

# 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



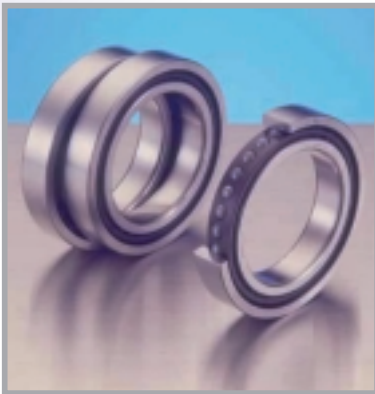
# High-Speed Precision Angular Contact Ball Bearings

*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,  $\text{Si}_3\text{N}_4$ /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,  $\text{Si}_3\text{N}_4$ /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).

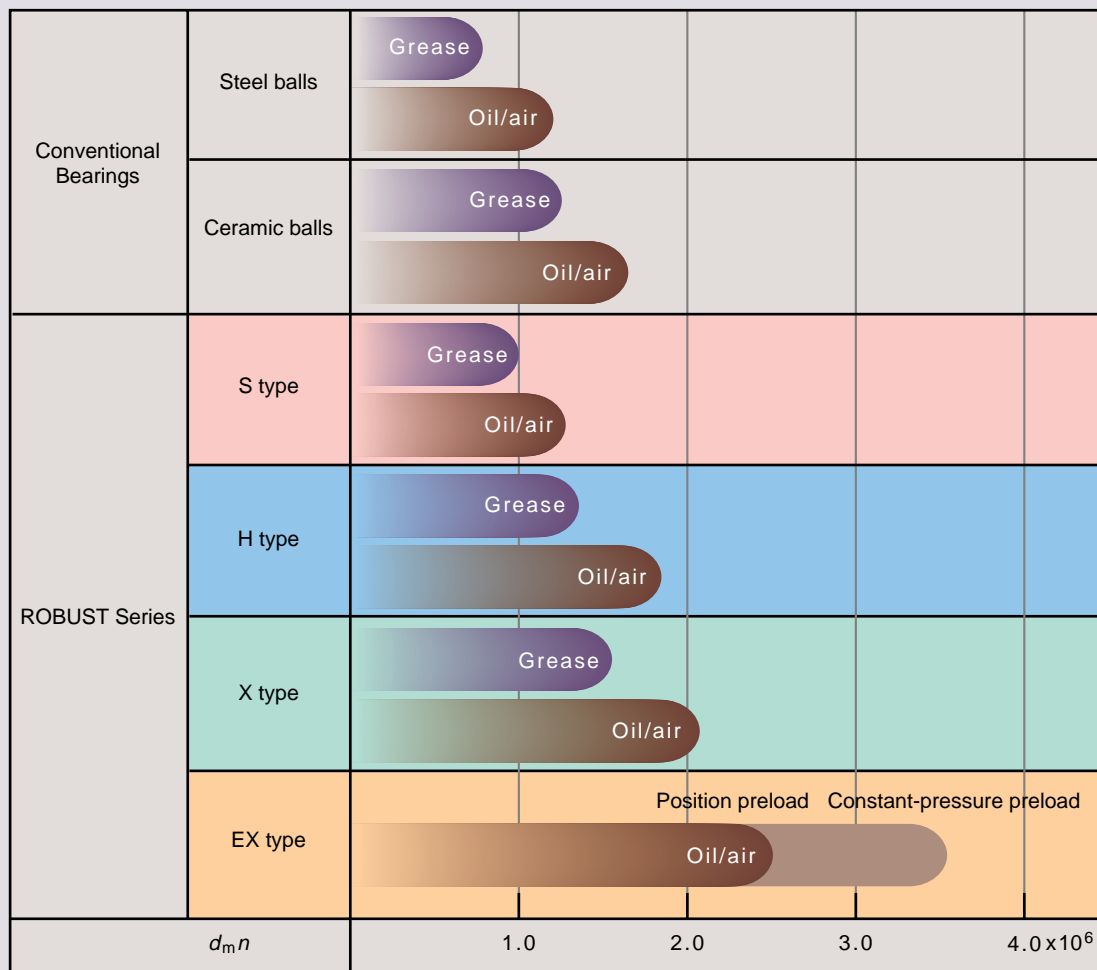
## EX type (balls: silicon nitride, Si<sub>3</sub>N<sub>4</sub>/rings: SHX steel/Spinshot™ Technology)



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  $d_m n$ , 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  $\phi 150$ , 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.

