



**INCH AND METRIC LINEAR BALL BUSHINGS  
AND 60 HRC SHAFTING**



**INCH SERIES**

**Self-Aligning Ball Bushings**

Features ..... 3

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SPB – Block Type With Seals ..... 10

TWN – Twin Block Type With Seals ..... 11

SPB-ADJ – Clearance Adjustable Block Type With Seals ..... 12

TWN-ADJ – Clearance Adjustable Twin Block Type With Seals ..... 13

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PLC now offers a new standard in linear motion. The self-aligning ball bushing is a high performance bushing with three times the load capacity, capable of providing up to 27 times normal travel life of a conventional ball bushing.

It is available in a variety of configurations to fit various service conditions. PLC's self-aligning ball bushing 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 development, careful thought and consideration was given to such factors as quality, cost, performance and interchangeability. The results of these efforts are reflected in the features.

## FEATURES

### 1. Increased Load Capacity:

The uniquely designed ground load plate provides circular arch contact to the ball element resulting in a greater dispersion of the load, enabling the bushing to provide three times the load capacity of conventional ball bushings.

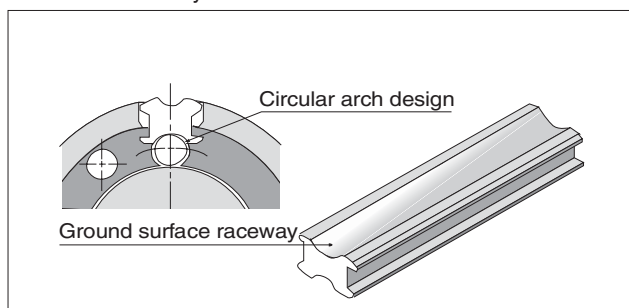
### 2. Longer Travel Life:

Dispersed stress on the load plate provides up to 27 times the travel life of conventional slide bushings.

### 3. 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.

Figure 1: Illustrating circular arch design and ground surface raceway



### 4. Floating Integral Wiper Seal:

The 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.

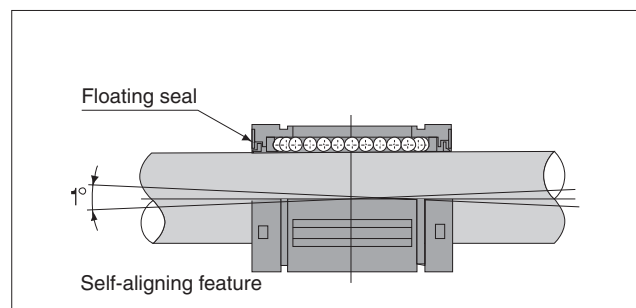
### 5. Clearance Adjustable:

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.

### 6. Cost Effectiveness:

Higher load capability 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 reduce maintenance cost.

Figure 2: Illustrating floating seal and self-aligning feature



## RATED LIFE

The life of a ball bushing can be easily calculated with the load rating of the bush, shaft hardness and applicable load. However, in many cases, ball bushing failure may be caused by improper design of 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 ball bushing application.

### Basic Dynamic Load Rating and Life Expectancy:

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

$$L = \left(\frac{C}{P}\right)^3 \cdot 50 \quad \text{Equation (1)}$$

L : travel life (km)  
C : basic dynamic load rating (N)  
P : load (N)

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:

$$L = \left(\frac{f_H}{f_W} \cdot \frac{C}{P}\right)^3 \cdot 50 \quad \text{Equation (2)}$$

$f_H$  : hardness coefficient (See Figure 3)  
 $f_W$  : load coefficient (See Table 1)

Life time can be calculated by obtaining the travelling distance per unit of time as follows:

$$L_h = \frac{L \cdot 10^3}{2 \cdot L_s \cdot N1 \cdot 60} \quad \text{Equation (3)}$$

$L_h$  : life time (hr)  
 $L_s$  : stroke length (m)  
 $N1$  : stroke frequency per min. (cpm)  
L : travel life (km)



## Load coefficient (fw):

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.

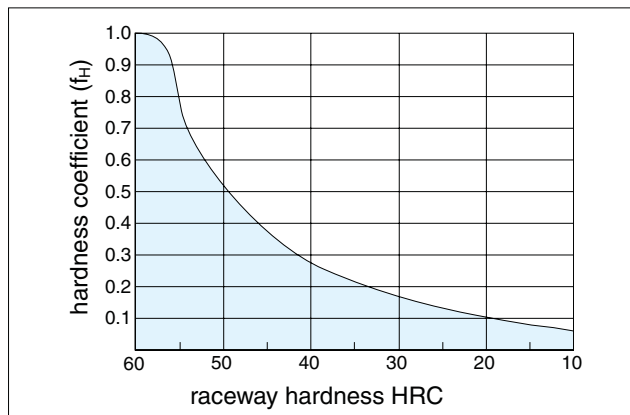
Table 1: Load Coefficient

OPERATING CONDITIONS	fw
operation at low speed (15m/min. or less) without impulsive shock from outside	1.0-1.5
operation at intermediate speed (60m/min. or less) without impulsive shock	1.5-2.0
operation at high speed (over 60m/min.) with impulsive shock	2.0-3.5

## Hardness Coefficient (fH):

The shaft must be hardened to over 58HRC when a slide bush is used. If not properly hardened, permissible load is lowered and the life of the bushing will be shortened.

Figure 3: Hardness coefficient



## Examples of Calculations:

(1) Life expectancy when PLC's SA16 is used under the following conditions:

Load per bush: 668N  
 Stroke length: 0.2m  
 Rate of cycles/min: 35  
 Shaft hardness: 60HRC

The basic dynamic load of SA16 is 3,780N hardness coefficient (fH) is 1.0, and the operating speed can be calculated as 0.014km/min. Therefore, the load coefficient (fw) is considered as 1.0.

Using Equation (1) (Page 4)

$$L = \left( \frac{3,780}{668} \right)^3 \cdot 50 = 9,060 \text{ km}$$

Using Equation (3) (Page 4)

$$L_h = \frac{9,060 \cdot 10^3}{2 \cdot 0.2 \cdot 35 \cdot 60} = 10,800 \text{ hours}$$

(2) Selection of size for the application

Expected life: 15,000 hours  
 Number of bushings in the carriage: 4  
 Gross weight on the carriage: 668N  
 Stroke length: 0.0009km  
 Traveling speed: 0.03km/min.  
 Shaft hardness: 60-64HRC

The life expected in traveling distance is:

$$L = 15,000 \cdot 0.03 \cdot 60 = 27,000 \text{ km}$$

From Equation (2)

$$C = \sqrt[3]{\frac{27,000}{50}} \cdot \left( \frac{f_w}{f_H} \right) \cdot P = 2,040 \text{ N}$$

Note that: fH = 1.0, fw = 1.5, P = 668/4 = 167N

As a result, the bushing that is able to handle this load is SA12.

**Basic Static Load Rating:**

If a ball bushing is loaded when it is in a stationary condition or working at a 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 ball bushing 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 ball bushing is used with two ball circuits loaded uniformly, the value will be greater. Table 2 shows the load ratio for the number of ball circuits in each case.

**Clearance and Fit:**

An appropriate clearance between the ball bushing and shaft is required for 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 PLC's recommended tolerances of the shaft and housing bore in order to maintain the appropriate clearance.

Table 2: Optional Load Positions

NUMBER OF ROWS	4	5	6
Co (LOAD RATING SPECIFIED IN THE TABLE)			
Co max (MAXIMUM LOAD RATING)			
LOAD RATIO Co max/Co	1,414	1,463	1,280

Table 3: Recommended Tolerance for Shaft Dia. and Housing Bore

size	shaft dia.		housing bore.	
	dr inch	tol. (g6) inch	D inch	tol. (H7) inch
SA3	.1875	- .0002 - .0006	.3750	+ .0005 0
SA4	.2500		.5000	+ .0007 0
SA6	.3750	- .0002 - .0007	.6250	+ .0008 0
SA8	.5000		.8750	
SA10	.6250	- .0003 - .0008	1.1250	+ .0010 0
SA12	.7500		1.2500	
SA16	1.0000	- .0004 - .0010	1.5625	+ .0012 0
SA20	1.2500		2.0000	
SA24	1.5000	- .0004 - .0012	2.3750	+ .0012 0
SA32	2.0000		3.0000	

## Shaft and Housing:

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

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

- A. A surface finish of 0.4Ra or less.
- B. Hardness of 60 HRC or more. Hardness less than 60 HRC decreases the life considerably and reduces the permissible load.
- C. The correct tolerance of the shaft diameter and housing bore is recommended in Table 3 (Page 6).

## Mounting:

The ball bushing is designed to be press fitted into the housing bore. When inserting bushing, however, don't apply excess force or shock load which may cause permanent damage. Refer to Table 3 (Page 6) for housing bore tolerances.

## Examples of Mounting

Figures 4 to 7 illustrate mounting methods as examples.

Figure 4: Use of holding plates

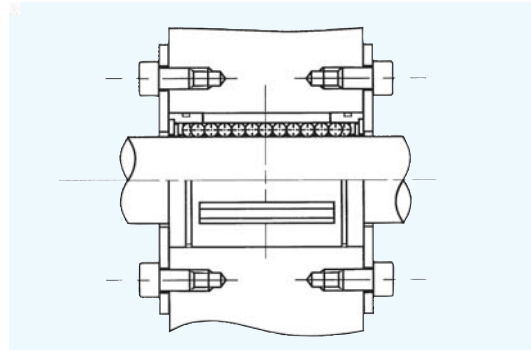


Figure 5 : Adjustable type housing

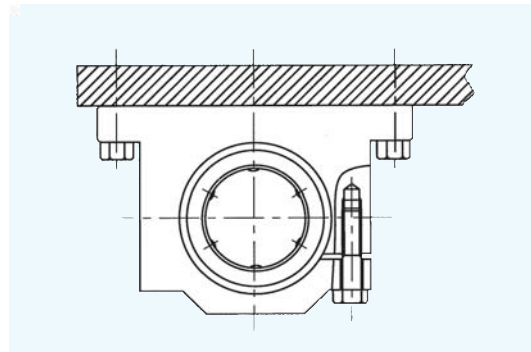


Figure 6 : Use of external retaining rings

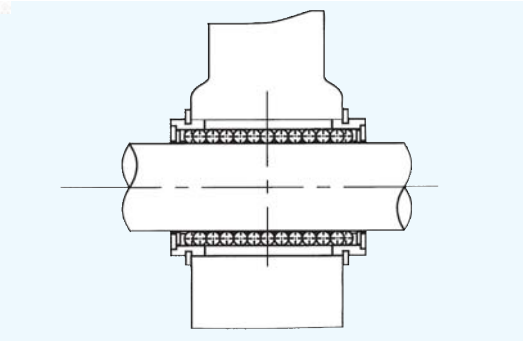
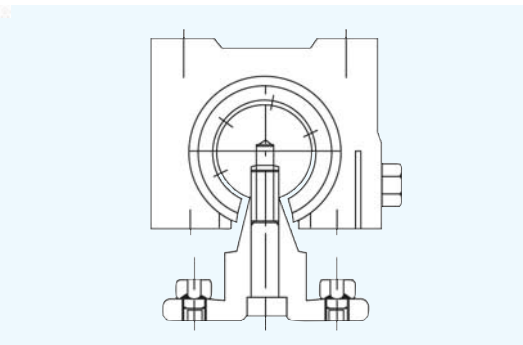
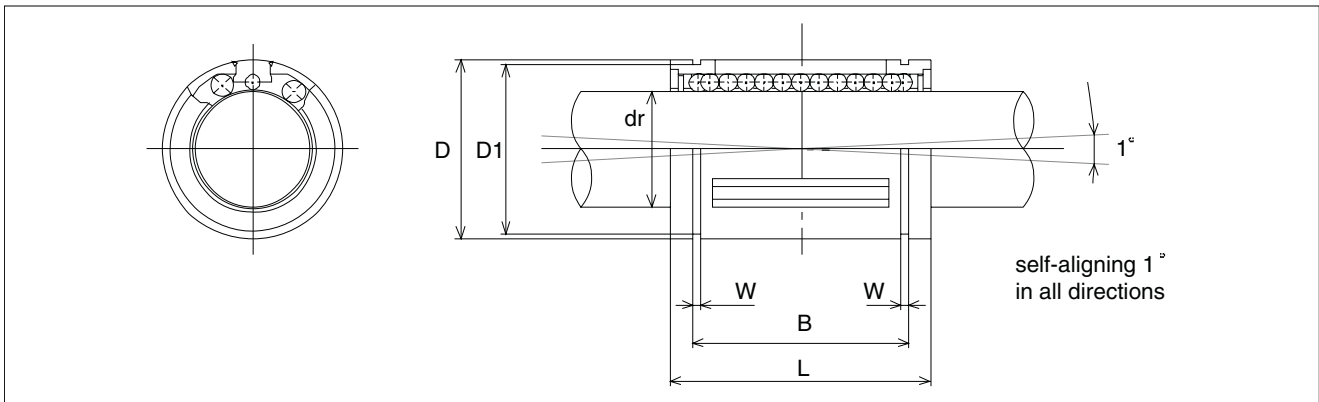
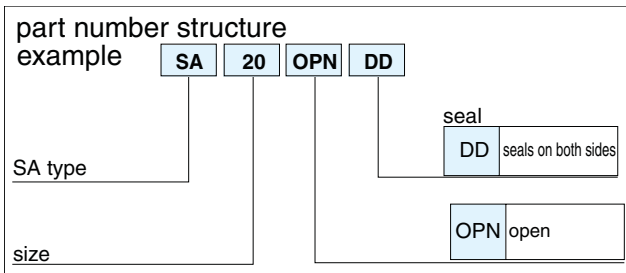


Figure 7 : Open type housing



# SA TYPE

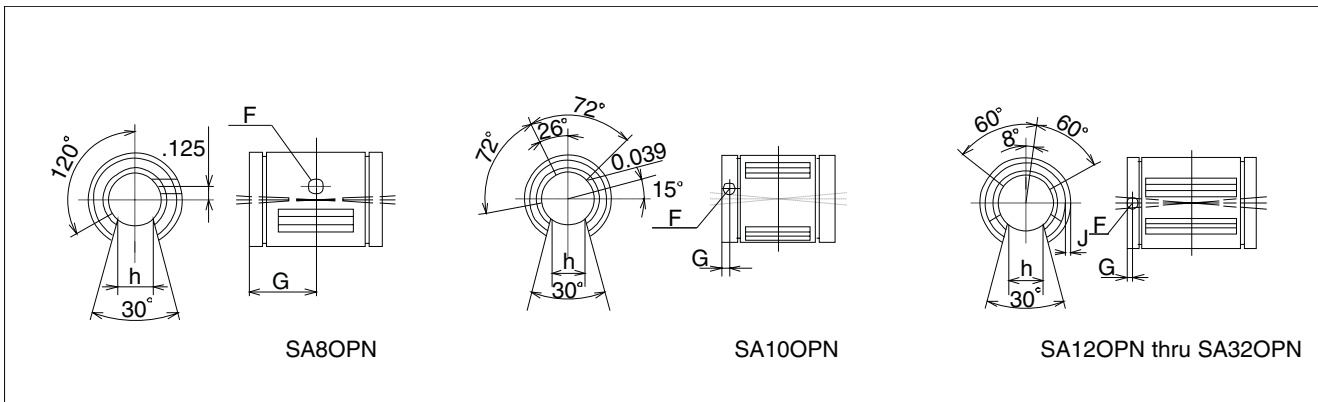
## Self-Aligning (Inch Type)



part number						major dimensions				
SA	closed type		open type			dr	tolerance*	D	L	tolerance
	no. of ball circuits	mass lbs		no. of ball circuits	mass lbs					
SA3	4	.004	–	–	–	.1875	0 – .0005	.3750	.562	± .008
SA4	4	.009	–	–	–	.2500		.5000	.750	0
SA6	4	.014	–	–	–	.3750		.6250	.875	– .015
SA8	4	.043	SA8OPN	3	.033	.5000		.8750	1.250	0 – .020
SA10	5	.103	SA10OPN	4	.083	.6250		1.1250	1.500	
SA12	6	.123	SA12OPN	5	.102	.7500		1.2500	1.625	
SA16	6	.265	SA16OPN	5	.220	1.0000		1.5625	2.250	0 – .025
SA20	6	.485	SA20OPN	5	.419	1.2500	2.0000	2.625		
SA24	6	.750	SA24OPN	5	.639	1.5000	2.3750	3.000	0/– .030	
SA32	6	1.411	SA32OPN	5	1.168	2.0000	3.0000	4.000	0/– .040	

\* Based on nominal housing bore.

