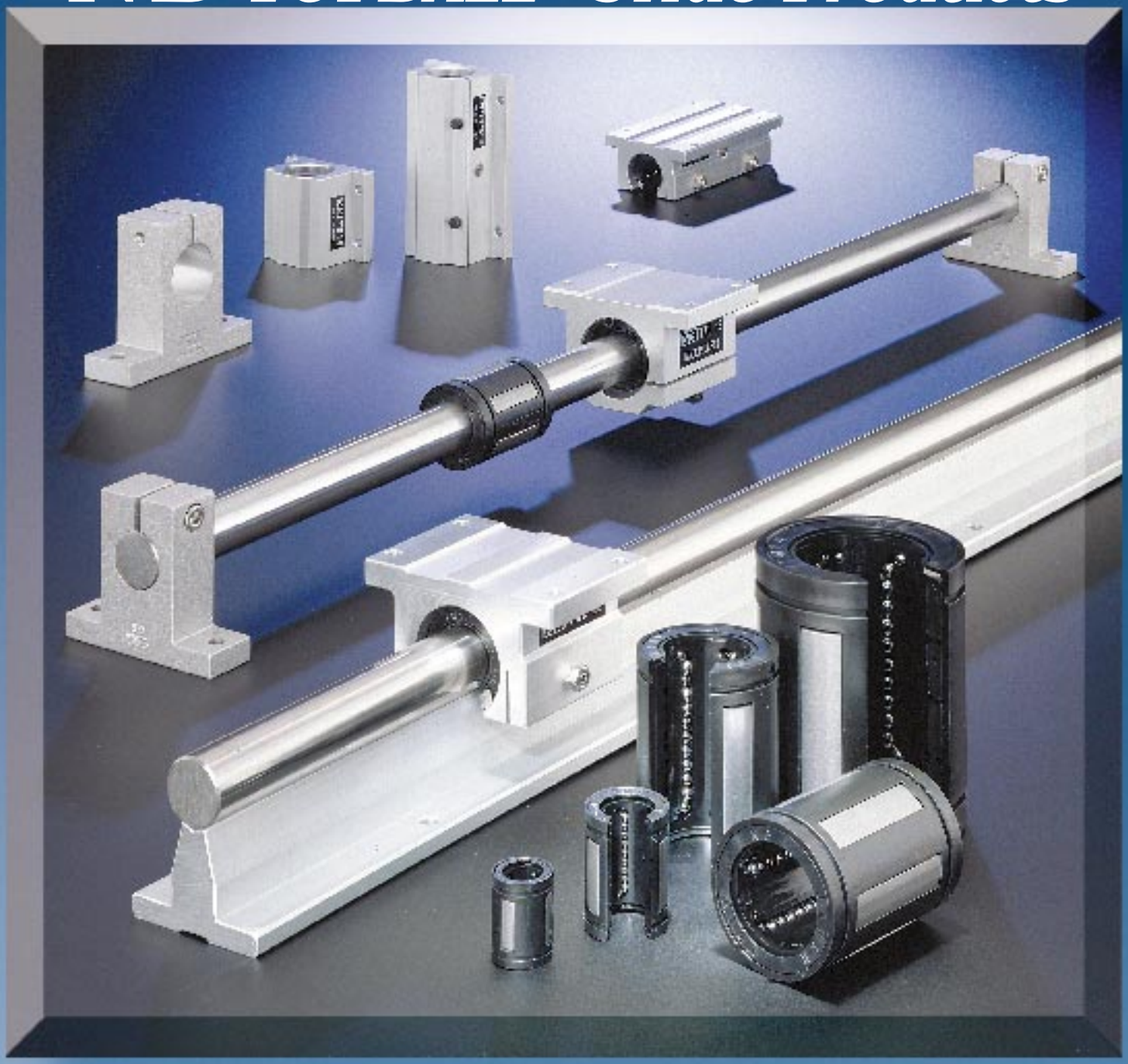
NB *TOPBALL™ Slide Products*



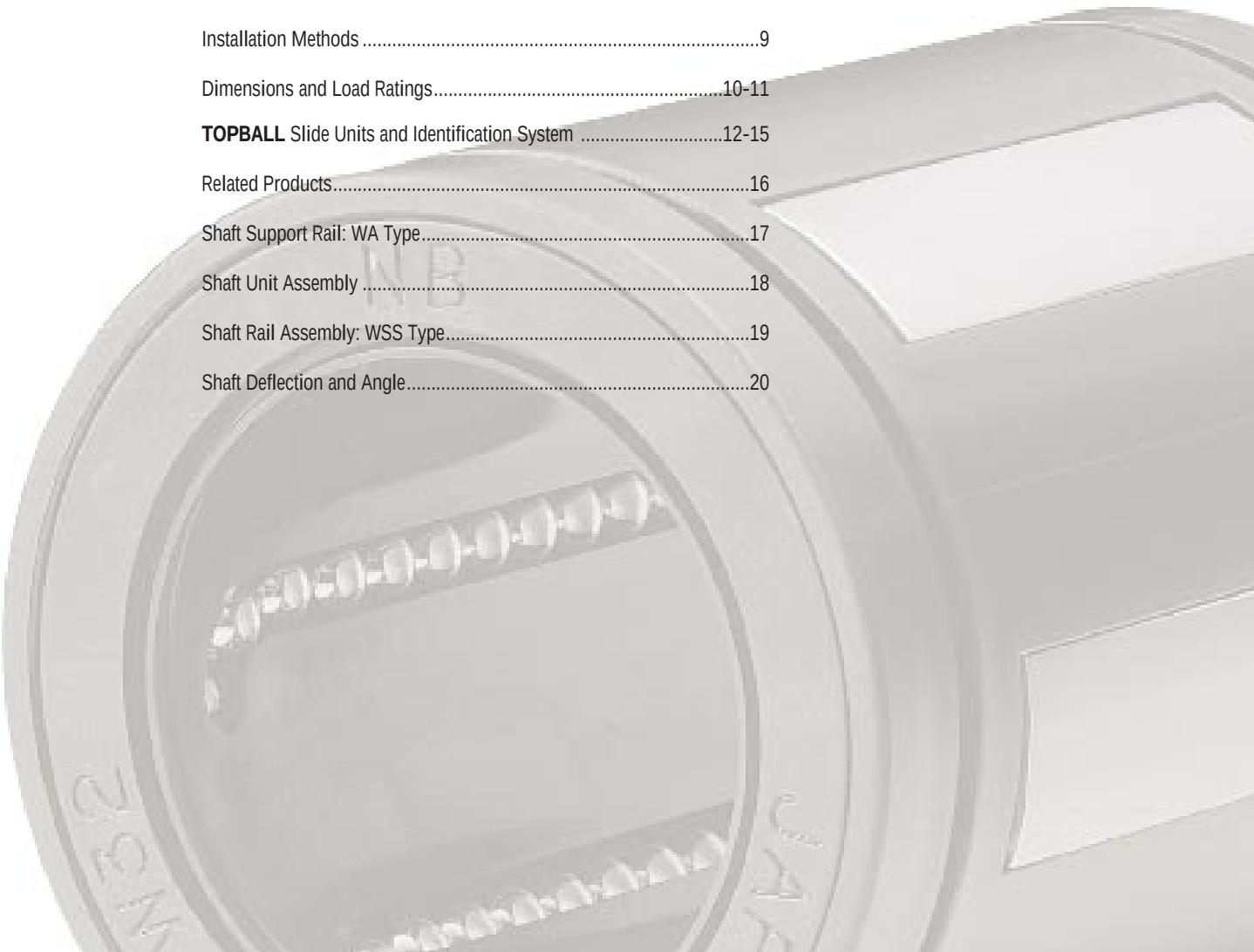
NIPPON
BEARING CO., LTD.

NB
Corporation
of America

NB TOPBALL™ Slide Products

NB TOPBALL slide products are a total related package of linear motion bushings and components designed and manufactured to the most exacting standards. The **TOPBALL** system consists of slide bushings, housings, slide shafts and various supports. The **TOPBALL** system is suitable for either new installations or for retrofitting existing installations. Components are available either individually, or as complete assemblies in standard or custom configurations.

Contents



NB TOPBALL™ Slide Bush

TOPBALL™ Features Include:

- **Increased Load Capacity**
- **Increased Travel Life**
- **Self-Alignment**
- **Floating Integral Wiper Seal**
- **Interchangeability**
- **Clearance Adjustability**
- **Cost Effectiveness**
- **Smooth Running/Low Friction**
- **Low Noise**
- **Light Weight**

Introduction / Design Features

Nippon Bearing Co., Ltd. now offers **TOPBALL** a new standard in linear motion bushings. The **TOPBALL** Slide Bush is a high performance bushing with three times the load capacity, capable of providing up to 27 times the normal travel life of a conventional slide bushing.

