MOTION & CONTROL NSK

ROBUST Series

High-Speed Precision Angular Contact Ball Bearings for Machine Tool Spindles

- Temperature tolerance and low heat generation
- Smooth running even during sudden rapid acceleration
- Higher speed and longer life

New!

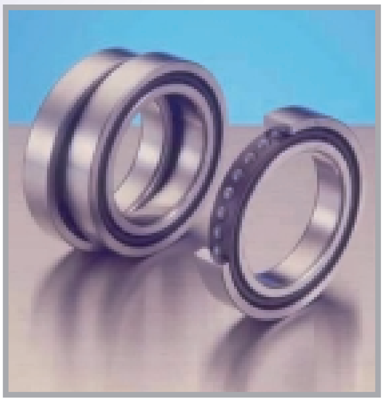
High-Speed Precision Angular Contact Ball Bearings

Bearing features indispensable to motorized main spindles—temperature tolerance, seizure resistance and low heat generation—have been improved to enable higher speeds with minimal thermal deformation.

A major trend in the machine tool industry is for higher maximum spindle speeds. In addition, machines are being required to perform a wider variety of tasks and undergo frequent tool changes. Under such conditions, excellent high-speed performance is imperative and spindles must accelerate and decelerate faster. During periods of rapid acceleration or deceleration, spindle bearings are subjected to severe thermal load conditions. These conditions are caused by drastic changes in the ambient environment that result from heat generated by the motor, housing cooling and other factors. Performing well under such conditions and being capable of higher speeds than conventional precision bearings, the ROBUST Series bearings provide solutions for high-speed spindles of the 21st century.

1. Features

S type (balls and rings: bearing steel) H type (balls: silicon nitride, Si_3N_4/rings: bearing steel)



These bearings are designed for motorized and non-motorized spindles and feature the optimal internal structure for minimizing heat generation and improving seizure resistance. The H type can be lubricated with grease at speeds where conventional bearings require oil/air lubrication (Fig. 1). Additionally, both the S type and H type are capable of speeds 20% higher than conventional precision angular contact ball bearings.

H type angular contact ball bearings

X type (balls: silicon nitride, Si_3N_4/rings: SHX steel)

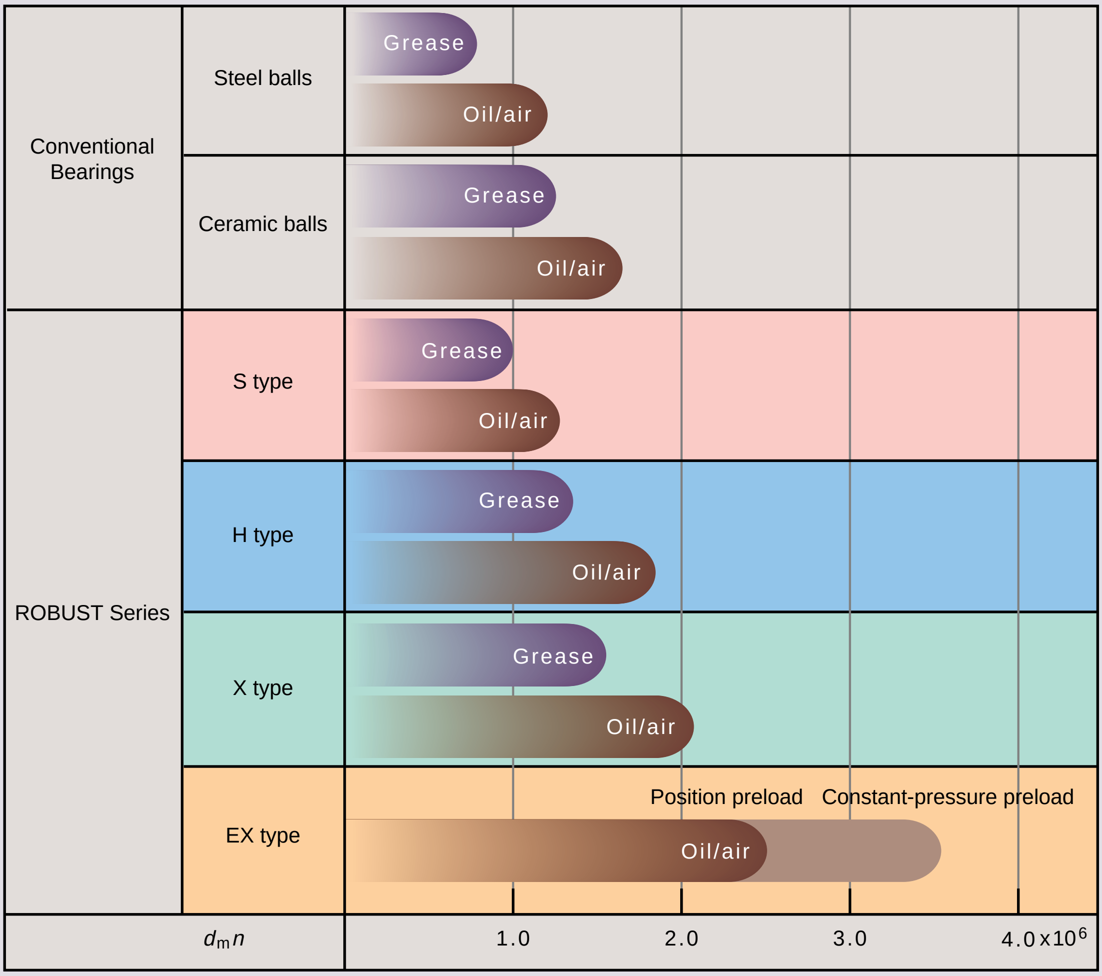
While this hybrid ceramic bearing has the same design as the S and H types, its rings are made of SHX steel, a new steel developed by NSK. SHX has excellent seizure and wear resistance during critical lubrication shortages. Also, its heat resistance is nearly equal to M50 steel, which is widely used in bearings for jet aircraft engines. With the X type, grease lubrication is feasible at even higher speeds than the H type (Fig. 1). In terms of both surface and subsurface fatigue, SHX steel provides longer life (Figs. 3 ~ 6).

EX type (balls: silicon nitride, Si_3N_4/rings: SHX steel/Spinshot™ Technology)

EX bearings have the same specifications as the X type, but employ NSK's exclusive Spinshot™ lubrication system (Fig. 7). While previously only oil jet lubrication has been feasible at speeds exceeding 2,000,000 d_mn, the Spinshot™ lubrication system utilizes a mixture of oil and air to enable the EX type to sustain such speeds (Fig. 1). The use of oil/air instead of oil jets reduces overall costs by allowing the structure of the spindle to be simplified and cutting down on the consumption of oil, an added environmental benefit.

