

Precision Bearings










For Machine Tool Applications



A Quick Reference Guide

NSK Super Precision Bearings – Product Range

Several types of super precision bearings are available from NSK, including the ROBUST™ series of high performance bearings, the special series of bearings for unique and specialized applications, and the standard series bearings.

| | | | |
|--|--|--|--|
|  <p>Standard Series</p> | <p>High Precision Angular Contact Ball Bearings</p> <p>Basic NSK super precision bearings manufactured to conform to ISO standards.</p> <ul style="list-style-type: none"> • 70xx, 72xx, 79xx series • Three types of contact angle: 15° (C), 25° (A5), 30° (A) • Two types of cage design: Select either phenolic (TR) or polyamide (TYN), depending on application requirements |  <p>Robust Series Standard Series</p> | <p>Ultra High-Speed Single Row Cylindrical Roller Bearings</p> <p>High performance cylindrical bearings designed for ultra high speed applications, such as machining center spindles.</p> <ul style="list-style-type: none"> • Two types of cage material: Brass (MR)⁽¹⁾ and PEEK resin (TP) • Three types of roller material: Steel, SHX and Ceramic • Ultra high speed ROBUST RXH design can be used up to 3 million $d_m n$. <p><small>(1) MR cage is used in the standard series</small></p> |
|  <p>Robust Series BNR, BER Series</p> | <p>Ultra High-Speed Angular Contact Ball Bearings</p> <p>High performance bearings developed for high speed operation with low temperature rise. Suitable for ultra high precision machining applications, and ultra high speed applications.</p> <ul style="list-style-type: none"> • Two types of contact angle: 18° (BNR), 25° (BER) • Two types of ball material: steel (S type) and ceramic (H type) • Two types of cage design: Select either phenolic (T) or polyamide (TYN), depending on application requirements • ROBUST series also can be used for ultra high speed applications of over 3 million $d_m n$. |  <p>Standard Series High Rigidity Series</p> | <p>Double Row Cylindrical Roller Bearings</p> <p>Designed to deliver high rigidity in high speed applications such as lathe spindles.</p> <ul style="list-style-type: none"> • Two types of cage material: Brass (MB), PPS resin (TB) • Standard specification E44: Outer ring oil holes and groove |
|  <p>Robust Series BAR, BTR Series</p> | <p>High-Speed Angular Contact Thrust Ball Bearings</p> <p>High rigidity thrust bearings for lathe applications.</p> <ul style="list-style-type: none"> • Two types of contact angle: 30° (BAR), 40° (BTR) • Two types of ball material: steel (S type) and ceramic (H type) |  <p>Special Series for Machine Tool Applications</p> | <p>Angular Contact Thrust Ball Bearings for Ball Screw Support</p> <p>High rigidity thrust bearings designed specifically for ball screw support applications in machine tools.</p> <ul style="list-style-type: none"> • Contact angle: 60° • Can be universally matched to any required rigidity specification or life cycle • A pre-greased line using special grease is also available |
|  <p>BGR Series</p> | <p>Ultra High Precision Angular Contact Ball Bearings</p> <p>High Performance bearings developed specifically for internal grinding or high speed motor applications under spring preload.</p> <ul style="list-style-type: none"> • Bore size range: $\phi 6$–25 mm, contact angle: 15° • Non separable type • Universal combinations (DU and SU) |  <p>Special Series for Injection Moulding Machines</p> | <p>Angular Contact Thrust Ball Bearings for Ball Screw Support</p> <p>The high load capacity design delivers five times the life expectancy compared to ball screw support bearings for machine tool applications of a similar size. The number of rows can also be reduced.</p> <ul style="list-style-type: none"> • Easier handling than tapered roller bearings or thrust spherical roller bearings as a result of non-separable configuration • Optimum ball bearing design results in lower rotational torque • Can be universally matched to any required rigidity specification or life cycle |
|  <p>Special Series</p> | <p>Sealed Angular Contact Ball Bearings</p> <p>Pre greased and sealed to reduce handling problems. Suitable for maintenance of machine tool spindles.</p> <ul style="list-style-type: none"> • Standard series super precision angular contact ball bearings • ROBUST series high speed angular contact ball bearings • Bore size range: $\phi 30$–100 mm in ISO series 10 and 19 (70xx and 79xx) |  <p>Special Series</p> | <p>High Precision Deep Groove Ball Bearings</p> <p>Suitable for high speed and high precision motors.</p> <ul style="list-style-type: none"> • Three types of cage : Ball guided polyamide cage (T1X,TYA) and inner ring guided phenolic cage (T), selection depends on the application • Suitable for silent or low vibration operation |