TOPBALL is available in a variety of configurations to fit various service conditions. **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.

In the early stages of **NB**'s development of **TOPBALL**, careful thought and consideration was given to such factors as quality, cost, performance and interchangeability. The results of these efforts are reflected in the **TOPBALL** features.

- **Increased Load Capacity**
  NB's uniquely designed ground load plate provides circular arch contact to the ball resulting in a greater dispersion of the load, enabling **TOPBALL** to provide three times the load capacity of conventional slide bushings. (See Fig. 1)

- **Longer Travel Life**
  Dispersed stress on the load plate provides **TOPBALL** up to 27 times the travel life of conventional slide bushings. (See Fig. 1)

- **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. (See Fig. 2)

- **Floating Integral Wiper Seal**
  Seals are made of oil resistant industrial grade rubber for long life and durability. **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. (See Fig. 2)

- **Interchangeability**
  NB has designed **TOPBALL** to be fully interchangeable with conventional slide bushings.

- **Clearance Adjustable**
  TOPBALL load plates are designed to "float" in the outer sleeve which allows for clearance between the balls and shaft to best suit application requirements. **TOPBALL** is also available in **NB**'s "adjustable" slide unit housing.

- **Cost Effectiveness**
  TOPBALL's higher load capacity and longer travel life enables the use of smaller components such as bushings, housings and shafts, reducing material cost and the overall cost of the system. Longer travel life also extends replacement periods and reduces maintenance cost.

- **Smooth Running Low Friction**
  TOPBALL is extremely smooth running due to the finely ground surface of the load plate. Self-alignment creates a smoother-running surface from shaft to load plate raceway. (See Fig. 1)

- **Low Noise**
  Sound absorbing resin retainers and outer-sleeves enable **TOPBALL** to operate quietly. **TOPBALL** is excellent for low noise applications.

- **Light Weight**
  TOPBALL's outer sleeve and retainer are made of high performance resin that is light weight and exceptionally rigid. **TOPBALL**'s light weight allows users the advantages of higher operating speeds and greater acceleration compared to conventional slide bushings.

Fig. 1 Illustrating circular arch design and ground surface raceway

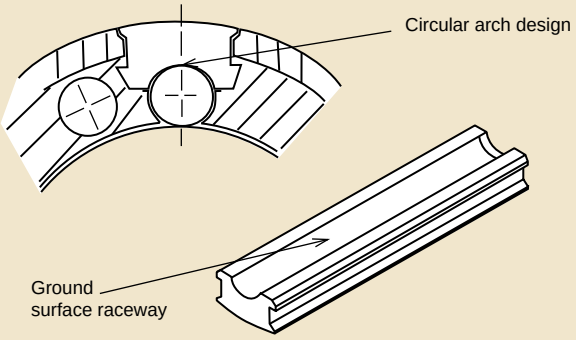
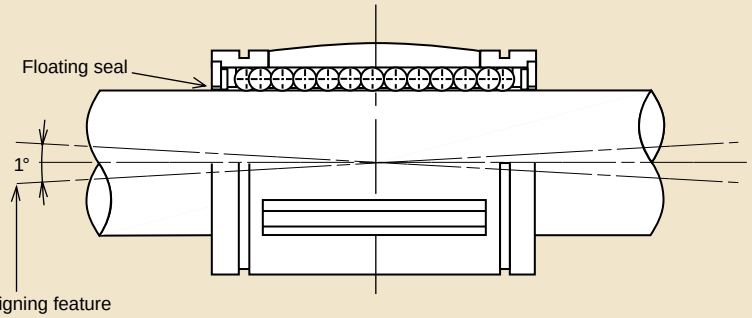


Fig. 2 Illustrating floating seal and self-aligning feature



TOPBALL™ Slide Bush Types

Standard Type

Floating load plate design features adjustable clearance, self-alignment ability and a light weight outer ring and retainer for low noise operation.

Open Type

One ball circuit is removed from the outer cylinder enabling it to be used with bottom supported shaft to eliminate shaft deflection. The open type **TOPBALL** is also considered clearance adjustable.

Sealed Type

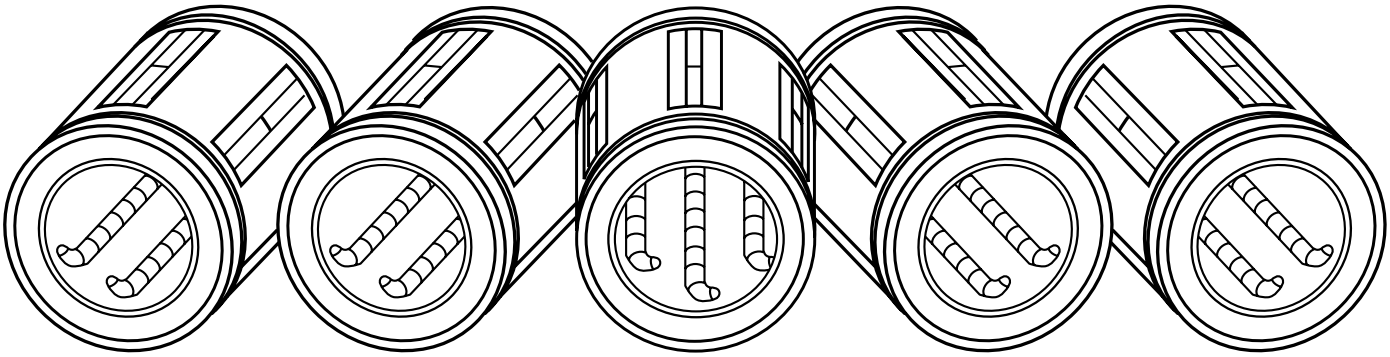
NB's unique integral seal design creates a free floating action of the wiper seal apart from the bushing itself, providing extremely smooth operation. All **TOPBALL** types are available with this feature, and in all sizes.

Anti-Corrosive Type

A special **TOPBALL** is also available for corrosive applications. Contact your nearest distributor for application information, price and delivery.

TOPBALL™ Slide Bush Identification System

SERIES	TYPE / DESIGN	STANDARD	OPEN
TW INCH DIMENSION	NO SEAL	TW	TW. . .OP
	SEALS ON BOTH ENDS ENDS	TW. . .UU	TW. . .UU-OP



T W 32 UU OP

Type

T	TOPBALL SERIES

Series

W	INCH DIMENSION SERIES

Size

INSCRIBED CIRCLE DIAMETER	4	6	8	10	12	16	20	24	32
CORRESPONDING INCH DIMENSION	.250	.375	.500	.625	.750	1.000	1.250	1.500	2.000

Seal

SYMBOL	
NO ENTRY	NO SEAL
UU	SEALS ON BOTH ENDS

Modification

SYMBOL	
NO ENTRY	STANDARD TYPE
OP	OPEN TYPE

Slide Bush Life

The life of a slide bush can be easily calculated with the load rating of the bush, shaft hardness and applicable load. However, in many cases, slide bushing failure may be caused by improper design of bush peripherals, including the shaft and housing, inappropriate mounting or improper operation. Serious consideration of these peripheral factors, in addition to load rating, are highly recommended when designing a slide bush application.

Basic Dynamic Load Rating and Life Expectancy

The basic dynamic load rating is the load which allows a rating life of 2-million inches (50 km), without changing its magnitude and direction. The rating life can be obtained from the following equation.

$$L = \left(\frac{C}{P}\right)^3 \cdot 2 \times 10^6 \qquad \text{Equation (1)}$$

L: Rating life (inches)

C: Basic dynamic load rating (lbs.)

P: Load (lbs.)