Please note that the EX type is not dimensionally interchangeable with conventional precision angular contact ball bearings.

Notes: 1. Special heat-resistant, high-strength polyimide resin cages are used in the X and EX types for extremely high speeds. In the S and H types and the X and EX types at low to moderate speeds, phenolic or polyamide cages are used.
2. For X and EX type bearings with outside diameters exceeding ϕ150, please consult NSK.



Note: Limiting speeds vary depending not only on the bearing and lubrication method used, but also on the main spindle driving system, cooling method, structure and other factors. Consider the above as a general reference guide and consult NSK for limiting speeds of specific applications.

Fig. 1 Comparison of application ranges of conventional and ROBUST Series bearings under position preload

High-Speed Precision Angular Contact Ball Bearings

Optimal Internal Design

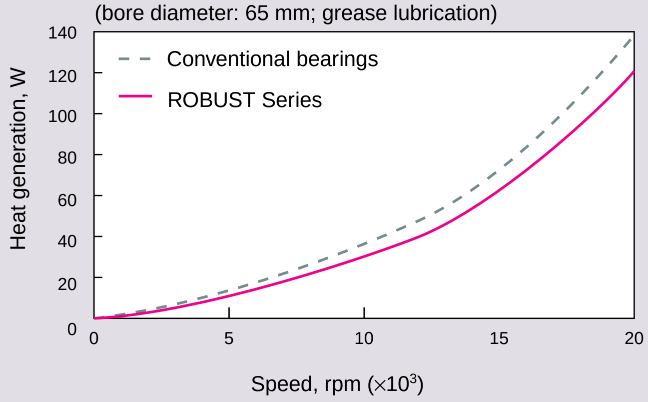
■ Improved temperature tolerance

Today, machining involves various cutting conditions within a wide range of speeds. Consequently, spindle temperatures vary widely and cause changes in internal bearing load. The unique design of the ROBUST Series bearings minimizes the adverse effect temperature variation has on internal bearing load.

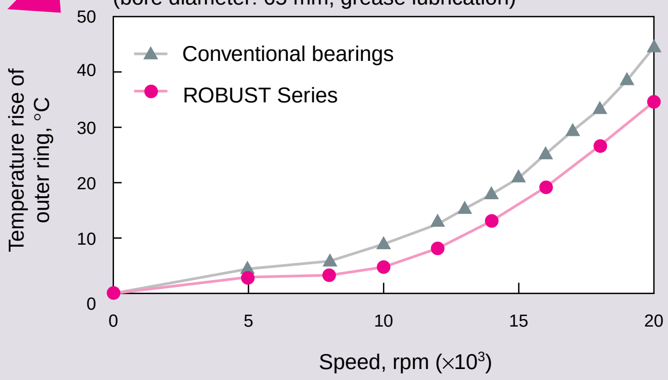
■ Minimal heat generation

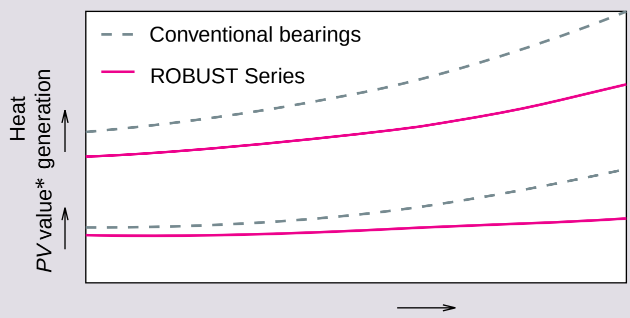
To ensure the accuracy of spindles by minimizing thermal displacement, suppression of bearing dynamic frictional loss is vital. The ROBUST Series design controls dynamic frictional loss, reducing heat generation by approximately 20% when compared to conventional bearings operating at the same speed.

Heat generation- Calculated values
(bore diameter: 65 mm; grease lubrication)



Temperature rise of outer ring- Measured values
(bore diameter: 65 mm; grease lubrication)





With a lower *PV* value* and less heat generation, ROBUST Series bearings operate with greater stability than conventional precision bearings.

* *PV* value measures the relationship between ball and raceway surface pressure and ball sliding speed.

Fig. 2 Analysis results on bearing dynamics

SHX Steel Used for Inner and Outer Rings of X and EX Types

SHX steel has heat resistance nearly equivalent to that of M50 steel and is superior to M50 in wear resistance, seizure resistance and durability. As such, SHX is highly suited for use in machine tool spindles, which must run at high speeds with a minimum supply of lubricant.

Heat resistance

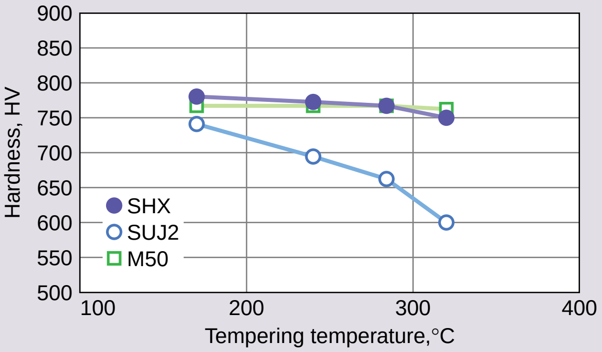


Fig. 3.1 Tempering temperature and hardness

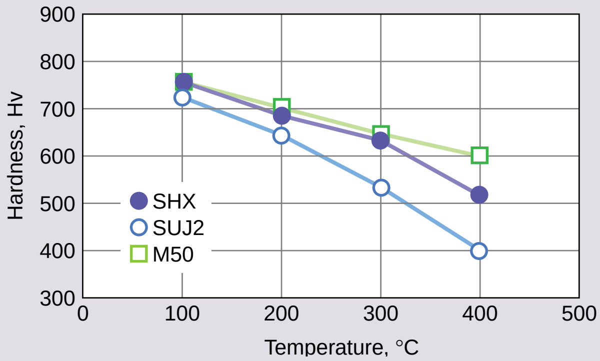
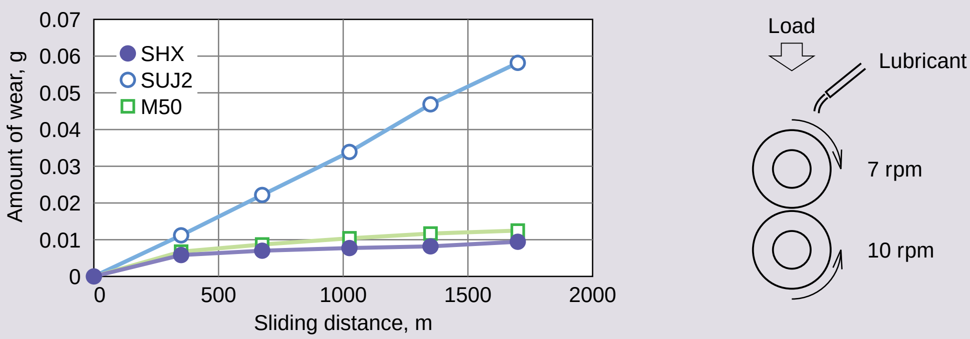