Comparison of Lubricating Methods

| Lubricating Methods | Advantages | Disadvantages |
|----------------------|---|---|
| Grease Lubrication | <ul style="list-style-type: none"> • Low cost • Limitation of temperature rise is possible. • Maintenance free | <ul style="list-style-type: none"> • If packed grease deteriorates, seizure may occur. • May allow penetration of dust or cutting fluid. |
| Oil Mist Lubrication | <ul style="list-style-type: none"> • Since new oil is always fed, no fear of oil deterioration. • Dust and cutting fluid cannot easily enter. | <ul style="list-style-type: none"> • Pollution of environment. • Oil supply quantity varies depending on the oil viscosity and temperature, so control of a small flow rate is difficult. • It is difficult to confirm that oil is actually fed. |
| Jet Lubrication | <ul style="list-style-type: none"> • Since the oil flow rate is high, dust and cutting fluid cannot enter and seizure hardly ever occurs. • Because of cooling by oil, the bearing temperature can be controlled to some degree. | <ul style="list-style-type: none"> • Frictional loss is high. • Since oil leaks, it is difficult to use for vertical spindles. • Cost is high. |
| Oil-Air Lubrication | <ul style="list-style-type: none"> • Since oil quantity control is possible, the optimum quantity of oil is fed and heat generation is low. • Besides little heat-generation, there is a cooling effect of the air, so the temperature is low. • Since new oil is always fed, no fear of oil deterioration. • Dust, cutting fluid cannot easily enter. • Environmental pollution mist is slight. | <ul style="list-style-type: none"> • Cost is rather high. • Confirmation of whether oil is actually fed to bearing is difficult. |

The Recommendable Grease Quantities for High-speed Spindle Bearings

Unit: cc/row

| Bore number | Bore diameter (mm) | Angular Contact Ball Bearings: 15% of internal free space | | | | Cylindrical Roller Bearings: 10% of internal free space | | | |
|-------------|--------------------|---|-----------------------------|-----------------------------|-------------------------------------|---|--------------------|--------------------|-------------------|
| | | BNR19, BGR19 79XX X-quantity | BGR10 70XX X-quantity | BGR02 72XX X-quantity | BNR10, BAR10 BTR10 X-quantity | NN49 X-quantity | NN39 X-quantity | NN30 X-quantity | N10 X-quantity |
| 08 | 40 | 0.75 | 1.2 | 2.1 | 0.92 | — | — | 1.0 | 0.7 |
| 09 | 45 | 0.83 | 1.5 | 2.6 | 1.2 | — | — | 1.3 | 1.0 |
| 10 | 50 | 0.91 | 1.6 | 3.0 | 1.2 | — | — | 1.4 | 1.1 |
| 11 | 55 | 1.1 | 2.4 | 3.9 | 1.7 | — | — | 2.0 | 1.5 |
| 12 | 60 | 1.2 | 2.6 | 4.8 | 1.8 | — | — | 2.1 | 1.6 |
| 13 | 65 | 1.3 | 2.6 | 5.7 | 1.9 | — | — | 2.2 | 1.6 |
| 14 | 70 | 2.1 | 3.6 | 6.5 | 2.8 | — | — | 3.2 | 2.4 |
| 15 | 75 | 2.3 | 3.6 | 7.0 | 2.9 | — | — | 3.5 | 2.5 |
| 16 | 80 | 2.4 | 5.1 | 8.7 | 3.8 | — | — | 4.7 | 3.5 |
| 17 | 85 | 3.5 | 5.3 | 11 | 4.0 | — | — | 4.9 | 3.7 |
| 18 | 90 | 3.6 | 6.6 | 13 | 5.5 | — | — | 6.5 | 4.5 |
| 19 | 95 | 3.6 | 6.8 | 16 | 5.7 | — | — | 6.6 | 4.7 |
| 20 | 100 | 4.9 | 7.2 | 19 | 6.1 | 5.4 | 4.5 | 6.8 | 4.9 |
| 21 | 105 | 5.1 | 9.0 | 23 | 7.6 | 5.6 | 4.6 | 9.3 | 5.9 |
| 22 | 110 | 5.2 | 12 | 27 | 9.1 | 5.7 | 4.8 | 11 | 7.5 |
| 24 | 120 | 7.9 | 12 | 31 | 9.8 | 8.4 | 6.5 | 12.5 | 8.1 |
| 26 | 130 | 9.0 | 18 | 34 | 15 | 11 | 8.5 | 18 | 12.4 |
| 28 | 140 | 9.9 | 20 | 42 | 17 | 12 | 9.3 | 20 | 12.9 |
| 30 | 150 | 14 | 25 | 53 | 22 | 24 | 14 | 23 | — |
| 32 | 160 | 16 | 34 | — | 26 | 20 | 15 | 29 | — |