Chart 1 shows the relationship between Life (L) and load ratio (C/P). In the practical use of a bushing, other factors that affect the life, such as shaft hardness and load condition should be considered. The equation for calculating bushing life considering these additional factors is:

$$L = \left(\frac{f_h}{f_w} \cdot \frac{C}{P}\right)^3 \cdot 2 \times 10^6 \qquad \text{Equation (2)}$$

f_h: Hardness factor (See Chart 2)

f_W: Load coefficient (See Table 1)

Rating life in hours can be calculated by obtaining the travelling distance per unit of time as follows:

$$Lh = \frac{L}{2 \cdot Ls \cdot N1 \cdot 60} \qquad \text{Equation (3)}$$

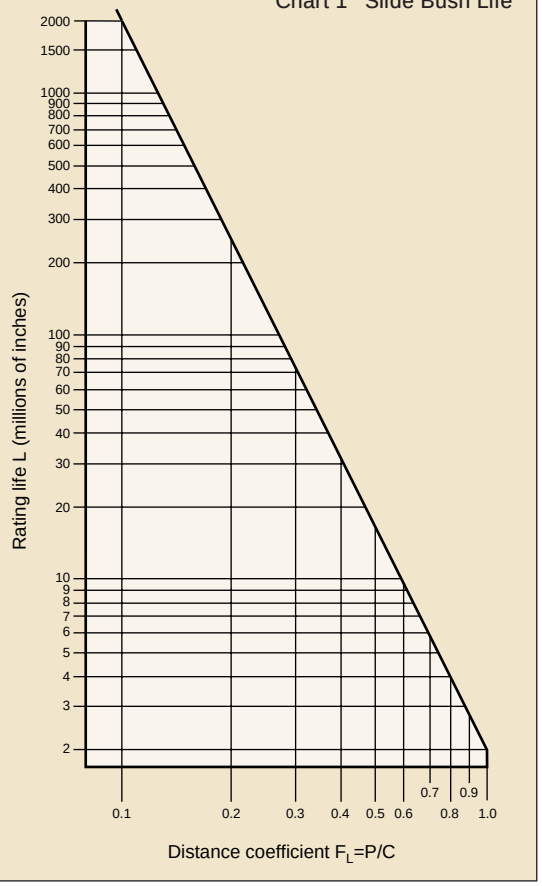
Lh: Rating life in hours (hr.)

Ls: Stroke length (in.)

N1: Rate of cycles per minute

L: Rating life (in.)

Chart 1 Slide Bush Life



Load Coefficient (f_W)

When calculating the bush load, it is necessary to accurately obtain weight, inertial force based on speed, moment load and each transition as time passes. However, it is difficult to calculate those values accurately because reciprocating motion involves the repetition of starts and stops as well as vibration and impact. A more practical approach is to obtain the load coefficient by taking the actual operating conditions into account.

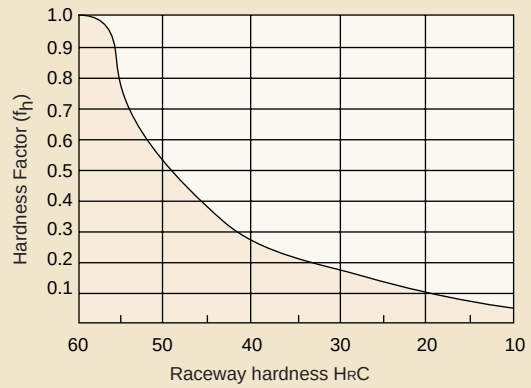
Table 1 Load Coefficient

OPERATING CONDITIONS	f_W
Operation at low speed (600 in./min. or less) without impulsive shock from outside	1 - 1.5
Operation at intermediate speed (2400 in./min. or less) without impulsive shock	1.5 - 2.0
Operation at high speed (over 2400 in./min.) with impulsive shock	2.0 - 3.5

Hardness Factor (fh)

The shaft must be hardened to 60-65 HRC when a slide bush is used. If not properly hardened, permissible load is lowered and the life of the bushing will be shortened.

Chart 2 Hardness factor (f_h)



Examples of Calculations:

(1) Life expectancy when **NB**'s **TOPBALL** TW 16 (1") is used under the following conditions:

Load per bush: 150 lbs.
Stroke distance: 8 inches
Rate of cycles/min: 35
Shaft hardness: 60 HRC

From Table 4 (Page 10) the basic dynamic load of TW 16 is 850 lbs. Hardness factor (f_h) is 1.0, and the operating speed can be calculated as 560"/min. Therefore, the load coefficient (f_W) is considered as 1.0.

Using equation (2)

$$L = \left(\frac{850}{1 \bullet 150}\right)^3 \bullet 2 \times 10^6 = 3.64 \times 10^8 \text{ inches}$$

Using equation (3)

$$Lh = \frac{3.64 \times 10^8}{2 \bullet 8 \bullet 35 \bullet 60} = 10{,}800 \text{ hours}$$

(2) Selection of size for the application as follows:

Expected life: 15,000 hours
Number of bushings in the carriage: 4
Gross weight on the carriage: 150 lbs.
Stroke distance: 36 inches
Traveling speed: 1200 inches/min.
Shaft hardness: 60-64 HRC

From equation (3), the life expected in traveling distance is:

$$L = 15{,}000 \bullet 2 \bullet 36 \bullet \frac{1200}{2 \bullet 36} \bullet 60$$

$$= 108 \times 10^9 \text{ inches}$$

$$C = \sqrt[3]{\frac{108 \times 10^9}{2 \times 10^6}} \bullet \left(\frac{f_w}{f_h}\right) \bullet P = 458 \text{ lbs}$$

From the equation (2),

Note that: f_h = 1.0, f_W = 1.5, P = 150/4 = 37.5 lbs.

As a result, the **TOPBALL** that is able to handle this load is: TW 12 (3/4").

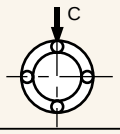
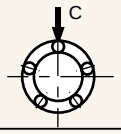
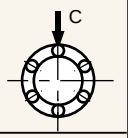
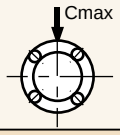
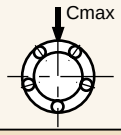
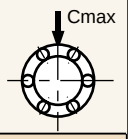
Basic Static Load Rating

If a slide bush is loaded when it is in a stationary condition or working at low speed, a permanent elastic deformation is formed on the rolling element. The deformation prevents smooth movement of the bushing. To eliminate this possibility, the basic static load rating must not be exceeded.

Relation Between Ball Circuits and Load Rating

The load rating of a slide bush varies according to the loaded position on the circumference. The value in the dimensional 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. The table to the right (Table 2) shows the load ratio for the number of ball circuits in each case.

Table 2 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

Clearance and Fit

An appropriate clearance between the slide bush 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 3 shows **NB**'s recommended tolerances of the shaft diameter and housing bore in order to maintain the appropriate clearance.

Table 3 Recommended Tolerance for Shaft O.D. and Housing Bore (Inch)

SIZE	SHAFT DIAMETER		HOUSING BORE	
	NOMINAL DIAMETER	TOLERANCE (g6)	NOMINAL BORE	TOLERANCE (H7)
TW 4	.2500	-.0002 to -.0006	.5000	0 to + .0007
TW 6	.3750	-.0002 to -.0006	.6250	0 to + .0007
TW 8	.5000	-.0002 to -.0007	.8750	0 to + .0008
TW 10	.6250	-.0002 to -.0007	1.1250	0 to + .0008
TW 12	.7500	-.0003 to -.0008	1.2500	0 to + .0010
TW 16	1.0000	-.0003 to -.0008	1.5625	0 to + .0010
TW 20	1.2500	-.0004 to -.0010	2.0000	0 to + .0012
TW 24	1.5000	-.0004 to -.0010	2.3750	0 to + .0012
TW 32	2.0000	-.0004 to -.0012	3.0000	0 to + .0012

Shaft and Housing

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

1. Shaft: Dimensional tolerance, surface finish and hardness greatly affect the traveling performance of the **TOPBALL**. The shaft must be manufactured to the following tolerances.

A. A surface finish of 16 micro-inch rms or less.

B. Hardness of HRC 60 to 64. Hardness less than HRC 60 decreases the life considerably and reduces the permissible load. Hardness over HRC 64 accelerates steel ball wear.

C. Case-hardened depth should be a minimum of .04 inches.

D. The correct tolerance of the shaft diameter is recommended on Table 3 (Page 8).

The **NB** Slide Shaft is an ideal component manufactured to these specifications. For details, please refer to the **NB** Slide Shaft catalog.

2. Housing: There are a wide range of designs and manufacturing techniques for mounted housings. **NB** pre-engineered slide units are also available. For proper fit, refer to Table 3 (Page 8).

Mounting

TOPBALL is designed to be slip fitted. Do not use extreme force when inserting bushing. Any shock load to the bushing may cause permanent damage.

Examples of Mounting

The following examples (Figs. 3 to 6) illustrate assembly of the inserted bush as they should be designed and mounted.