# SELF-ALIGNING BALL BUSHINGS

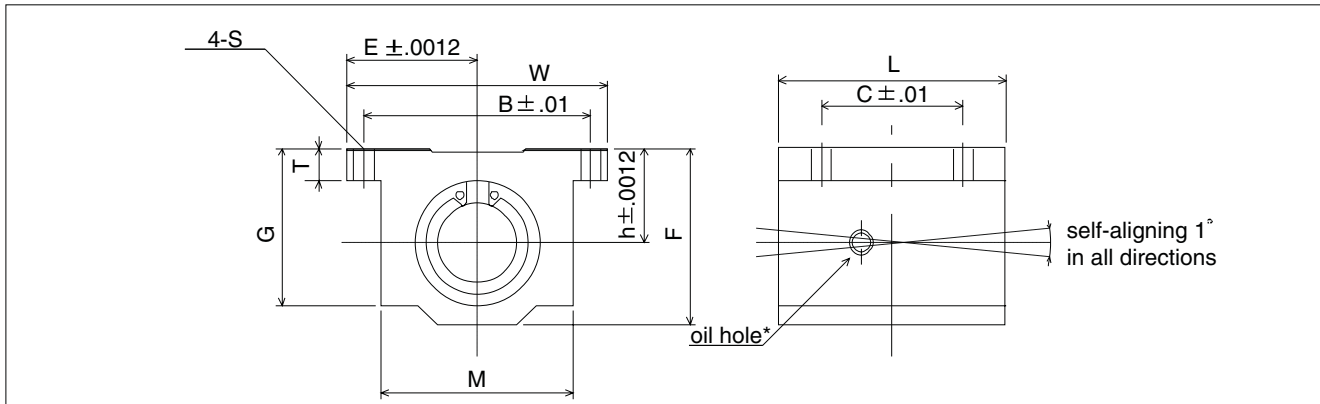
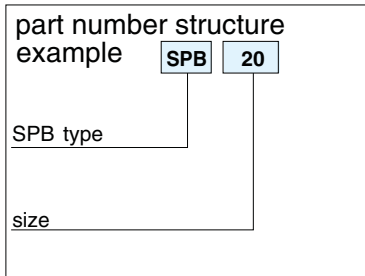
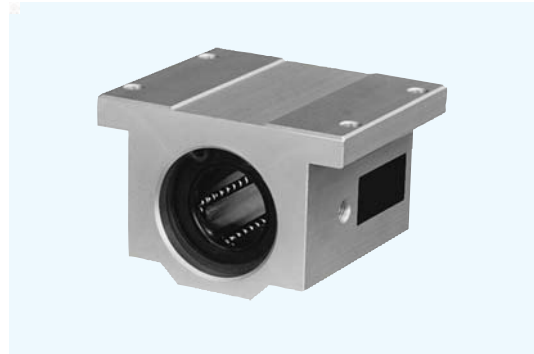


B	tolerance	W	D <sub>1</sub>	open type				basic load rating		nominal shaft diameter
				h	F	G	J	dynamic C	static C <sub>0</sub>	
inch	inch	inch	inch	inch	inch	inch	inch	lbs	lbs	inch
—	—	—	—	—	—	—	—	35	47	3/16
.515	0	.0390	.4687	—	—	—	—	60	80	1/4
.703	-.015	.0390	.5880	—	—	—	—	95	120	3/8
1.032	0	.0459	.8209	.313	.136	.6250	through	230	290	1/2
1.112		.0559	1.0590	.375	.105	.1250	.0390	400	500	5/8
1.272		.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

1 inch = 25.4 mm  
 1 lbs ≅ 0.454 kg  
 1 lbs ≅ 4.448 N

# SPB TYPE

**Block Type with seals on both sides  
(Inch Series)**



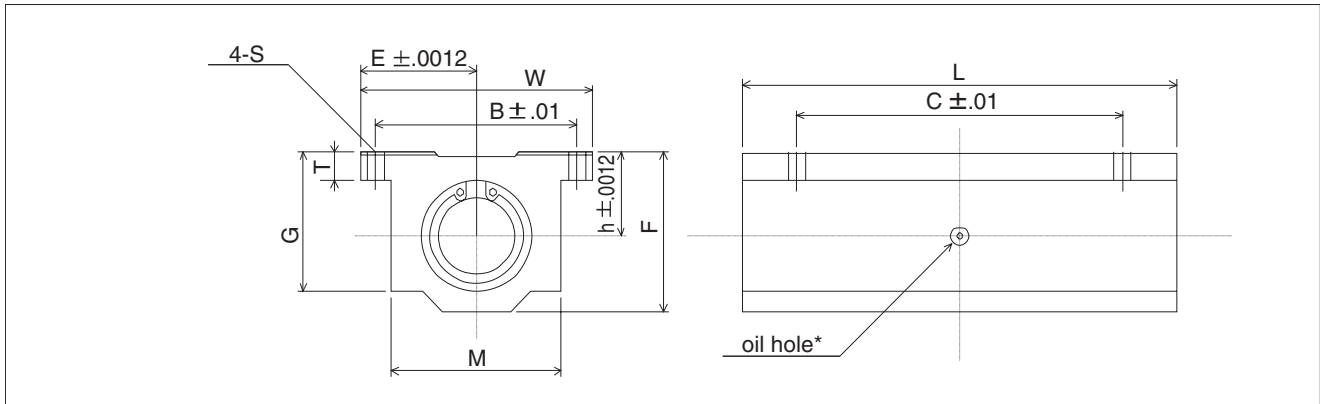
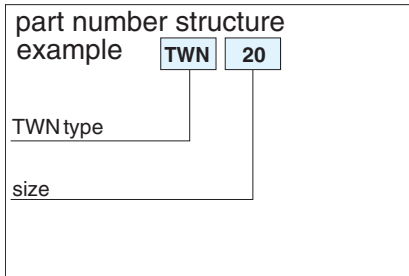
part number	nom. shaft dia. inch	major dimensions								mounting dimensions			basic load rating		mass lbs.
		h inch	E inch	W inch	L inch	F inch	T inch	G inch	M inch	B inch	C inch	S inch	C lbs.	Co lbs.	
SPB4	1/4	.4370	.8125	1.625	1.188	.813	.188	.750	1.000	1.312	.750	.156	60	80	.090
SPB6	3/8	.5000	.8750	1.750	1.313	.938	.188	.875	1.125	1.437	.875	.156	95	120	.120
SPB8	1/2	.6870	1.0000	2.000	1.688	1.250	.250	1.125	1.375	1.688	1.000	.156	230	290	.248
SPB10	5/8	.8750	1.2500	2.500	1.938	1.625	.281	1.437	1.750	2.125	1.125	.188	400	500	.465
SPB12	3/4	.9370	1.3750	2.750	2.063	1.750	.313	1.563	1.875	2.375	1.250	.188	470	590	.553
SPB16	1	1.1870	1.6250	3.250	2.813	2.188	.375	1.938	2.375	2.875	1.750	.219	850	1,060	1.200
SPB20	1-1/4	1.5000	2.0000	4.000	3.625	2.813	.438	2.500	3.000	3.500	2.000	.219	1,230	1,530	2.380
SPB24	1-1/2	1.7500	2.3750	4.750	4.000	3.250	.500	2.875	3.500	4.125	2.500	.281	1,480	1,850	3.460
SPB32	2	2.1250	3.0000	6.000	5.000	4.063	.625	3.625	4.500	5.250	3.250	.406	2,430	3,040	6.830

\* 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.

1inch = 25.4mm  
1lbs ≅ 0.454kg  
1lbs ≅ 4.448N

# TWN TYPE

**Twin Block Type with seals on both sides  
(Inch Series)**



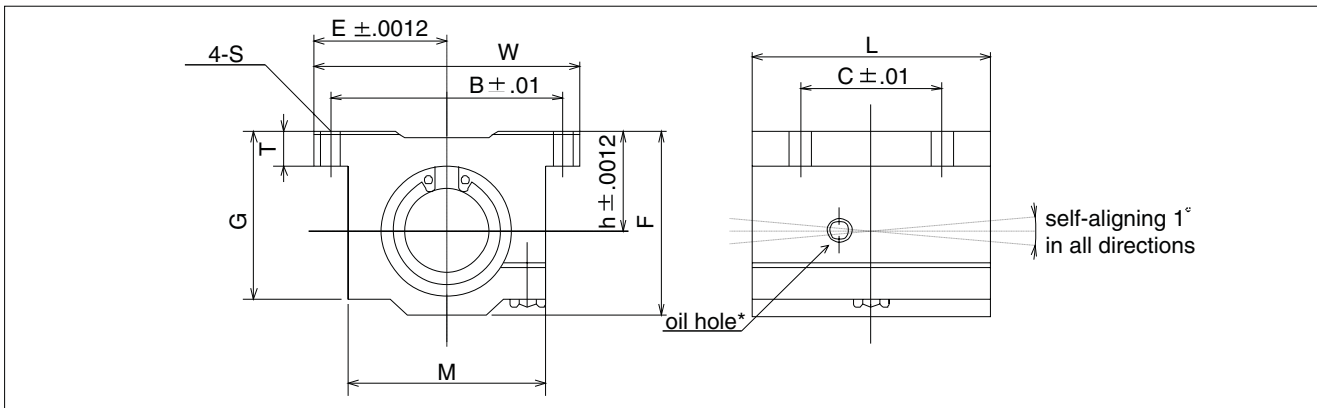
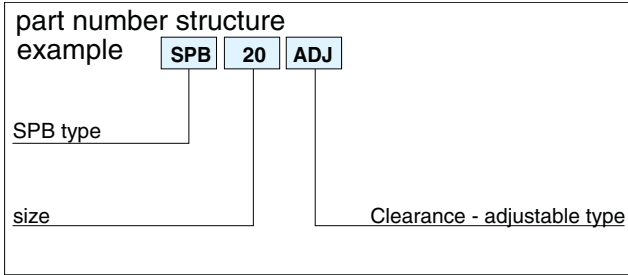
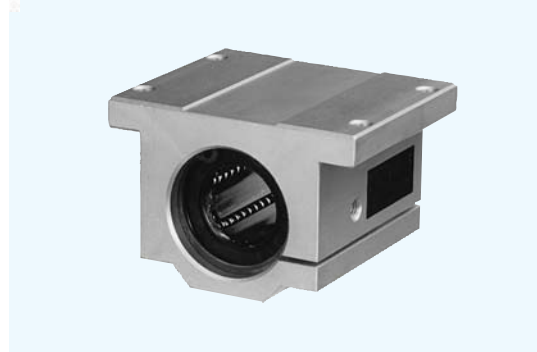
part number	nom. shaft dia. inch	major dimensions								mounting dimensions			basic load rating		mass lbs.
		h inch	E inch	W inch	L inch	F inch	T inch	G inch	M inch	B inch	C inch	S inch	C lbs.	Co lbs.	
TWN4	1/4	.4370	.8125	1.625	2.500	.813	.188	.750	1.000	1.312	2.000	.156	96	160	.190
TWN6	3/8	.5000	.8750	1.750	2.750	.938	.188	.875	1.125	1.437	2.250	.156	150	240	.250
TWN8	1/2	.6870	1.0000	2.000	3.500	1.250	.250	1.125	1.375	1.688	2.500	.156	370	580	.510
TWN10	5/8	.8750	1.2500	2.500	4.000	1.625	.281	1.437	1.750	2.125	3.000	.188	640	1,000	1.000
TWN12	3/4	.9370	1.3750	2.750	4.500	1.750	.313	1.563	1.875	2.375	3.500	.188	750	1,180	1.200
TWN16	1	1.1870	1.6250	3.250	6.000	2.188	.375	1.938	2.375	2.875	4.500	.219	1,360	2,120	2.400
TWN20	1-1/4	1.5000	2.0000	4.000	7.500	2.813	.438	2.500	3.000	3.500	5.500	.219	1,970	3,060	5.000
TWN24	1-1/2	1.7500	2.3750	4.750	9.000	3.250	.500	2.875	3.500	4.125	6.500	.281	2,370	3,700	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.

1inch = 25.4mm  
1lbs ≈ 0.454kg  
1lbs ≈ 4.448N

# SPB-ADJ TYPE

## Clearance Adjustable Block Type with seals on both sides (Inch Series)



part number	nom. shaft dia. inch	major dimensions								mounting dimensions			basic load rating		mass lbs.
		h inch	E inch	W inch	L inch	F inch	T inch	G inch	M inch	B inch	C inch	S inch	C lbs.	Co lbs.	
SPB4ADJ	1/4	.4370	.8125	1.625	1.188	.813	.188	.750	1.000	1.312	.750	.156	60	80	.090
SPB6ADJ	3/8	.5000	.8750	1.750	1.313	.938	.188	.875	1.125	1.437	.875	.156	95	120	.120
SPB8ADJ	1/2	.6870	1.0000	2.000	1.688	1.250	.250	1.125	1.375	1.688	1.000	.156	230	290	.248
SPB10ADJ	5/8	.8750	1.2500	2.500	1.938	1.625	.281	1.437	1.750	2.125	1.125	.188	400	500	.465
SPB12ADJ	3/4	.9370	1.3750	2.750	2.063	1.750	.313	1.563	1.875	2.375	1.250	.188	470	590	.553
SPB16ADJ	1	1.1870	1.6250	3.250	2.813	2.188	.375	1.938	2.375	2.875	1.750	.219	850	1,060	1.200
SPB20ADJ	1-1/4	1.5000	2.0000	4.000	3.625	2.813	.438	2.500	3.000	3.500	2.000	.219	1,230	1,530	2.380
SPB24ADJ	1-1/2	1.7500	2.3750	4.750	4.000	3.250	.500	2.875	3.500	4.125	2.500	.281	1,480	1,850	3.460
SPB32ADJ	2	2.1250	3.0000	6.000	5.000	4.063	.625	3.625	4.500	5.250	3.250	.406	2,430	3,040	6.830

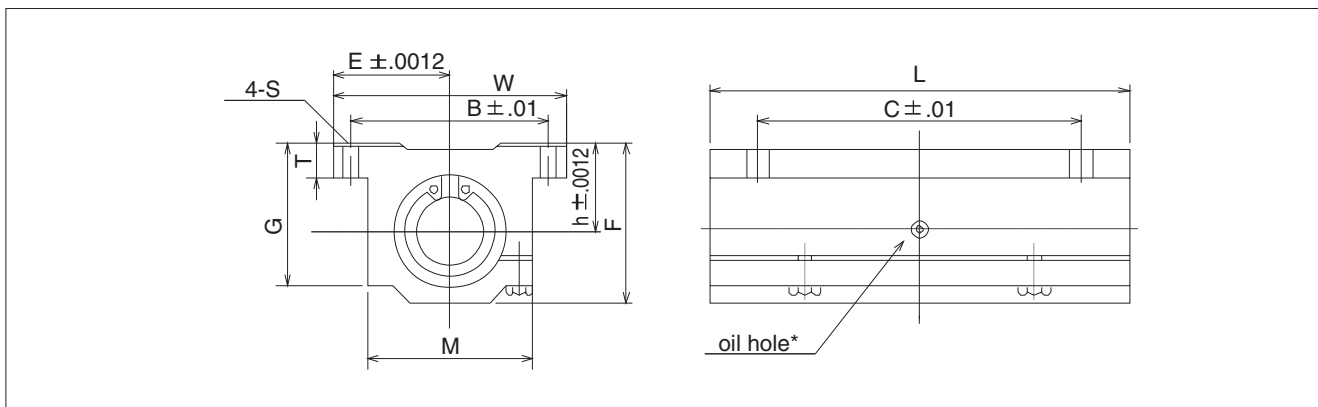
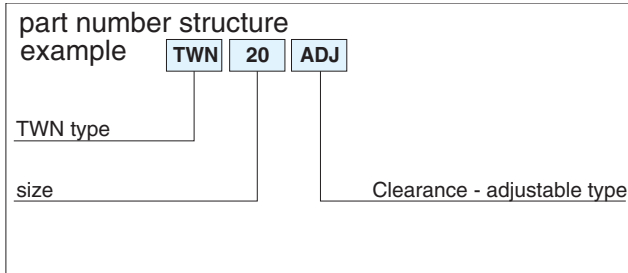
\* Provided with push-in oil fitting for 1/4" to 1/2" size. Sizes from 5/8" to 2" offer a 1/4-28 tapped hole with a plug for adding a fitting if desired.

