# TOPBALL®

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The NB TOPBALL is a linear motion mechanism utilizing the rotational motion of ball elements. NB's self-aligning TOPBALL can be designed into many different applications such as factory automated equipment, machine tools, industrial machines, electrical equipment, optical and measuring instruments.

## STRUCTURE AND ADVANTAGES

### Higher Load Capacity and Longer Travel life

NB's uniquely designed load plate provides circular arch contact to the ball element resulting in a greater dispersion of the load, enabling TOPBALL to provide up to three times the load capacity therefore 27 times the travel life of conventional slide bushings.

### Self Aligning Capability

Load plates are thinner at the ends to provide a pivot point at the center of the plate. The center acts as a fulcrum to compensate for any slight misalignment between the shaft and the housing bore that might be caused by inaccurate machining, mounting errors or shaft deflection.

### Floating Seal

NB's unique floating seal design allows for self-alignment while maintaining equal and constant contact to the shaft. Seals do not add to the overall length of the bushing allowing for more compact designs.

### High Speed

TOPBALL meets high speed requirements. The maximum speed is 180m/min.

### Clearance Adjustable

TOPBALL load plates are designed to "float" in the outer sleeve which allows for clearance between the ball elements and shaft to best suit application requirements.

### TOPBALL Unit

This is a TOPBALL with a housing. The housing has the most appropriate bore tolerance that optimizes TOPBALL's performance.

Figure D-1 Circular Arch Design and Ground Surface Raceway

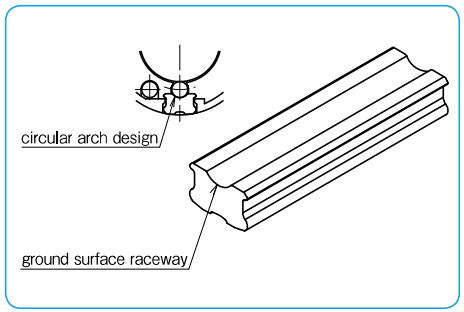
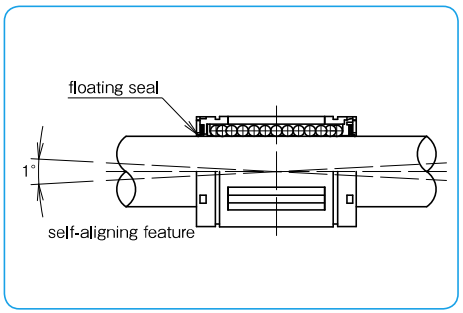



Figure D-2 Floating Seal and Self-aligning Feature








## TYPES

Table D-1 Types

| | | Metric Series | | Inch Series | |
|---|---|---|---|---|---|
| TOPBALL | closed type | TK  P.D-6 | | TW  P.D-8 | |
| | open type | TK-OP  P.D-6 | | TW-OP  P.D-8 | |
| TOPBALL Unit | closed type | TKA  P.D-10 | TKA-W  P.D-11 | TWA  P.D-16 | TWA-W  P.D-17 |
| | adjustable type | | | TWJ  P.D-18 | TWJ-W  P.D-19 |
| | open type | TKE  P.D-12 | TKE-W  P.D-13 | | |
| | adjustable-open type | TKD  P.D-14 | TKD-W  P.D-15 | TWD  P.D-20 | TWD-W  P.D-21 |

# LIFE CALCULATION

Since ball elements are used as the rolling element in the NB TOPBALL, the following equation is used to calculate the rated life.

$$L=\left(\frac{f_H \cdot f_T \cdot f_C}{f_W} \cdot \frac{C}{P}\right)^3 \cdot 50$$

L: rated life (km) $f_H$: hardness coefficient
$f_T$: temperature coefficient $f_C$: contact coefficient
$f_W$: applied load coefficient (Table D-2)
C: basic dynamic load rating (N) P: applied load (N)
*Refer to page Eng-5 for the coefficients.

## Applied Load Coefficient (fw)

When calculating the applied load, the weight of the mass, inertial force, moment resulting from the motion, and the variation with time should be accurately estimated. However, it is very difficult to accurately estimate the applied load due to the existence of numerous variables, including the start/stop conditions of the reciprocating motion and of the shock/vibration. Estimation is simplified by using the values given in Table D-2.