Fig. 3 Use of holding plates

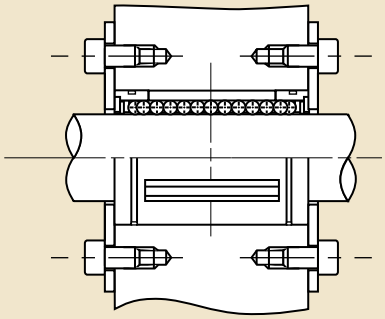


Fig. 4 Adjustable type housing

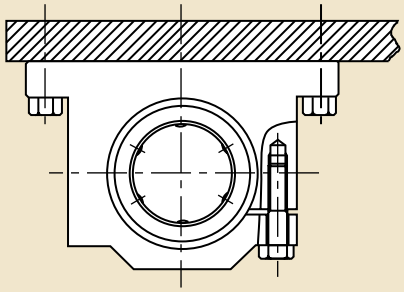


Fig. 5 Use of external retaining rings

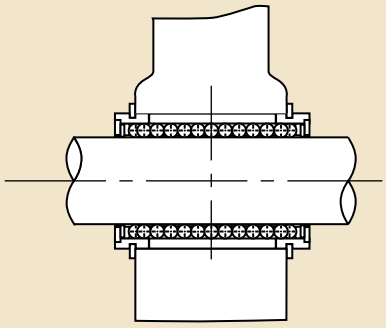
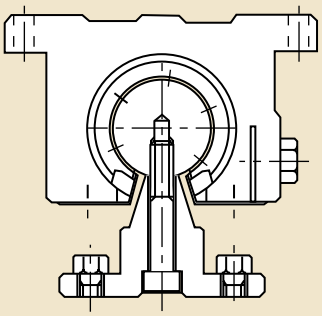


Fig. 6 Open type housing



Dimensions and Load Ratings
TOPBALL™ Standard Type

Fig. 7 Standard Type TOPBALL Slide Bush

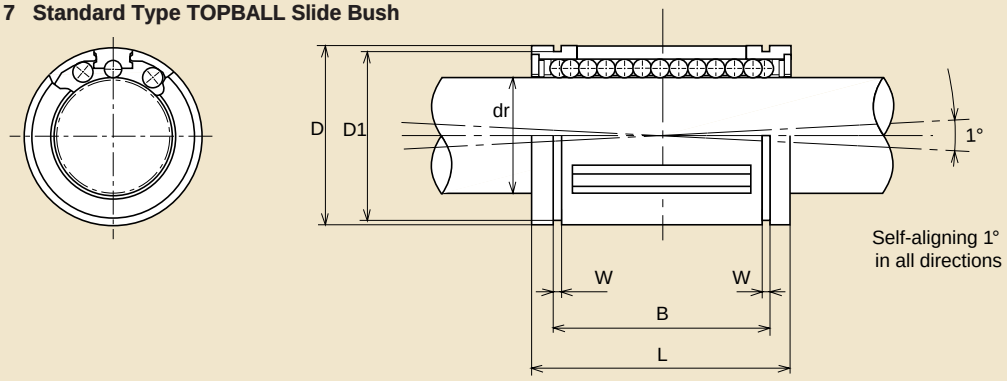


Table 4 Standard Type Dimensions and Load Ratings

NOM. SHAFT DIA. (inch)	P/N STANDARD & W/SEALS	WORKING DIAMETER (1)		NOM. O.D. (3)	LENGTH		RETAINING RINGS				BALL DIA. (inch)	NO. OF ROWS	LOAD RATINGS (2)		Wt. (lbs.)
							DISTANCE		WIDTH	DIA.			DYNAMIC	STATIC	
		dr (inch)	TOL (inch)	D (inch)	L (inch)	TOL (inch)	B (inch)	TOL (inch)	W (inch)	D1 (inch)			C (lbs.)	C_0 (lbs.)	
1/4	TW 4 TW 4UU	0.2500	0.0000 -0.0005	0.5000	0.750	0.000 -0.015	0.515	0.000 -0.015	0.0390	0.4687	1/16	4	60	80	0.008 0.009
3/8	TW 6 TW 6UU	0.3750	0.0000 -0.0005	0.6250	0.875	0.000 -0.015	0.703	0.000 -0.015	0.0390	0.5880	1/16	4	95	120	0.013 0.014
1/2	TW 8 TW 8UU	0.5000	0.0000 -0.0005	0.8750	1.250	0.000 -0.020	1.032	0.000 -0.020	0.0459	0.8209	3/32	4	230	290	0.042 0.043
5/8	TW 10 TW 10UU	0.6250	0.0000 -0.0005	1.1250	1.500	0.000 -0.020	1.112	0.000 -0.020	0.0559	1.0590	1/8	5	400	500	0.101 0.103
3/4	TW 12 TW 12UU	0.7500	0.0000 -0.0005	1.2500	1.625	0.000 -0.020	1.272	0.000 -0.020	0.0559	1.1760	1/8	6	470	590	0.123 0.123
1	TW 16 TW 16UU	1.0000	0.0000 -0.0005	1.5625	2.250	0.000 -0.020	1.886	0.000 -0.020	0.0679	1.4687	5/32	6	850	1060	0.265 0.265
1-1/4	TW 20 TW 20UU	1.2500	0.0000 -0.0006	2.0000	2.625	0.000 -0.025	2.011	0.000 -0.025	0.0679	1.8859	3/16	6	1230	1530	0.485 0.485
1-1/2	TW 24 TW 24UU	1.5000	0.0000 -0.0006	2.3750	3.000	0.000 -0.030	2.422	0.000 -0.030	0.0859	2.2389	7/32	6	1480	1850	0.750 0.750
2	TW 32 TW 32UU	2.0000	0.0000 -0.0008	3.0000	4.000	0.000 -0.040	3.206	0.000 -0.040	0.1029	2.8379	1/4	6	2430	3040	1.389 1.411

(1) Based on nominal housing bore.
(2) See Table 2 for maximum load rating.
(3) See Table 3 for recommended tolerances.

Dimensions and Load Ratings
TOPBALL™ Open Type

Fig. 8 TW 8 OP

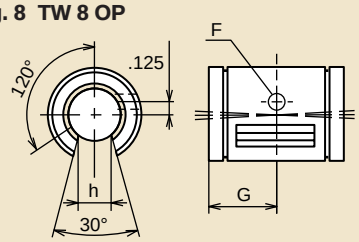


Fig. 9 TW 10 OP

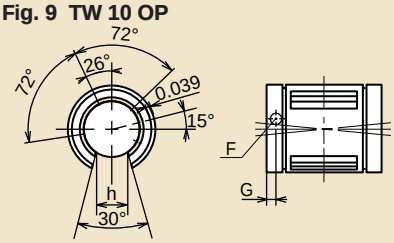


Fig. 10 TW 8 OP through TW 12 OP

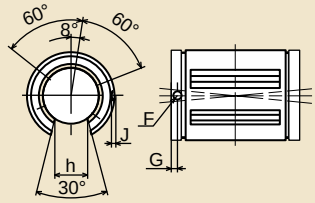


Table 5 Open Type Dimensions and Load Ratings

NOM. SHAFT DIA. (inch)	P/N OPEN & W/SEALS	WORKING DIAMETER (1)		NOM. O.D. (3)	LENGTH		RETAINING RINGS			
							DISTANCE		WIDTH	DIA.
		dr (inch)	TOL (inch)	D (inch)	L (inch)	TOL (inch)	B (inch)	TOL (inch)	W (inch)	D1 (inch)
1/2	TW 8-OP TW 8 UU-OP	0.5000	0.0000 -0.0005	0.8750	1.250	0.000 -0.020	1.032	0.000 -0.020	0.0459	0.8209
5/8	TW 10-OP TW 10 UU-OP	0.6250	0.0000 -0.0005	1.1250	1.500	0.000 -0.020	1.112	0.000 -0.020	0.0559	1.0590
3/4	TW 12-OP TW 12 UU-OP	0.7500	0.0000 -0.0005	1.2500	1.625	0.000 -0.020	1.272	0.000 -0.020	0.0559	1.1760
1	TW 16-OP TW 16 UU-OP	1.0000	0.0000 -0.0005	1.5625	2.250	0.000 -0.020	1.886	0.000 -0.020	0.0679	1.4687
1-1/4	TW 20-OP TW 20 UU-OP	1.2500	0.0000 0.0006	2.0000	2.625	0.000 -0.025	2.011	0.000 -0.025	0.0679	1.8859
1-1/2	TW 24-OP TW 24 UU-OP	1.5000	0.0000 -0.0006	2.3750	3.000	0.000 -0.030	2.422	0.000 -0.030	0.0859	2.2389
2	TW 32-OP TW 32 UU-OP	2.0000	0.0000 -0.0008	3.0000	4.000	0.000 -0.040	3.206	0.000 -0.040	0.1029	2.8379