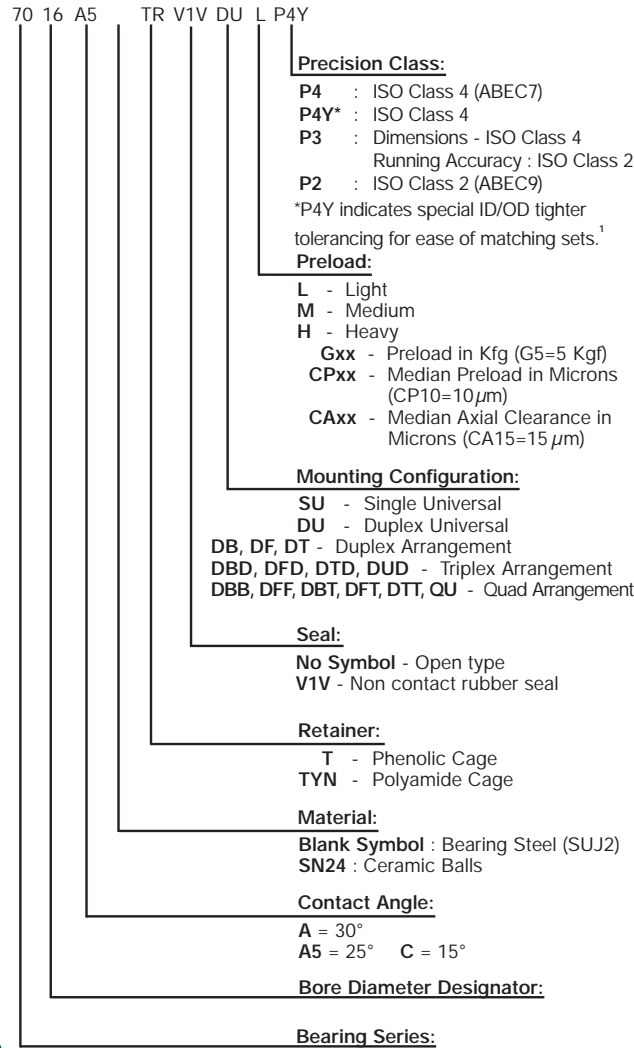
* Do not operate bearings at full spindle speed when bearings are first installed. It is necessary to break the grease in. Contact NSK for assistance.

Grease Brand Names and Properties

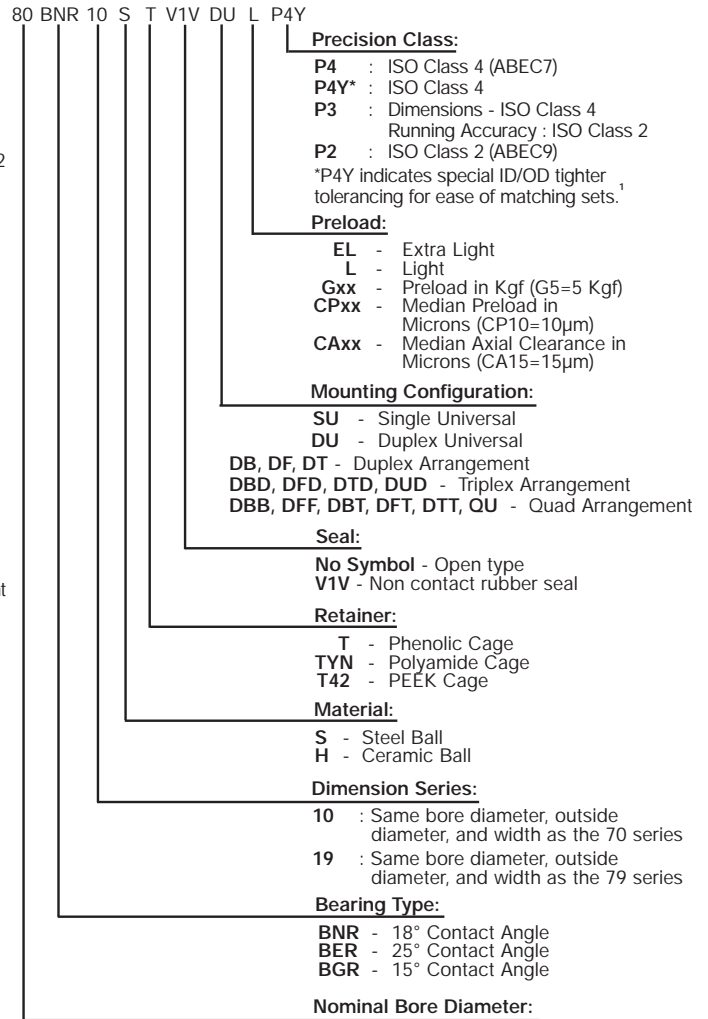
| Brand Names | Manufacturers | Thickeners | Base oils | Base oils viscosity mm (40°C) | Dropping point (°C) | Working temperature range (°C) | Main application |
|------------------|---------------|----------------|------------------------------------|-------------------------------|---------------------|--------------------------------|---|
| MTE | NSK | Barium complex | Ester oil | 20 | 200 | -30~+120 | Bearings for high speed spindles, high speed cylindrical roller bearings. |
| MTS | NSK | Urea | Ester + Synthetic hydro carbon oil | 22 | 220 | -40~+130 | Bearings for high speed spindles. |
| Isoflex NBU15 | Klüber | Barium complex | Diester oil + Mineral oil | 20 | 250 | -30~+120 | Bearings for main spindles. |
| Isoflex NCA15 | Klüber | Special Ca | Ester oil | 23 | 180 | -40~+130 | Bearings for main spindles. |
| Mobilux 2 | Mobil | Lithium | Mineral oil | 26 | 190 | -10~+110 | Bearings for boring heads, live centers. |
| Multemp LRL3 | Kyodo Yushi | Lithium | Tetraester oil | 37 | 208 | -30~+130 | Bearings for main spindles. |
| Stabragus NBU8EP | Klüber | Barium complex | Mineral oil | 105 | 220 | -30~+130 | Heavy load cylindrical roller bearings. |
| Alvania 2 | Shell | Lithium | Mineral oil | 140 | 182 | -10~+110 | Ball screw support bearings. |
| ENS | NSK | Diurea | Tetraester oil | 32 | 260 | -40~+160 | Bearings for motors. |