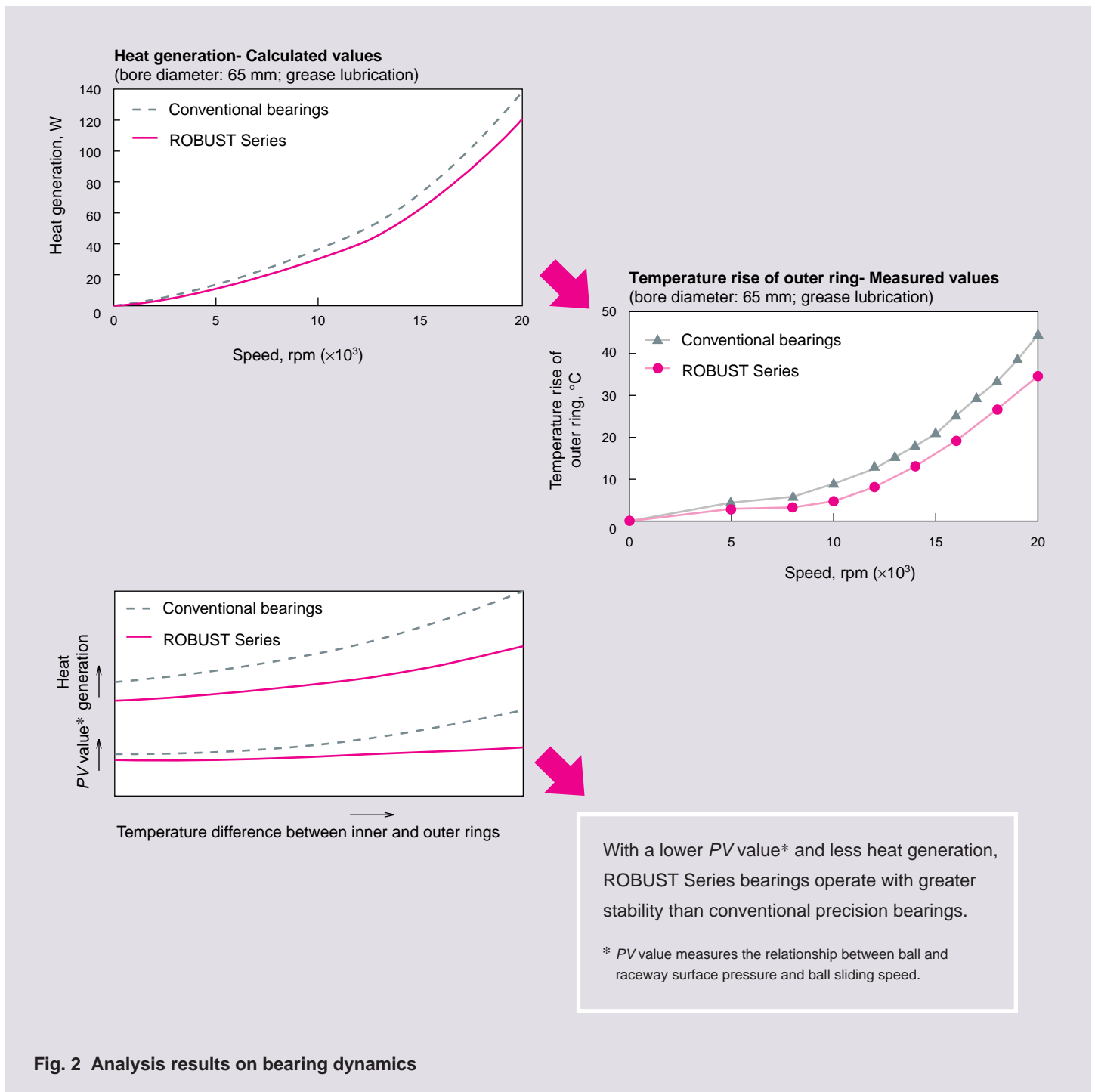


Fig. 2 Analysis results on bearing dynamics

## 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

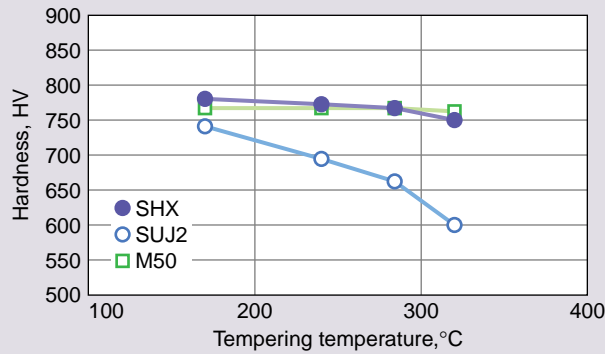


Fig. 3.1 Tempering temperature and hardness

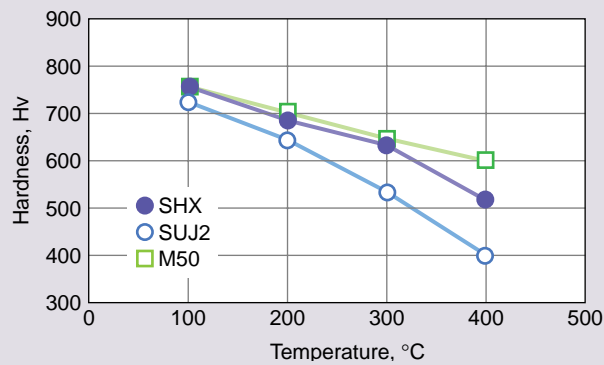
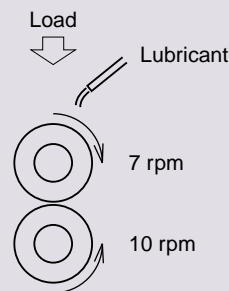
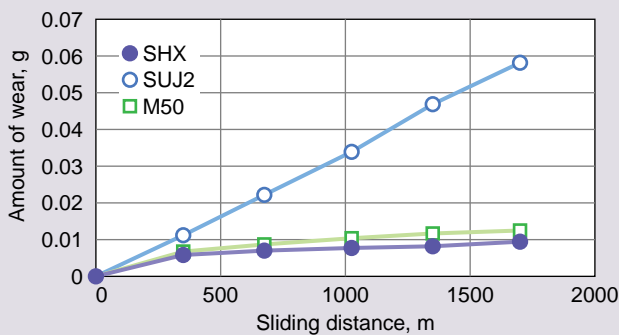


Fig. 3.2 High-temperature hardness

### Wear resistance



#### Test conditions

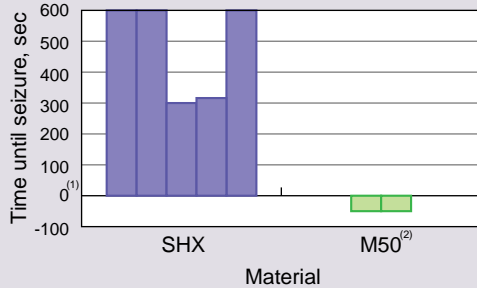
Surface pressure: 880 MPa  
 Sliding ratio: 30%  
 Lubrication: Spindle oil (2 cm<sup>3</sup>/min)  
 Temperature: Room temperature

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

# High-Speed Precision Angular Contact Ball Bearings

## Seizure resistance

**Test conditions**  
 Lubrication: None  
 Sliding condition:  $PV = 3,720\text{N} \cdot \text{mm}^2 \cdot \text{m/s}$   
 ( $380\text{ kgf} \cdot \text{mm}^2 \cdot \text{m/s}$ )



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)

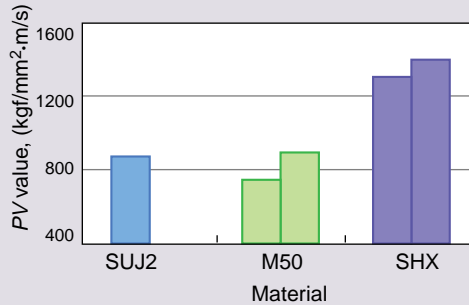
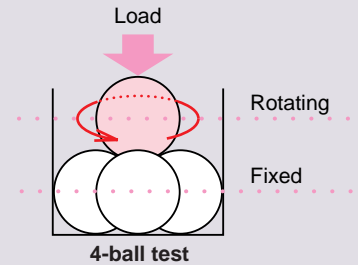


Fig. 5.2 Seizure limit test (4-ball test)