Table 5 Continued

NOM. SHAFT DIA. (inch)	P/N OPEN & W/SEALS	SLOT WIDTH h (inch)	RETENTION HOLE			BALL DIA. (inch)	NO. OF ROWS	LOAD RATINGS (2)		Wt. (lbs.)
			DIA.	LOC.	DEPTH			DYNAMIC	STATIC	
			F (inch)	G (inch)	J (inch)			C (lbs.)	C_0 (lbs.)	
1/2	TW 8-OP TW 8 UU-OP	0.313	0.136	0.6250	Thru hole	3/32	3	230	290	0.033 0.033
5/8	TW 10-OP TW 10 UU-OP	0.375	0.105	0.1250	0.0390	1/8	4	400	500	0.082 0.083
3/4	TW 12-OP TW 12 UU-OP	0.438	0.136	0.1250	0.0590	1/8	5	470	590	0.101 0.102
1	TW 16-OP TW 16 UU-OP	0.563	0.136	0.1250	0.0470	5/32	5	850	1060	0.220 0.220
1-1/4	TW 20-OP TW 20 UU-OP	0.625	0.201	0.1875	0.0900	3/16	5	1230	1530	0.397 0.419
1-1/2	TW 24-OP TW 24 UU-OP	0.750	0.201	0.1875	0.0900	7/32	5	1480	1850	0.617 0.639
2	TW 32-OP TW 32 UU-OP	1.000	0.265	0.3125	Thru hole	1/4	5	2430	3040	1.146 1.168

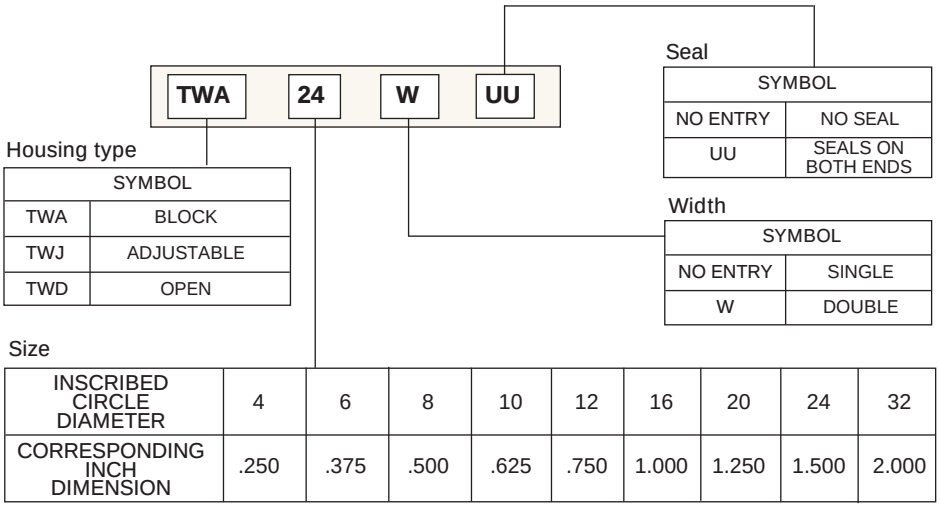
(1) Based on nominal housing bore.
(2) See Table 2 for maximum load rating.
(3) See Table 3 for recommended tolerances.

Introduction/Design Features

NB TOPBALL Slide Units include a clear anodized corrosion resistant aluminum block and either one or two **TOPBALL** self-aligning slide bushings. Closed and adjustable clearance styles incorporate machined snap ring grooves in combination with standard retaining rings for slide bush retention. The open style incorporates bottom plates and mounting screws to retain bushing in proper position. All styles are provided with standard machined reference edges for proper alignment and installation.

WIDE / SPECIFICATION		HOUSING TYPE		
		BLOCK	ADJUSTABLE	OPEN
SINGLE	SINGLE; • Conventional Type • Self-Aligning Capability • High Load Capacity compared with SW type units	TWA 	TWJ 	TWD 
DOUBLE	DOUBLE; • Compact Tandem Design • Oiling feature available • Double Capacity compared with single type units	TWA-W 	TWJ-W 	TWD-W 

TOPBALL™ Slide Unit Identification System



TWA Block Type

Fig. 11 Block type slide unit

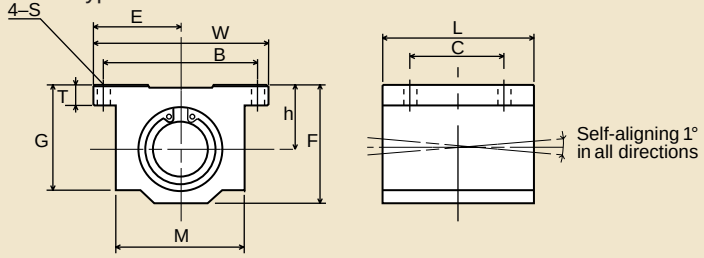


Table 6 Block Type Dimensions and Load Ratings

NB PART NUMBER	NOM. SHAFT DIA. (inch)	MAIN DIMENSIONS (inch)								MOUNTING DIMENSIONS (inch)			LOAD RATING		Wt. (lbs.)
													DYNAMIC	STATIC	
		h ± .0012	E ± .0012	W	L	F	T	G	M	B ± .01	C ± .01	S	C (lbs.)	C0 (lbs.)	
TWA 4UU	1/4	.4370	.8125	1.625	1.188	.813	.188	.750	1.000	1.312	.750	.156	60	80	.090
TWA 6UU	3/8	.5000	.8750	1.750	1.313	.938	.188	.875	1.125	1.437	.875	.156	95	120	.120
TWA 8UU	1/2	.6870	1.0000	2.000	1.688	1.250	.250	1.125	1.375	1.688	1.000	.156	230	290	.248
TWA 10UU	5/8	.8750	1.2500	2.500	1.938	1.625	.281	1.437	1.750	2.125	1.125	.188	400	500	.465
TWA 12UU	3/4	.9370	1.3750	2.750	2.063	1.750	.313	1.563	1.875	2.375	1.250	.188	470	590	.553
TWA 16UU	1	1.1870	1.6250	3.250	2.813	2.188	.375	1.938	2.375	2.875	1.750	.219	850	1060	1.200
TWA 20UU	1-1/4	1.5000	2.0000	4.000	3.625	2.813	.438	2.500	3.000	3.500	2.000	.219	1230	1530	2.380
TWA 24UU	1-1/2	1.7500	2.3750	4.750	4.000	3.250	.500	2.875	3.500	4.125	2.500	.281	1480	1850	3.460
TWA 32UU	2	2.1250	3.0000	6.000	5.000	4.063	.625	3.625	4.500	5.250	3.250	.406	2430	3040	6.830

Fig. 12 Double-wide block type slide unit

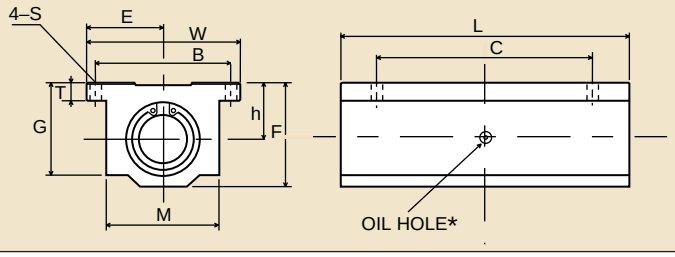


Table 7 Double-Wide Block Type Dimensions and Load Ratings

NB PART NUMBER	NOM. SHAFT DIA. (inch)	MAIN DIMENSIONS (inch)								MOUNTING DIMENSIONS (inch)			LOAD RATING		Wt. (lbs.)
													DYNAMIC	STATIC	
		h ±.0012	E ±.0012	W	L	F	T	G	M	B ±.01	C ±.01	S	C (lbs.)	C0 (lbs.)	
TWA 4WUU	1/4	.4370	.8125	1.625	2.500	.813	.188	.750	1.000	1.312	2.000	.156	96	160	.190
TWA 6WUU	3/8	.5000	.8750	1.750	2.750	.938	.188	.875	1.125	1.437	2.250	.156	150	240	.250
TWA 8WUU	1/2	.6870	1.0000	2.000	3.500	1.250	.250	1.125	1.375	1.688	2.500	.156	370	580	.510
TWA 10WUU	5/8	.8750	1.2500	2.500	4.000	1.625	.281	1.437	1.750	2.125	3.000	.188	640	1000	1.000
TWA 12WUU	3/4	.9370	1.3750	2.750	4.500	1.750	.313	1.563	1.875	2.375	3.500	.188	750	1180	1.200
TWA 16WUU	1	1.1870	1.6250	3.250	6.000	2.188	.375	1.938	2.375	2.875	4.500	.219	1360	2120	2.400
TWA 20WUU	1-1/4	1.5000	2.0000	4.000	7.500	2.813	.438	2.500	3.000	3.500	5.500	.219	1970	3060	5.000
TWA 24WUU	1-1/2	1.7500	2.3750	4.750	9.000	3.250	.500	2.875	3.500	4.125	6.500	.281	2370	3700	7.800

*Provided with push-in oil fitting for 1/4" to 1/2" sizes. Sizes from 5/8" to 2" offer a 1/4-28 tapped hole with a plug for adding a fitting if desired.

