearing Size	Bearing Bore mm	Shaft mm	Bearing O.D. mm	Housing Dia. mm
BS 15/42	15.000 14.996	14.997 14.993	42.000 41.995	42.008 42.000
BS 15/47	15.000 14.996	14.997 14.993	47.000 46.995	47.008 47.000
BS 17/47	17.000 16.996	16.997 16.992	47.000 46.995	47.008 47.000
BS 20/47	20.000 19.995	19.997 19.992	47.000 46.995	47.008 47.000
BS 25/52	25.000 24.995	24.997 24.992	52.000 51.995	52.008 52.000
BS 25/62	25.000 24.995	24.997 24.992	62.000 61.995	62.008 62.000
BS 30/62	30.000 29.995	29.997 29.992	62.000 61.995	62.008 62.000
BS 30/72	30.000 29.995	29.997 29.992	72.000 71.995	72.008 72.000
BS 35/72	35.000 34.995	34.995 34.990	72.000 71.995	72.008 72.000
BS 35/100	35.000 34.995	34.995 34.990	100.000 99.992	100.010 100.000
BS 40/72	40.000 39.995	39.995 39.990	72.000 71.995	72.008 72.000
BS 40/90	40.000 39.995	39.995 39.990	90.000 89.992	90.008 90.000
BS 40/100	40.000 39.995	39.995 39.990	100.000 99.992	100.010 100.000
BS 45/75	45.000 44.995	44.995 44.990	75.000 74.993	75.008 75.000
BS 45/100	45.000 44.995	44.995 44.990	100.000 99.992	100.010 100.000
BS 50/90	50.000 49.995	49.995 49.990	90.000 89.992	90.008 90.000
BS 50/100	50.000 49.995	49.995 49.990	100.000 99.992	100.010 100.000
BS 55/100	55.000 54.995	54.995 54.990	100.000 99.992	100.010 100.000
BS 55/120	55.000 54.995	54.995 54.990	120.000 119.992	120.010 120.000
BS 60/120	60.000 59.995	59.995 59.990	120.000 119.992	120.010 120.000

Tolerance of Mating Parts for BS Series Bearings

Form Tolerance for Shaft



Form Tolerance for Housing



Shaft	Tolerance Symbol	Tolerance Designation	Permissible Form Error Tolerance/Roughness Class		
			tolerance of bearing P5	P4A	P2A
Roundness	○	t	$\frac{IT3}{2}$	$\frac{IT2}{2}$	$\frac{IT1}{2}$
Cylindricity	⌭	t1	$\frac{IT3}{2}$	$\frac{IT2}{2}$	$\frac{IT1}{2}$
Taper	∠	t2	–	$\frac{IT3}{2}$	$\frac{IT2}{2}$
Runout	↗	t3	IT3	IT3	IT2
Concentricity	◎	t4	IT5	IT4	IT3
Roughness Ra					
d≤80mm			N4	N4	N3
d>80mm			N5	N5	N4

Housing	Tolerance Symbol	Tolerance Designation	Permissible Form Error Tolerance/Roughness Class		
			tolerance of bearing P5	P4A	P2A
Roundness	○	t	$\frac{IT3}{2}$	$\frac{IT2}{2}$	$\frac{IT1}{2}$
Cylindricity	⌭	t1	$\frac{IT3}{2}$	$\frac{IT2}{2}$	$\frac{IT1}{2}$
Runout	↗	t3	IT3	IT3	IT2
Concentricity	◎	t4	IT5	IT4	IT3
Roughness Ra					
D≤80mm			N5	N5	N4
80<D≤250mm			N6	N6	N5

ISO Basic Tolerance according to DIN 7151

Diameter over mm	including	Tolerance IT0 µm	IT1	IT2	IT3	IT4	IT5	IT6	IT7
6	10	0.6	1	1.5	2.5	4	6	9	15
10	18	0.8	1.2	2	3	5	8	11	28
18	30	1	1.5	2.5	4	6	9	13	21
30	50	1	1.5	2.5	4	7	11	16	25
50	80	1.2	2	3	5	8	13	19	30
80	120	1.5	2.5	4	6	10	15	22	35
120	180	2	3.5	5	8	12	18	25	40

Roughness class	Roughness Value(Ra) µm
N3	0.1
N4	0.2
N5	0.4
N6	0.8
N7	1.6

Torque Required to Clamp Preloaded Bearings

$T = KD\left(\frac{C_F}{n}\right)$

Where T: torque(N-mm) per screw or nut
K: screw/nut friction constant=0.2
D: nominal screw or nut Dia.
C_F: clamping force=2× preload value(in newton)
n: number of retaining screws or nuts

Example:

1. Find out the torque per screw required for bearing set BS35/72/15 P4A.QUM in QFC arrangement (clamping by eight pieces M10 cover screws)