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

## Long life

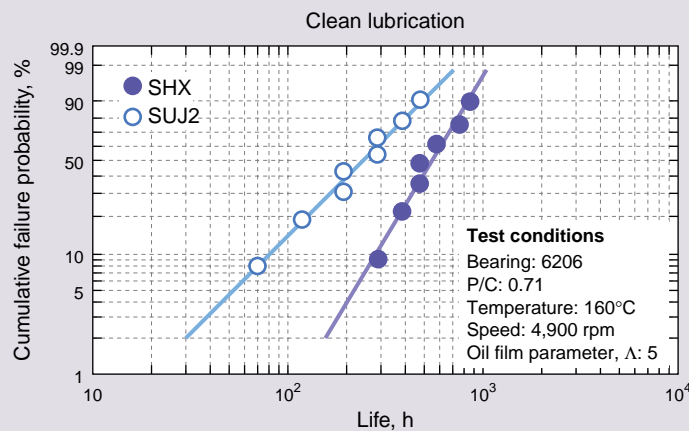


Fig. 6.1 Life test for subsurface-originated flaking

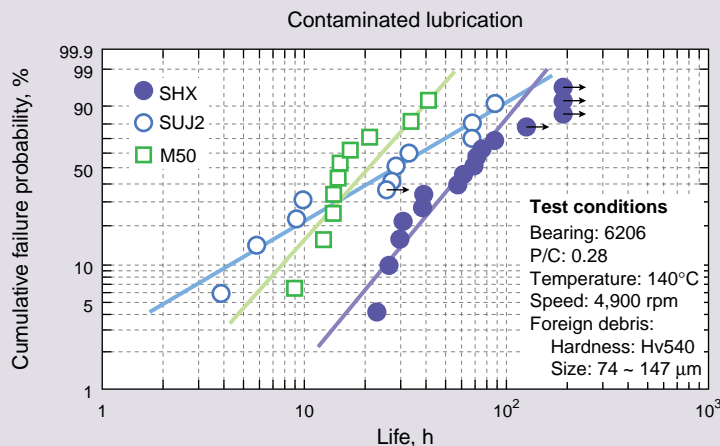


Fig. 6.2 Life test for surface-originated flaking

## 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.

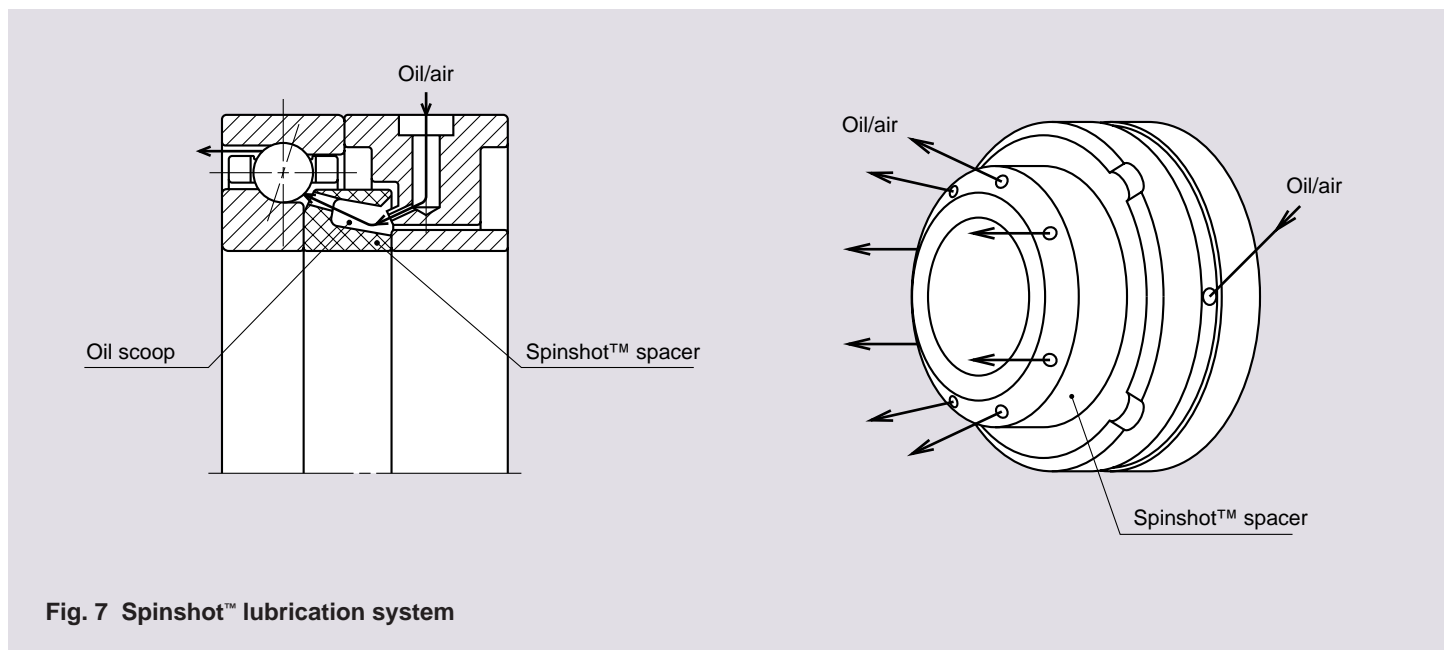


Fig. 7 Spinshot™ lubrication system

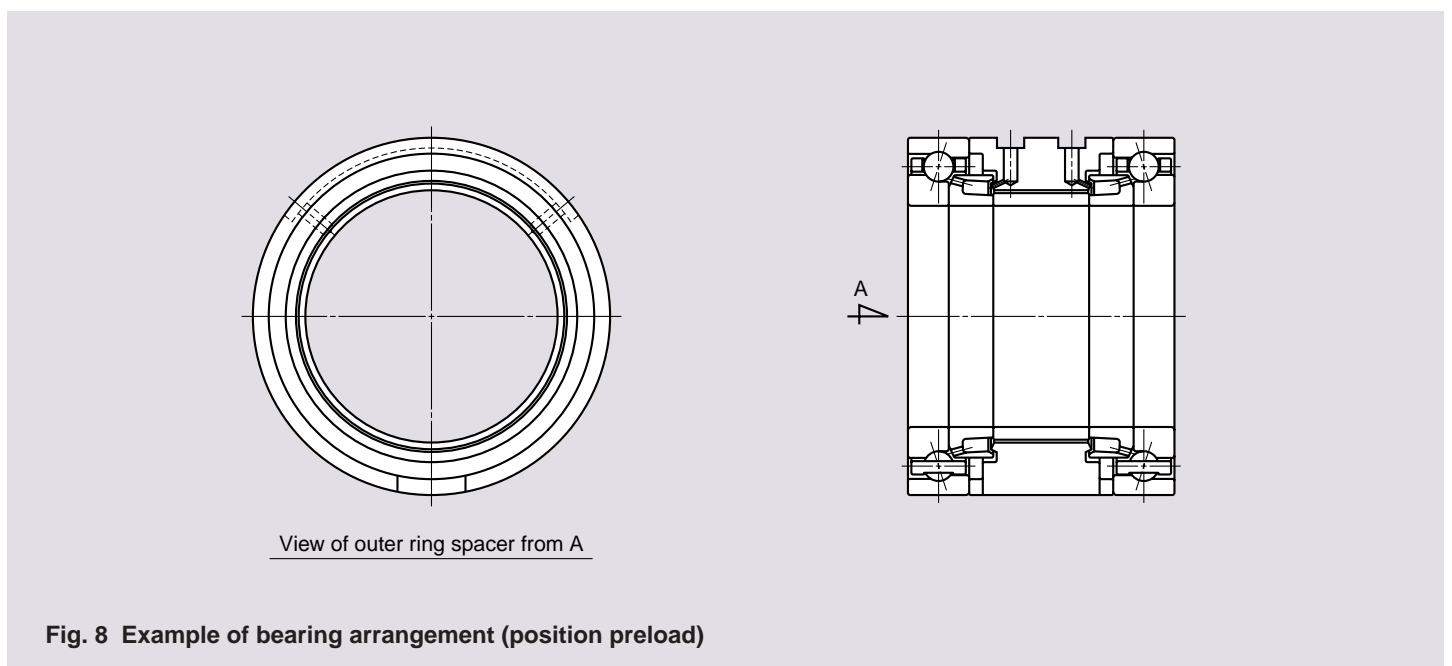
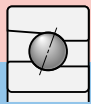

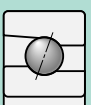



Fig. 8 Example of bearing arrangement (position preload)

# High-Speed Precision Angular Contact Ball Bearings

## 2. Bearing Materials and Construction

| Type | Material   |            |                                | Bearing construction  |
|------|------------|------------|--------------------------------|---|
|      | Inner ring | Outer ring | Balls                          |   |
| S    | SUJ2       | SUJ2       | SUJ2                           |  |
| H    | SUJ2       | SUJ2       | Si <sub>3</sub> N <sub>4</sub> |  |
| X    | SHX        | SHX        | Si <sub>3</sub> N <sub>4</sub> |  |
| EX   | SHX        | SHX        | Si <sub>3</sub> N <sub>4</sub> |  |

Note: SUJ2 is equivalent to ASTM 52100.