TWJ Adjustable Type

Fig. 13 Adjustable Type Slide Unit

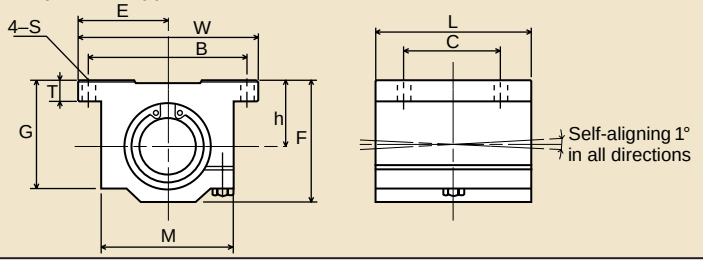


Table 8 Adjustable Type Dimensions and Load Ratings

NB PART NUMBER	NOM. SHAFT DIA. (inch)	MAIN DIMENSIONS (inch)								MOUNTING DIMENSIONS (inch)			LOAD RATING		Wt. (lbs.)
													DYNAMIC	STATIC	
		h ± .0012	E ± .0012	W	L	F	T	G	M	B ± .01	C ± .01	S	C (lbs.)	C0 (lbs.)	
TWJ 4 UU	1/4	.4370	.8125	1.625	1.188	.813	.188	.750	1.000	1.312	.750	.156	60	80	.090
TWJ 6 UU	3/8	.5000	.8750	1.750	1.313	.938	.188	.875	1.125	1.437	.875	.156	95	120	.120
TWJ 8 UU	1/2	.6870	1.0000	2.000	1.688	1.250	.250	1.125	1.375	1.688	1.000	.156	230	290	.248
TWJ 10 UU	5/8	.8750	1.2500	2.500	1.938	1.625	.281	1.437	1.750	2.125	1.125	.188	400	500	.465
TWJ 12 UU	3/4	.9370	1.3750	2.750	2.063	1.750	.313	1.563	1.875	2.375	1.250	.188	470	590	.553
TWJ 16 UU	1	1.1870	1.6250	3.250	2.813	2.188	.375	1.938	2.375	2.875	1.750	.219	850	1060	1.200
TWJ 20 UU	1-1/4	1.5000	2.0000	4.000	3.625	2.813	.438	2.500	3.000	3.500	2.000	.219	1230	1530	2.380
TWJ 24 UU	1-1/2	1.7500	2.3750	4.750	4.000	3.250	.500	2.875	3.500	4.125	2.500	.281	1480	1850	3.460
TWJ 32 UU	2	2.1250	3.0000	6.000	5.000	4.063	.625	3.625	4.500	5.250	3.250	.406	2430	3040	6.830

Fig. 14 Double-wide Adjustable Type Slide Unit

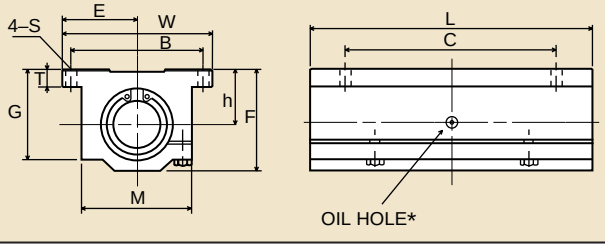


Table 9 Double-Wide Adjustable Type Dimensions and Load Ratings

NB PART NUMBER	NOM. SHAFT DIA. (inch)	MAIN DIMENSIONS (inch)								MOUNTING DIMENSIONS (inch)			LOAD RATING		Wt. (lbs.)
													DYNAMIC	STATIC	
		h ±.0012	E ±.0012	W	L	F	T	G	M	B ±.01	C ±.01	S	C (lbs.)	C0 (lbs.)	
TWJ 4WUU	1/4	.4370	.8125	1.625	2.500	.813	.188	.750	1.000	1.312	2.000	.156	96	160	.190
TWJ 6WUU	3/8	.5000	.8750	1.750	2.750	.938	.188	.875	1.125	1.437	2.250	.156	150	240	.250
TWJ 8WUU	1/2	.6870	1.0000	2.000	3.500	1.250	.250	1.125	1.375	1.688	2.500	.156	370	580	.510
TWJ 10WUU	5/8	.8750	1.2500	2.500	4.000	1.625	.281	1.437	1.750	2.125	3.000	.188	640	1000	1.000
TWJ 12WUU	3/4	.9370	1.3750	2.750	4.500	1.750	.313	1.563	1.875	2.375	3.500	.188	750	1180	1.200
TWJ 16WUU	1	1.1870	1.6250	3.250	6.000	2.188	.375	1.938	2.375	2.875	4.500	.219	1360	2120	2.400
TWJ 20WUU	1-1/4	1.5000	2.0000	4.000	7.500	2.813	.438	2.500	3.000	3.500	5.500	.219	1970	3060	5.000
TWJ 24WUU	1-1/2	1.7500	2.3750	4.750	9.000	3.250	.500	2.875	3.500	4.125	6.500	.281	2370	3700	7.800

*Provided with push-in oil fitting for 1/4" to 1/2" sizes. Sizes from 5/8" to 2" offer a 1/4-28 tapped hole with a plug for adding a fitting if desired.

TWD Open Type

Fig. 15 Open Type Slide Unit

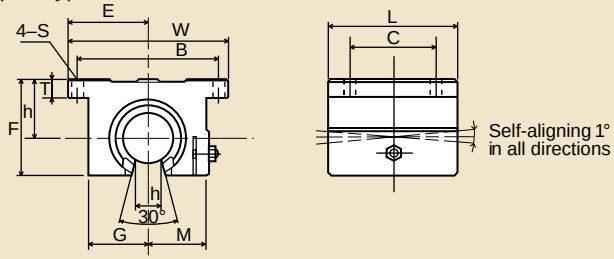


Table 10 Open Type Dimensions and Load Ratings

NB PART NUMBER	NOM. SHAFT DIA. (inch)	MAIN DIMENSIONS (inch)									MOUNTING DIMENSIONS (inch)			LOAD RATING		Wt. (lbs.)
														DYNAMIC	STATIC	
		h ± .0012	E ± .0012	W	L	F	T	G	M	h_1	B ±.01	C ±.01	S	C (lbs).	C0 (lbs).	
TWD 8UU	1/2	.6870	1.000	2.000	1.500	1.100	.250	.688	.905	.260	1.688	1.000	.156	230	290	.188
TWD 10UU	5/8	.8750	1.2500	2.500	1.750	1.405	.281	.875	1.095	.319	2.125	1.125	.188	400	500	.365
TWD 12UU	3/4	.9370	1.3750	2.750	1.875	1.535	.315	.937	1.161	.386	2.375	1.250	.188	470	590	.452
TWD 16UU	1	1.1870	1.6250	3.250	2.625	1.975	.375	1.188	1.457	.512	2.875	1.750	.218	850	1060	1.010
TWD 20UU	1-1/4	1.5000	2.0000	4.000	3.375	2.485	.437	1.500	1.831	.569	3.500	2.000	.218	1230	1530	1.980
TWD 24UU	1-1/2	1.7500	2.3750	4.750	3.750	2.910	.500	1.750	2.087	.681	4.125	2.500	.281	1480	1850	2.950
TWD 32UU	2	2.1250	3.0000	6.000	4.750	3.660	.625	2.250	2.638	.933	5.250	3.250	.406	2430	3040	5.840

Fig. 16 Double-wide Open Type Slide Unit

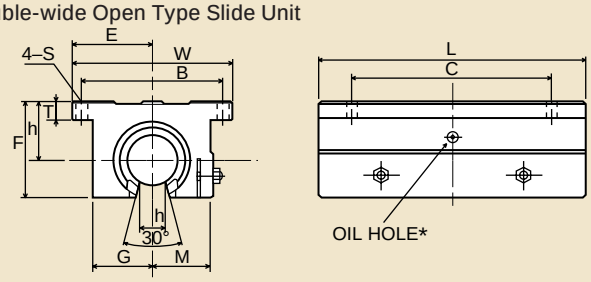


Table 11 Double-Wide Open Type Dimensions and Load Ratings

NB PART NUMBER	NOM. SHAFT DIA. (inch)	MAIN DIMENSIONS (inch)									MOUNTING DIMENSIONS (inch)			LOAD RATING		Wt. (lbs.)
														DYNAMIC	STATIC	
		h ± .0012	E	W	L	F	T	G	M	h_1	B ± .01	C ± .01	S	C (lbs.)	C0 (lbs.)	
TWD 8WUU	1/2	.6870	1.000	2.000	3.500	1.100	.250	.688	.905	.260	1.688	2.500	.156	370	580	.400
TWD 10WUU	5/8	.8750	1.2500	2.500	4.000	1.405	.281	.875	1.095	.319	2.125	3.000	.188	640	1000	.800
TWD 12WUU	3/4	.9370	1.3750	2.750	4.500	1.535	.315	.937	1.161	.386	2.375	3.500	.188	750	1180	1.000
TWD 16WUU	1	1.1870	1.6250	3.250	6.000	1.975	.375	1.188	1.457	.512	2.875	4.500	.218	1360	2120	2.000
TWD 20WUU	1-1/4	1.5000	2.0000	4.000	7.500	2.485	.437	1.500	1.831	.569	3.500	5.500	.218	1970	3060	4.200
TWD 24WUU	1-1/2	1.7500	2.3750	4.750	9.000	2.910	.500	1.750	2.087	.681	4.125	6.500	.281	2370	3700	6.700

*Provided with push-in oil fitting for 1/2" size only. Sizes from 5/8" to 2" offer a 1/4-28 tapped hole with a plug for adding a fitting if desired.