Fig. 3.2 High-temperature hardness

Wear resistance

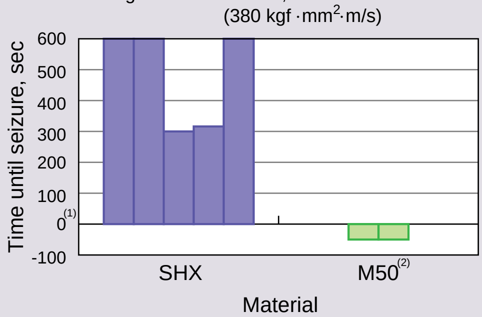


Test conditions
Surface pressure: 880 MPa
Sliding ratio: 30%
Lubrication: Spindle oil (2 cm³/min)
Temperature: Room temperature

Fig. 4 Wear resistance (2-cylinder wear test)

Seizure resistance

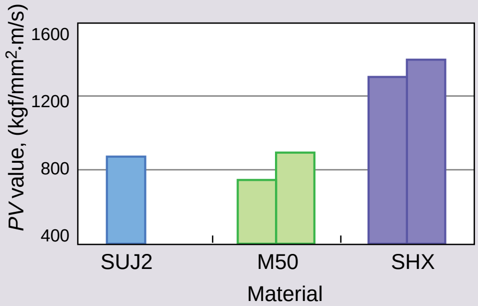
Test conditions
Lubrication: None
Sliding condition: PV = 3,720N ·mm^2·m/s
(380 kgf ·mm^2·m/s)



Notes: (1) Oil shut-off point
(2) M50 seized before the oil shut-off point was reached.

Fig. 5.1 Dry seizure test (4-ball test)

Test conditions
Lubrication: Oil bath
Speed: 6,000 rpm (constant)



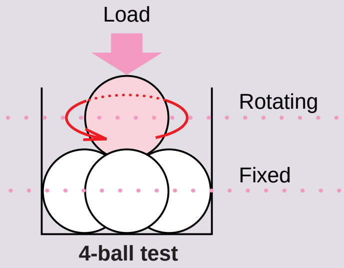


Fig. 5.2 Seizure limit test (4-ball test)

These tests confirm that SHX is superior to M50 in seizure resistance. Silicon nitride balls offer even higher seizure resistance.

Long life

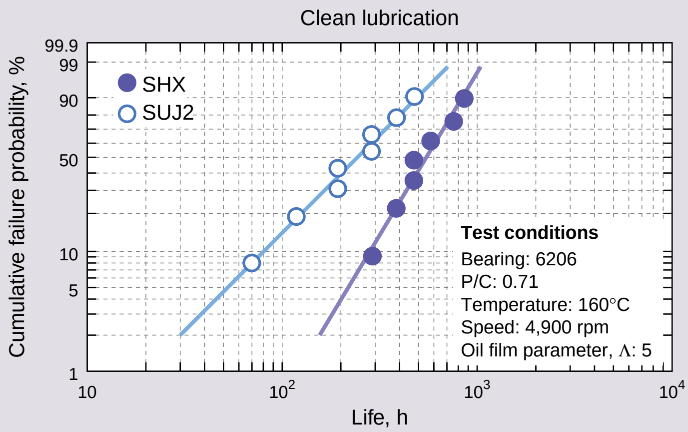


Fig. 6.1 Life test for subsurface-originated flaking

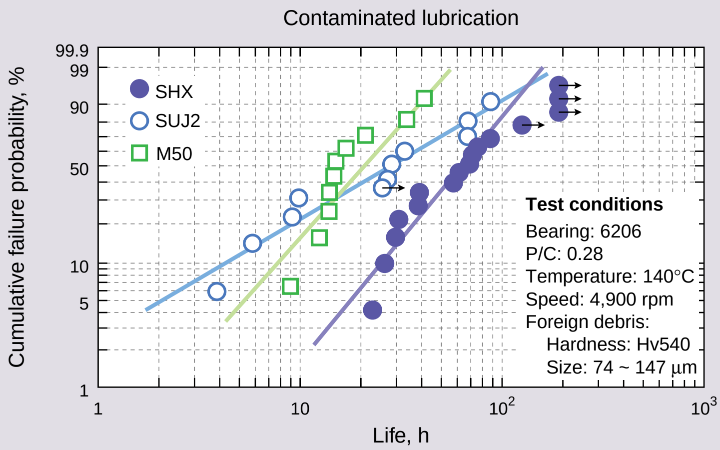


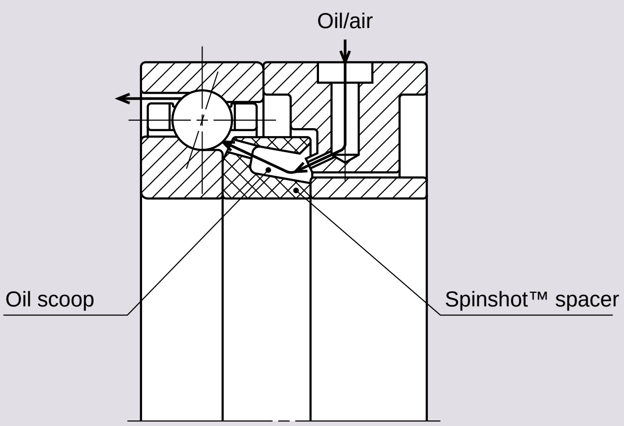
Fig. 6.2 Life test for surface-originated flaking

Spinshot™ Lubrication System

The EX type features the widely accepted Spinshot™ lubrication system for machine tool main spindles. This system ensures a steady supply of lubricating oil to the bearing and excellent high-speed performance.

The Spinshot™ lubrication system is illustrated in Fig. 7. Oil/air (a mixture of the minimum necessary amount of oil and compressed air) is fed from the lubrication device to the bearing via nozzles and oil scoops in the spacer. The nozzles in the spacer are inclined outward so that centrifugal force makes the oil flow into the bearing with greater velocity as speed increases. With the Spinshot™ lubrication system, the steady supply of lubrication and the cooling effect of the oil/air mixture greatly increase the limiting speed of the bearing.

Please note that the EX type is not dimensionally interchangeable with conventional precision angular contact ball bearings.