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1lbs ≅ 0.454kg  
1lbs ≅ 4.448N



## TWN-ADJ Type

### Clearance Adjustable Twin Block Type with seals on both sides (Inch Series)



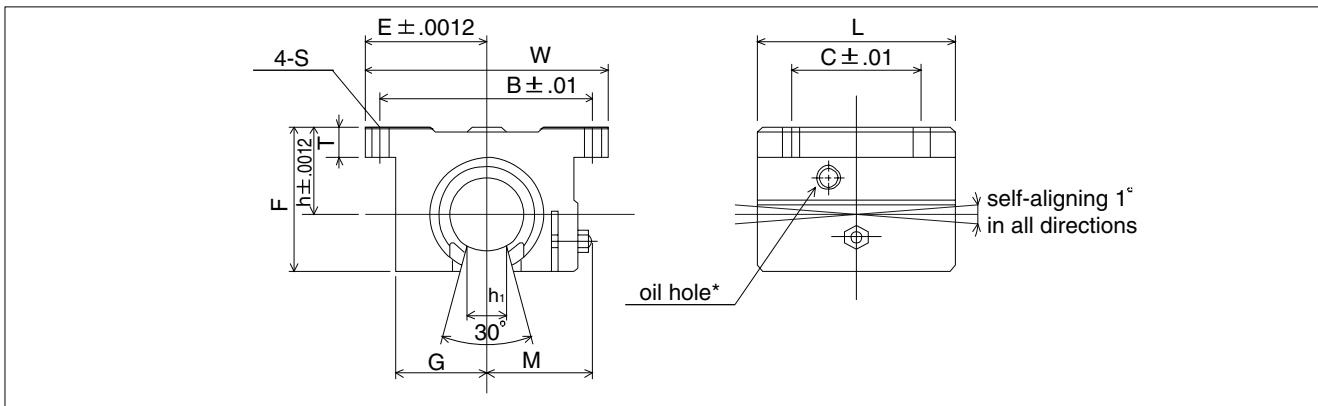
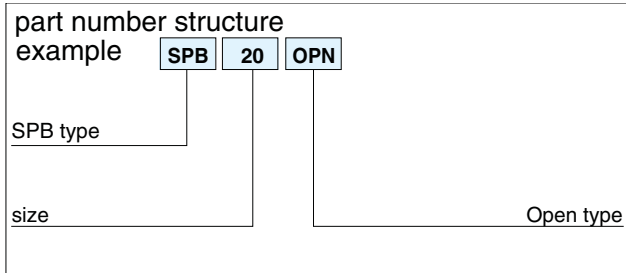
part number	nom. shaft dia. inch	major dimensions								mounting dimensions			basic load rating		mass lbs.
		h inch	E inch	W inch	L inch	F inch	T inch	G inch	M inch	B inch	C inch	S inch	C lbs.	Co lbs.	
<b>TWN4ADJ</b>	1/4	.4370	.8125	1.625	2.500	.813	.188	.750	1.000	1.312	2.000	.156	96	160	.190
<b>TWN6ADJ</b>	3/8	.5000	.8750	1.750	2.750	.938	.188	.875	1.125	1.437	2.250	.156	150	240	.250
<b>TWN8ADJ</b>	1/2	.6870	1.0000	2.000	3.500	1.250	.250	1.125	1.375	1.688	2.500	.156	370	580	.510
<b>TWN10ADJ</b>	5/8	.8750	1.2500	2.500	4.000	1.625	.281	1.437	1.750	2.125	3.000	.188	640	1,000	1.000
<b>TWN12ADJ</b>	3/4	.9370	1.3750	2.750	4.500	1.750	.313	1.563	1.875	2.375	3.500	.188	750	1,180	1.200
<b>TWN16ADJ</b>	1	1.1870	1.6250	3.250	6.000	2.188	.375	1.938	2.375	2.875	4.500	.219	1,360	2,120	2.400
<b>TWN20ADJ</b>	1-1/4	1.5000	2.0000	4.000	7.500	2.813	.438	2.500	3.000	3.500	5.500	.219	1,970	3,060	5.000
<b>TWN24ADJ</b>	1-1/2	1.7500	2.3750	4.750	9.000	3.250	.500	2.875	3.500	4.125	6.500	.281	2,370	3,700	7.800

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

1inch = 25.4mm  
1lbs ≈ 0.454kg  
1lbs ≈ 4.448N

## SPB-OPN TYPE

Open Block Type with seals on both sides (Inch Series)



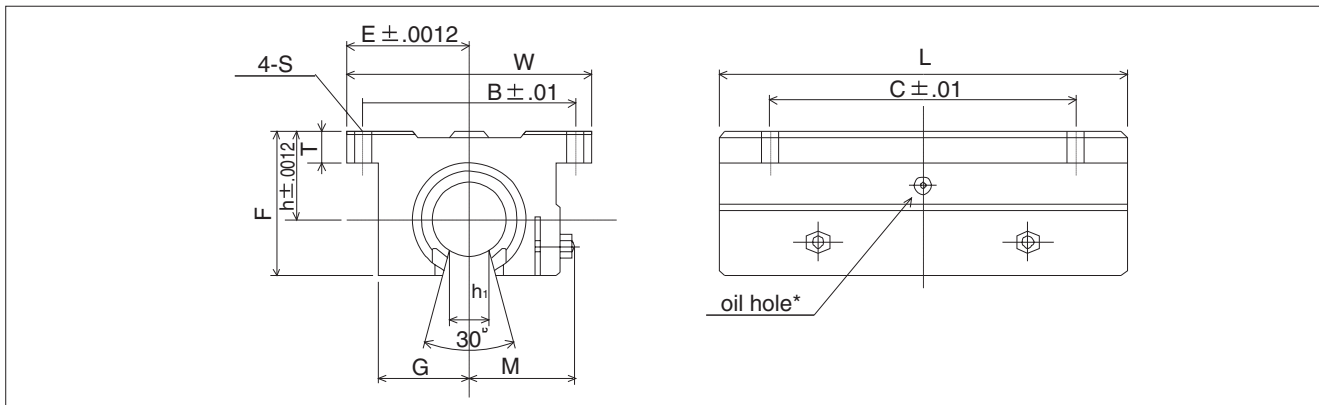
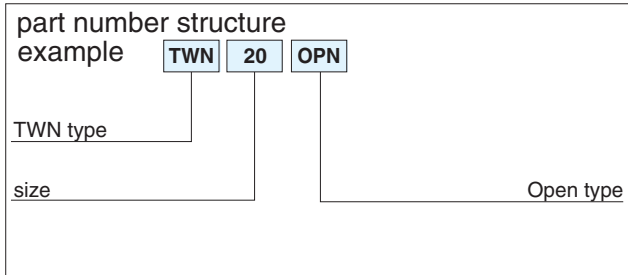
part number	nom. shaft dia. inch	major dimensions									mounting dimensions			basic load rating		mass lbs.
		h inch	E inch	W inch	L inch	F inch	T inch	G inch	M inch	h <sub>1</sub> inch	B inch	C inch	S inch	C lbs.	Co lbs.	
SPB8OPN	1/2	.6870	1.000	2.000	1.500	1.100	.250	.688	.98	.260	1.688	1.000	.156	230	290	.188
SPB10OPN	5/8	.8750	1.2500	2.500	1.750	1.405	.281	.875	1.15	.319	2.125	1.125	.188	400	500	.365
SPB12OPN	3/4	.9370	1.3750	2.750	1.875	1.535	.315	.937	1.23	.386	2.375	1.250	.188	470	590	.452
SPB16OPN	1	1.1870	1.6250	3.250	2.625	1.975	.375	1.188	1.48	.512	2.875	1.750	.218	850	1,060	1.010
SPB20OPN	1-1/4	1.5000	2.0000	4.000	3.375	2.485	.437	1.500	1.88	.569	3.500	2.000	.218	1,230	1,530	1.980
SPB24OPN	1-1/2	1.7500	2.3750	4.750	3.750	2.910	.500	1.750	2.12	.681	4.125	2.500	.281	1,480	1,850	2.950
SPB32OPN	2	2.1250	3.0000	6.000	4.750	3.660	.625	2.250	2.70	.933	5.250	3.250	.406	2,430	3,040	5.840

\* Provided with push-in oil fitting for 1/4" to 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.

1inch = 25.4mm  
1lbs  $\approx$  0.454kg  
1lbs  $\approx$  4.448N

# TWN-OPN TYPE

**Twin Open Block Type with seals on both sides (Inch Series)**



part number	nom. shaft dia. inch	major dimensions									mounting dimensions			basic load rating		mass lbs.
		h	E	W	L	F	T	G	M	h <sub>1</sub>	B	C	S	C	Co	
		inch	inch	inch	inch	inch	inch	inch	inch	inch	inch	inch	inch	lbs.	lbs.	
TWN8OPN	1/2	.6870	1.000	2.000	3.500	1.100	.250	.688	.98	.260	1.688	2.500	.156	370	580	.400
TWN10OPN	5/8	.8750	1.2500	2.500	4.000	1.405	.281	.875	1.15	.319	2.125	3.000	.188	640	1,000	.800
TWN12OPN	3/4	.9370	1.3750	2.750	4.500	1.535	.315	.937	1.23	.386	2.375	3.500	.188	750	1,180	1.000
TWN16OPN	1	1.1870	1.6250	3.250	6.000	1.975	.375	1.188	1.48	.512	2.875	4.500	.218	1,360	2,120	2.000
TWN20OPN	1-1/4	1.5000	2.0000	4.000	7.500	2.485	.437	1.500	1.88	.569	3.500	5.500	.218	1,970	3,060	4.200
TWN24OPN	1-1/2	1.7500	2.3750	4.750	9.000	2.910	.500	1.750	2.12	.681	4.125	6.500	.281	2,370	3,700	6.700

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

1 inch = 25.4mm  
 1 lbs ≅ 0.454kg  
 1 lbs ≅ 4.448N



The PLC ball bushing is a linear motion mechanism utilizing the rotational motion of ball elements. Since linear motion is obtained using a simple mechanism, the ball bushing can be used in a wide variety of applications, including transportation equipment, food processing equipment, and semiconductor equipment.

## FEATURES

The PLC ball bushing consists of the outer cylinder and a ball retainer that guide the circulation of the ball elements, resulting in smooth linear motion.

### Compact Mechanism:

The PLC ball bushing uses a round shaft for the guide, resulting in effective space utilization, which allows for compact designs.

### A Wide Variety of Shapes and Installation Methods:

The PLC ball bushing is available in various shapes, which make it suitable for various types of installations: standard, clearance adjustable, open, and twin types.

### Selection According to Environment:

Standard and anti-corrosion PLC ball bushings are both available with metallic retainers suitable for use in harsh environments. These options can be specified according to application need.

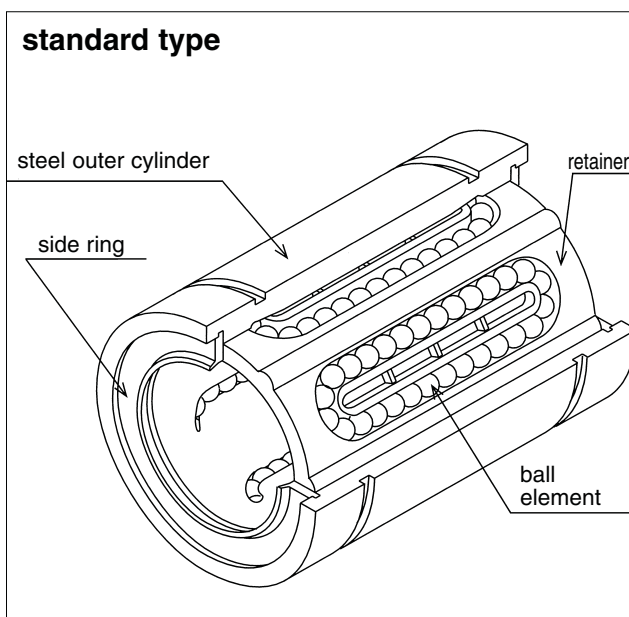
### Compatibility:

The PLC ball bushing is fully compatible with a variety of shaft types.

### Low Friction:

The raceway surface is precision ground. Since the contact surface between the ball elements and the raceway surface is minimized, the PLC ball bushing provides low friction when compared to other linear motion mechanisms.

Figure 8: Basic Structure of PLC Ball Bushing



## SPECIFICATIONS

### Dimensional Series:

The PLC ball bushing is available in three primary dimensional series, each with different dimensions and tolerances depending on the application.

### Allowable Load:

PLC ball bushings are categorized into three functional types depending on the number and location of retainers: single, double, and triple. The single type uses only one retainer, so when a moment load is to be applied, the double or triple type should be used.

### Material:

The standard ball bushing uses a bearing steel outer cylinder with a single-body steel retainer. The anti-corrosion ball bushing uses Martensitic stainless steel with a stainless steel retainer.

### Seals:

The seals effectively retain the lubricant within the ball bushing, extending the time between lubrications. The DD type has seals on both sides. Nitril rubber, which has low wear and good sealing characteristics, is used as the seal material.

Table 4: Comparison of Allowable Loads

type	basic dynamic load rating	basic static load rating	allowable static moment
single	1	1	1
double	1.6	2	6 approx.
triple	1.6	2	21 approx.

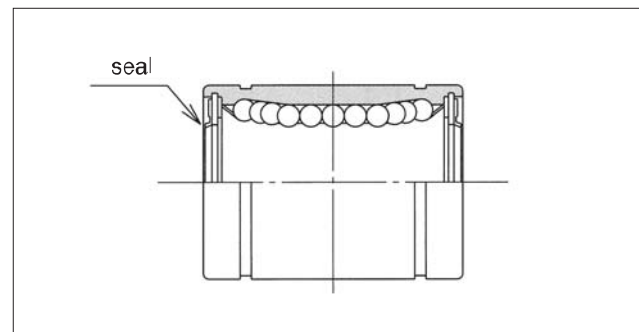
\* The single type is designated as "1" for comparison purposes.

Table 5: Operating Environment Temperature

material		temperature range
outer cylinder	retainer	
steel	steel	- 20 ~ 110°C
stainless	stainless	- 20 ~ 140°C*

\* When a ball bushing with seals is used, the temperature should never exceed 120°C.

Table 9: Seal Profile



## LIFE CALCULATION

Since ball elements are used as the rolling element in the PLC ball bushing, Equation (4) is used to calculate the Travel life.

$$L = \left( \frac{f_H \cdot f_T \cdot f_C}{f_W} \cdot \frac{C}{P} \right)^3 \cdot 50 \dots \dots \dots (4)$$

L : travel life (Km)                      f<sub>H</sub> : hardness coefficient  
 f<sub>T</sub> : temperature coefficient          f<sub>W</sub> : load coefficient  
 C : basic dynamic load rating        P : load (N)  
 \*Refer to page 20 for the coefficient.