Related Products

End Shaft Support: WH-A Type

Precision machined aluminum die cast support blocks provide end support for shafts in applications where slight deflection is not critical.

Fig. 17 End Shaft Support

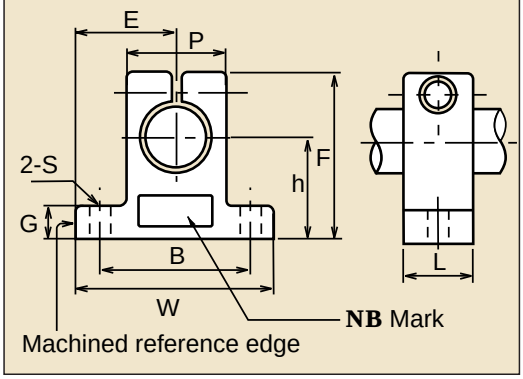


Table 12 End Shaft Support Dimensions and Mounting Dimensions

NB PART NUMBER	NOMINAL SHAFT DIA. (inch)	MAIN DIMENSIONS (inch)								MOUNTING HOLE(S)		Wt. (LBS.)
		h ± .0010	E ± .0005	W	L	F	G	P	B ± 0.01	S	BOLT #	
WH 4A	1/4	.6875	.7500	1.500	.500	1.063	.250	.500	1.125	.156	#6	.033
WH 6A	3/8	.7500	.8125	1.625	.563	1.187	.250	.688	1.250	.156	#6	.044
WH 8A	1/2	1.0000	1.0000	2.000	.625	1.625	.250	.875	1.500	.188	#8	.075
WH 10A	5/8	1.0000	1.2500	2.500	.688	1.750	.313	1.000	1.875	.218	#10	.106
WH 12A	3/4	1.2500	1.2500	2.500	.750	2.063	.313	1.250	2.000	.218	#10	.156
WH 16A	1	1.5000	1.5315	3.063	1.000	2.500	.375	1.500	2.500	.281	1/4	.294
WH 20A	1-1/4	1.7500	1.8750	3.750	1.125	3.000	.438	2.000	3.000	.346	5/16	.531
WH 24A	1-1/2	2.0000	2.1875	4.375	1.250	3.437	.500	2.250	3.500	.346	5/16	.725
WH 32A	2	2.5000	2.7500	5.500	1.500	4.375	.625	3.000	4.500	.406	3/8	1.400

Shaft Support Rail: WA and WA-PD Types

Precision machined aluminum extrusion available with or without pre-drilled mounting holes. Offers continuous shaft support and consistent shaft centerline.

Fig. 18 Top View of Shaft Support Rail

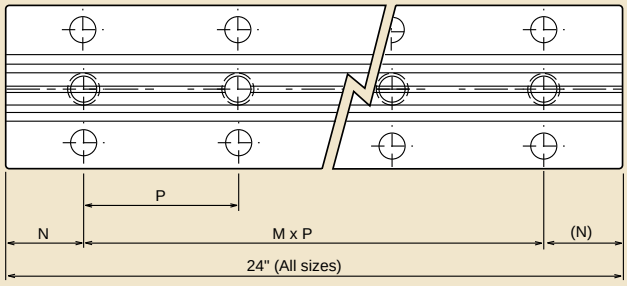


Fig. 19 Side View

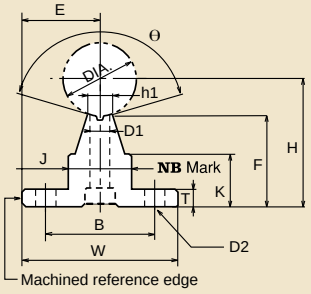


Table 13 Shaft Support Rail Dimensions and Mounting Dimensions

NB PART NUMBER	NOMINAL SHAFT DIA. (inch)	MAIN DIMENSIONS (inch)									MOUNTING DIMENSIONS							Wt. (lbs.)
														D1		D2		
		H ± .0010	E ± .0050	W	F	T	K	J	h1	Θ (Deg.)	B ± .01	N	M x P	HOLE	BOLT #	HOLE	BOLT #	
WA 8-24 PD	1/2	1.1250	.7500	1-1/2	.903	3/16	.466	.500	.255	145°	1	2	(5) x 4	.169	#6	.169	#6	1.326
WA 10-24 PD	5/8	1.1250	.8125	1-5/8	.841	1/4	.423	.500	.276	145°	1-1/8	2	(5) x 4	.193	#8	.193	#8	1.488
WA 12-24 PD	3/4	1.5000	.8750	1-3/4	1.158	1/4	.592	.625	.322	145°	1-1/4	3	(3) x 6	.221	#10	.221	#10	2.100
WA 16-24 PD	1	1.7500	1.0625	2-1/8	1.280	1/4	.727	.875	.359	150°	1-1/2	3	(3) x 6	.281	1/4	.281	1/4	2.776
WA 20-24 PD	1-1/4	2.1250	1.2500	2-1/2	1.537	5/16	.799	1.100	.437	150°	1-7/8	3	(3) x 6	.343	5/16	.343	5/16	4.060
WA 24-24 PD	1-1/2	2.5000	1.5000	3	1.798	3/8	.922	1.375	.558	150°	2-1/4	4	(2) x 8	.406	3/8	.343	5/16	5.840
WA 32-24 PD	2	3.2500	1.8750	3-3/4	2.322	1/2	1.450	1.500	.800	150°	2-3/4	4	(2) x 8	.531	1/2	.406	3/8	9.500

All sizes are also available without pre-drilled mounting holes. Specify Part Number as WA##-## when ordering. Complete shaft-rail assemblies are also available as well as custom drilling and lengths. Please send drawing for quotation on custom configurations.

Low Shaft Support Rail: LWA (Solid) and LWA-PD (Pre-Drilled) Types

Fig. 20 Low Shaft Shaft Support Rail

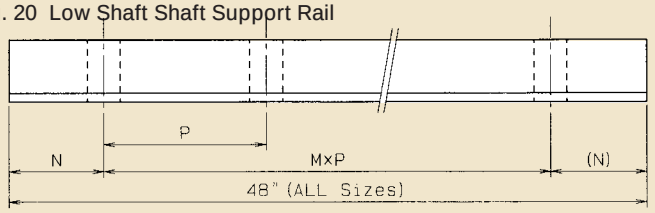
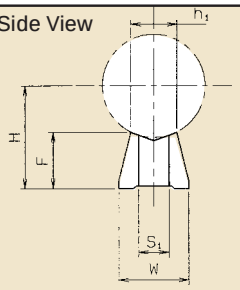


Table 14 Lowshaft Support Rail Dimensions and Mounting Dimensions

NB Part Number	Nominal Shaft Dia.	Dimensions in Inch			Mounting Dimensions				Weight lbs / foot
		F	W	H (2) +/- .002	h_1	S_1	P	N (3)	
LWA 08 PD	1 / 2	.315	.37	.562	.216	.169	4	2	.11
LWA 10 PD	5 / 8	.405	.45	.687	.269	.193	4	2	.17
LWA 12 PD	3 / 4	.412	.51	.750	.317	.221	6	3	.20
LWA 16 PD	1	.511	.69	1.000	.422	.281	6	3	.35
LWA 20 PD	1 1/4	.617	.78	1.187	.523	.343	6	3	.44
LWA 24 PD	1 1/2	.691	.93	1.375	.623	.406	8	4	.58
LWA 32 PD	2	.843	1.18	1.750	.824	.531	8	4	.89

Fig. 21 Side View



Slide Units and Shaft Rail Accessories

NB's Slide Units and Shaft Rail accessories are produced to tightly controlled tolerances to provide reliably high performance.