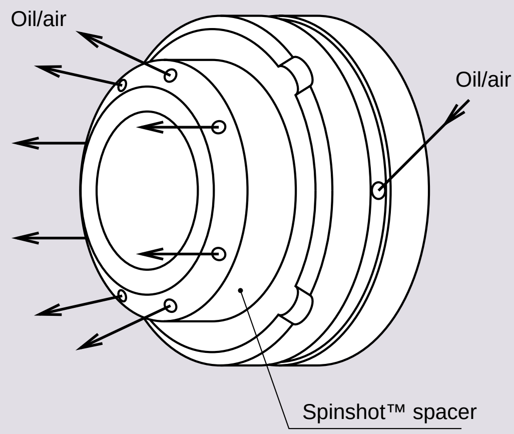
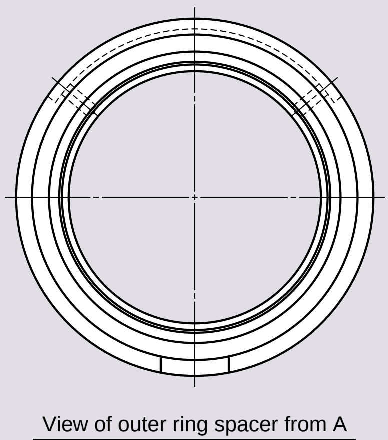


Fig. 7 Spinshot™ lubrication system



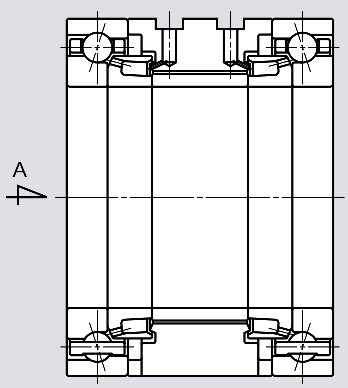
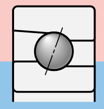
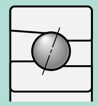
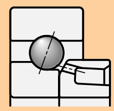


Fig. 8 Example of bearing arrangement (position preload)

2. Bearing Materials and Construction

Type	Material			Bearing construction
	Inner ring	Outer ring	Balls	
S	SUJ2	SUJ2	SUJ2	
H	SUJ2	SUJ2	Si_3N_4	
X	SHX	SHX	Si_3N_4	
EX	SHX	SHX	Si_3N_4	

Note: SUJ2 is equivalent to ASTM 52100.

3. Test Results

H type

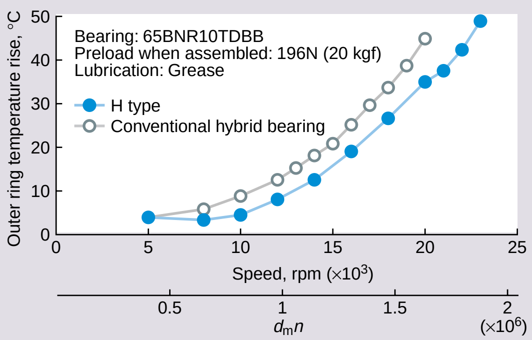
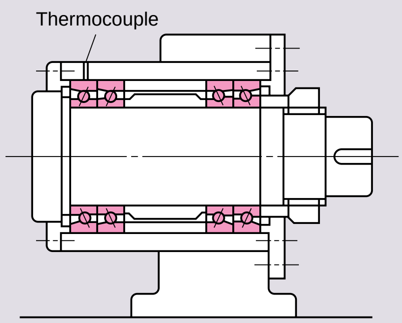


Fig. 9 Comparison of temperature rise with grease lubrication



Testing machine structure

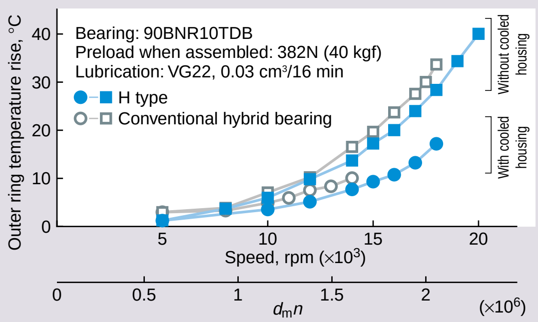
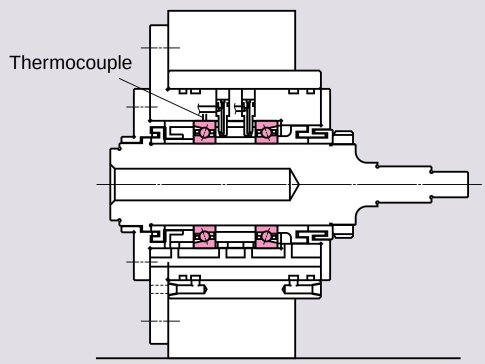


Fig. 10 Comparison of temperature rise with oil/air lubrication



Testing machine structure

X type

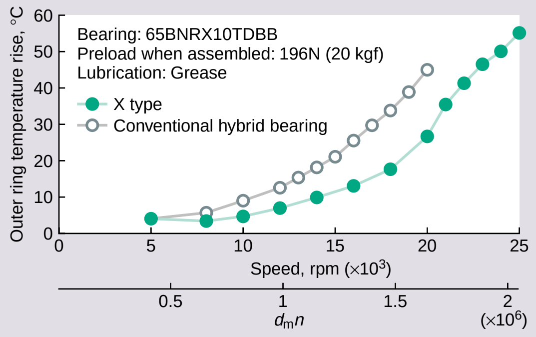
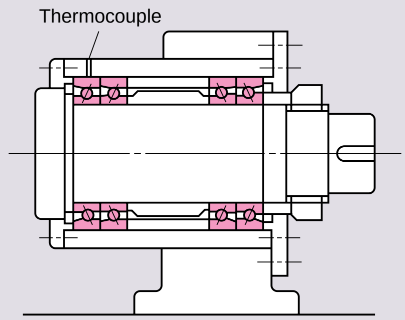


Fig. 11 Comparison of temperature rise with grease lubrication



Testing machine structure

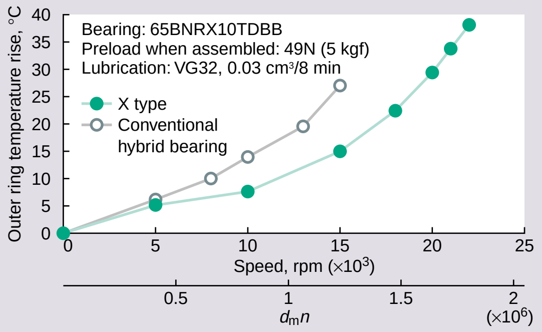
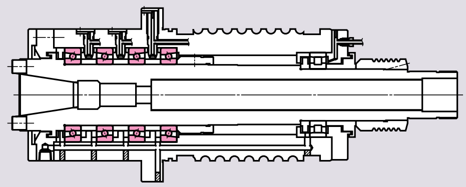