## 3. Test Results

### H type

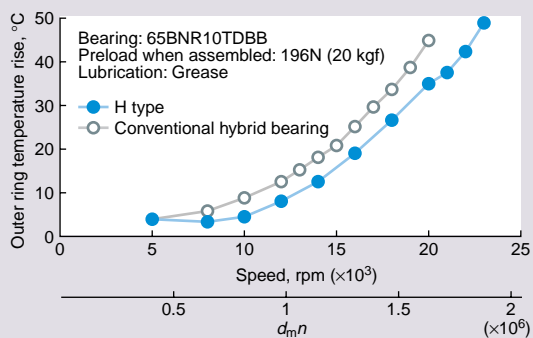
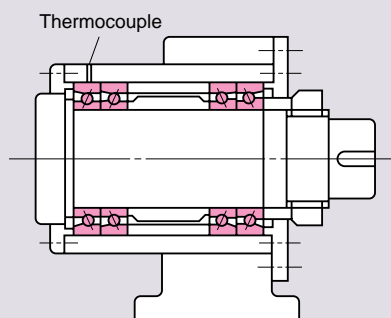


Fig. 9 Comparison of temperature rise with grease lubrication



Testing machine structure

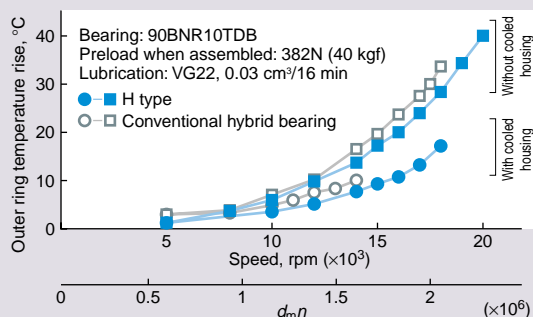
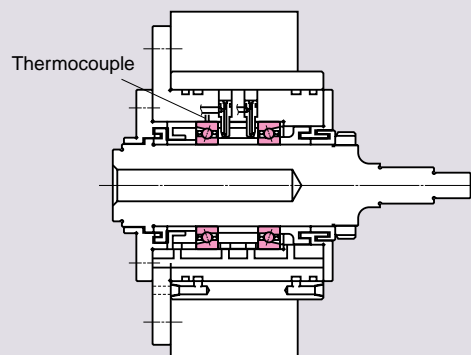
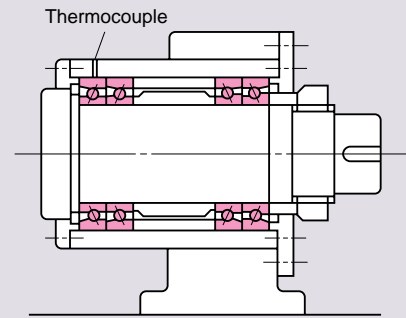
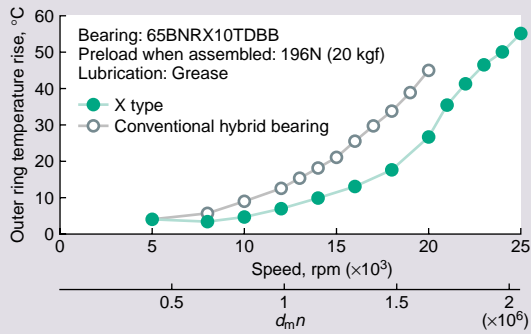


Fig. 10 Comparison of temperature rise with oil/air lubrication



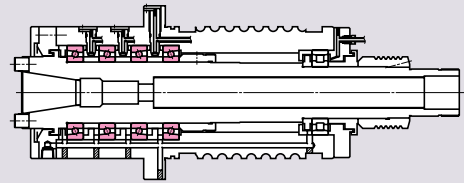
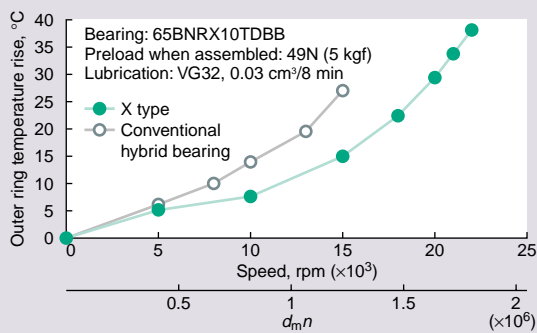
Testing machine structure

## X type



Testing machine structure

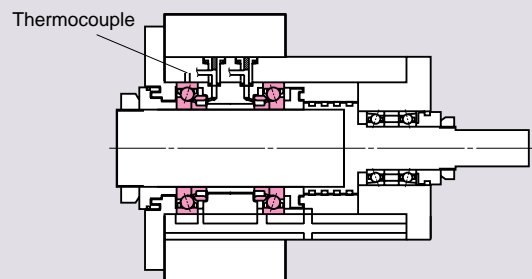
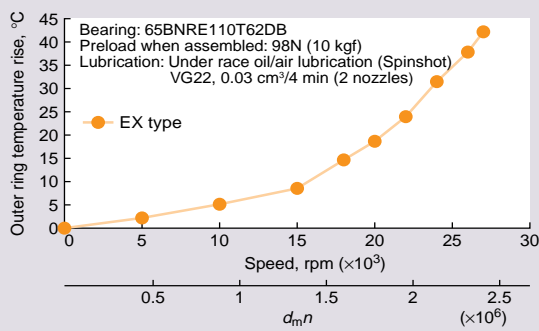
Fig. 11 Comparison of temperature rise with grease lubrication



Testing machine structure

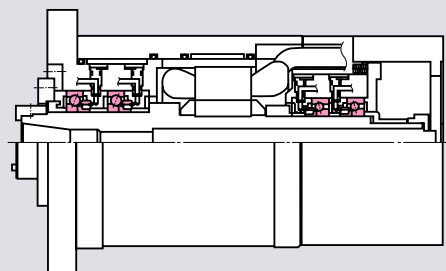
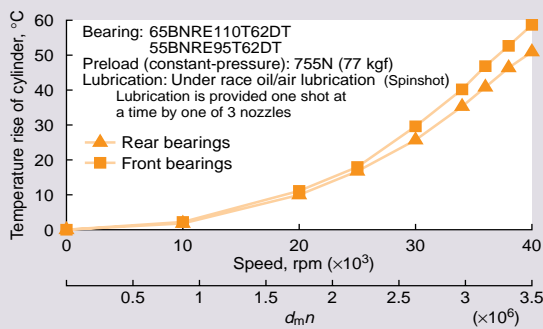
Fig. 12 Comparison of temperature rise with oil/air lubrication