If the stroke and number of cycles per unit time are constant, the life time is calculated using the following equation.

$$L_h=\frac{L \cdot 10^3}{2 \cdot \ell_s \cdot n_1 \cdot 60}$$

$L_h$: life time (hr) $\ell_s$: stroke length (m)
L: rated life (km) $n_1$: number of cycles per minute (cpm)

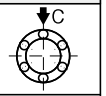
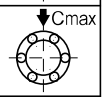
Table D-2 Applied Load Coefficient

| operating conditions | applied load coefficient $f_W$ |
|---|---|
| no shock/vibration<br>15 m/min or less | 1.0~1.5 |
| low shock/vibration<br>60 m/min or less | 1.5~2.0 |
| high shock/vibration<br>90 m/min or less | 2.0~3.5 |
| high shock/vibration<br>180 m/min or less | 3.5 or more |

## Relation Between Ball Circuits and Load Rating

The load rating of a slide bush varies according to the loaded positin on the circumference.
The value in the dimension table indicates the lowest load rating with the load placed on top of one ball circuit.
If the slide bush is used with two ball circuits loaded uniformly, the value will be greater.
Table D-3 shows the load ratio for the number of ball circuits in each case.

Table D-3 Optional Load Positions

| number of rows | 4 | 5 | 6 |
|---|---|---|---|
| C (load rating specified on the table) |  |  |  |
| Cmax (maximum load rating) |  |  |  |
| load ratio Cmax/C | 1.414 | 1.463 | 1.280 |

# MOUNTING

## Clearance and Fit

An appropriate clearance between TOPBALL and shaft is required in TOPBALL operation. Inadequate clearance may cause early failure and/or poor, rough movement. Proper clearance is determined by shaft diameter and housing bore. Table D-4 and D-5 show recommended tolerances of the shaft and housing bore.

## Shaft and Housing

To optimize NB TOPBALL performance, high precision shafts and housings are required.

1. Shaft: Dimensional tolerance, surface roughness and hardness greatly affect the traveling performance of the TOPBALL.
   The shaft must be manufactured to the following tolerances.
   A. Surface roughness of 0.4Ra or less.
   B. Hardness of 60 HRC or more (refer to page Eng-5).
   C. The proper tolerance of the shaft diameter is recommended on Table D-4 and D-5.

The NB Shaft is an ideal component manufactured to meet these specifications. Please see pages F-1 ~ for details.

2. Housing: There are a wide range of designs and manufacturing techniques for housings. NB TOPBALL Units are available as standard products. When housings are prepared separately please refer to Table D-4 and D-5 for a proper fit.



Table D-4: Recommended Tolerance for Shaft Dia. and Housing Bore

| part number | shaft dia. dr mm | shaft dia. tol. (h6) μm | housing bore D mm | housing bore tol. (H7) μm |
|---|---|---|---|---|
| TK 8 | 8 | 0 | 16 | +18/0 |
| TK10 | 10 | −9 | 19 | +21 0 |
| TK12 | 12 | 0 | 22 | |
| TK16 | 16 | −11 | 26 | |
| TK20 | 20 | 0 | 32 | +25 0 |
| TK25 | 25 | −13 | 40 | |
| TK30 | 30 | | 47 | |
| TK40 | 40 | 0 | 62 | +30 0 |
| TK50 | 50 | −16 | 75 | |

Table D-5: Recommended Tolerance for Shaft Dia. and Housing Bore

| part number | shaft dia. dr inch | shaft dia. tol. (g6) inch | housing bore D inch | housing bore tol. (H7) inch |
|---|---|---|---|---|
| TW 3 | .1875 | −.0002 −.0006 | .3750 | +.0005/0 |
| TW 4 | .2500 | | .5000 | +.0007 |
| TW 6 | .3750 | | .6250 | 0 |
| TW 8 | .5000 | −.0002 | .8750 | +.0008 |
| TW10 | .6250 | −.0007 | 1.1250 | 0 |
| TW12 | .7500 | −.0003 | 1.2500 | +.0010 |
| TW16 | 1.0000 | −.0008 | 1.5625 | 0 |
| TW20 | 1.2500 | −.0004 | 2.0000 | +.0012 0 |
| TW24 | 1.5000 | −.0010 | 2.3750 | |
| TW32 | 2.0000 | -.0004/-.0012 | 3.0000 | |

## Mounting

TK type TOPBALL is designed to be press fitted into the housing bore. When inserting bushing, however, don't apply excess force nor shock load which may cause permanent damage. For TW type TOPBALL, examples of mouting are shown in Figures D-3~6 and D-8.

## Examples of Mounting

Figures D-3 to D-8 illustrate mounting methods as example.