Fig. 12 Comparison of temperature rise with oil/air lubrication



Testing machine structure

EX type

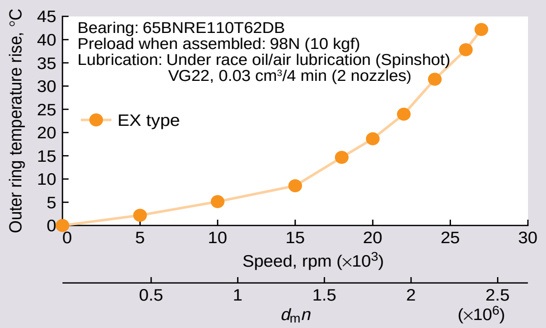
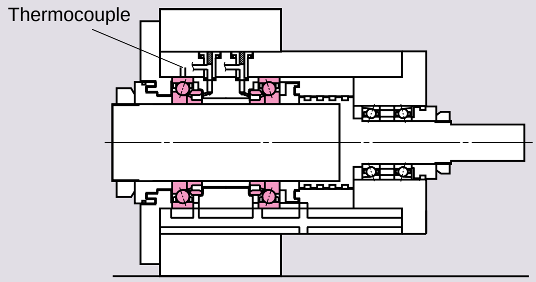


Fig. 13 Temperature rise with oil/air lubrication and position preload



Testing machine structure

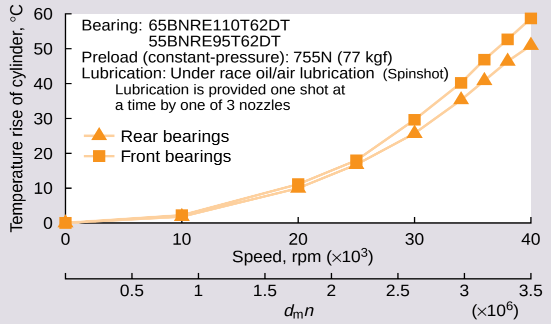
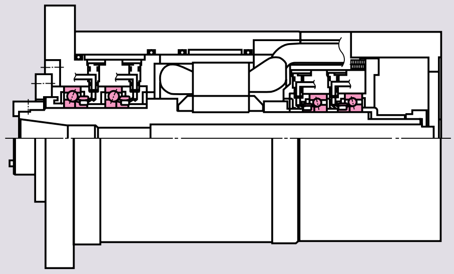


Fig. 14 Temperature rise with oil/air lubrication and constant-pressure preload



Testing machine structure

4. Bearing Nomenclature

S type (balls and rings: bearing steel)

Example: 65 BNRS 10 TY DB L P4

- **65** — Nominal bearing bore
- **BNRS** — Indicates type of bearing
  - BNRS: 18°
  - BARS: 30°
  - BTRS: 40°
- **10** — Size series no.
  - 10: Bore, outside diameter and width are same as 70 series
  - 19: Bore, outside diameter and width are same as 79 series
  - 10X: Bore and outside diameter are same as 70 series (width is a special dimension)
- **TY** — Cage symbol
  - T: Phenolic cage
  - TY: Polyamide cage
- **DB** — Arrangement symbol
  - DB: Back-to-back arrangement
  - DT: Tandem
  - DBB: 4-row arrangement
- **L** — Preload symbol
  - EL: Extra light
  - L: Light
  - CP: Preload (negative clearance) (CP10: -10 µm)
  - CA: Axial clearance (CA10: +10 µm)
- **P4** — Accuracy symbol
  - P4: ISO Class 4
  - P4A: NSK tolerance for BARS and BTRS
  - P3: Dimensions- ISO Class 4
    Running accuracy- ISO Class 2
  - P2: ISO Class 2

H type (balls: silicon nitride, Si_3N_4/rings: bearing steel)

Example: 65 BNR 10 TY DB L P4

- **65** — Nominal bearing bore
- **BNR** — Indicates type of bearing-BNR: 18°
- **10** — Size series no.
  - 10: Bore, outside diameter and width are same as 70 series
  - 19: Bore, outside diameter and width are same as 79 series
- **TY DB L P4** — See above

X type (balls: silicon nitride, Si_3N_4/rings: SHX steel)

Example: 65 BNRX 10 T DB L P4

- **65** — Nominal bearing bore
- **BNRX** — Indicates type of bearing-BNRX: 18°
- **10** — Size series no.
  - 10: Bore, outside diameter and width are same as 70 series
  - 19: Bore, outside diameter and width are same as 79 series
- **T DB L P4** — See above

EX type (balls: silicon nitride, Si_3N_4/rings: SHX steel/Spinshot™ Technology)

Example: 65 BNRE 110 T62 DB L P4

- **65** — Nominal bearing bore
- **BNRE** — Indicates type of bearing
- **110** — Nominal bearing outside diameter
- **T62** — Cage symbol
  - T: Phenolic cage
  - T62: Polyimide cage
- **DB L P4** — See above

5. Tolerances for Boundary Dimensions and Running Accuracy

For most tolerances, i.e., P2, P3 and P4, refer to NSK catalog number E124, “Precision Rolling Bearings for Machine-Tool Spindles.” However, for the tolerances of BARS10X and BTRS10X series, which have Class 4A tolerance, refer to Tables 1.1 and 1.2. Class 4A tolerance is an NSK specification. In Class 4A, all of the tolerances are the same as ISO Class 4 except for those related to the outside diameter.

Table 1.1 Inner ring tolerances of BARS10X and BTRS10X series

Units: μm

Brg bore d (mm)		Single plane mean bore dia. deviation Δd_{mp}		Deviation of a single bore dia. Δd_s		Bore dia. variation in a single radial plane V_{dp}		Mean bore dia. variation V_{dmp}	Radial runout of assembled brg inner ring K_{ia}	Inner ring reference face runout with bore S_d	Assembled brg inner ring face runout with raceway S_{ia}	Inner ring width variation V_{Bs}	Deviation of a single inner ring width ΔB_s (ΔC_s)	
						Diameter series								
						9	0							
over	incl	high	low	high	low	max	max	max	max	max	max	max	high	low
–	50	0	-6	0	-6	6	5	3	4	4	4	3	0	-300
50	80	0	-7	0	-7	7	5	3.5	4	5	5	4	0	-500
80	120	0	-8	0	-8	8	6	4	5	5	5	4	0	-500
120	150	0	-10	0	-10	10	8	5	6	6	7	5	0	-750