   C_F= 2× preload = 2× (2 × 3400 Newtons) = 13,600 Newtons
   n=8, D=10
   ∴ Minimum torque for each M10 screw to clamp bearing set in this case:
   ⟹ $T = 0.2 \times 10 \times \left(\frac{13600}{8}\right)$ = 3,400 N–mm= 3.4 N–m

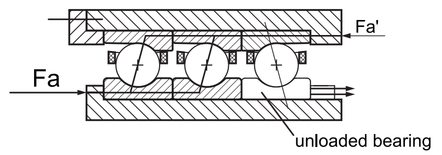
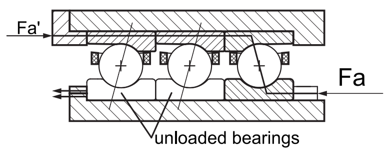
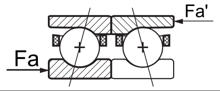
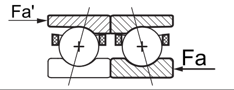
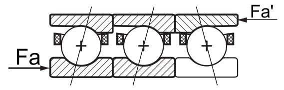
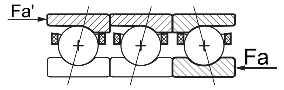
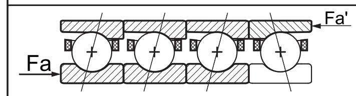
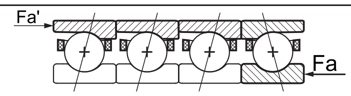
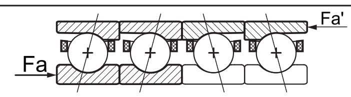
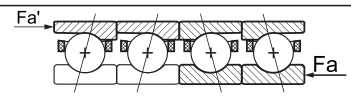
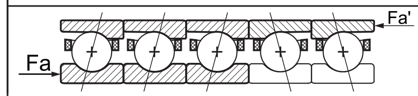
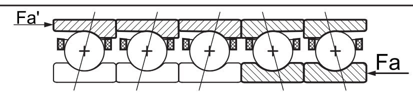
2. Find out the torque of M35 locknut to fully clamp bearing set BS 35/72/15 P4A.QUM in QBC arrangement.

   C_F= 2× preload = 2× (2 × 3400 Newtons) = 13,600 Newtons
   $T = 0.2 \times 35 \times \left(\frac{13600}{1}\right)$ = 95,200 N–mm = 95.2 N–m

Remarks :

1. In practice, tighten the screw or nut to twice T, release and retighten to T value.
2. Oil preservative & sharp burrs should be removed from screw or nut threads.
   You may use oil preservative coated screw or nut, but use twice T value.
   The most ideal application is a screw or nut of clean and dry threads incorporated with thread tightening liquid thread locker such as Loctite 243.
3. In many cases of DF mounting, medium carbon steel being chosen as material for end cover, an excessive clamping force will deform the end cover, and reduce the elasticity of bearings (shortening life).

Axial Stiffness, Preload & Unloading Force Comparison

						
load in main direction Side A B	Axial Stiffness Factor Ka	Unloading Force X*Pr	load in reverse order Side A B	Axial Stiffness Factor Ka	Unloading Force X*Pr	Bearing Set Preload K*Pr
	1.0	2.83		1.0	2.83	1
	1.63	5.66		1.30	2.83	1.36
	2.22	8.49		1.54	2.83	1.57
	2.0	5.66		2.0	5.66	2.0
	2.64	8.49		2.31	5.66	2.42

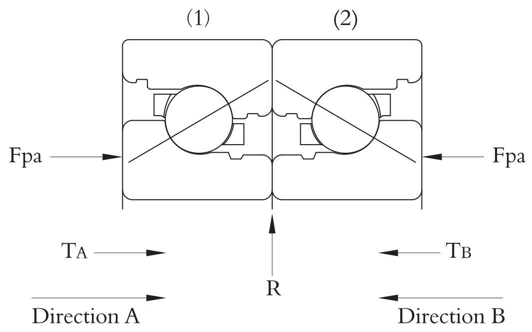
Pr=Preload force of DB and DF arrangement
The bearings in combinations above have identical contact angle

Above table illustrates the data of bearing performance under various combinations and directions with variables, including **1) stiffness, 2) preload and 3) unloading forces.**
Stiffness and preload of DB and DF arrangements can be obtained from bearing data table (P7 ~ P8)
It is recommended that any rolling elements of ball-screw support bearings are operated at least with minimum preload. Any applications should avoid any chance of bearing sets unloading(zero preload). Bearing unloading would cause sliding of balls in bearing and reduce service life.
Last but not least, we strongly advise the unloading risk of bearing sets are considered during the design and service life evaluation.

Life Calculation

Basic rating life L_{10} is the life of a bearing or an arrangement of identical bearings operating under the same conditions associated with 90% reliability.
The basic life rating calculation method of the BS duplex and quadruplex units will be shown in the following paragraph.

Life Calculation Method for Duplex Set



F_{pa} is the preload value of this duplex arrangement. We can obtain it from the bearing data table. ABM recommends that the radial load should not exceed 90% of the preload.