## EX type



Testing machine structure

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



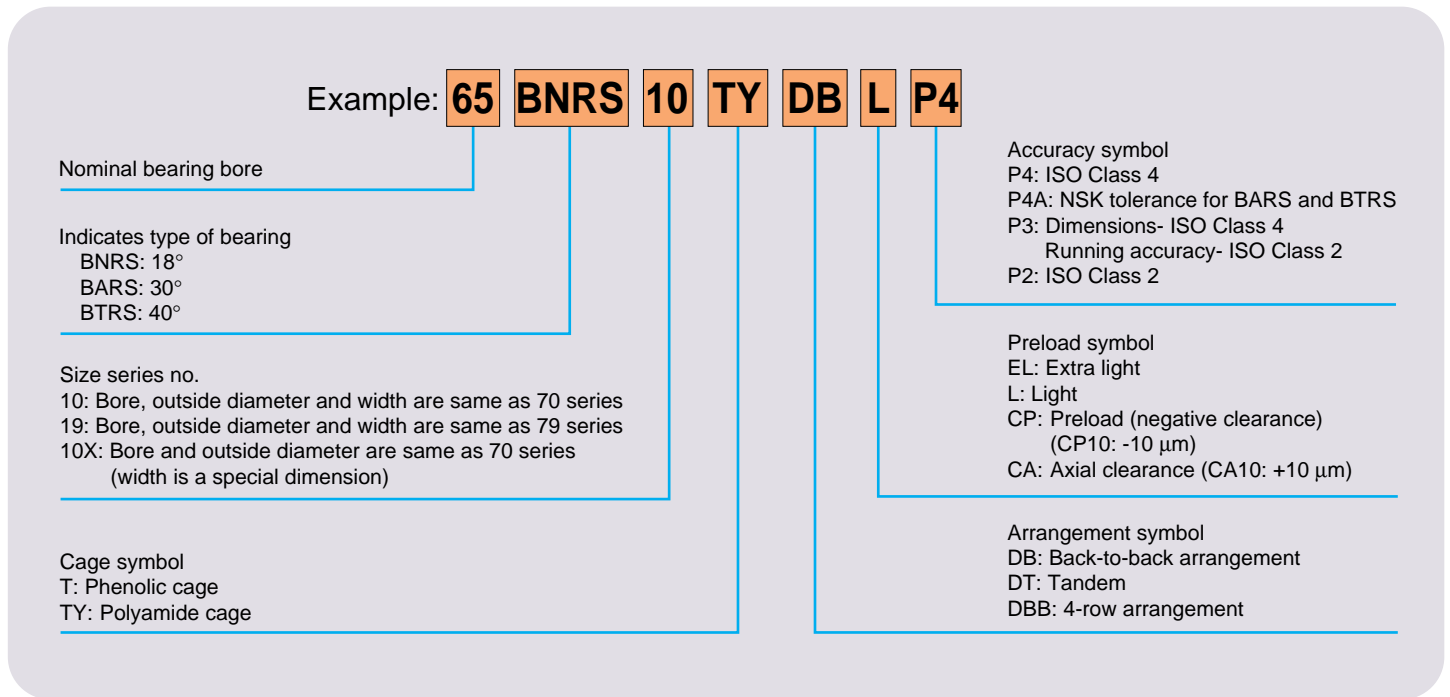
Testing machine structure

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

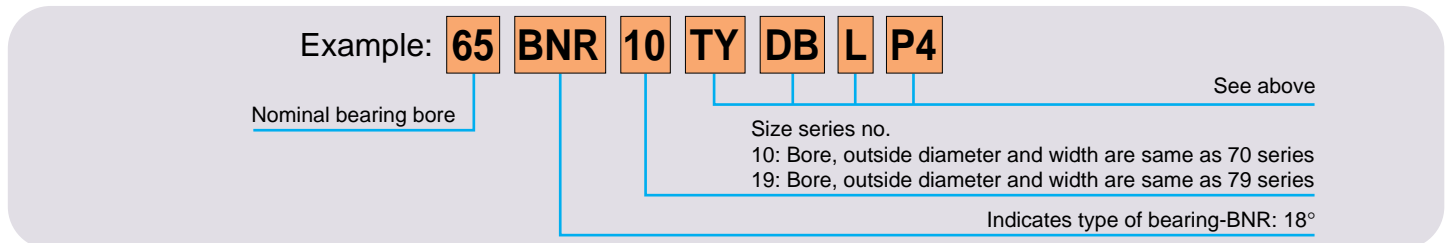
# High-Speed Precision Angular Contact Ball Bearings

## 4. Bearing Nomenclature

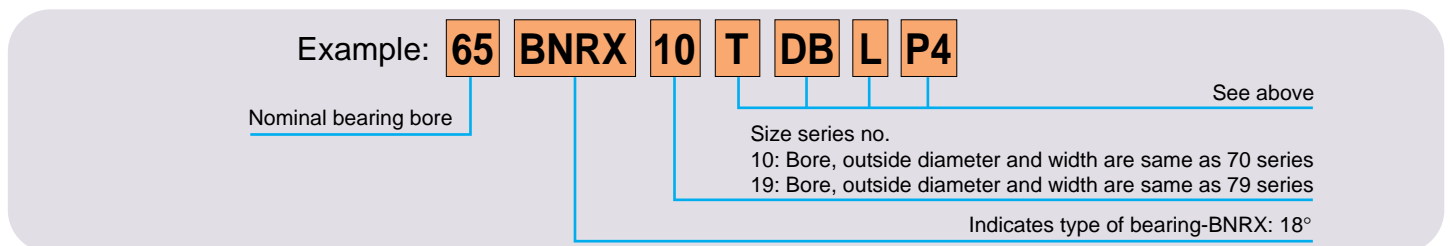
**S type** (balls and rings: bearing steel)



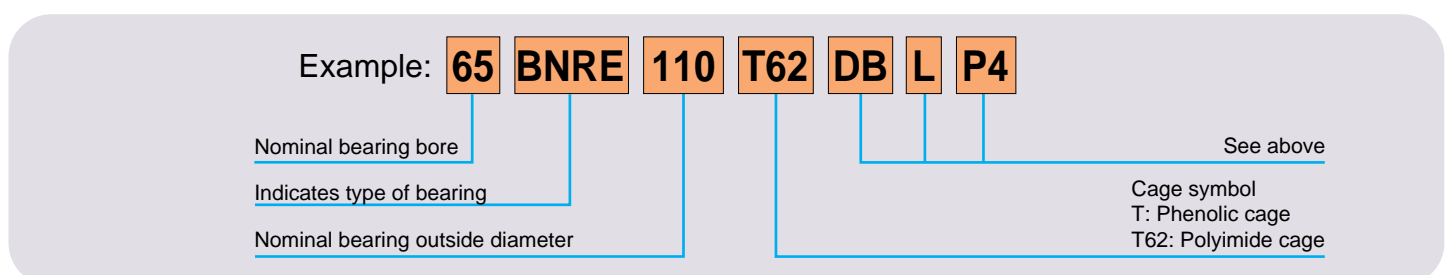
**H type** (balls: silicon nitride, Si<sub>3</sub>N<sub>4</sub>/rings: bearing steel)