Table 1.2 Outer ring tolerances of BARS10X and BTRS10X series

Units: μm

Brg outside diameter D (mm)		Single plane mean outside dia. deviation ΔD_{mp}		Deviation of a single outside dia. ΔD_s		Outside dia. variation in a single radial plane V_{Dp}		Mean outside dia. variation V_{Dmp}	Radial runout of assembled brg outer ring K_{ea}	Variation of brg outside surface generatrix inclination with outer ring face S_D	Assembled brg outer ring face runout with raceway S_{ea}	Outer ring width variation V_{Cs}
						Diameter series						
						9	0					
over	incl	high	low	high	low	max	max	max	max	max	max	max
–	80	-30	-37	-30	-37	7	5	3.5	5	4	5	3
80	120	-40	-48	-40	-48	8	6	4	6	5	6	4
120	150	-50	-59	-50	-59	9	7	5	7	5	7	5
150	180	-50	-60	-50	-60	10	8	5	8	5	8	5
180	250	-50	-61	-50	-61	11	8	6	10	7	10	7

6. Preloads for Duplex Bearings

When determining the appropriate preload for your application, please consult NSK.

Table 2.1 BNRS19, BNR19 and BNRX19 Series

Bearing bore diameter	Axial Preload (N)			
	BNRS19 (α = 18°)		BNR19, BNRX19 (α = 18°)	
	EL	L	EL	L
35	49	147	49	157
40	49	147	49	157
45	49	157	49	176
50	49	167	49	176
55	49	167	49	186
60	49	176	49	196
65	49	186	49	206
70	49	186	49	206
75	49	186	49	206
80	49	196	49	215
85	49	196	49	215
90	98	294	98	314
95	98	294	98	314
100	98	343	98	372
105	98	343	98	412
110	98	392	98	461
120	98	412	98	471
130	–	–	–	–

Table 2.2 BNRS10, BNR10 and BNRX10 Series

Bearing bore diameter	Axial Preload (N)			
	BNRS10 (α = 18°)		BNR10, BNRX10 (α = 18°)	
	EL	L	EL	L
35	49	108	49	118
40	49	118	49	127
45	49	118	49	127
50	49	118	49	127
55	49	118	49	137
60	49	127	49	137
65	49	137	49	147
70	49	235	49	265
75	49	245	49	274
80	98	343	98	372
85	98	343	98	372
90	98	343	98	372
95	98	343	98	392
100	98	343	98	392
105	98	441	98	490
110	98	539	98	637
120	98	588	98	637
130	–	–	–	–

Table 2.3 BARS10X and BTRS10X Series

Bearing bore diameter	Axial Preload (N)			
	BARS10X (α = 30°)		BTRS10X (α = 40°)	
	EL	L	EL	L
35	–	–	–	–
40	196	441	294	686
45	196	441	294	735
50	245	490	343	784
55	245	637	343	784
60	245	637	392	882
65	245	686	392	931
70	245	931	392	1 570
75	245	931	392	1 670
80	343	1 130	539	1 860
85	343	1 130	539	1 910
90	392	1 670	539	2 890
95	392	1 760	539	2 990
100	392	1 810	588	3 090
105	392	1 860	588	3 190
110	392	1 910	588	3 280
120	392	2 060	588	3 530
130	392	2 600	588	4 510

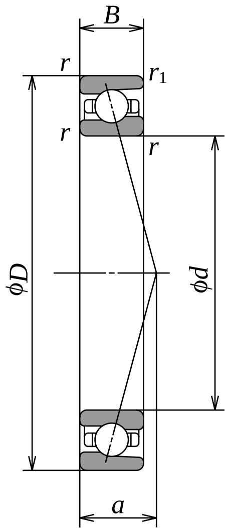
Note: α is the contact angle

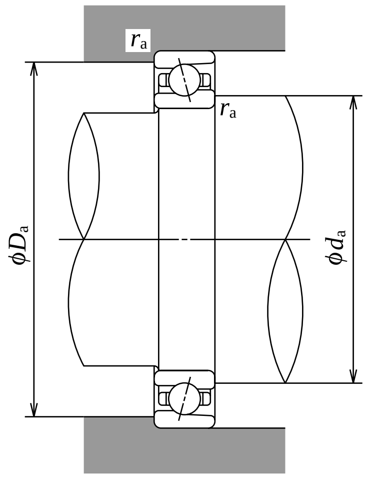
High-Speed Precision Angular Contact Ball Bearings

BNRS19
BNR19
BNRX19

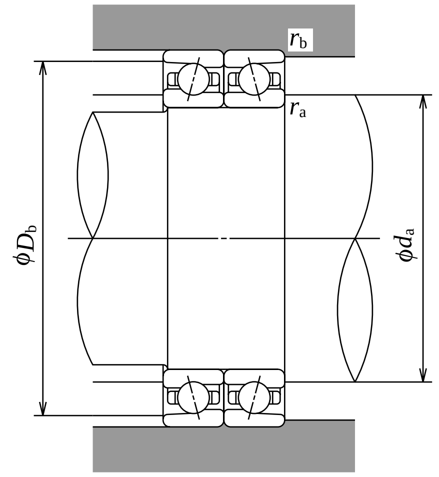
Contact angle 18°

	Material		
	Inner rings	Outer rings	Balls
BNRS19	SUJ2	SUJ2	SUJ2
BNR19	SUJ2	SUJ2	Si_3N_4
BNRX19	SHX	SHX	Si_3N_4





Boundary Dimensions (mm)					Basic Load Ratings (N)		{kgf}	
d	*D*	*B*	*r* min	r_1 min	C_r	C_{or}	C_r	C_{or}
35	55	10	0.6	0.3	8 300	4 600	845	470
40	62	12	0.6	0.3	10 300	5 900	1 050	600
45	68	12	0.6	0.3	11 000	6 700	1 120	685
50	72	12	0.6	0.3	11 700	7 500	1 190	765
55	80	13	1	0.6	13 300	8 900	1 350	905
60	85	13	1	0.6	13 500	9 400	1 380	955
65	90	13	1	0.6	14 100	10 300	1 440	1 050
70	100	16	1	0.6	19 500	13 900	1 990	1 420
75	105	16	1	0.6	19 900	14 600	2 030	1 490
80	110	16	1	0.6	20 300	15 400	2 060	1 570
85	120	18	1.1	0.6	27 000	20 300	2 750	2 070
90	125	18	1.1	0.6	29 000	23 000	2 950	2 350
95	125	18	1.1	0.6	29 500	24 000	3 000	2 450
100	140	20	1.1	0.6	35 000	27 100	3 550	2 760



Dynamic Equivalent Load $P = XF_r + YF_a$

Nominal Contact Angle	$\frac{C_{or}*}{iF_a}$	e	Single, DT				DB or DT			
			$F_a/F_r \le e$		$F_a/F_r > e$		$F_a/F_r \le e$		$F_a/F_r > e$	
			X	Y	X	Y	X	Y	X	Y
18°	—	0.57	1	0	0.43	1	1	1.09	0.70	1.63

*For i, use 2 for DB and DF and 1 for DT.