High-Precision Single-Row Angular Contact Ball Bearings

Conventional Type 72, 70, 79 Series



ROBUST, High-Speed Type BNR 10, BNR 19 Series



1. See far right for more extensive definition of Precision Class (P4Y)

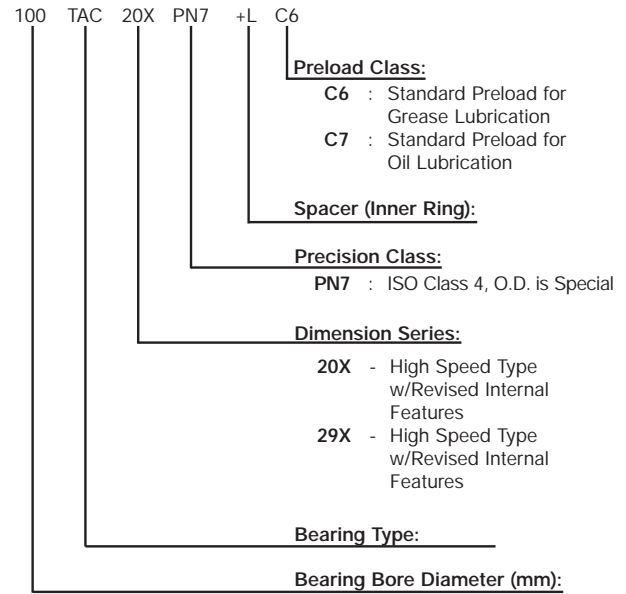
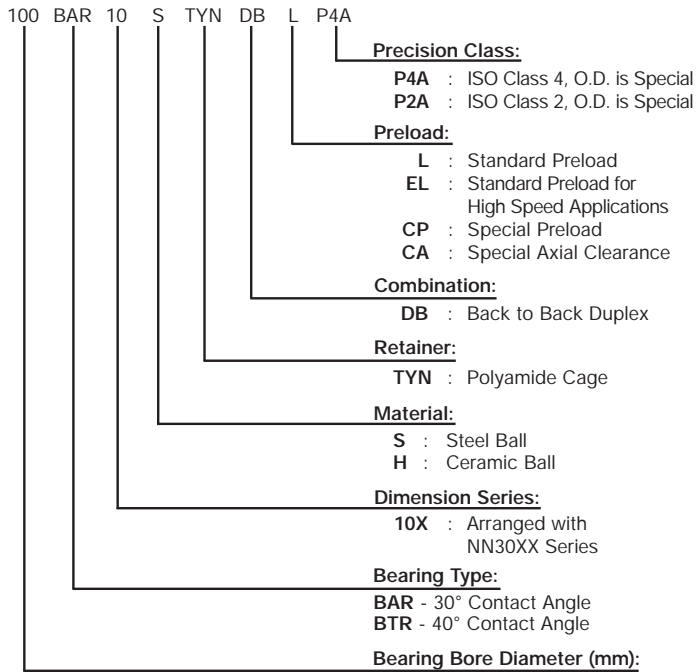
| | NSK | | Fafnir | Barden | NDH | MRC | SKF | FAG | RHP ¹ |
|-------------------------------------|---------------|------------------------------------|--------------|--------|-----------|----------|------------|---------------|------------------|
| | Standard Type | Ultra-High Speed Type ¹ | | | | | | | |
| ISO Class 4 or AFBMA ABEC7 | 7210CTY*P4 | - | 2MM210WI* | 210H* | Q20210*7 | 210R*7B | 7210CP4* | B7210CTPAP4* | 7210CTP4* |
| | 7210A5TY*P4 | - | 3MM210WI* | 2210H* | QH20210*7 | 7210*7B | 7210ACP4* | B7210CETPAP4* | 7210ETP4* |
| | 7010CTY*P4 | 50BNR10T*P4 | 2MM9110WI* | 110H* | Q0L210*7 | 110KR*7B | 7010CP4* | B7010CTPAP4* | 7010CTP4* |
| | 7010A5TY*P4 | - | 3MM9110WI* | 2110H* | QH0L10*7 | 7110R*7B | 7010ACP4* | B7010ETPAP4* | 7010ETP4* |
| | 7910CTY*P4 | 50BNR19T*P4 | 2MM9310WOCR* | - | - | 1910R*7B | 71910CP4* | B71910CTPAP4* | 7910CTP4* |
| | 7910A5TY*P4 | - | - | - | - | - | 71910ACP4* | B71910ETPAP4* | 7910ETP4* |