**X type** (balls: silicon nitride, Si<sub>3</sub>N<sub>4</sub>/rings: SHX steel)



**EX type** (balls: silicon nitride, Si<sub>3</sub>N<sub>4</sub>/rings: SHX steel/Spinshot™ Technology)



## 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:  $\mu\text{m}$

| Brg bore<br>$d$<br>(mm) |      | Single plane<br>mean bore<br>dia. deviation<br>$\Delta d_{mp}$ |     | Deviation<br>of a single<br>bore dia.<br>$\Delta d_s$ |     | Bore dia. variation<br>in a single<br>radial plane<br>$Vd_p$ |     | Mean bore<br>dia. variation<br>$Vd_{mp}$ | Radial runout<br>of assembled<br>brg inner ring<br>$K_{ia}$ | Inner ring<br>reference face<br>runout with bore<br>$S_d$ | Assembled brg<br>inner ring<br>face runout<br>with raceway<br>$S_{ia}$ | Inner ring<br>width variation<br>$VB_s$ | Deviation of a<br>single inner<br>ring width<br>$\Delta B_s (\Delta C_s)$ |      |      |     |
|-------------------------|------|--|-----|---|-----|--|-----|--|---|---|--|---|---|------|------|-----|
|                         |      |  |     |   |     | Diameter series  |     |  |   |   |  |   | max   | max  | high | low |
|                         |      |  |     |   |     | 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:  $\mu\text{m}$

| Brg outside<br>diameter<br>$D$<br>(mm) |      | Single plane<br>mean outside<br>dia. deviation<br>$\Delta D_{mp}$ |     | Deviation<br>of a single<br>outside dia.<br>$\Delta D_s$ |     | Outside dia. variation<br>in a single<br>radial plane<br>$VD_p$ |     | Mean outside<br>dia. variation<br>$VD_{mp}$ | Radial runout<br>of assembled<br>brg outer ring<br>$K_{ea}$ | Variation of brg<br>outside surface<br>generatrix inclination<br>with outer ring face<br>$S_D$ | Assembled brg<br>outer ring<br>face runout<br>with raceway<br>$S_{ea}$ | Outer ring<br>width variation<br>$VC_s$ |     |     |     |     |
|--|------|---|-----|--|-----|---|-----|---|---|--|--|---|-----|-----|-----|-----|
|  |      |   |     |  |     | Diameter series   |     |   |   |  |  |   | max | max | max | max |
|  |      |   |     |  |     | 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                                       |     |     |     |     |

# High-Speed Precision Angular Contact Ball Bearings

## 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 ( $\alpha = 18^\circ$ ) |     | BNR19, BNRX19 ( $\alpha = 18^\circ$ ) |     |
|                       | 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 ( $\alpha = 18^\circ$ ) |     | BNR10, BNRX10 ( $\alpha = 18^\circ$ ) |     |
|                       | 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

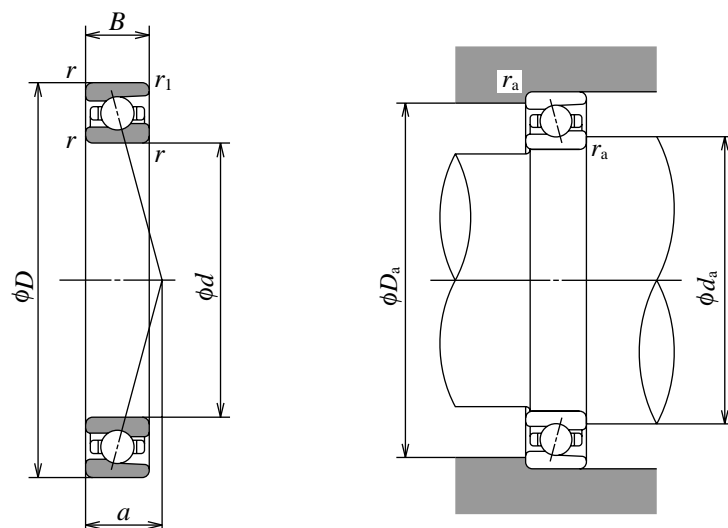
| Bearing bore diameter | Axial Preload (N)               |       |                                 |       |
|-----------------------|---------------------------------|-------|---------------------------------|-------|
|                       | BARS10X ( $\alpha = 30^\circ$ ) |       | BTRS10X ( $\alpha = 40^\circ$ ) |       |
|                       | 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:  $\alpha$  is the contact angle

# High-Speed Precision Angular Contact Ball Bearings

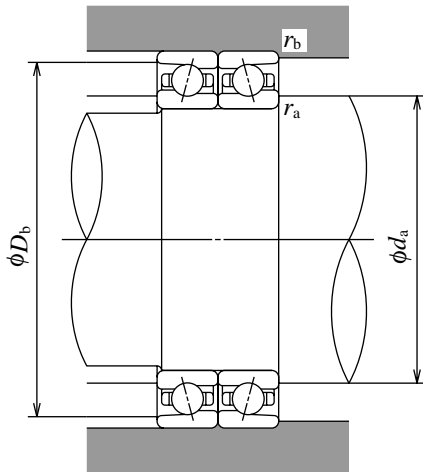
**BNRS19**  
**BNR19**  
**BNRX19**

Contact angle  $18^\circ$



|        | Material    |             |                                |
|--------|-------------|-------------|--------------------------------|
|        | Inner rings | Outer rings | Balls                          |
| BNRS19 | SUJ2        | SUJ2        | SUJ2                           |
| BNR19  | SUJ2        | SUJ2        | Si <sub>3</sub> N <sub>4</sub> |
| BNRX19 | SHX         | SHX         | Si <sub>3</sub> N <sub>4</sub> |

| Boundary Dimensions (mm) |     |     |            |             | Basic Load Ratings |              |             |                |
|--------------------------|-----|-----|------------|-------------|--------------------|--------------|-------------|----------------|
| $d$                      | $D$ | $B$ | $r_{\min}$ | $r_{1\min}$ | $C_r$ (N)          | $C_{or}$ (N) | $C_r$ {kgf} | $C_{or}$ {kgf} |
| 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 $P = X F_r + Y F_a$

| Nominal Contact Angle | $\frac{C_{or^*}}{i F_a}$ | $e$  | 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 $P_0 = X_0 F_r + Y_0 F_a$

| 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  $F_r > 0.5 F + Y_0 F_a$   
use  $P_0 = F_r$