If the stroke distance and number of strokes per unit time are constant, the life is calculated using Equation (5).

$$L_h = \frac{L \cdot 10^3}{2 \cdot Q_s \cdot n_1 \cdot 60} \dots \dots \dots (5)$$

L<sub>h</sub> : travel life in time (h)    Q<sub>s</sub> : stroke distance (mm)  
 L : travel life (Km)    n<sub>1</sub> : stroke frequency per min (cpm)

## LOAD RATING FOR OPEN TYPE BALL BUSHING

In the open type ball bushing, an opening is provided to allow the shaft to be supported from underneath. When a load is constantly applied in the direction of the opening (for example, when used with a vertical shaft or when an overhang loading is applied), the rated load decreases due to the reduction in the number of rows of ball elements that are loaded. Therefore, the load rating must be adjusted at the time of selection based on the direction of the loading.

Table 6: Direction of Load and Basic Static Load Rating

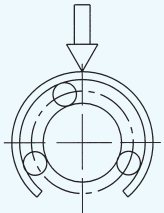
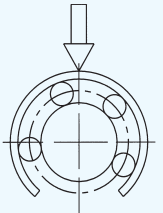
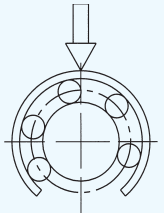
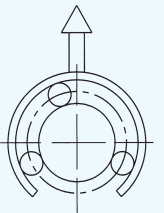
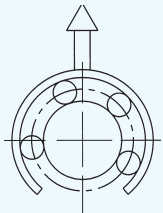
part number	OPN81420 ~ OPN101824	OPN122026	OPN162536 ~ OPN6496128
loading from above	<p>Load P</p>  <p>C</p>	<p>Load P</p>  <p>C</p>	<p>Load P</p>  <p>C</p>
	loading from below	<p>Load P</p>  <p>C</p>	<p>Load P</p>  <p>0.54C</p>

Figure 10: Hardness Coefficient ( $f_H$ )

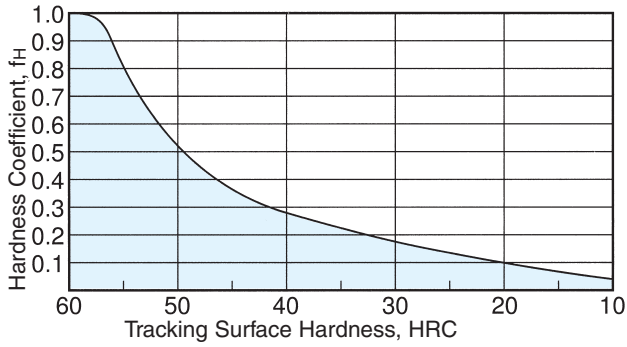


Figure 11: Temperature Coefficient ( $f_T$ )

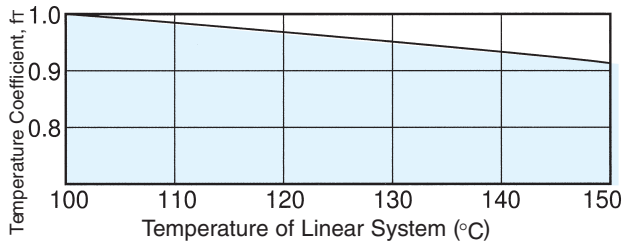


Table 7: Contact Coefficient ( $f_C$ )

number of linear systems in contact and applied to a single shaft	contact coefficient $f_C$
1	1.00
2	0.81
3	0.72
4	0.66
5	0.61

Table 8: Applied Load Coefficient ( $f_W$ )

operating condition		applied load coefficient $f_W$
loading condition	velocity	
no shock/vibration	15 m/min or less	1.0 ~ 1.5
low shock/vibration	60 m/min or less	1.5 ~ 2.0
high shock/vibration	60 m/min or more	2.0 ~ 3.5



## MOUNTING

Examples of Mounting methods are shown in Figures 12 ~ 14.

Figure 12: Standard Type

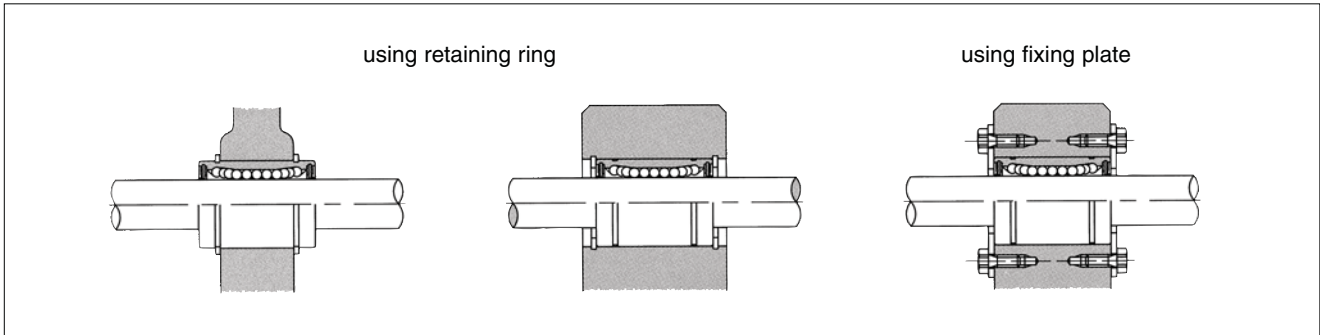


Figure 13: Clearance Adjustable Type

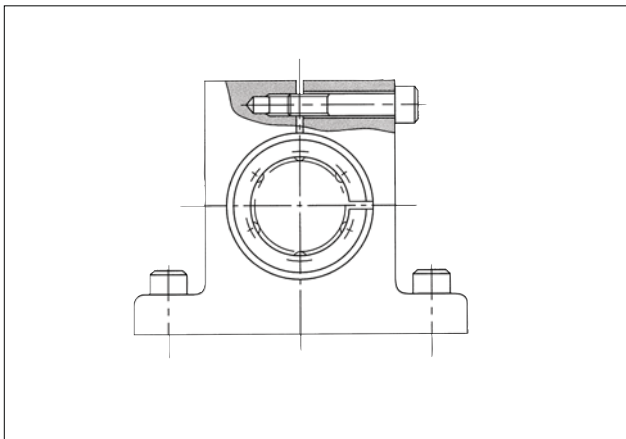
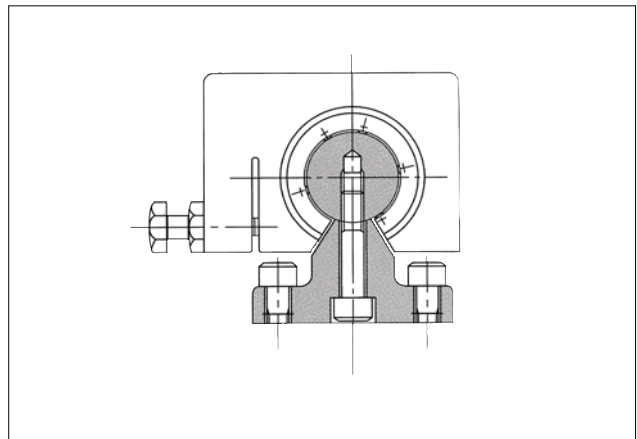


Figure 14: Open Type



**Fit:**

The normal clearances listed in Table 9 are generally used for the PLC ball bushing. The transition fit is used to reduce clearance and increase accuracy. Matching the clearance as specified between bushing and shaft is also possible.

The pre-load for the clearance adjustable and open type ball bushing must be adjusted carefully so that excessive pre-load does not exceed limits, based on the radial clearances listed in the table.

**Notes on Installation:**

When inserting a ball bushing into a housing, carefully insert it by using a jig to apply a uniform pushing force at the end of the outer cylinder, as illustrated in Figure 15. Life expectancy may be diminished if an excessive force is applied to the outer cylinder, the side-ring, or the seal.

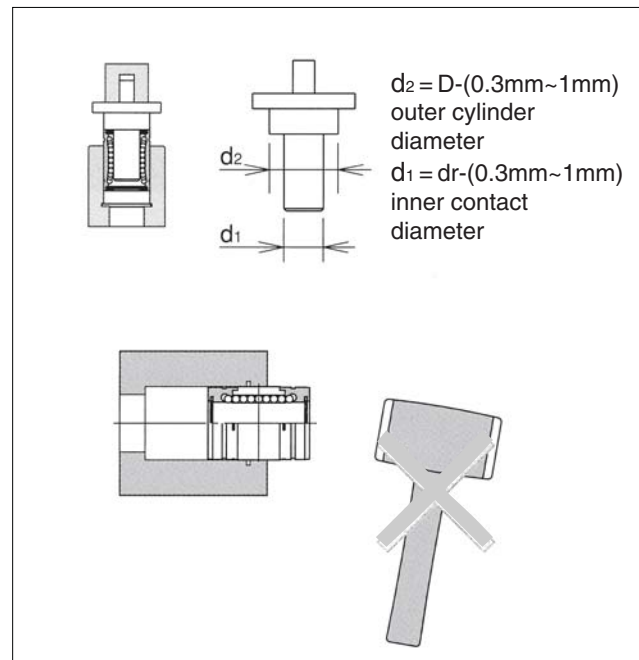
Ensure that all burrs are removed from the shaft and carefully insert the bushing by aligning it with the center of the bore. The ball elements may drop out if excessive force is used during insertion.

When two or more shafts are used, the parallelism of the shafts will greatly affect the motion characteristics and life of the ball bushing. The parallelism should be adjusted by moving the ball bushing back and forth the length of stroke to check for freedom of movement before final fixing of shaft.

**Table 9: Normal Clearances**

series	accuracy grade	shaft		housing	
		clearance fit	transition fit	clearance fit	transition fit
A	high	g6	h6	H7	J7
	precision (P)	g5	h5	H6	J6

**Figure 15: Insertion of Ball Bushing**



## LUBRICATION

For a ball bushing to continue operating accurately and have a long life, it must be lubricated on a regular basis. Anti-rust oil is applied to the PLC ball bushing prior to shipment. When ball bushings are delivered, they should be cleaned with non-residue degreaser and dried, then a lubricant should be applied before usage.

### Grease Lubricant:

Grease should be applied to the internal components of the ball bushing and periodically reapplied depending on the operating conditions. Reapplication may be done by adding the grease directly to the internal components or by using a mechanism similar to that shown in Figure 16. Lithium soap grease is recommended.

### Oil Lubricant:

Oil can be applied directly to the shaft or by using a mechanism similar to that shown in Figure 16. Turbine oil (ISO standard VG32-68) is recommended for high speed applications.

Lubrication oil holes can be fabricated (see Figure 17) in the center portion of the outer cylinder to simplify oil application. Contact PLC for further details.

## Dust Prevention

If foreign particles such as dust or grinding chips are introduced into the slide bush, they will disrupt the smooth circulation of the ball elements. The PLC ball bushing is available with seals as an option. Bellows or protective covers should be used under harsh environmental operating conditions.

Figure 16: Example of Mechanism for Applying Lubrication

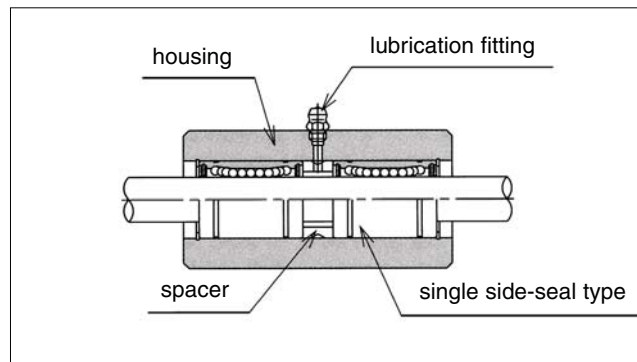


Figure 17: Oil Hole (Custom Specification)

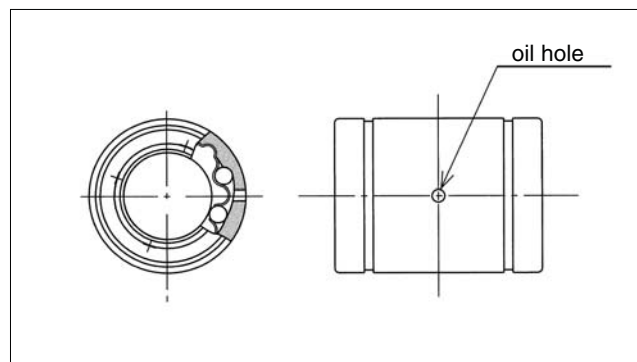
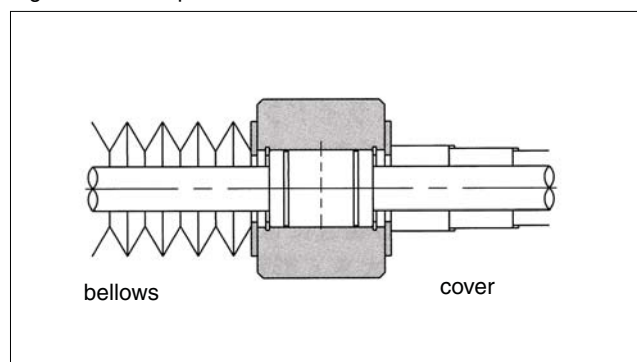
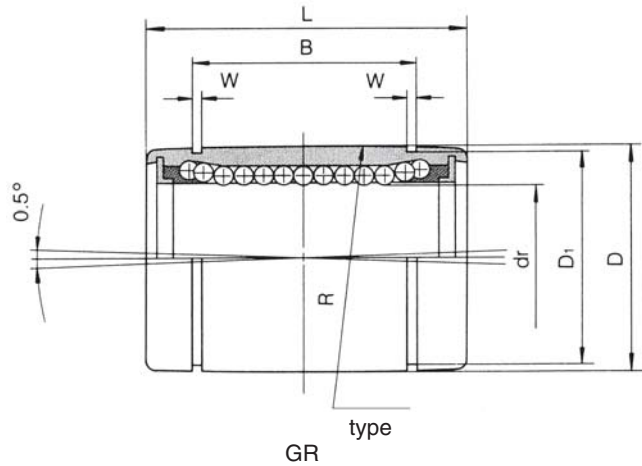
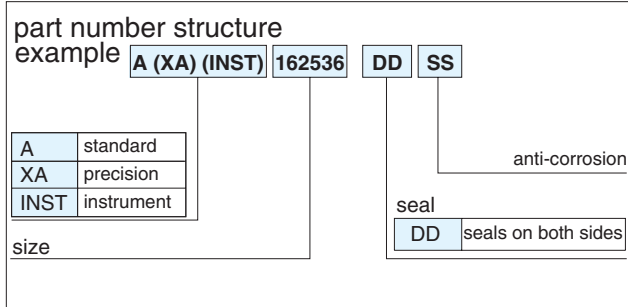