1. Phenolic cage = "T", Polyamide cage = "TY" Notes: Underlined digits (10) vary with bearing bore. Asterisks indicate the position of the preload designation for Universal Duplex Bearings.

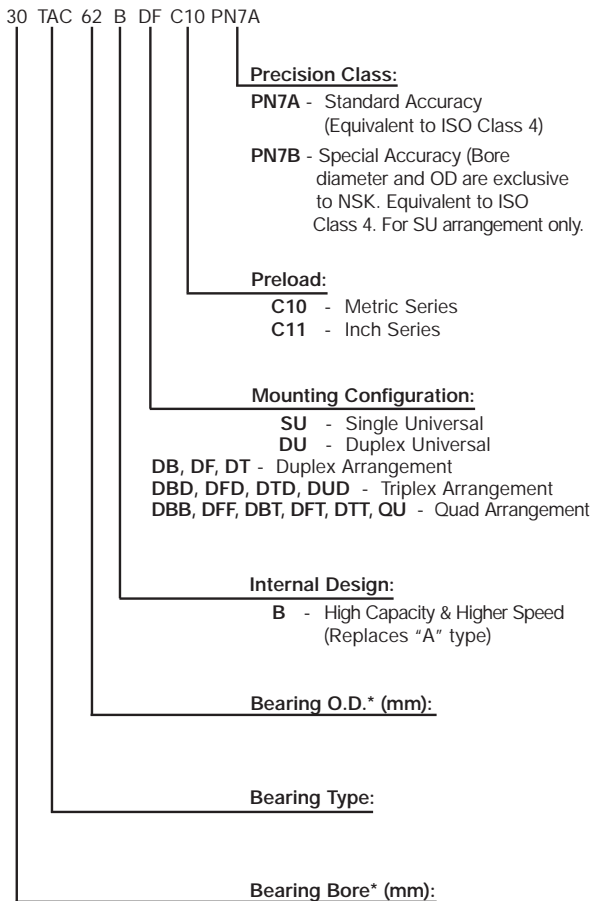
Preload Designation for Universal Duplex Bearings

| Preload | NSK | Fafnir | Barden | NDH | MRC | SKF | FAG | RHP |
|---------|-----|--------|--------|-----|-----|-----|-----|-----|
| Light | DUL | DUL | DL | DTL | DUL | DGA | UL | DUL |
| Medium | DUM | DUM | DM | DTX | DUM | DGB | UM | DUM |
| Heavy | DUH | DUH | DH | DTT | DUH | DGC | US | DUH |