Static Equivalent Load $P_0 = X_0F_r + Y_0F_a$

Nominal Contact Angle	Single, DT		DB or DF	
	X_0	Y_0	X_0	Y_0
18°	0.5	0.42	1	0.84

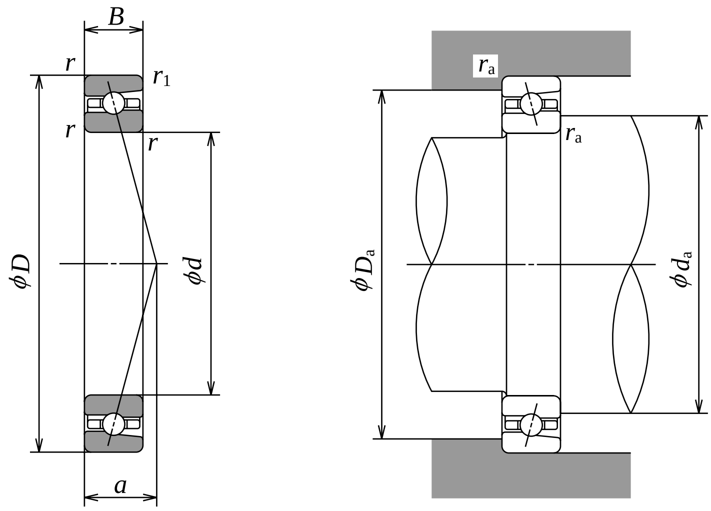
Single or DT mounting when $F_r > 0.5F + Y_0F_a$ use $P_0 = F_r$

Bearing Numbers	Eff. Load Center (mm) a	Abutment and Fillet Dimensions (mm) d_a min	D_a max	D_b max	r_a max	r_b max	Mass (kg) approx	Internal Free Space (cm³/row)
35BNRS19 35BNR19 35BNRX19	12.3	40	50	52.5	0.6	0.3	0.074	3
40BNRS19 40BNR19 40BNRX19	14.3	45	57	59.5	0.6	0.3	0.109	4.8
45BNRS19 45BNR19 45BNRX19	15.2	50	63	65.5	0.6	0.3	0.129	5.2
50BNRS19 50BNR19 50BNRX19	15.9	55	67	69.5	0.6	0.3	0.130	5.9
55BNRS19 55BNR19 55BNRX19	17.5	61	74	75	1	0.5	0.182	7.4
60BNRS19 60BNR19 60BNRX19	18.3	66	79	80	1	0.5	0.195	7.2
65BNRS19 65BNR19 65BNRX19	19.1	71	84	85	1	0.5	0.208	8.6
70BNRS19 70BNR19 70BNRX19	21.8	76	94	95	1	0.5	0.338	14
75BNRS19 75BNR19 75BNRX19	22.6	81	99	100	1	0.5	0.358	15
80BNRS19 80BNR19 80BNRX19	23.4	86	104	105	1	0.5	0.377	16
85BNRS19 85BNR19 85BNRX19	25.7	92	113	115	1	0.6	0.534	24
90BNRS19 90BNR19 90BNRX19	26.5	97	118	120	1	0.6	0.568	24
95BNRS19 95BNR19 95BNRX19	27.3	102	123	125	1	0.6	0.597	23
100BNRS19 100BNR19 100BNRX19	29.5	107	133	135	1	0.6	0.800	31

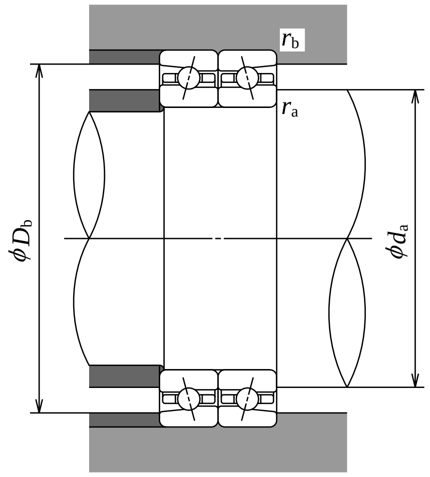
BNRS10
BNR10
BNRX10

Contact angle 18°

	Material		
	Inner rings	Outer rings	Balls
BNRS10	SUJ2	SUJ2	SUJ2
BNR10	SUJ2	SUJ2	Si_3N_4
BNRX10	SHX	SHX	Si_3N_4



Boundary Dimensions (mm)					Basic Load Ratings (N)		{kgf}	
d	*D*	*B*	*r* min	r_1 min	C_r	C_{or}	C_r	C_{or}
35	62	14	1	0.6	9 150	5 500	935	560
40	68	15	1	0.6	9 650	6 150	985	630
45	75	16	1	0.6	10 700	6 950	1 090	710
50	80	16	1	0.6	11 200	7 700	1 140	785
55	90	18	1.1	0.6	13 900	9 800	1 420	995
60	95	18	1.1	0.6	14 500	10 700	1 480	1 090
65	100	18	1.1	0.6	15 100	11 600	1 540	1 180
70	110	20	1.1	0.6	20 500	15 200	2 090	1 550
75	115	20	1.1	0.6	20 800	16 000	2 120	1 630
80	125	22	1.1	0.6	24 500	19 000	2 500	1 940
85	130	22	1.1	0.6	24 800	19 900	2 530	2 030
90	140	24	1.5	1	32 500	25 800	3 300	2 630
95	145	24	1.5	1	33 000	26 900	3 350	2 740
100	150	24	1.5	1	33 500	28 000	3 400	2 860



Dynamic Equivalent Load $P = XF_r + YF_a$

Nominal Contact Angle	$\frac{C_{or}*}{iF_a}$	e	Single, DT				DB or DT			
			$F_a/F_r \leq e$		$F_a/F_r > e$		$F_a/F_r \leq e$		$F_a/F_r > e$	
			X	Y	X	Y	X	Y	X	Y
18°	—	0.57	1	0	0.43	1	1	1.09	0.70	1.63

*For i, use 2 for DB and DF and 1 for DT.