The **WSS** Shaft Rail Assembly comes to you pre-assembled and ready for use.

For corrosive environments, Stainless Steel Slide Shaft is mated with Aluminum Rail Supports which are clear anodized. Slide Units are also made available with corrosion resistance components.

Longer than Maximum Length Rail supports are available making use of Butt Joint or Dowel Pin Joint - quoted by factory.

NB's Slide Units and Shaft Rail accessories contain referenced edges to provide quick and accurate installation.

Shaft Rail Assemblies: WSS Type

Fig. 22 Side View

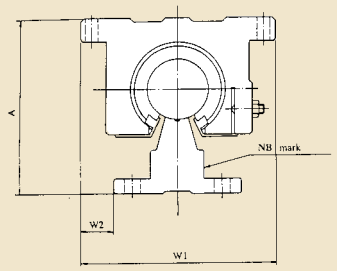


Fig. 23 Shaft Rail Assemblies

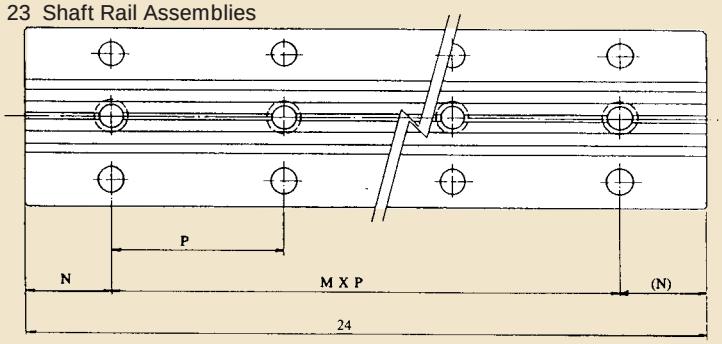


Table 15 Shaft Rail Assembly Dimensions and Mounting Dimensions

NB Part Number	Nominal Shaft Dia.	Outer Assembly Dimensions (Inch)			Maximum Length 1 - Piece	Base Mounting Holes		WT / FT Lbs.
		A	W 1	W 2		N (Inch)	P (Inch)	
WSS 08 X L	1 / 2	1.812	2.000	.2500	144"	2	4	1.26
WSS 10 X L	5 / 8	2.000	2.500	.4375	144"	2	4	1.83
WSS 12 X L	3 / 4	2.437	2.750	.5000	144"	3	6	2.50
WSS 16 X L	1	2.937	3.250	.5625	144"	3	6	4.06
WSS 20 X L	1 1/4	3.625	4.000	.7500	168"	3	6	6.28
WSS 24 X L	1 1/2	4.250	4.750	.8750	168"	4	8	8.60
WSS 32 X L	2	5.375	6.000	1.1250	168"	4	8	14.88

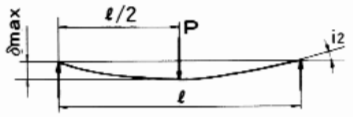
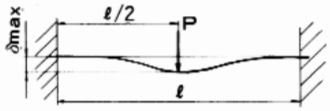
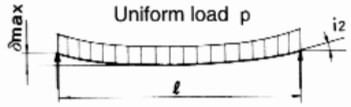
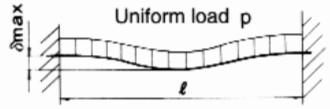
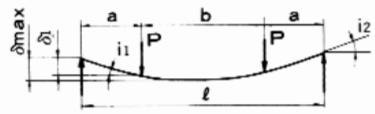
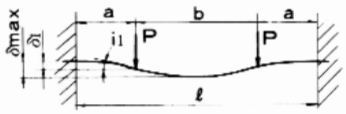
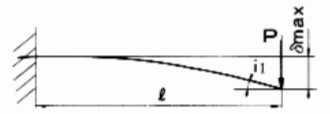
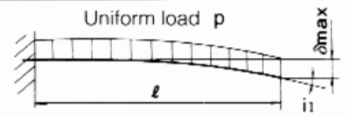
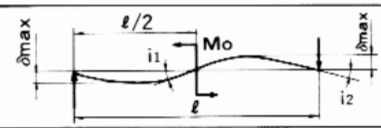
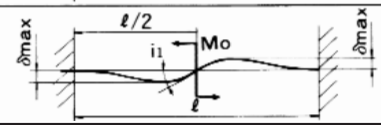
Notes:

(1) Specify Length (L) when ordering.
(2) Reference to nominal shaft diameter, measured while clamped.
(3) Dimension “N” will be provided equal (both ends) unless otherwise requested.
(4) Ordering Example: Need 1-1/2” x 48” order Part Number as WSS 24 x 48.0”
(5) Longer than “Maximum Std Length” contact **NB** for quotation.
(6) For Custom Hole Location or Non-Standard Lengths, contact **NB** for quotation.

Shaft Deflection and Angle

As Shafts are used for guideways it becomes important that shaft deflection constraints be maintained within certain limits under load. Deflection under load must be maintained otherwise the functioning and service life of the linear bearing assembly could be reduced and cause premature failures.

To aid in the determination of the shaft deflection and its angle, we have established a list of the most common loading conditions and the appropriate calculations for the selected condition. The table below shows the conditions and calculations for the deflection and its angle.

	Supporting method	Specified conditions	Deflection equation	Deflection angle equation
1	Free at both ends		$\delta_{max} = \frac{P\ell^3}{48EI} = P\ell^3C$	$i_1 = 0$ $i_2 = \frac{P\ell^2}{16EI} = P\ell^2C$
2	Fixed at both ends		$\delta_{max} = \frac{P\ell^3}{192EI} = \frac{1}{4}P\ell^3C$	$i_1 = 0$ $i_2 = 0$
3	Free at both ends		$\delta_{max} = \frac{5p\ell^4}{384EI} = \frac{5}{8}p\ell^4C$	$i_2 = \frac{p\ell^3}{24EI} = 2p\ell^3C$
4	Fixed at both ends		$\delta_{max} = \frac{p\ell^4}{384EI} = \frac{1}{8}p\ell^4C$	$i_2 = 0$
5	Free at both ends		$\delta_1 = \frac{Pa^3}{6EI}\left(2+\frac{3b}{a}\right) = 8Pa^3\left(2+\frac{3b}{a}\right)C$ $\delta_{max} = \frac{Pa^3}{24EI}\left(\frac{3\ell^2}{a^2}-4\right) = 2Pa^3\left(\frac{3\ell^2}{a^2}-4\right)C$	$i_1 = \frac{Pab}{2EI} = 24PabC$ $i_2 = \frac{Pa(a+b)}{2EI} = 24Pa(a+b)C$
6	Fixed at both ends		$\delta_1 = \frac{Pa^3}{6EI}\left(2-\frac{3a}{\ell}\right) = 8Pa^3\left(2-\frac{3a}{\ell}\right)C$ $\delta_{max} = \frac{5}{8}p\ell^4C = 0.27(mm)$	$i_1 = \frac{Pa^2b}{2EI\cdot\ell} = \frac{24Pa^2bC}{\ell}$ $i_2 = 0$
7	Fixed at one end		$\delta_{max} = \frac{P\ell^3}{3EI} = 16P\ell^3C$	$i_1 = \frac{P\ell^2}{2EI} = 24P\ell^2C$ $i_2 = 0$
8	Fixed at one end		$\delta_{max} = \frac{p\ell^4}{8EI} = 6p\ell^4C$	$i_1 = \frac{p\ell^3}{6EI} = 8p\ell^3C$ $i_2 = 0$
9	Free at both ends		$\delta_{max} = \frac{\sqrt{3}M_o\ell^2}{216EI} = \frac{2\sqrt{3}}{9}M_o\ell^2C$	$i_1 = \frac{M_o\ell}{12EI} = 4M_o\ell C$ $i_2 = \frac{M_o\ell}{24EI} = 2M_o\ell C$
10	Fixed at both ends		$\delta_{max} = \frac{M_o\ell^2}{216EI} = \frac{2}{9}M_o\ell^2C$	$i_1 = \frac{M_o\ell}{16EI} = 3M_o\ell C$ $i_2 = 0$

Σfi_1: Deflection at loaded point (mm)
Σfi_max: Maximum deflection (mm)
*i*1: Deflection angle at loading point

*i*2: Delfection agle at supporting point
Mo: Moment (N•mm)
P: Concentrated load (N)

p: Uniform load (N/mm)
a,b: Loading point distance (mm)
l: Span (mm)

I: Geometrical moment of inertia (mm^4)
E: Modulus of direct elasticity 2.1 x 105 (N/mm^2)
C: 1/48EI ($1/N•mm^2$)