Thrust Angular Contact Ball Bearings

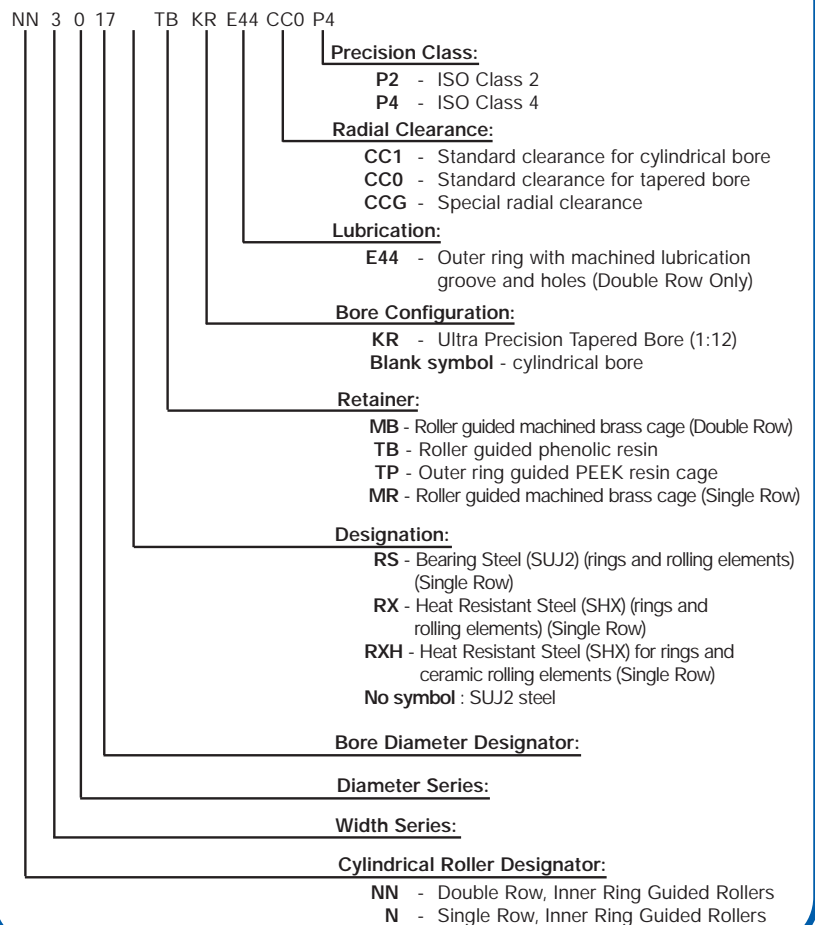


Ball Screw Support Bearings



*For inch series bearings, the fractional portion of the size is omitted.

Cylindrical Roller Bearings



Fitting of Shaft and Housing

It is of utmost importance that shafts and housings are accurately and precisely mated in order to take full advantage of the precision bearings' capabilities, which include rotational accuracy, high speed performance, and low heat generation.

When the inner ring or outer ring is mounted onto a shaft or into a housing with some interference, the shape of shaft or housing (out of roundness) is transferred to the bearing raceway surfaces and affects running accuracy. When different arrangements of angular contact ball bearings are used, cylindricity affects the distribution of preload for each bearing. Therefore, the mating parts should be as accurate as possible. Inaccurate mating of parts can cause the formation of peaks or ridges along the shaft of a precision lathe, which can affect the quality of finished work.

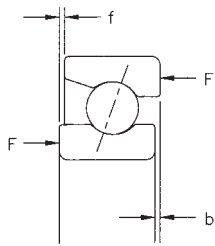
| FITS ¹ ON SHAFTS | | | | | | |
|--|----------------------------|-------|--|---------|---|----------|
| Bearing Type ³ | Shaft Outer Diameter (mm) | | Tolerance of Shaft ² Outer Diameter (mm) | | Target Interference ^{2,4} (mm) | |
| | over | incl. | minimum | maximum | minimum | maximum |
| Machine tool spindle bearing | 10 | 18 | -0.003 | 0 | 0 | 0.002 T |
| | 18 | 50 | -0.004 | 0 | 0 | 0.0025 T |
| | 50 | 80 | -0.005 | 0 | 0 | 0.003 T |
| | 80 | 120 | -0.003 | 0.003 | 0 | 0.004 T |
| | 120 | 180 | -0.004 | 0.004 | 0 | 0.004 T |
| | 180 | 250 | -0.005 | 0.005 | 0 | 0.005 T |
| Angular contact thrust ball bearing for ball screw support | 10 | 18 | -0.008 | 0 | - | - |
| | 18 | 30 | -0.009 | 0 | - | - |
| | 30 | 50 | -0.011 | 0 | - | - |
| | 50 | 80 | -0.013 | 0 | - | - |
| | 80 | 120 | -0.015 | 0 | - | - |
| FITS ¹ ON HOUSING | | | | | | |
| Bearing Type ³ | Housing Bore Diameter (mm) | | Tolerance of Housing ² Bore Diameter (mm) | | Target Clearance ^{2,4} (mm) | |
| | over | incl. | minimum | maximum | minimum | maximum |
| Angular Contact Ball Bearing (Fixed side) | 18 | 50 | -0.002 | 0.002 | 0.002 L | 0.006 L |
| | 50 | 80 | -0.0025 | 0.0025 | 0.002 L | 0.006 L |
| | 80 | 120 | -0.003 | 0.003 | 0.003 L | 0.008 L |
| | 120 | 180 | -0.004 | 0.004 | 0.003 L | 0.008 L |
| | 180 | 250 | -0.005 | 0.005 | 0.005 L | 0.010 L |
| Angular Contact Ball Bearing (Free side) | 18 | 50 | 0 | 0.004 | 0.006 L | 0.011 L |
| | 50 | 80 | 0 | 0.005 | 0.006 L | 0.011 L |
| | 80 | 120 | 0 | 0.006 | 0.009 L | 0.015 L |
| | 120 | 180 | 0 | 0.008 | 0.009 L | 0.015 L |
| | 180 | 250 | 0 | 0.010 | 0.015 L | 0.022 L |
| Cylindrical Roller Bearing | 18 | 50 | -0.006 | 0 | 0.002 L | 0.002 T |
| | 50 | 80 | -0.007 | 0 | 0.002 L | 0.002 T |
| | 80 | 120 | -0.008 | 0 | 0.002 L | 0.002 T |
| | 120 | 180 | -0.009 | 0 | 0.002 L | 0.002 T |
| | 180 | 250 | -0.011 | 0 | 0.002 L | 0.002 T |
| Angular Contact Thrust Ball Bearing for Ball Screw Support | 10 | 18 | - | - | - | - |
| | 18 | 30 | - | - | - | - |
| | 30 | 50 | 0 | 0.016 | - | - |
| | 50 | 80 | 0 | 0.019 | - | - |
| | 80 | 120 | 0 | 0.022 | - | - |