Figure 18: Example of Dust Prevention

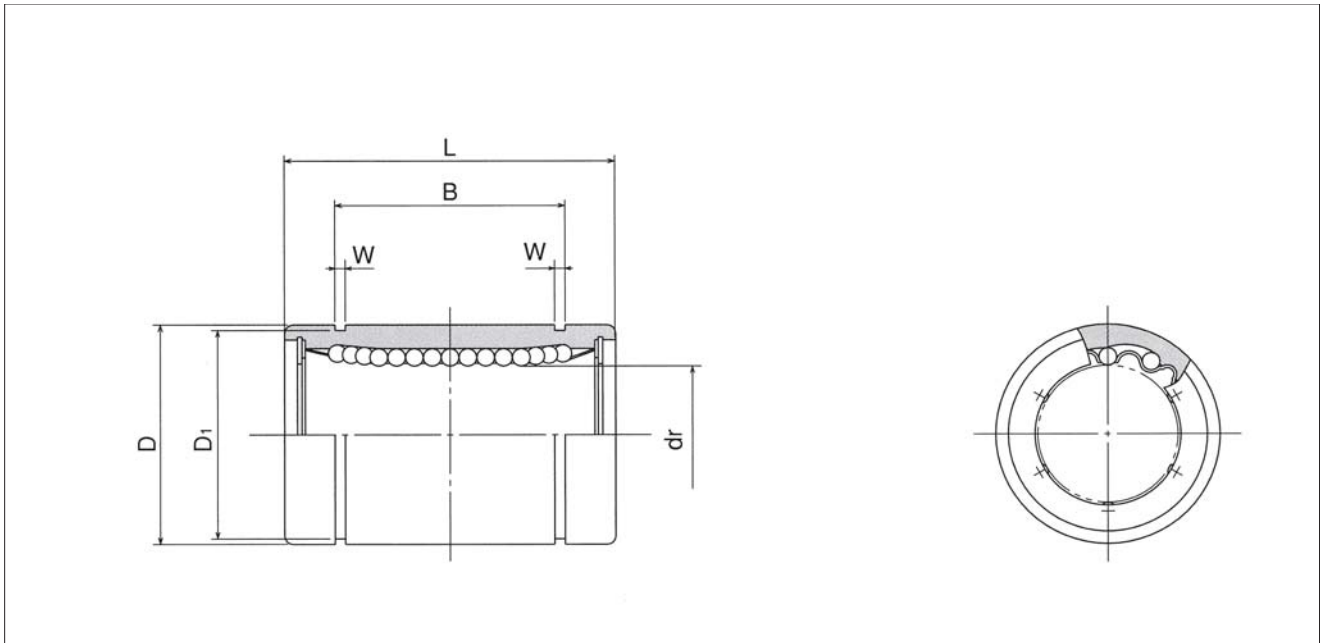


# A TYPE

## Standard Type (Inch Series)



part number		number of ball circuits	dr				D	
standard	anti-corrosion		inch mm	tolerance inch/ μm		inch mm	tolerance inch/μm	
steel retainer	stainless retainer			precision	high			
-	<b>INST258SS</b>	4	.1250 3.175	0 - .00035	0 - 8	.3125 7.938	0 - .00040	
-	<b>INST369SS</b>	4	.1875 4.763	0 - 8	0 - 9	.3750 9.525	0 - 9	
<b>A4812</b>	<b>A4812SS</b>	3	.2500 6.350	0 - .00025	0 - .00040	.5000 12.700	0 - .00045 - 11	
<b>A61014</b>	<b>A61014SS</b>	4	.3750 9.525	0 - .00025	0 - .00040	.6250 15.875	0 - .00050	
<b>A81420</b>	<b>A81420SS</b>	4	.5000 12.700	0 - 6	0 - 9	.8750 22.225	0 - 13	
<b>A101824</b>	<b>A101824SS</b>	4	.625 15.875	0 - .00030	0 - .00040	1.1250 28.575	0 - .00065	
<b>A122026</b>	<b>A122026SS</b>	5	.7500 19.050	0 - .00030	0 - .00040	1.2500 31.750	0 - .00075	
<b>A162536</b>	<b>A162536SS</b>	6	1.0000 25.400	0 - 7	0 - 10	1.5625 39.688	0 - 16	
<b>A203242</b>	-	6	1.2500 31.750	0 - .00035	0 - .00050	2.0000 50.800	0 - .00075	
<b>A243848</b>	-	6	1.5000 38.100	0 - 8	0 - 12	2.3750 60.325	0 - 19	
<b>A324864</b>	-	6	2.0000 50.800	0 - .00040	0 - .00060	3.0000 76.200	0 - .00090	
<b>A406080</b>	-	6	2.5000 63.500	0 - .00040	0 - .00060	3.7500 95.250	0 - 22	
<b>A487296</b>	-	6	3.0000 76.200	0 - 9	0 - 15	4.50000 114.300	0 - 25	
<b>A6496128</b>	-	6	4.0000 101.600	0 - .00040 - 10	0 - .00080 - 20	6.0000 152.400	0 - .00100 - 25	

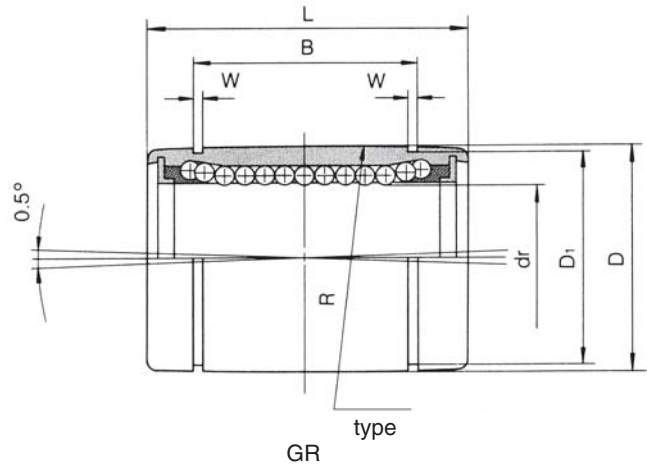
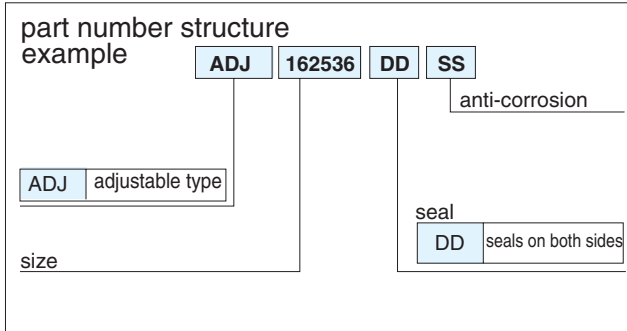


major dimensions						eccentricity		radial clearance (maximum)	basic load rating		mass	shaft diameter
inch	L	inch	B	W	D <sub>1</sub>	precision	high		dynamic	static		
mm	tolerance	mm	tolerance	mm	mm	inch/μm	inch/μm	inch/μm	C	Co	g	inch
	inch/mm		inch/mm						N	N		mm
.5000 12.700		.3681 9.35		.0280 0.710	.2902 7.370		.0003	-.0001 - 2	59	76	2.8	1/8 3.175
.5625 14.275		.4311 10.95		.0280 0.710	.3520 8.940		8		91	110	3.6	3/16 4.763
.7500 19.050	0 -.008	.5110 12.98	0 -.008	.0390 0.992	.4687 11.906			-.0001 - 3	206	265	9.5	1/4 6.350
.8750 22.225		.6358 16.15		.0390 0.992	.5880 14.935	.0003	.0005		225	314	15	3/8 9.525
1.2500 31.750	0 -.02	.9625 24.46	0 -.02	.0459 1.168	.8209 20.853	8	12	-.0001	510	784	42	1/2 12.700
1.5000 38.100		1.1039 28.04		.0559 1.422	1.0590 26.899			- 4	774	1,180	85	5/8 15.875
1.6250 41.275		1.1657 29.61		.0559 1.422	1.1760 29.870	.0004	.0006	-.0002	862	1,370	104	3/4 19.050
2.2500 57.150		1.7547 44.57		.0679 1.727	1.4687 37.306	10	15	- 6	980	1,570	220	1 25.400
2.6250 66.675	0 -.012	2.0047 50.92	0 -.012	.0679 1.727	1.8859 47.904	.0005	.0008	-.0003	1,570	2,740	465	1-1/4 31.750
3.0000 76.200		2.4118 61.26		0.859 2.184	2.2389 56.870	12	20	- 8	2,180	4,020	720	1-1/2 38.100
4.0000 101.600	0 -.03	3.1917 81.07	0 -.03	.1029 2.616	2.8379 72.085			-.0005	3,820	7,940	1,310	2 50.800
5.0000 127.000		3.9760 100.99		.1200 3.048	3.5519 90.220	.0007	.0010	- 13	4,700	10,000	2,600	2-1/2 63.500
6.0000 152.400	0 -.016	4.726 120.04	0 -.016	.1200 3.048	4.3100 109.474	17	25	-.0008	7,350	16,000	4,380	3 76.200
8.0000 203.200	0 -.04	6.258 158.95	0 -.04	.1389 3.530	5.745 145.923	.0008 20	.0012 30	- 20	14,100	34,800	10,200	4 101.600

1N ≅ 0.225lbs 1kg ≅ 2.205lbs

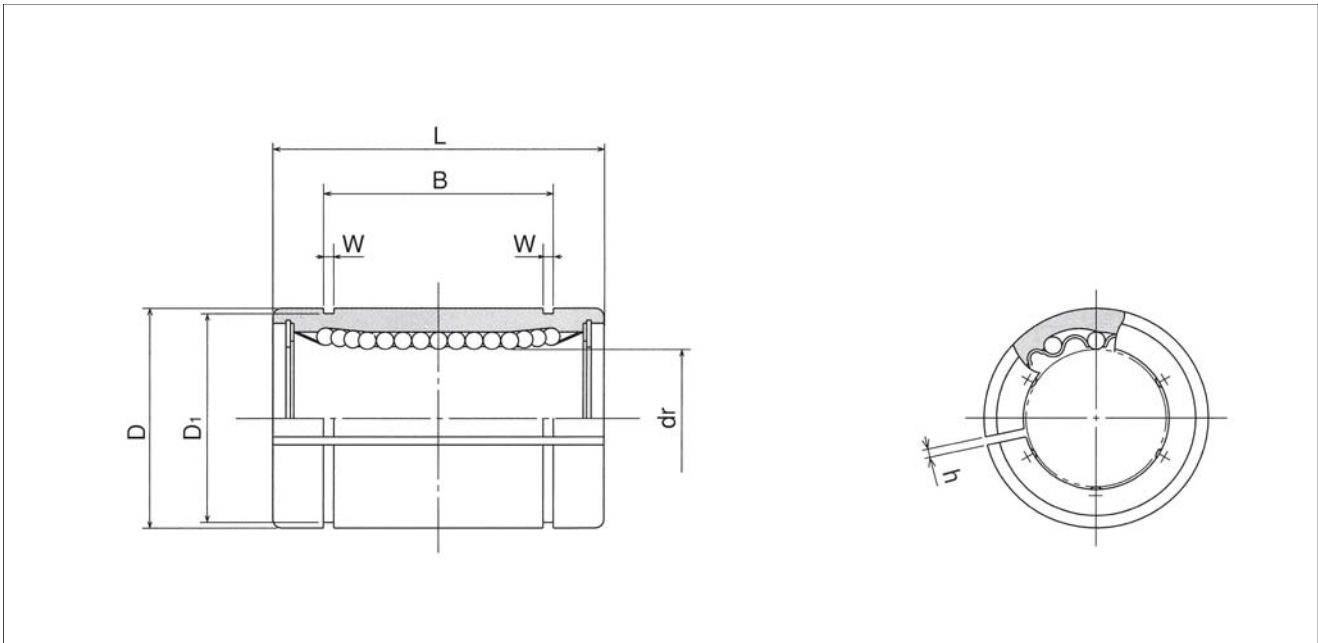
# ADJ TYPE

## Clearance Adjustable Type (Inch Series)



part number		number of ball circuits	dr		D	
standard	anti-corrosion		inch mm	tolerance* inch/ μm	inch mm	tolerance* inch/ μm
steel retainer	stainless retainer					
-	-	4	.2500 6.350		.5000 12.700	$0$ $-.00045$ $0$ $- 11$
-	-	4	.3750 9.525	$0$ $-.00040$	.6250 15.875	$0$ $0$
<b>ADJ81420</b>	<b>ADJ81420SS</b>	4	5.000 12.700	$0$ $- 9$	.8750 22.225	$0$ $-.00050$ $0$
<b>ADJ101824</b>	<b>ADJ101824SS</b>	4	.625 15.875		1.1250 28.575	$0$ $- 13$
<b>ADJ122026</b>	<b>ADJ122026SS</b>	5	.7500 19.050	$0$ $-.00040$	1.2500 31.750	$0$ $-.00065$ $0$
<b>ADJ162536</b>	<b>ADJ162536SS</b>	6	1.0000 25.400	$0$ $- 10$	1.5625 39.688	$0$ $- 16$
<b>ADJ203242</b>	-	6	1.2500 31.750	$0$ $-.00050$	2.0000 50.800	$0$ $-.00075$ $0$
<b>ADJ243848</b>	-	6	1.5000 38.100	$0$ $- 12$	2.3750 60.325	$0$ $- 19$
<b>ADJ324864</b>	-	6	2.0000 50.800	$0$ $-.00060$	3.0000 76.200	$0$ $-.00090$ $0$
<b>ADJ406080</b>	-	6	2.5000 63.500	$0$ $- 15$	3.7500 95.250	$0$ $- 22$
<b>ADJ487296</b>	-	6	3.0000 76.200	$0$ $-.00080$ $0$ $- 20$	4.50000 114.300	$0$ $-.00100$ $0$ $- 25$
<b>ADJ6496128</b>	-	6	4.0000 101.600		6.0000 152.400	

\* Accuracy is measured prior to machining clearance slot.

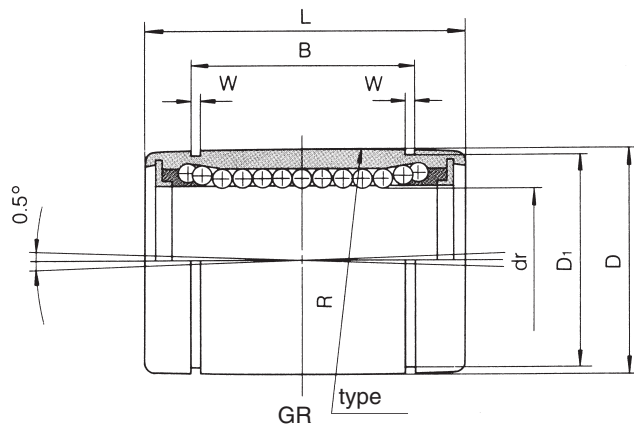
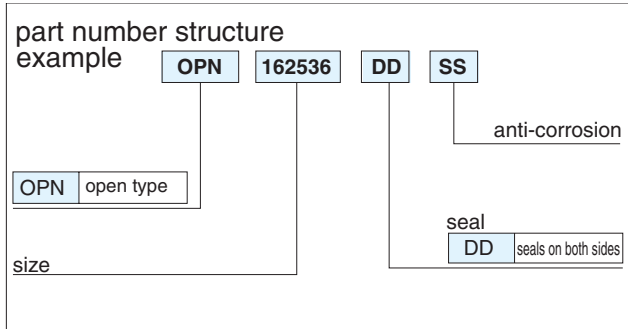
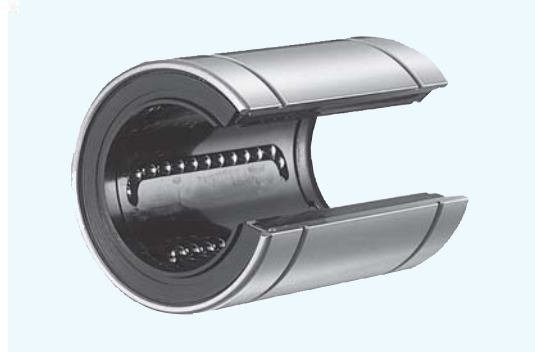


major dimensions							eccentricity	Radial clearance (Max)	basic load rating		mass	shaft diameter
L		B		W	D <sub>1</sub>	h			dynamic	static		
inch	tolerance	inch	tolerance	inch	inch	inch	inch	C	Co	g	inch	
mm	inch/mm	mm	inch/mm	mm	mm	mm	μm	N	N		mm	
.7500 19.050	0	.5100 12.98	0	.0390 0.992	.4687 11.906	.04 1	.0005	– .0001	206	265	7.5	1/4 6.350
.8750 22.225		.6358 12.15		.0390 0.992	.5880 14.935	.04 1	12	– 3	225	314	13.5	3/8 9.525
1.2500 31.750	– .008	.9625 24.46	– .008	.0459 1.168	.8209 20.853	.06 1.5	.0005	– .0001	510	784	41	1/2 12.700
1.5000 38.100	– 0.2	1.1039 28.04	– 0.2	.0559 1.422	1.0590 26.899	.06 1.5	12	– 4	774	1,180	83	5/8 15.875
1.6250 41.275	0	1.1657 29.61	0	.0559 1.422	1.1760 29.870	.06 1.5	.0006	– .0002	862	1,370	102	3/4 19.050
2.2500 57.150		1.7547 44.57		.0679 1.727	1.4687 37.306	.06 1.5	15	– 6	980	1,570	218	1 25.400
2.6250 66.675	– .012	2.0047 50.92	0	.0679 1.727	1.8859 47.904	.10 2.5	.0008	– .0003	1,570	2,740	455	1-1/4 31.750
3.0000 76.200		2.4118 61.26		.0859 2.184	2.2389 56.870	.12 3	20	– 8	2,180	4,020	710	1-1/2 38.100
4.0000 101.600	– 0.3	3.1917 81.07	– 0.3	.1029 2.616	2.8379 72.085	.12 3	.0010	– .0005	3,820	7,940	1,290	2 50.800
5.0000 127.000	0	3.9760 100.99	0	.1200 3.048	3.5519 90.220	.12 3		25	– 13	4,700	10,000	2,560
6.0000 152.400		– .016		4.726 120.04	– .016	.1200 3.048	4.3100 109.474	.12 3	– .0008	7,350	16,000	4,350
8.0000 203.200	– 0.4	6.258 158.95	– 0.4	.1389 3.530	5.745 145.923	.12 3	.0012 30	– 20	14,100	34,800	10,150	4 101.60