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

# High-Speed Precision Angular Contact Ball Bearings

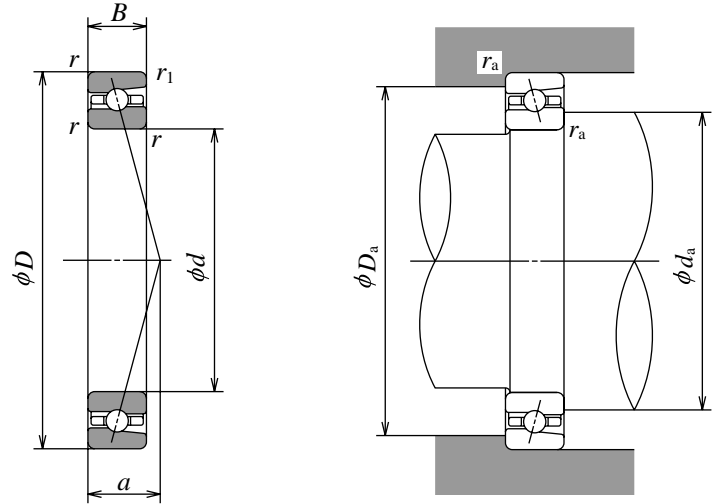
**BNRS10**

**BNR10**

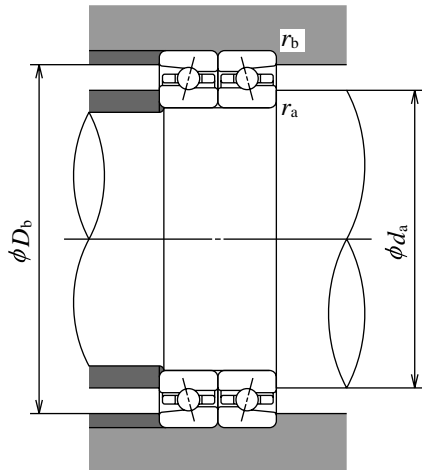
**BNRX10**

Contact angle 18°

|        | Material    |             |                                |
|--------|-------------|-------------|--------------------------------|
|        | Inner rings | Outer rings | Balls                          |
| BNRS10 | SUJ2        | SUJ2        | SUJ2                           |
| BNR10  | SUJ2        | SUJ2        | Si <sub>3</sub> N <sub>4</sub> |
| BNRX10 | SHX         | SHX         | Si <sub>3</sub> N <sub>4</sub> |



| Boundary Dimensions (mm) |     |     |            |             | Basic Load Ratings |          |             |          |
|--------------------------|-----|-----|------------|-------------|--------------------|----------|-------------|----------|
| $d$                      | $D$ | $B$ | $r_{\min}$ | $r_{1\min}$ | $C_r$ (N)          | $C_{or}$ | $C_r$ {kgf} | $C_{or}$ |
| 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) |           |           |           |           | Mass (kg) approx | Internal Free Space (cm <sup>3</sup> /row) |
|-----------------|---------------------------|-------------------------------------|-----------|-----------|-----------|-----------|------------------|--|
|                 |                           | $d_a$ min                           | $D_a$ max | $D_b$ max | $r_a$ max | $r_b$ max |                  |  |
| 35BNRS10        | 14.9                      | 41                                  | 56        | 57        | 1         | 0.5       | 0.162            | 5.3  |
| 35BNR10         |                           |                                     |           |           |           |           |                  |  |
| 35BNRX10        |                           |                                     |           |           |           |           |                  |  |
| 40BNRS10        | 16.3                      | 46                                  | 62        | 63        | 1         | 0.5       | 0.204            | 7  |
| 40BNR10         |                           |                                     |           |           |           |           |                  |  |
| 40BNRX10        |                           |                                     |           |           |           |           |                  |  |
| 45BNRS10        | 17.7                      | 51                                  | 69        | 70        | 1         | 0.5       | 0.259            | 8.9  |
| 45BNR10         |                           |                                     |           |           |           |           |                  |  |
| 45BNRX10        |                           |                                     |           |           |           |           |                  |  |
| 50BNRS10        | 18.6                      | 56                                  | 74        | 75        | 1         | 0.5       | 0.281            | 9.9  |
| 50BNR10         |                           |                                     |           |           |           |           |                  |  |
| 50BNRX10        |                           |                                     |           |           |           |           |                  |  |
| 55BNRS10        | 20.8                      | 62                                  | 83        | 85        | 1         | 0.6       | 0.418            | 13   |
| 55BNR10         |                           |                                     |           |           |           |           |                  |  |
| 55BNRX10        |                           |                                     |           |           |           |           |                  |  |
| 60BNRS10        | 21.6                      | 67                                  | 88        | 90        | 1         | 0.6       | 0.453            | 13   |
| 60BNR10         |                           |                                     |           |           |           |           |                  |  |
| 60BNRX10        |                           |                                     |           |           |           |           |                  |  |
| 65BNRS10        | 22.4                      | 72                                  | 93        | 95        | 1         | 0.6       | 0.476            | 15   |
| 65BNR10         |                           |                                     |           |           |           |           |                  |  |
| 65BNRX10        |                           |                                     |           |           |           |           |                  |  |
| 70BNRS10        | 24.6                      | 77                                  | 103       | 105       | 1         | 0.6       | 0.649            | 22   |
| 70BNR10         |                           |                                     |           |           |           |           |                  |  |
| 70BNRX10        |                           |                                     |           |           |           |           |                  |  |
| 75BNRS10        | 25.4                      | 82                                  | 108       | 110       | 1         | 0.6       | 0.684            | 24   |
| 75BNR10         |                           |                                     |           |           |           |           |                  |  |
| 75BNRX10        |                           |                                     |           |           |           |           |                  |  |
| 80BNRS10        | 27.7                      | 87                                  | 118       | 120       | 1         | 0.6       | 0.928            | 29   |
| 80BNR10         |                           |                                     |           |           |           |           |                  |  |
| 80BNRX10        |                           |                                     |           |           |           |           |                  |  |
| 85BNRS10        | 28.5                      | 92                                  | 123       | 125       | 1         | 0.6       | 0.972            | 31   |
| 85BNR10         |                           |                                     |           |           |           |           |                  |  |
| 85BNRX10        |                           |                                     |           |           |           |           |                  |  |
| 90BNRS10        | 30.7                      | 99                                  | 131       | 134       | 1.5       | 0.8       | 1.25             | 41   |
| 90BNR10         |                           |                                     |           |           |           |           |                  |  |
| 90BNRX10        |                           |                                     |           |           |           |           |                  |  |
| 95BNRS10        | 31.5                      | 104                                 | 136       | 139       | 1.5       | 0.8       | 1.3              | 43   |
| 95BNR10         |                           |                                     |           |           |           |           |                  |  |
| 95BNRX10        |                           |                                     |           |           |           |           |                  |  |
| 100BNRS10       | 32.3                      | 109                                 | 141       | 144       | 1.5       | 0.8       | 1.35             | 45   |
| 100BNR10        |                           |                                     |           |           |           |           |                  |  |
| 100BNRX10       |                           |                                     |           |           |           |           |                  |  |