Figure D-3 Use of Holding Plates

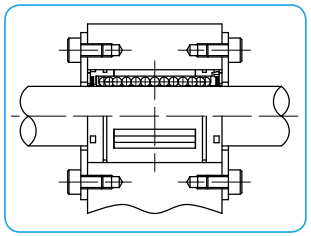


Figure D-4 Clearance Adjustable Type

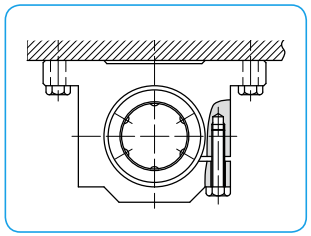


Figure D-5 Use of Retaining Rings

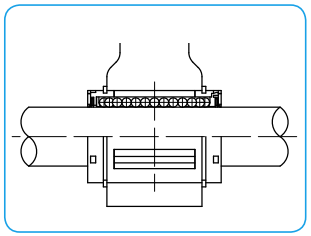


Figure D-6 Open Type

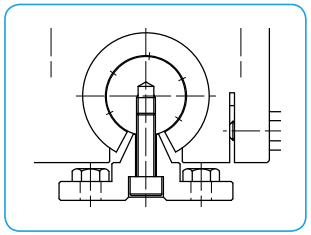


Figure D-7 Press Fit (TK type)

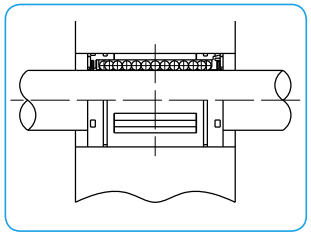
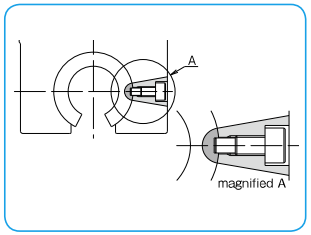


Figure D-8 Pin Fixing




* SA type support rails are not compatible with the TOPBALL units.

* Please fix by the pin for open type housing .

# SPECIFICATION

## Anti-Corrosive Type

A special TOPBALL is also available for anti-corrosive requirements. Please specify with a suffix "-SK" for either TOPBALL or TOPBALL Unit part number. The load plates are electroless nickel plated and balls are made of stainless steel.

# TK TYPE
## – TOPBALL Metric Type –

TK type

TK-OP type

### part number structure

example TK 20 UU -OP -SK

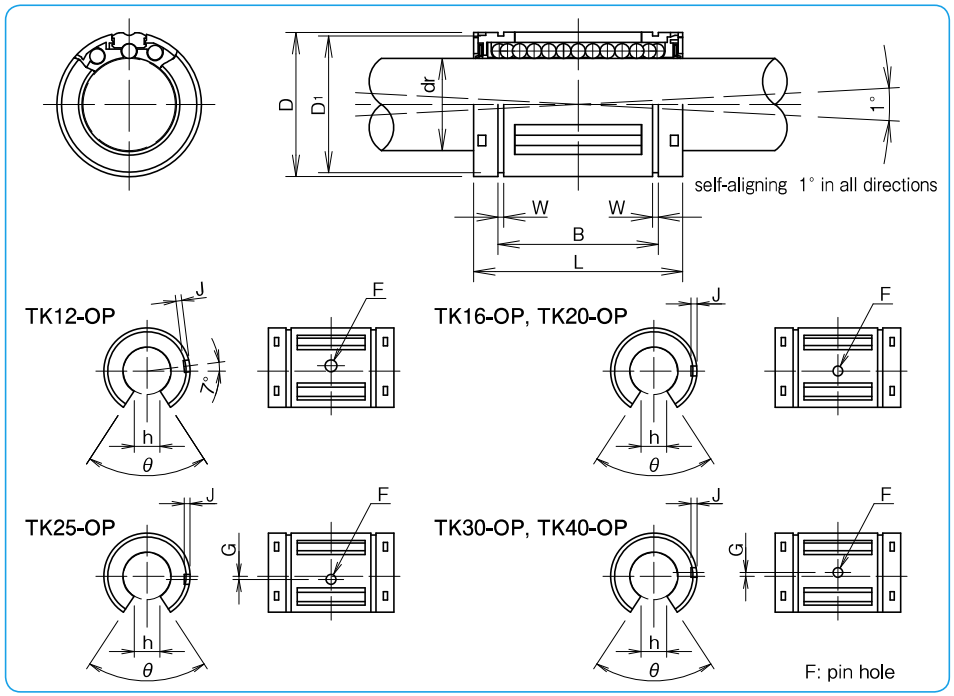
- TK type
- inner contact diameter (dr)
- seal — **blank**: without seal; **UU**: seals on both sides
- **blank**: closed; **OP**: open
- **blank**: standard; **SK**: anti-corrosion※