1N ≅ 0.225lbs 1kg ≅ 2.205lbs

# OPN TYPE

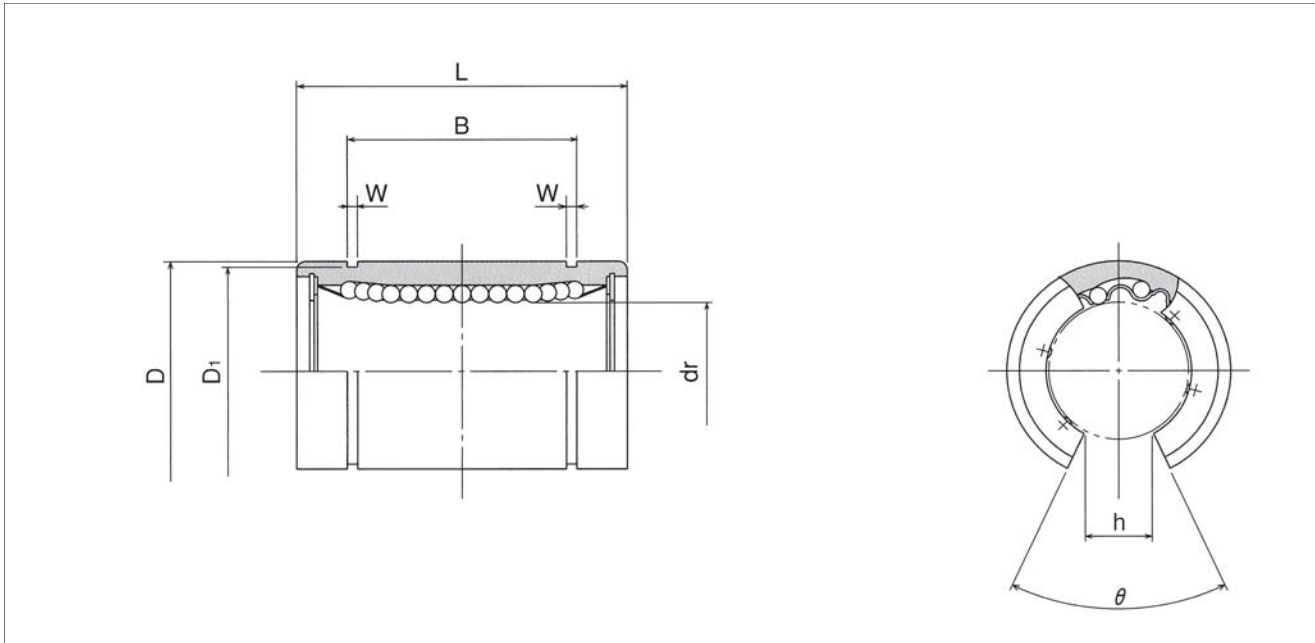
## Open Type (Inch Series)



526

part number		number of ball circuits	dr		D	
standard	anti-corrosion		inch mm	tolerance inch/ $\mu$ m	inch mm	tolerance inch/ $\mu$ m
steel retainer	stainless retainer					
OPN81420	OPN81420SS	3	.5000 12.700	0 - .00040	.8750 22.225	0 - .00050
OPN101824	OPN101824SS	3	.625 15.875	0 - 9	1.1250 28.575	0 - 13
OPN122026	OPN122026SS	4	.7500 19.050	0 - .00040	1.2500 31.750	0 - .00065
OPN162536	OPN162536SS	5	1.0000 25.400	0 - 10	1.5625 39.688	0 - 16
OPN203242	-	5	1.2500 31.750	0 - .00050	2.0000 50.800	0 - .00075
OPN243848	-	5	1.5000 38.100	0 - 12	2.3750 60.325	0 - 19
OPN324864	-	5	2.0000 50.800	0 - .00060	3.0000 76.200	0 - .00090
OPN406080	-	5	2.5000 63.500	0 - 15	3.7500 95.250	0 - 22
OPN487296	-	5	3.0000 76.200	0 - 20	4.50000 114.300	0 - 25
OPN6496128	-	5	4.0000 101.600	0 - 20	6.0000 152.400	0 - 25





major dimensions								eccentricity*	Radial clearance (Max)	basic load rating		mass	shaft diameter
L		B		W	D <sub>1</sub>	h	θ			dynamic	static		
inch	tolerance	inch	tolerance	inch	inch	inch		inch	inch/μm	C	Co	g	inch
mm	inch/mm	mm	inch/mm	mm	mm	mm		μm		N	N		mm
1.2500 31.750	0 - .008	.9625 24.46	0 - .008	.0459 1.168	.8209 20.853	.34 7.9375	80°	.0005 12	-.0001 - 4	510	784	32	1/2 12.700
1.5000 38.100	0 - .008	1.1039 28.04	0 - .008	.0559 1.422	1.0590 26.899	.375 9.5250	80°	.0005 12	-.0001 - 4	774	1,180	64	5/8 15.875
1.6250 41.275	0 - .02	1.1657 29.61	0 - .02	.0559 1.422	1.1760 29.870	.4375 11.1125	60°	.0006 15	-.0002 - 6	862	1,370	86	3/4 19.050
2.2500 57.150	0 - .012	1.7547 44.57	0 - .012	.0679 1.727	1.4687 37.306	.5625 14.2875	50°	.0006 15	-.0002 - 6	980	1,570	190	1 25.400
2.6250 66.675	0 - .012	2.0047 50.92	0 - .012	.0679 1.727	1.8859 47.904	.625 15.875	50°	.0008 20	-.0003 - 8	1,570	2,740	390	1-1/4 31.750
3.0000 76.200	0 - .012	2.4118 61.26	0 - .012	.0859 2.184	2.2389 56.870	.75 19.05	50°	.0008 20	-.0003 - 8	2,180	4,020	610	1-1/2 38.100
4.0000 101.600	0 - .03	3.1917 81.07	0 - .03	.1029 2.616	2.8379 72.085	1.0 25.40	50°	.0010 25	-.0005 - 13	3,820	7,940	1,120	2 50.800
5.0000 127.000	0 - .03	3.9760 100.99	0 - .03	.1200 3.048	3.5519 90.220	1.25 31.75	50°	.0010 25	-.0005 - 13	4,700	10,000	2,230	2-1/2 63.500
6.0000 152.400	0 - .016	4.726 120.04	0 - .016	.1200 3.048	4.3100 109.474	1.5 38.10	50°	.0012 30	-.0008 - 20	7,350	16,000	3,750	3 76.200
8.0000 203.200	0 - .04	6.258 158.95	0 - .04	.1389 3.530	5.745 145.923	2.0 50.8	50°	.0012 30	-.0008 - 20	14,100	34,800	8,740	4 101.60

\* Accuracy is measured prior to machining open slot.

1N ≅ 0.225lbs 1kg ≅ 2.205lbs



## **60 HRC Precision Case Hardened and Ground Steel Linear Shafting**

PLC's **60 HRC** Linear Shafting is produced to exceed industry requirements for uniform hardness, depth of case, accurate diameters and straightness. To achieve these properties efficiently and consistently requires specialized high frequency induction equipment, proven techniques and experienced personnel.

### **APPLICATIONS:**

**60 HRC** Linear Shafting is used extensively by virtually every segment of industry to satisfy rigid requirements for resistance to abrasion. In many cases, the shafts are used as the inner races of linear motion ball bearings and similar products which require one of the five precise diameter tolerance codes shown in the tables on page 31.

**60 HRC** Linear Shafting is primarily produced for linear motion. However, the consistency maintained throughout the manufacturing process provides a shaft with uniformity that is also a perfect choice for your power transmission needs.

### **STANDARD SPECIFICATIONS:**

#### **Materials & Hardness**

**60 HRC** Linear Shafting is uniformly case hardened by the high frequency induction hardening method to Rockwell 60-65C. Our 440C Precision Case Hardened and ground shafting is hardened to Rockwell 50-55C. Case depth and diameter specifications can be found on page 31.

#### **Surface Finish**

Normally between 10 and 16 micro-inches RMS. Other finishes can be furnished to meet special requirements if quantities justify.

#### **Maximum Lengths**

The maximum lengths in stock for each diameter are shown in the tables on pages 31 and 32. Shafting can be joined to provide longer lengths.

#### **Straightness**

With the exception of 3/8" diameters and less, the standard straightness tolerance is .001"-.002" per foot cumulative. Straighter requirements can be supplied at additional cost.

#### **Diameters**

The tables on page 31 list the standard size shafts in stock. Diameters other than those shown can be supplied economically if a sufficient quantity is required and adequate time is allowed to obtain the special size raw material from the steel mills. Please submit specifications for price quotations.

#### **Chamfered Ends**

Normally, all shafts are chamfered approximately 1/16" x 45°. Precision chamfers of other dimensions are classified as special fabrication and carry extra charges.

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### **SHAFTING WITH HARD CHROME (The Stainless Alternative)**

Our **60 HRC** precision case hardened and ground steel shafting is also available with hard chrome plating. Hard chrome offers good corrosion resistance, an enhanced appearance, and a hardness of approximately Rockwell 70C. When permissible, **60 HRC** with hard chrome can be

supplied as a replacement for stainless shafting. The surface will be harder than case hardened stainless steel and therefore offers longer shafting life with greater corrosion resistance. When plating, we prepare a pre-plate diameter to compensate for chrome thickness.

# 60 HRC PRECISION CASE HARDENED AND GROUND STEEL SHAFTING

The following are the specific diameter tolerances stocked in the lengths as indicated, ready to be cut and processed for further special machining in accordance with customer drawings or simply cut to required lengths, chamfered, polished and shipped.

## SOLID 60 HRC PRECISION CASE HARDENED & GROUND SHAFTS

HARDNESS: ROCKWELL 60 TO 65 "C"

NOM. DIA.	TOLERANCES (PLEASE SPECIFY TOLERANCE CODE ON ORDER)					WEIGHT PER INCH (lbs.)	MINIMUM DEPTH OF HARDNESS (INCHES)	*MAXIMUM LENGTH
	CLASS "L"	CLASS "S"	CLASS "D"	CLASS "N"	g6			
1/4	.2490 / .2495	.2485 / .2490	-	.2498 / .2500	.2494 / .2498	.014	0.025	96
3/8	.3740 / .3745	.3735 / .3740	-	.3748 / .3750	.3744 / .3748	.031	0.025	168
1/2	.4990 / .4995	.4985 / .4990	-	.4998 / .5000	.4993 / .4998	.055	0.025	180
5/8	.6240 / .6245	.6235 / .6240	-	.6248 / .6250	.6243 / .6248	.086	0.030	180
3/4	.7490 / .7495	.7485 / .7490	-	.7498 / .7500	.7492 / .7497	.125	0.030	180
7/8	.8740 / .8745	-	-	.8748 / .8750	-	.170	0.035	144
1	.9990 / .9995	.9985 / .9990	1.0000 / 1.0003	.9998 / 1.0000	.9992 / .9997	.222	0.035	180
1-1/8	1.1240 / 1.1245	-	-	1.1248 / 1.1250	-	.281	0.035	144
1-1/4	1.2490 / 1.2495	1.2485 / 1.2490	1.2500 / 1.2503	1.2498 / 1.2500	1.2490 / 1.2497	.348	0.040	180
1-3/8	1.3740 / 1.3745	-	-	1.3747 / 1.3750	-	.420	0.040	132
1-1/2	1.4989 / 1.4994	1.4984 / 1.4989	1.5000 / 1.5003	1.4997 / 1.5000	1.4990 / 1.4997	.500	0.040	180
1-3/4	1.7490 / 1.7495	-	-	1.7497 / 1.7500	-	.681	0.040	180
2	1.9987 / 1.9994	1.9980 / 1.9987	2.0000 / 2.0003	1.9997 / 2.0000	1.9989 / 1.9996	.890	0.040	180
2XL	1.9991 / 1.9994	-	-	-	-	.890	0.040	180
2-1/2	2.4985 / 2.4993	2.4977 / 2.4985	-	2.4996 / 2.5000	-	1.391	0.050	132
3	2.9983 / 2.9992	2.9974 / 2.9983	-	2.9996 / 3.0000	-	2.003	0.060	132

## SOLID STAINLESS STEEL PRECISION CASE HARDENED & GROUND SHAFTS

AISI 440C STEEL

HARDNESS: ROCKWELL 50 TO 55 "C"

NOM. DIA.	TOLERANCES (PLEASE SPECIFY TOLERANCE CODE ON ORDER)			WEIGHT PER INCH (lbs.)	MINIMUM DEPTH OF HARDNESS (INCHES)	*MAXIMUM LENGTH
	CLASS "L"	CLASS "S"	g6			
3/8	.3740 / .3745	.3735 / .3740	.3744 / .3748	.031	0.025	168
1/2	.4990 / .4995	.4985 / .4990	.4993 / .4998	.055	0.025	168
5/8	.6240 / .6245	.6235 / .6240	.6243 / .6248	.086	0.030	180
3/4	.7490 / .7495	.7485 / .7490	.7492 / .7497	.125	0.030	180
1	.9990 / .9995	.9985 / .9990	.9992 / .9997	.222	0.035	180
1-1/4	1.2490 / 1.2495	1.2485 / 1.2490	1.2490 / 1.2497	.348	0.040	144
1-1/2	1.4989 / 1.4994	1.4984 / 1.4989	1.4990 / 1.4997	.500	0.040	144
2	1.9987 / 1.9994	1.9980 / 1.9987	1.9989 / 1.9996	.890	0.040	180

## TUBULAR 60 HRC PRECISION CASE HARDENED & GROUND SHAFTS

NO. 52100 BEARING QUALITY

HARDNESS: ROCKWELL 60 TO 65 "C"

NOM. O.D.	NOM. I.D. ±5%	TOLERANCES (PLEASE SPECIFY TOLERANCE CODE ON ORDER)		WEIGHT PER INCH (lbs.)	MINIMUM DEPTH OF HARDNESS (INCHES)	*MAXIMUM LENGTH
		CLASS "L"	CLASS "S"			
1-1/2	.890	1.4989 / 1.4994	1.4984 / 1.4989	.328	0.040	144
2	1.250	1.9987 / 1.9994	1.9980 / 1.9987	.542	0.040	144

## SOLID METRIC 60 HRC PRECISION CASE HARDENED & GROUND SHAFTS

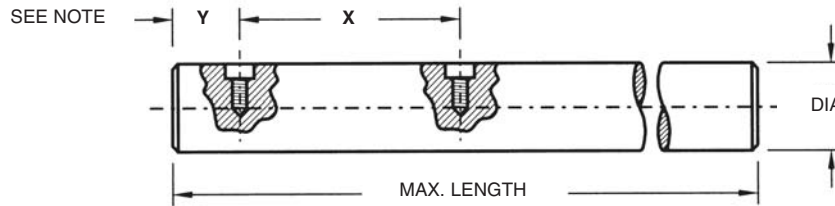
HARDNESS: ROCKWELL 60 TO 65 "C"

TOLERANCE h6

NOM. DIA.	METRIC TOLERANCE (INCH)	WEIGHT PER INCH (lbs.)	MINIMUM DEPTH OF HARDNESS (INCHES)	*MAXIMUM LENGTH
8mm	.3146 / .3150	.022	0.025	168
12mm	.4720 / .4724	.050	0.025	180
16mm	.6295 / .6299	.088	0.030	180
20mm	.7869 / .7874	.138	0.035	180
25mm	.9838 / .9843	.216	0.035	180
30mm	1.1806 / 1.1811	.311	0.040	180
40mm	1.5743 / 1.5748	.553	0.040	180
50mm	1.9679 / 1.9685	.864	0.040	180

\* Shafts can be joined for longer lengths.  
Please contact Customer Service.