1. The fitting data above provides general recommendations for machine tool spindles operating under normal conditions and for $d_m n$ values of less than 800,000. For high speeds, heavy loads, or outer ring rotation, please contact NSK for assistance.

2. Use the target interference when the bearings can be matched to the shaft or housing. Otherwise use the shaft outer diameter and housing bore min and max for random matching.

3. Applies to angular contact ball bearings: 70XX, 79XX, 72XX, BNR and BER
Angular contact thrust ball bearings: BAR, BTR and TAC
Cylindrical roller bearings: N10XX, NN30XX, NN39XX, NN49XX and NNU49XX

4. T=Interference or tight fit
L=Clearance or loose fit



Universal Combination Bearings

NSK offers “universal” bearings, SU or DU, that can be used to create various angular contact ball bearing arrangements. A universal angular contact ball bearing is one with the same offset ground on both front and back faces. Reference Fig. 1, ($f=b$). This offset relates directly to the bearing’s stringent preload control and enables universal bearings to be combined or form back to back (DB, DBD, DBB) or face to face (DF, DFD, DFF) sets.

f: Offset of front face
b: Offset of back face

Fig. 1
Offset of Inner & Outer Rings

Precision Class (P4Y)

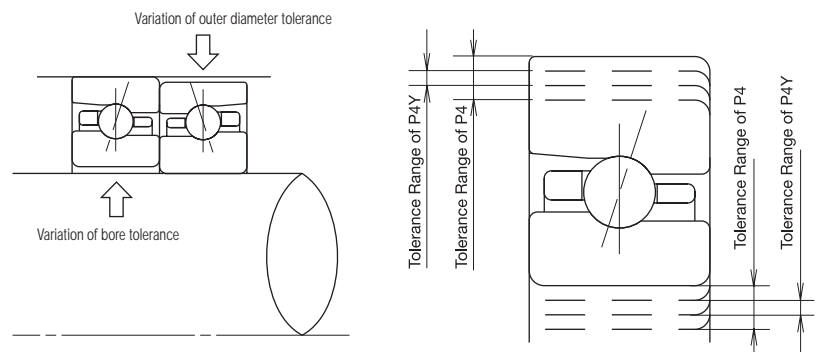
NSK also provides universal bearings with tighter bore and outer diameter tolerance control designated by precision class P4Y. This aspect makes universal bearings suitable for random matching to form combinations, yet maintain equal load sharing and high running accuracy for sets.

NSK Super Precision Universal Duplexed Angular Contact Bearings

Features

- State-of-the art preload control
- Easier matching with tighter Bore & OD tolerances - P4Y
- High Point of Eccentricity marked on inner and outer rings
- Packaged marked with actual bore, OD, and width deviation from nominal (units are microns μm)
- High performance phenolic cage

Tolerance of P4 and P4Y Accuracy



When bearings are mounted in random matching method, variation of tolerance should be considered.