After applying external radial load R, total axial preload P_a would become:

$P_a = \frac{R}{4.34} + F_{pa}$

Discussion in direction "A":
After applying external axial load T_A,axial load on each bearing would become:

$F_{a1} = \frac{2}{3} T_A + P_a \qquad F_{a2} = P_a - \frac{1}{3} T_A$

Radial load on each bearing:

$F_{r1} = \frac{F_{a1}^{2/3}}{F_{a1}^{2/3} + F_{a2}^{2/3}} \times R \qquad F_{r2} = \frac{F_{a2}^{2/3}}{F_{a1}^{2/3} + F_{a2}^{2/3}} \times R$

Note: $\frac{F_a}{F_r}$ should not be less than 2.17

The equivalent axial load on bearing 1:
$E_{1A} = 0.92F_{r1} + F_{a1}$

The equivalent axial load on bearing 2:
$E_{2A} = 0.92F_{r2} + F_{a2}$

We can determine E_{1B} and E_{2B} for axial load in direction"B" by applying the above method.
The cubic mean equivalent axial load on bearing 1:
$P_{E1} = 0.7937\,(E_{1A}^3 + E_{1B}^3)^{1/3}$

The cubic mean equivalent axial load on bearing 2:
$P_{E2} = 0.7937\,(E_{2A}^3 + E_{2B}^3)^{1/3}$

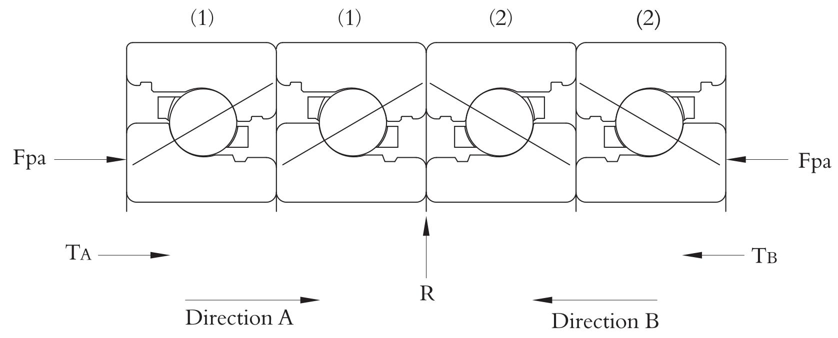
The basic rating life (L_{10}) of each bearing:

$L_{10(1)} = \left(\frac{C_a}{P_{E1}}\right)^3 \times 10^6$ revolutions

$L_{10(2)} = \left(\frac{C_a}{P_{E2}}\right)^3 \times 10^6$ revolutions

L_{10} for the unit = $\frac{1}{\left(\frac{1}{L_{10(1)}^{1.11}} + \frac{1}{L_{10(2)}^{1.11}}\right)^{0.9}}$ revolutions

Life Calculation Method for Quadruplex Set



F_{pa} is 2.0 x the preload values which is obtained from the bearing data table.

After applying external radial load R, total axial preload P_a would become:

$P_a = \frac{R}{8.68} + \frac{F_{pa}}{2}$

Discussion in direction "A":
After applying external axial load T_A, axial load on eachbearing would become:

$F_{a1} = \frac{1}{3} T_A + P_a \qquad F_{a2} = P_a - \frac{1}{6} T_A$

Radial load on each bearing:

$F_{r1} = \frac{F_{a1}^{2/3}}{F_{a1}^{2/3} + F_{a2}^{2/3}} \times \frac{R}{2} \qquad F_{r2} = \frac{F_{a2}^{2/3}}{F_{a1}^{2/3} + F_{a2}^{2/3}} \times \frac{R}{2}$

Note: $\frac{F_a}{F_r}$ should not be less than 2.17

The equivalent axial load on bearing 1:
$E_{1A} = 0.92F_{r1} + F_{a1}$

The equivalent axial load on bearing 2:
$E_{2A} = 0.92F_{r2} + F_{a2}$

We can determine E_{1B} and E_{2B} for axial load in direction"B" by applying the above method.
The cubic mean equivalent axial load on bearing 1:
$P_{E1} = 0.7937\,(E_{1A}^3 + E_{1B}^3)^{1/3}$

The cubic mean equivalent axial load on bearing 2:
$P_{E2} = 0.7937\,(E_{2A}^3 + E_{2B}^3)^{1/3}$

The basic rating life (L_{10}) of each bearing:

$L_{10(1)} = \left(\frac{C_a}{P_{E1}}\right)^3 \times 10^6$ revolutions

$L_{10(2)} = \left(\frac{C_a}{P_{E2}}\right)^3 \times 10^6$ revolutions

L_{10} for the unit = $\frac{1}{\left(\frac{2}{L_{10(1)}^{1.11}} + \frac{2}{L_{10(2)}^{1.11}}\right)^{0.9}}$ revolutions