## Pre-Drilled Shafts



### PRE-DRILLED SHAFTS SOLID 60 HRC & 440C STAINLESS STEEL

NOM. DIA.	DIAMETER TOLERANCE	MAX LENGTH	"X" HOLE SPACING ± .015" (NON-CUMULATIVE)	TAP SIZE (TO CENTER OF SHAFT)
1/2LPD	.4990 / .4995	180	4	6-32
5/8LPD	.6240 / .6245	180	4	8-32
3/4LPD	.7490 / .7495	180	6	10-32
1LPD	.9990 / .9995	180	6	1/4-20
1-1/4LPD	1.2490 / 1.2495	180	6	5/16-18
1-1/2LPD	1.4989 / 1.4994	180	8	3/8-16
2LPD	1.9987 / 1.9994	180	8	1/2-13
3LPD*	2.9983 / 2.9992	132	8	3/4-10

\*3" PD is not available in 440C stainless  
For longer lengths, please contact customer service

**Note:**

The standard "Y" dimension of in-stock shafts is 1/2 of the "X" dimension, but different first-hole locations may be specified when ordering, providing the location is not more than the "X" hole spacing. Holes are drilled and tapped to center of shaft.

### METRIC PRE-DRILLED SHAFTS SOLID 60 HRC

DIAMETER TOL h6	LENGTH		TAP SIZE	"X" SPACING	
	INCHES	MILLIMETER		INCHES	MILLIMETER
12MM	180	4.572mm	M4 X 0.7	2.9528	75mm
16MM	180	4.572mm	M5 X 0.8	3.9370	100mm
20MM	180	4.572mm	M6 X 1	3.9370	100mm
25MM	180	4.572mm	M8 X 1.25	4.7244	120mm
30MM	180	4.572mm	M10 X 1.5	5.9055	150mm
40MM	180	4.572mm	M10 X 1.5	7.8740	200mm
50MM	180	4.572mm	M12 X 1.75	7.8740	200mm

**Note:**

The standard "Y" dimension of in-stock shafts is 1/2 of the "X" dimension, but different first-hole locations may be specified when ordering, providing the location is not more than the "X" hole spacing. Holes are drilled and tapped to center of shaft.

### HOW TO ORDER

When ordering shafts that do not require any special machining, simply specify the nominal diameter along with the tolerance class, overall length, material and quantity.

If special machining is required, please send us a sketch or print by fax or otherwise with all dimensions, tolerances and quantity. Your request will be handled promptly.

## **Custom Precision Machining Operations**

60 HRC Case Hardened Linear Shafts often require precision machining to fulfill their prescribed function effectively. Secondary operations are readily and economically performed by trained machinists who have extensive experience working on case hardened material with specially designed tools and modern machinery.

PLC offers all of these services to provide a one-source supply of your shafting needs. Machining one piece or a million at relatively low cost and maintaining rigid delivery schedules is routine. Quotations are promptly replied to upon receipt of a drawing, rough sketch or verbal description, along with the desired quantities needed.

Some of the operations may simply require special length tolerances, straightness, chamfers, etc. Others may necessitate annealing operations before turning, threading, etc. When annealing, the shaft diameter may also be out of tolerance in the annealed area. The hardness of the major shaft diameter near the annealed area will be below normal hardness. If the effects of annealing are undesirable, contact customer service for possible alternative methods.

### **Threading**

Standard threads are UNC or UNF Class 2-A. The shaft will be annealed and soft around the circumference in the threaded area.

### **Diameter Reduction**

The normal tolerance for turned down diameters is within  $\pm .005$ " and concentricity is within  $.002$ ", unless otherwise specified. Shafts that are turned down will require annealing.

### **Coaxial Holes in End of Shaft**

UNC or UNF Class 2-B threads with  $.005$ " concentricity are offered. The thread depth standard is double the size of the tap. Some shafts may require annealing when the tap size is within close proximity to the case.

### **Radial Holes to Center of Shaft**

Drilled and tapped holes, UNC or UNF Class 2-B threads are available in 1/2" to 3" diameter shafts. Alignment location tolerances are  $\pm 1/64$ ", but can be within  $\pm .010$ " or  $\pm .005$ " at a slight additional cost.

### **Radial Holes Drilled and/or Tapped Through Shaft**

With the shaft annealed around the circumference within the hole area, 1/2" to 3" diameter shafts can be drilled and/or tapped through within  $\pm .010$ " of location tolerance. If holes are to be counterbored for a cap screw and drilled thru, the shafting does not need the annealing operation and can remain hard in most cases.

### **Shafts Joined for Longer Lengths**

Shafts of 5/8" to 3" diameter can be doweled with a concentricity of  $.002$ " or can be butt jointed to obtain longer lengths. In each case, the ends are machined square and there is no chamfer.

### **Retaining Ring Groove**

Normally the shaft is annealed and soft in the area of the groove. Groove location tolerance is normally  $\pm 1/16$ ".  $\pm .005$ " tolerance can be supplied at an extra charge. If annealing for the groove is objectionable, contact factory for alternate method.

### **Keyways**

They can be square or American Standard Woodruff. Shafts are annealed and soft around the circumference in the keyway area.

### **Flats**

Normal flat location tolerance is  $\pm 1/64$ ". There can be multiple flats on any given shaft. (A flat extending over the entire length of a long shaft is not available).

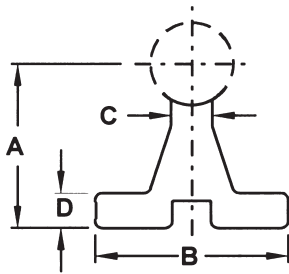
### **Gun Drilling (Deep Hole Drilling)**

Gun drilling is generally used for air or oil passages where concentricity is not critical. It should be noted that the maximum size of a gun drilled hole is limited by the depth of the case hardening.

## Aluminum Support Rails

For effective, low-cost continuous or intermittent support, PLC extruded aluminum support rails are available in a full range of sizes to accommodate shafts up to 4" diameter (see specification chart below). These rails can be supplied with or without mounting holes and can be used vertically or horizontally to provide optimum rigidity. Available in standard lengths of 24" and 48" + 0", - 1/8"...which can easily be cut to meet shorter length requirements.

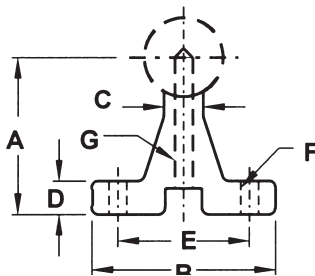
### TYPE SR EXTRUDED ALUMINUM SUPPORT RAILS



PART NO.	NOM. SHAFT DIA.	A ± .002	B	C	D	WT. PER 24" (LBS)
SR8	1/2	1.125	1-1/2	1/4	3/16	1.2
SR10	5/8	1.125	1-5/8	5/16	1/4	1.5
SR12	3/4	1.500	1-3/4	3/8	1/4	2.0
SR16	1	1.750	2-1/8	1/2	1/4	2.6
SR20	1-1/4	2.125	2-1/2	9/16	5/16	3.5
SR24	1-1/2	2.500	3	11/16	3/8	5.1
SR32	2	3.250	3-3/4	7/8	1/2	8.2
SR48	3	4.000	6	1-3/8	3/4	15.3
SR64	4	5.000	8	2-1/4	1-3/8	38.9

\*SR64 available in 24" length only.

### TYPE SR-PD SERIES EXTRUDED ALUMINUM SUPPORT RAILS WITH PRE-DRILLED HOLES TO MATE WITH TYPE PD SHAFTS



PART NO.	NOM. SHAFT DIA.	A ± 0.002	B	C	D	E	BOLT	F HOLE	G BOLT	HOLE	WT. PER 24" (LBS)
SR8PD	1/2	1.125	1-1/2	1/4	3/16	1	#6	0.169	6-32X7/8	0.169	1.2
SR10PD	5/8	1.125	1-5/8	5/16	1/4	1-1/8	#8	0.193	8-32X7/8	0.193	1.5
SR12PD	3/4	1.500	1-3/4	3/8	1/4	1-1/4	#10	0.221	10-32X1-1/4	0.221	2.0
SR16PD	1	1.750	2-1/8	1/2	1/4	1-1/2	1/4	0.281	1/4-20X1-1/2	0.281	2.6
SR20PD	1-1/4	2.125	2-1/2	9/16	5/16	1-7/8	5/16	0.343	5/16-18X1-3/4	0.343	3.5
SR24PD	1-1/2	2.500	3	11/16	3/8	2-1/4	5/16	0.343	3/8-16X2	0.406	5.1
SR32PD	2	3.250	3-3/4	7/8	1/2	2-3/4	3/8	0.406	1/2-13X2-1/2	0.531	8.2
SR48PD	3	4.000	6	1-3/8	3/4	4-1/4	5/8	21/32	3/4-10X3-1/4	25/32	15.3
SR64PD	4	5.000	8	2-1/4	1-3/8	6	5/8	21/32	7/8-9X4	29/32	38.9

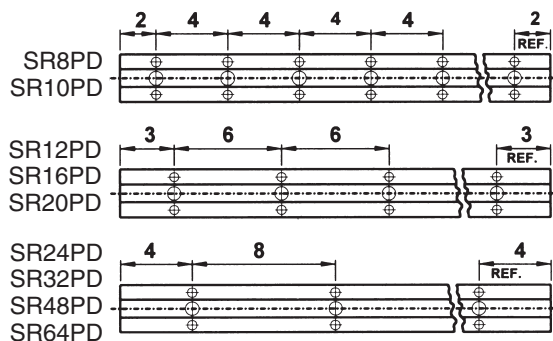
\*SR64PD available in 24" length only.

Note:

Pre-drilled support rails are stocked for immediate delivery in standard 24" and 48" lengths, but can be cut to size. When longer shafts are to be supported, the rails can be continuously mounted end-to-end or intermittently mounted.

### MOUNTING HOLE PATTERNS

The alignment and location of holes are ± .010 non-cumulative.



### HOW TO ORDER

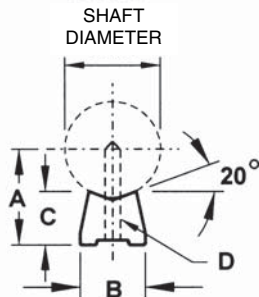
When ordering standard support rails with mounting holes, order by part number only (for example, SR20PD, 48"). If a shorter length is required, specify part number and exact length. For example, SR20PD, 18" long. We provide a cutting service at a slight additional charge.

PLC can supply shafts and rails as complete assemblies in any length. When ordering, please specify the shaft diameter and overall length, and we will assemble using standard pre-drilled shafts and support rails. (See page 38). For hole spacing other than the standard patterns shown above, please send drawings with your request for a quotation.

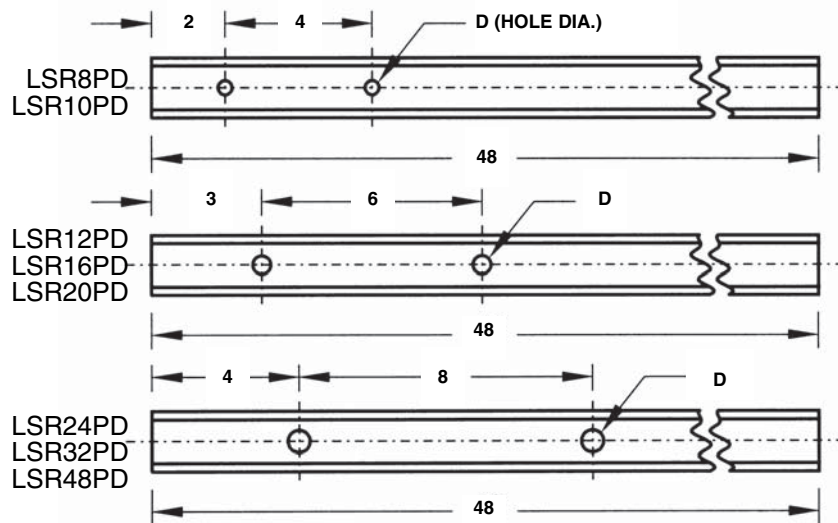
## Low Support Rails

Low shaft support rails permit the design of compact linear motion systems with more than a 40% lower profile. The low shaft support rails are made of AISI C-1018 steel. Continuous or intermittent support is permissible when using PLC open-type

linear ball bushings. LSR-PD rails have pre-drilled mounting holes to match the pre-drilled and tapped holes in the PD series shafts described on page 32. Standard length for all low shaft rails is 48".



PART NO.	SHAFT DIA.	A ± 0,002	B ± 0,005	C (REF)	BOLT	D HOLE	HOLE SPACING FOR LSR-PD		APPROX. WT. IN LBS. PER 48"
							Y	X	
LSR8 LSR8PD	.500	.562	.370	.341	6-32	.169	2	4	1.32
LSR10 LSR10PD	.625	.687	.450	.412	8-32	.193	2	4	1.95
LSR12 LSR12PD	.750	.750	.510	.420	10-32	.221	3	6	2.25
LSR16 LSR16PD	1.000	1.000	.690	.560	1/4-20	.281	3	6	4.25
LSR20 LSR20PD	1.250	1.187	.780	.626	5/16-18	.343	3	6	5.08
LSR24 LSR24PD	1.500	1.375	.930	.703	3/8-16	.406	4	8	6.72
LSR32 LSR32PD	2.000	1.750	1.180	.845	1/2-13	.17/32	4	8	11.00
LSR48 LSR48PD	3.000	2.750	1.875	1.404	3/4-10	0.812	4	8	27.92



### HOW TO ORDER

When ordering standard 48" long low shaft rails without mounting holes, order by part number only.

For example, LSR12.

If standard mounting holes are required, specify low shaft rails with pre-drilled mounting holes by part number.

For example, LSR12PD, and we will supply rails with hole sizes and spacings shown in the table.

If other than standard hole spacing is required, please send drawings with all dimensions, tolerances and quantity required.

With or without mounting holes, low shaft rails will only be supplied in 48" lengths when ordered by part number.

Special lengths can be provided at a slight additional cost. Contact customer service for a quotation.

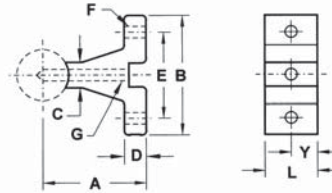


## Intermittent Support Rails

### INTERMITTENT SUPPORT RAILS #SRI 1

The SRI 1 supports are for those applications not requiring continuous support.