※For anti-corrosion the load plates are electroless nickel plated with stainless steel balls.

| part number | | | | | | major dimensions | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| closed type | | | open type | | | dr* | | D | L | |
| | number of ball circuits | mass g | | number of ball circuits | mass g | mm | tolerance μm | mm | mm | tolerance mm |
| TK 8 | 4 | 7.3 | – | – | – | 8 | +8 0 | 16 | 25 | ±0.2 |
| TK10 | 5 | 14 | – | – | – | 10 | | 19 | 29 | |
| TK12 | 5 | 21 | TK12-OP | 4 | 17 | 12 | | 22 | 32 | |
| TK16 | 5 | 43 | TK16-OP | 4 | 35 | 16 | +9 −1 | 26 | 36 | |
| TK20 | 6 | 58 | TK20-OP | 5 | 48 | 20 | | 32 | 45 | |
| TK25 | 6 | 123 | TK25-OP | 5 | 103 | 25 | +11 −1 | 40 | 58 | |
| TK30 | 6 | 216 | TK30-OP | 5 | 177 | 30 | | 47 | 68 | |
| TK40 | 6 | 333 | TK40-OP | 5 | 275 | 40 | +13 −2 | 62 | 80 | |
| TK50 | 6 | 618 | TK50-OP | 5 | 520 | 50 | | 75 | 100 | |

* Based on nominal housing bore

** One-sided seal is also available. Please contact NB for details.




| B | | W | D1 | open type | | | | | basic load rating | | shaft diameter |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | h | θ | F H11 | G | J | dynamic | static | |
| mm | tolerance mm | mm | mm | mm | | mm | mm | mm | C N | Co N | mm |
| 16.5 | 0 −0.2 | 1.1 | 15.2 | – | – | – | – | – | 423 | 534 | 8 |
| 22.0 | | 1.3 | 18 | – | – | – | – | – | 750 | 935 | 10 |
| 22.9 | | 1.3 | 21 | 6.5 | 66° | 3 | – | 0.7 | 1,020 | 1,290 | 12 |
| 24.9 | | 1.3 | 24.9 | 9 | 68° | | – | 1.0 | 1,250 | 1,550 | 16 |
| 31.5 | | 1.6 | 30.3 | 9 | 55° | | – | 1.0 | 2,090 | 2,630 | 20 |
| 44.1 | 0 −0.3 | 1.85 | 37.5 | 11.5 | 57° | | 1.5 | 1.5 | 3,780 | 4,720 | 25 |
| 52.1 | | 1.85 | 44.5 | 14 | 57° | | 2 | 1.7 | 5,470 | 6,810 | 30 |
| 60.6 | | 2.15 | 59 | 19.5 | 56° | | 1.5 | 2.4 | 6,590 | 8,230 | 40 |
| 77.6 | | 2.65 | 72 | 22.5 | 54° | 5 | 2.5 | 2.7 | 10,800 | 13,500 | 50 |