Static Equivalent Load $P_0 = X_0F_r + Y_0F_a$

Nominal Contact Angle	Single, DT		DB or DF	
	X_0	Y_0	X_0	Y_0
18°	0.5	0.42	1	0.84

Single or DT mounting when $F_r > 0.5F + Y_0F_a$ use $P_0 = F_r$

Bearing Numbers	Eff. Load Center (mm) a	Abutment and Fillet Dimensions (mm) d_a min	D_a max	D_b max	r_a max	r_b max	Mass (kg) approx	Internal Free Space (cm^3/row)
35BNRS10 35BNR10 35BNRX10	14.9	41	56	57	1	0.5	0.162	5.3
40BNRS10 40BNR10 40BNRX10	16.3	46	62	63	1	0.5	0.204	7
45BNRS10 45BNR10 45BNRX10	17.7	51	69	70	1	0.5	0.259	8.9
50BNRS10 50BNR10 50BNRX10	18.6	56	74	75	1	0.5	0.281	9.9
55BNRS10 55BNR10 55BNRX10	20.8	62	83	85	1	0.6	0.418	13
60BNRS10 60BNR10 60BNRX10	21.6	67	88	90	1	0.6	0.453	13
65BNRS10 65BNR10 65BNRX10	22.4	72	93	95	1	0.6	0.476	15
70BNRS10 70BNR10 70BNRX10	24.6	77	103	105	1	0.6	0.649	22
75BNRS10 75BNR10 75BNRX10	25.4	82	108	110	1	0.6	0.684	24
80BNRS10 80BNR10 80BNRX10	27.7	87	118	120	1	0.6	0.928	29
85BNRS10 85BNR10 85BNRX10	28.5	92	123	125	1	0.6	0.972	31
90BNRS10 90BNR10 90BNRX10	30.7	99	131	134	1.5	0.8	1.25	41
95BNRS10 95BNR10 95BNRX10	31.5	104	136	139	1.5	0.8	1.3	43
100BNRS10 100BNR10 100BNRX10	32.3	109	141	144	1.5	0.8	1.35	45

BARS10X

Contact angle 30°

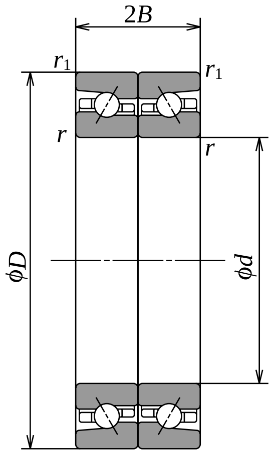
BTRS10X

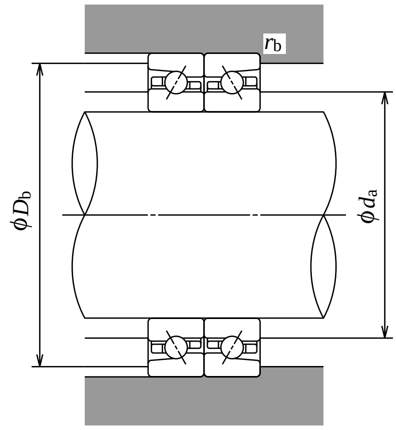
Contact angle 40°

	Material		
	Inner rings	Outer rings	Balls
BARS10X	SUJ2	SUJ2	SUJ2
BTRS10X	SUJ2	SUJ2	SUJ2

Note: These bearings are only available in Class 4A tolerance (Tables 1.1 and 1.2, page 10).

Boundary Dimensions (mm)					Basic Load Ratings (N)		Basic Load Ratings {kgf}	
d	*D*	2*B*	*r* min	r_1 min	C_a	C_{oa}	C_a	C_{oa}
40	68	27	1	0.6	11 700 14 100	17 200 19 600	1 200 1 440	1 760 2 000
45	75	28.5	1	0.6	13 000 15 600	19 500 22 200	1 330 1 590	1 980 2 260
50	80	28.5	1	0.6	13 600 16 300	21 400 24 400	1 390 1 660	2 190 2 490
55	90	33	1.1	0.6	16 900 20 200	27 300 31 000	1 720 2 060	2 790 3 150
60	95	33	1.1	0.6	17 600 21 100	29 800 34 000	1 800 2 150	3 050 3 450
65	100	33	1.1	0.6	18 300 21 900	32 500 37 000	1 870 2 230	3 300 3 750
70	110	36	1.1	0.6	24 800 29 700	42 500 48 500	2 530 3 050	4 350 4 950
75	115	36	1.1	0.6	25 300 30 000	44 500 50 500	2 570 3 100	4 550 5 150
80	125	40.5	1.1	0.6	29 700 35 500	53 000 60 500	3 050 3 600	5 400 6 150
85	130	40.5	1.1	0.6	30 000 36 000	55 500 63 000	3 050 3 650	5 650 6 450
90	140	45	1.5	1	39 500 47 000	72 000 82 000	4 000 4 800	7 350 8 350
95	145	45	1.5	1	40 000 48 000	75 000 85 500	4 100 4 900	7 650 8 700
100	150	45	1.5	1	40 500 48 500	78 500 89 000	4 150 4 950	8 000 9 050
105	160	49.5	2	1	46 000 55 000	89 500 102 000	4 700 5 600	9 100 10 400
110	170	54	2	1	52 000 62 000	102 000 116 000	5 300 6 350	10 400 11 800
120	180	54	2	1	53 500 64 000	110 000 125 000	5 450 6 550	11 200 12 700
130	200	63	2	1	67 500 80 500	133 000 151 000	6 850 8 200	13 500 15 400





Bearing Numbers	Abutment and Fillet Dimensions (mm) d_a min	D_b max	r_b max	Mass (kg) approx	Internal Free Space (cm³/row)
40BARS10X 40BTRS10X	50	63	0.5	0.200	6.1
45BARS10X 45BTRS10X	56	70	0.5	0.255	7.4
50BARS10X 50BTRS10X	61	75	0.5	0.272	8
55BARS10X 55BTRS10X	68	84	0.6	0.412	13
60BARS10X 60BTRS10X	73	89	0.6	0.433	12
65BARS10X 65BTRS10X	78	94	0.6	0.472	14
70BARS10X 70BTRS10X	85	104	0.6	0.637	20
75BARS10X 75BTRS10X	90	110	0.6	0.671	21
80BARS10X 80BTRS10X	97	117	0.6	0.912	28
85BARS10X 85BTRS10X	102	122	0.6	0.971	29
90BARS10X 90BTRS10X	109	132	0.8	1.27	40
95BARS10X 95BTRS10X	113.5	137	0.8	1.32	42
100BARS10X 100BTRS10X	119	142	0.8	1.37	43
105BARS10X 105BTRS10X	125	151	1	1.74	56
110BARS10X 110BTRS10X	132	159	1	2.23	67
120BARS10X 120BTRS10X	142	169	1	2.39	72
130BARS10X 130BTRS10X	156	188	1	3.57	110

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