# High-Speed Precision Angular Contact Ball Bearings

## BARS10X

Contact angle 30°

## BTRS10X

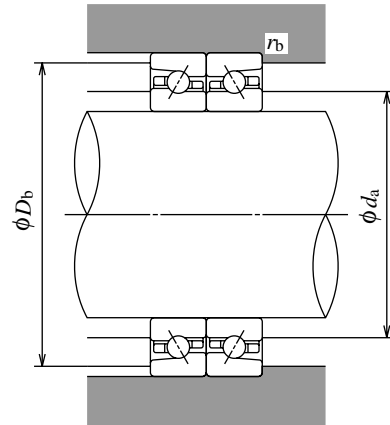
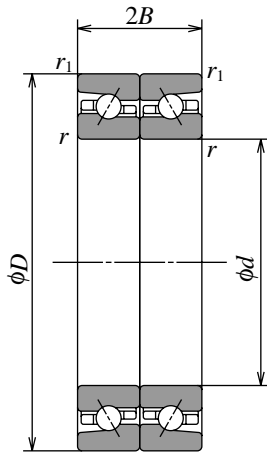
Contact angle 40°

|         | 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).

| <i>d</i> | <i>D</i> | Boundary Dimensions (mm) |                         |                           | Basic Load Ratings        |                        |                             |                        |  |
|----------|----------|--------------------------|-------------------------|---------------------------|---------------------------|------------------------|-----------------------------|------------------------|--|
|          |          | <i>2B</i>                | <i>r</i> <sub>min</sub> | <i>r</i> <sub>1 min</sub> | <i>C</i> <sub>a</sub> (N) | <i>C</i> <sub>0a</sub> | <i>C</i> <sub>a</sub> {kgf} | <i>C</i> <sub>0a</sub> |  |
| 40       | 68       | 27                       | 1                       | 0.6                       | 11 700<br>14 100          | 17 200<br>19 600       | 1 200<br>1 440              | 1 760<br>2 000         |  |
| 45       | 75       | 28.5                     | 1                       | 0.6                       | 13 000<br>15 600          | 19 500<br>22 200       | 1 330<br>1 590              | 1 980<br>2 260         |  |
| 50       | 80       | 28.5                     | 1                       | 0.6                       | 13 600<br>16 300          | 21 400<br>24 400       | 1 390<br>1 660              | 2 190<br>2 490         |  |
| 55       | 90       | 33                       | 1.1                     | 0.6                       | 16 900<br>20 200          | 27 300<br>31 000       | 1 720<br>2 060              | 2 790<br>3 150         |  |
| 60       | 95       | 33                       | 1.1                     | 0.6                       | 17 600<br>21 100          | 29 800<br>34 000       | 1 800<br>2 150              | 3 050<br>3 450         |  |
| 65       | 100      | 33                       | 1.1                     | 0.6                       | 18 300<br>21 900          | 32 500<br>37 000       | 1 870<br>2 230              | 3 300<br>3 750         |  |
| 70       | 110      | 36                       | 1.1                     | 0.6                       | 24 800<br>29 700          | 42 500<br>48 500       | 2 530<br>3 050              | 4 350<br>4 950         |  |
| 75       | 115      | 36                       | 1.1                     | 0.6                       | 25 300<br>30 000          | 44 500<br>50 500       | 2 570<br>3 100              | 4 550<br>5 150         |  |
| 80       | 125      | 40.5                     | 1.1                     | 0.6                       | 29 700<br>35 500          | 53 000<br>60 500       | 3 050<br>3 600              | 5 400<br>6 150         |  |
| 85       | 130      | 40.5                     | 1.1                     | 0.6                       | 30 000<br>36 000          | 55 500<br>63 000       | 3 050<br>3 650              | 5 650<br>6 450         |  |
| 90       | 140      | 45                       | 1.5                     | 1                         | 39 500<br>47 000          | 72 000<br>82 000       | 4 000<br>4 800              | 7 350<br>8 350         |  |
| 95       | 145      | 45                       | 1.5                     | 1                         | 40 000<br>48 000          | 75 000<br>85 500       | 4 100<br>4 900              | 7 650<br>8 700         |  |
| 100      | 150      | 45                       | 1.5                     | 1                         | 40 500<br>48 500          | 78 500<br>89 000       | 4 150<br>4 950              | 8 000<br>9 050         |  |
| 105      | 160      | 49.5                     | 2                       | 1                         | 46 000<br>55 000          | 89 500<br>102 000      | 4 700<br>5 600              | 9 100<br>10 400        |  |
| 110      | 170      | 54                       | 2                       | 1                         | 52 000<br>62 000          | 102 000<br>116 000     | 5 300<br>6 350              | 10 400<br>11 800       |  |
| 120      | 180      | 54                       | 2                       | 1                         | 53 500<br>64 000          | 110 000<br>125 000     | 5 450<br>6 550              | 11 200<br>12 700       |  |
| 130      | 200      | 63                       | 2                       | 1                         | 67 500<br>80 500          | 133 000<br>151 000     | 6 850<br>8 200              | 13 500<br>15 400       |  |

# ROBUST Series



| Bearing Numbers          | Abutment and Fillet Dimensions (mm) |           |           | Mass (kg) approx | Internal Free Space (cm <sup>3</sup> /row) |
|--------------------------|-------------------------------------|-----------|-----------|------------------|--|
|                          | $d_a$ min                           | $D_b$ max | $r_b$ max |                  |  |
| 40BARS10X<br>40BTRS10X   | 50                                  | 63        | 0.5       | 0.200            | 6.1  |
| 45BARS10X<br>45BTRS10X   | 56                                  | 70        | 0.5       | 0.255            | 7.4  |
| 50BARS10X<br>50BTRS10X   | 61                                  | 75        | 0.5       | 0.272            | 8  |
| 55BARS10X<br>55BTRS10X   | 68                                  | 84        | 0.6       | 0.412            | 13   |
| 60BARS10X<br>60BTRS10X   | 73                                  | 89        | 0.6       | 0.433            | 12   |
| 65BARS10X<br>65BTRS10X   | 78                                  | 94        | 0.6       | 0.472            | 14   |
| 70BARS10X<br>70BTRS10X   | 85                                  | 104       | 0.6       | 0.637            | 20   |
| 75BARS10X<br>75BTRS10X   | 90                                  | 110       | 0.6       | 0.671            | 21   |
| 80BARS10X<br>80BTRS10X   | 97                                  | 117       | 0.6       | 0.912            | 28   |
| 85BARS10X<br>85BTRS10X   | 102                                 | 122       | 0.6       | 0.971            | 29   |
| 90BARS10X<br>90BTRS10X   | 109                                 | 132       | 0.8       | 1.27             | 40   |
| 95BARS10X<br>95BTRS10X   | 113.5                               | 137       | 0.8       | 1.32             | 42   |
| 100BARS10X<br>100BTRS10X | 119                                 | 142       | 0.8       | 1.37             | 43   |
| 105BARS10X<br>105BTRS10X | 125                                 | 151       | 1         | 1.74             | 56   |
| 110BARS10X<br>110BTRS10X | 132                                 | 159       | 1         | 2.23             | 67   |
| 120BARS10X<br>120BTRS10X | 142                                 | 169       | 1         | 2.39             | 72   |
| 130BARS10X<br>130BTRS10X | 156                                 | 188       | 1         | 3.57             | 110  |



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