Bore and Outer Diameter Tolerance

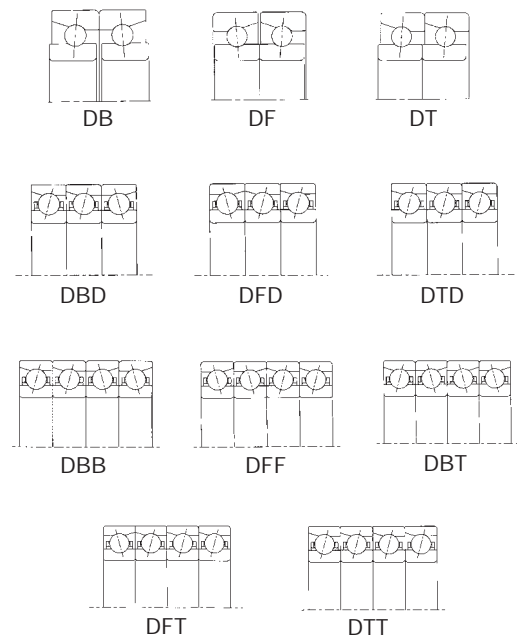
| Tolerance of Bore Diameter of Inner Ring | | | | | | Unit: μm |
|--|------|------|----------------------------------|-----|--|---------------------|
| Bore Diameter Over Incl. | P4 | | P4Y (Controlled to median value) | | | |
| | High | Low | High | Low | | |
| 30 50 | 0 | - 6 | - 1 | - 3 | | |
| 50 80 | 0 | - 7 | - 2 | - 5 | | |
| 80 120 | 0 | - 8 | - 3 | - 6 | | |
| 120 150 | 0 | - 10 | - 3 | - 7 | | |

* Tolerances for bearings under 30mm bore are the same as values quoted between 30 - 50 mm bore.

| Tolerance of Outer Diameter of Outer Ring | | | | | | Unit: μm |
|---|------|------|----------------------------------|-----|--|---------------------|
| Outer Diameter Over Incl. | P4 | | P4Y (Controlled to median value) | | | |
| | High | Low | High | Low | | |
| 50 80 | 0 | - 7 | - 2 | - 6 | | |
| 80 120 | 0 | - 8 | - 2 | - 6 | | |
| 120 150 | 0 | - 9 | - 3 | - 7 | | |
| 150 180 | 0 | - 10 | - 3 | - 7 | | |
| 180 200 | 0 | - 11 | - 4 | - 9 | | |
| 200 Under 215 | 0 | - 11 | - 2 | - 9 | | |

Tolerances for bearings under 50mm outer diameter are the same as values quoted between 50 - 80mm outer diameter.

Universal Bearing Combinations



Cause and Countermeasures for Operating Irregularities

| Irregularities | | Possible cause | Countermeasures |
|---------------------------------------|---|--|---|
| Noise | Loud metallic sound | Abnormal load | Improve the fit, internal clearance, preload, position of housing shoulder, etc. |
| | | Incorrect mounting | Improve the machining accuracy and alignment of shaft and housing, accuracy of mounting method. |
| | | Insufficient or improper lubricant | Replenish the lubricant or select another lubricant. |
| | | Contact of rotating parts | Modify the labyrinth seal, etc. |
| | Loud regular sound | Dents generated by foreign matters, corrosion, flaws, or scratches on raceways | Replace or clean the bearing, improve the seals, and use clean lubricant. |
| | | Brinelling | Replace the bearing, and use care when handling bearings. |
| | | Flaking on raceway | Replace the bearing. |
| | Irregular sound | Excessive clearance | Improve the fit, clearance, and preload. |
| | | Penetration of foreign particles | Replace or clean the bearing, improve the seals, and use clean lubricant. |
| | | Flaws or flaking on balls | Replace the bearing. |
| Abnormal temperature rise | Excessive amount of lubricant | Reduce amount of lubricant, or select stiffer grease. | |
| | Insufficient or improper lubricant | Replenish lubricant or select a better one. | |
| | Abnormal load | Improve the fit, internal clearance, preload, or position of housing shoulder. | |
| | Incorrect mounting | Improve the machining accuracy and alignment of the shaft and housing, accuracy of mounting, or mounting method. | |
| | Creep on fitted surface, excessive seal friction | Correct the seals, replace the bearing, or correct the fitting or mounting. | |
| Vibration (Radial runout of shaft) | Brinelling | Replace the bearing and use care when handling bearing. | |
| | Flaking | Replace the bearing. | |
| | Incorrect mounting | Correct the squareness between the shaft and housing shoulder or side of spacer. | |
| | Penetration of foreign particles | Replace or clean the bearing, improve the seals. | |
| Leakage or discoloration of lubricant | Too much lubricant. Penetration by foreign matter or abrasion chips | Reduce the amount of lubricant, select a stiffer grease. Replace the bearing or lubricant. Clean the housing and adjacent parts. | |

Note ¹ Squeaking may arise from grease lubricated ball bearings or cylindrical roller bearings (medium to large sized). This is especially true during winter when temperature will not rise, leaving fatigue or grease life unaffected. Consequently, such a bearing can continue to be used. If you have concerns regarding squeaking noise, please contact NSK.

MOTION & CONTROL
NSK

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