1N≒0.102kgf

# TW TYPE
## – TOPBALL Inch Type –

TW type

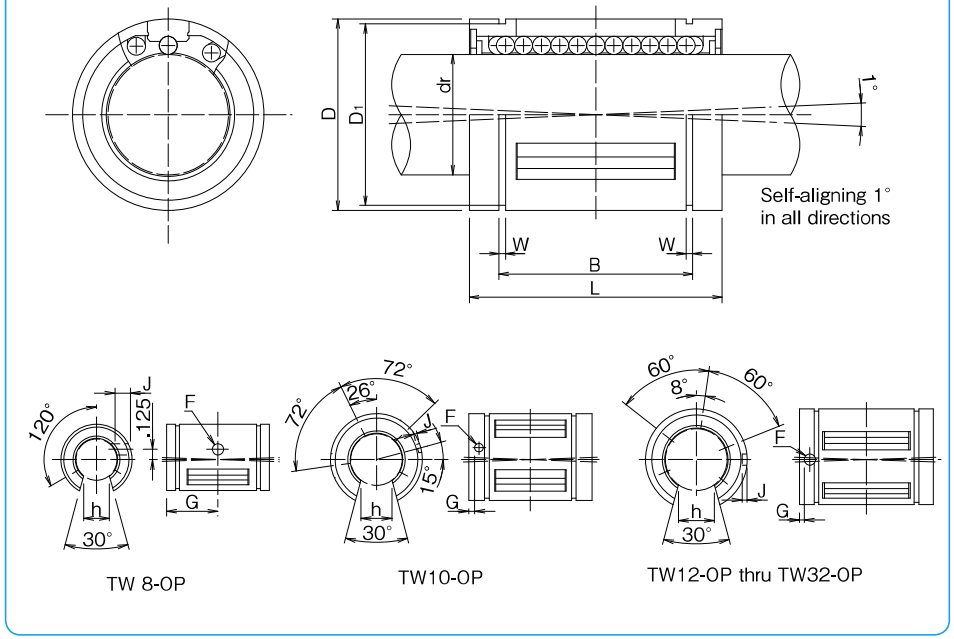
TW-OP type

### part number structure

example TW 20 UU -OP -SK

- TW type
- size
- seal — blank: without seal; UU: seals on both sides
- blank: closed; OP: open
- blank: standard; SK: anti-corrosion※

※For anti-corrosion the load plates are electroless nickel plated with stainless steel balls.




| part number: closed type | number of ball circuits | mass lbs | part number: open type | number of ball circuits | mass lbs | major dimensions: dr* inch | dr* tolerance inch | D inch | L inch | L tolerance inch |
|---|---|---|---|---|---|---|---|---|---|---|
| TW 3 | 4 | .004 | – | – | – | .1875 | | .3750 | .562 | ±.008 |
| TW 4 | 4 | .009 | – | – | – | .2500 | | .5000 | .750 | 0 |
| TW 6 | 4 | .014 | – | – | – | .3750 | | .6250 | .875 | -.015 |
| TW 8 | 4 | .043 | TW 8-OP | 3 | .033 | .5000 | 0 | .8750 | 1.250 | |
| TW 10 | 5 | .103 | TW 10-OP | 4 | .083 | .6250 | -.0005 | 1.1250 | 1.500 | 0 |
| TW 12 | 6 | .123 | TW 12-OP | 5 | .102 | .7500 | | 1.2500 | 1.625 | -020 |
| TW 16 | 6 | .265 | TW 16-OP | 5 | .220 | 1.0000 | | 1.5625 | 2.250 | |
| TW 20 | 6 | .485 | TW 20-OP | 5 | .419 | 1.2500 | 0 | 2.0000 | 2.625 | 0/-.025 |
| TW 24 | 6 | .750 | TW 24-OP | 5 | .639 | 1.5000 | -.0006 | 2.3750 | 3.000 | 0/-.030 |
| TW 32 | 6 | 1.411 | TW 32-OP | 5 | 1.168 | 2.0000 | 0/-.0008 | 3.0000 | 4.000 | 0/-.040 |

* Based on nominal housing bore
** Seals are not available on TW3.
*** One-sided seal is also available. Please contact NB for details.

| B inch | B tolerance inch | W inch | D1 inch | open type: h inch | F inch | G inch | J inch | basic load rating: dynamic C lbf | static Co lbf | nominal shaft diameter inch |
|---|---|---|---|---|---|---|---|---|---|---|
| – | – | – | – | – | – | – | – | 35 | 47 | 3/16 |
| .515 | 0 | .0390 | .4687 | – | – | – | – | 60 | 80 | 1/4 |
| .703 | -.015 | .0390 | .5880 | – | – | – | – | 95 | 120 | 3/8 |
| 1.032 | | .0459 | .8209 | .313 | .136 | .6250 | through | 230 | 290 | 1/2 |
| 1.112 | 0 | .0559 | 1.0590 | .375 | .105 | .1250 | .0390 | 400 | 500 | 5/8 |
| 1.272 | -.020 | .0559 | 1.1760 | .438 | .136 | .1250 | .0590 | 470 | 590 | 3/4 |
| 1.886 | | .0679 | 1.4687 | .563 | .136 | .1250 | .0470 | 850 | 1,060 | 1 |
| 2.011 | 0/-.025 | .0679 | 1.8859 | .625 | .201 | .1875 | .0900 | 1,230 | 1,530 | 1-1/4 |
| 2.422 | 0/-.030 | .0859 | 2.2389 | .750 | .201 | .1875 | .0900 | 1,480 | 1,850 | 1-1/2 |
| 3.206 | 0/-.040 | .1029 | 2.8379 | 1.000 | .265 | .3125 | through | 2,430 | 3,040 | 2 |

1inch=25.4mm
1lbs≒0.454kg
1lbf≒4.448N