PART NO.	SHAFT DIA.	A	B	C	D	E	F	G	Y	L
SRI1-8	1/2	1.125	1-1/2	1/4	3/16	1	#6	6-32	1	2
SRI1-10	5/8	1.125	1-5/8	5/16	1/4	1-1/8	#8	8-32	1	2
SRI1-12	3/4	1.500	1-3/4	3/8	1/4	1-1/4	#10	10-32	1-1/2	3
SRI1-16	1	1.750	2-1/8	1/2	1/4	1-1/2	1/4	1/4-20	1-1/2	3
SRI1-20	1-1/4	2.125	2-1/2	9/16	5/16	1-7/8	5/16	5/16-18	1-1/2	3
SRI1-24	1-1/2	2.500	3	11/16	3/8	2-1/4	5/16	3/8-16	2	4
SRI1-32	2	3.250	3-3/4	7/8	1/2	2-3/4	3/8	1/2-13	2	4
SRI1-48	3	4.000	6	1-7/16	3/4	4-1/4	5/8	3/4-10	2	4

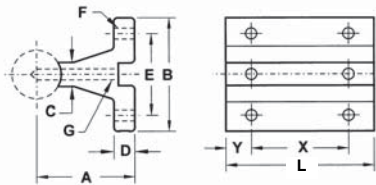


SRI 1 SERIES

### INTERMITTENT SUPPORT RAILS #SRI 2

The SRI 2 intermittent support rails are ideal for support below joints in shafting.

PART NO.	SHAFT DIA.	A	B	C	D	E	F	G	Y	X	L
SRI2-8	1/2	1.125	1-1/2	1/4	3/16	1	#6	6-32	1	4	6
SRI2-10	5/8	1.125	1-5/8	5/16	1/4	1-1/8	#8	8-32	1	4	6
SRI2-12	3/4	1.500	1-3/4	3/8	1/4	1-1/4	#10	10-32	1	6	8
SRI2-16	1	1.750	2-1/8	1/2	1/4	1-1/2	1/4	1/4-20	1	6	8
SRI2-20	1-1/4	2.125	2-1/2	9/16	5/16	1-7/8	5/16	5/16-18	1	6	8
SRI2-24	1-1/2	2.500	3	11/16	3/8	2-1/4	5/16	3/8-16	1-1/2	8	11
SRI2-32	2	3.250	3-3/4	7/8	1/2	2-3/4	3/8	1/2-13	1-1/2	8	11
SRI2-48	3	4	6	1-7/16	3/4	4-1/4	5/8	3/4-10	1-1/2	8	11

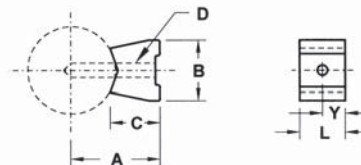


SRI 2 SERIES

### INTERMITTENT LOW SHAFT SUPPORT RAILS #LSRI 1

The LSRI 1 supports are for those applications not requiring continuous support.

PART NO.	SHAFT DIA.	A	B	C	BOLT	D HOLE	Y	L
LSRI1-8	1/2	.562	.370	.341	6-32	.169	1	2
LSRI1-10	5/8	.687	.450	.412	8-32	.193	1	2
LSRI1-12	3/4	.750	.510	.420	10-32	.221	1-1/2	3
LSRI1-16	1	1.000	.690	.560	1/4-20	.281	1-1/2	3
LSRI1-20	1-1/4	1.187	.780	.626	5/16-18	.343	1-1/2	3
LSRI1-24	1-1/2	1.375	.930	.703	3/8-16	.406	2	4
LSRI1-32	2	1.750	1.180	.845	1/2-13	.531	2	4
LSRI1-48	3	2.750	1.875	1.404	3/4-10	.812	2	4

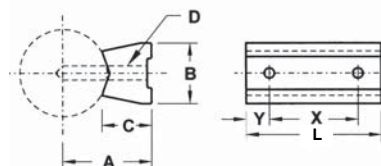


LSRI 1 SERIES

### INTERMITTENT LOW SHAFT SUPPORT RAILS #LSRI 2

The LSRI 2 intermittent support rails are ideal for support below joints in shafting.

PART NO.	SHAFT DIA.	A	B	C	BOLT	D HOLE	Y	X	L
LSRI2-8	1/2	.562	0.370	0.341	6-32	.169	1	4	6
LSRI2-10	5/8	.687	0.450	0.412	8-32	.193	1	4	6
LSRI2-12	3/4	.750	0.510	0.420	10-32	.221	1	6	8
LSRI2-16	1	1.000	0.690	0.560	1/4-20	.281	1	6	8
LSRI2-20	1-1/4	1.187	0.780	0.626	5/16-18	.343	1	6	8
LSRI2-24	1-1/2	1.375	0.930	0.703	3/8-16	.406	1-1/2	8	11
LSRI2-32	2	1.750	1.180	0.845	1/2-13	.531	1-1/2	8	11
LSRI2-48	3	2.750	1.875	1.404	3/4-10	.812	1-1/2	8	11



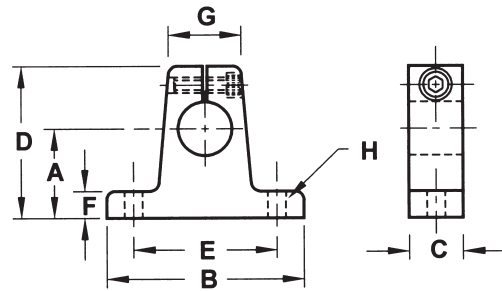
LSRI 2 SERIES



## Shaft Support Blocks

### TYPE SB

Shaft support blocks provide a means of supporting shafts without the need of having to machine harden material. The support blocks are primarily intended for applications where loading is relatively light and the resulting deflection between the supports does not create a problem that would hinder the pillow block and reduce its travel life.

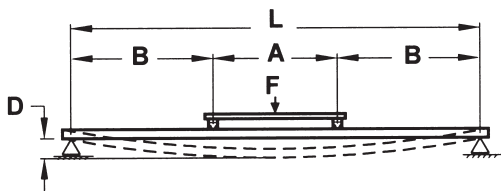


PART NO.	SHAFT SIZE	A ± .002	B	C	D	E ± .005	F	G	BOLT	HOLE	WEIGHT (LBS)
SB8	1/2"	1.000"	2"	5/8"	1.72	1-1/2"	1/4"	3/4"	#10	7/32"	.27
SB10	5/8"	1.000"	2-1/2"	3/4"	1.82	1-7/8"	5/16"	7/8"	#10	7/32"	.40
SB12	3/4"	1.250"	2-3/4"	3/4"	2.19	2"	3/8"	1"	1/4"	9/32"	.52
SB16	1"	1.500"	3-5/16"	1"	2.70	2-1/2"	3/8"	1-3/8"	1/4"	9/32"	1.11
SB20	1-1/4"	1.750"	4"	1-1/4"	3.10	3"	7/16"	1-3/4"	5/16"	11/32"	1.91
SB24	1-1/2"	2.000"	4-3/4"	1-1/4"	3.48	3-1/2"	1/2"	2"	5/16"	11/32"	2.52
SB32	2"	2.500"	6"	1-1/2"	4.53	4-1/2"	5/8"	2-5/8"	3/8"	13/32"	5.1
SB48	3"	3.500"	8-1/2"	2"	6.25	7"	1"	4-1/4"	3/4"	25/32"	15.0

Material: Aluminum casting alloy #356-T6 changing to C1045 steel

### SHAFT DEFLECTION

Shaft Deflection will affect the system's performance. Use the following equation to calculate the maximum shaft deflection (in the center) of a system using **60 HRC** shafting and end supports.



$$D = \frac{F \times B \times [3L^2 - 4B^2]}{48EI} + \frac{5SL^4}{384EI}$$

D = Deflection (in)

L = Distance between the shaft support (in)

E = Modulus of elasticity (lbf/in<sup>2</sup>)

I = Shafts moment of inertia (in<sup>4</sup>)

S = Shaft unit weight (lbf/in)

F = Load (including carriage weight) (lbf)

A = Distance between the carriage bearings (in)

B = (L - A)/2 (in)

\*Notes:

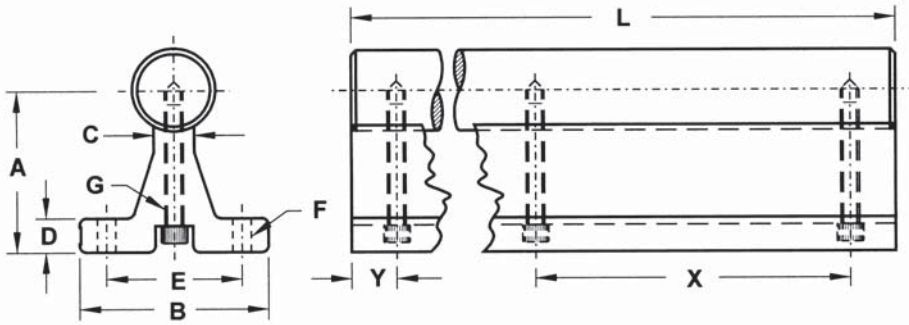
For shaft deflection of a system using single pillow block with no carriage use the above equation with A = 0.

For shaft deflection of systems using double or twin pillow blocks with no carriage use the above equation with A = Distance between the pillow block bearing (See tables).

VALUES FOR 60HRC LINEAR SHAFTING								
SOLID SHAFT			TUBULAR SHAFT			METRIC SHAFT		
SHAFT DIAMETER (INCHES)	EI (lbf/in <sup>2</sup> )	S (lbf/in)	SHAFT DIAMETER (INCHES)	EI (lbf/in <sup>2</sup> )	S (lbf/in)	SHAFT DIAMETER (INCHES)	EI (lbf/in <sup>2</sup> )	S (lbf/in)
.250	5.75X10 <sup>3</sup>	0.014	-	-	-	8	1.45X10 <sup>4</sup>	0.022
.375	2.91X10 <sup>4</sup>	0.031	-	-	-	12	7.34X10 <sup>4</sup>	0.050
.500	9.20X10 <sup>4</sup>	.055	-	-	-	16	2.32X10 <sup>5</sup>	0.088
.625	2.25X10 <sup>5</sup>	.086	-	-	-	20	5.66X10 <sup>5</sup>	0.138
.750	4.66X10 <sup>5</sup>	0.125	-	-	-	25	1.38X10 <sup>6</sup>	0.216
.875	8.63X10 <sup>5</sup>	0.170	-	-	-	30	2.87X10 <sup>6</sup>	0.311
1.000	1.47X10 <sup>6</sup>	.222	-	-	-	40	9.06X10 <sup>6</sup>	0.552
1.125	2.36X10 <sup>6</sup>	.281	-	-	-	50	2.21X10 <sup>7</sup>	0.863
1.250	3.60X10 <sup>6</sup>	.348	-	-	-			
1.375	5.26X10 <sup>6</sup>	.420	-	-	-			
1.500	7.46X10 <sup>6</sup>	.500	1.500 / 0.890	6.53X10 <sup>6</sup>	0.325			
1.750	1.38X10 <sup>7</sup>	.681	-	-	-			
2.000	2.36X10 <sup>7</sup>	0.890	2.000 / 1.250	2.00X10 <sup>7</sup>	0.543			
3.000	1.19X10 <sup>8</sup>	2.003	-	-	-			

## Shaft Rail Assemblies

Assembled from standard pre-drilled material

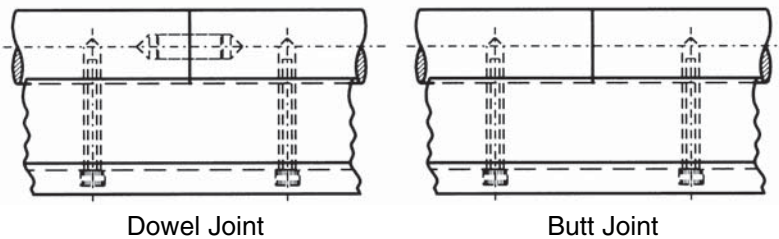


Shafting can be provided in **60 HRC** or 440C (3" is not available in 440C). The support rails are manufactured in standard 24" and 48" lengths. Longer lengths of shafting require the use of multiple rails. Hole spacing will be the standard Pre-Drilled hole pattern associated with that diameter.

PART NO.	NOM. OD.	A	B	C	D	E	F BOLT	F HOLE	G THD	Y	X
SRA8 SRA8SS	1/2	1.125	1-1/2	1/4	3/16	1	#6	.169	6-32	2	4
SRA10 SRA10SS	5/8	1.125	1-5/8	5/16	1/4	1-1/8	#8	.193	8-32	2	4
SRA12 SRA12SS	3/4	1.500	1-3/4	3/8	1/4	1-1/4	#10	.221	10-32	3	6
SRA16 SRA16SS	1	1.750	2-1/8	1/2	1/4	1-1/2	1/4	.281	1/4-20	3	6
SRA20 SRA20SS	1-1/4	2.125	2-1/2	9/16	5/16	1-7/8	5/16	.343	5/16-18	3	6
SRA24 SRA24SS	1-1/2	2.500	3	11/16	3/8	2-1/4	5/16	.343	3/8-16	4	8
SRA32 SRA32SS	2	3.250	3-3/4	7/8	1/2	2-3/4	3/8	.406	1/2-13	4	8
SRA48 SRA48SS	3	4.000	6	1-3/8	3/4	4-1/4	5/8	.656	3/4-10	4	8

Standard "Y" dimension of in-stock shafts and rails is 1/2 of the "X" dimension, but different first hole locations may be specified, providing that they do not exceed the "X" dimension.

### UNLIMITED LENGTHS



Assembly shafts can be doweled with a concentricity of .002" or can simply have butted ends to obtain longer lengths. In each case, the mating ends are machined square and there is no chamfer.

**SELF-ALIGNING BALL BUSHINGS** (Pages 8 - 9)

Shaft Diameter (inch)	Designation				
	PLC	Thomson	NB	Star	INA
3/16	SA3	SUPER3	TW3	0755-003-00	KNZ 03
1/4	SA4	SUPER4	TW4	0755-004-00	KNZ 04
3/8	SA6	SUPER6	TW6	0755-006-00	KNZ 06
1/2	SA8	SUPER8	TW8	0755-008-00	KNZ 08
5/8	SA10	SUPER10	TW10	0755-010-00	KNZ 10
3/4	SA12	SUPER12	TW12	0755-012-00	KNZ 12
1	SA16	SUPER16	TW16	0755-016-00	KNZ 16
1-1/4	SA20	SUPER20	TW20	0755-020-00	KNZ 20
1-1/2	SA24	SUPER24	TW24	0755-024-00	KNZ 24
2	SA32	SUPER32	TW32	0755-032-00	KNZ 32

**SELF-ALIGNING BALL BUSHINGS WITH SEALS** (Pages 8 - 9)

Shaft Diameter (inch)	Designation				
	PLC	Thomson	NB	Star	INA
1/2	SA8DD	SUPER8DD*	TW8UU	0755-208-00	KNZ 08 PP
5/8	SA10DD	SUPER10DD*	TW10UU	0755-210-00	KNZ 10 PP
3/4	SA12DD	SUPER12DD*	TW12UU	0755-212-00	KNZ 12 PP
1	SA16DD	SUPER16DD*	TW16UU	0755-216-00	KNZ 16 PP

\* The "DD" type's overall length is longer in comparison to PLC pre-sealed SA series

**SELF-ALIGNING BALL BUSHINGS – OPEN TYPE** (Pages 8 - 9)

Shaft Diameter (inch)	Designation				
	PLC	Thomson	NB	Star	INA
3/16	SA3OPN	SUPER3OPN	TW3-OP	–	–
1/4	SA4OPN	SUPER4OPN	TW4-OP	–	–
3/8	SA6OPN	SUPER6OPN	TW6-OP	–	–
1/2	SA8OPN	SUPER8OPN	TW8-OP	0756-008-00	KNZ 08 OP
5/8	SA10OPN	SUPER10OPN	TW10-OP	0756-010-00	KNZ 10 OP
3/4	SA12OPN	SUPER12OPN	TW12-OP	0756-012-00	KNZ 12 OP
1	SA16OPN	SUPER16OPN	TW16-OP	0756-016-00	KNZ 16 OP
1-1/4	SA20OPN	SUPER20OPN	TW20-OP	0756-020-00	KNZ 20 OP
1-1/2	SA24OPN	SUPER24OPN	TW24-OP	0756-024-00	KNZ 24 OP
2	SA32OPN	SUPER32OPN	TW32-OP	0756-032-00	KNZ 32 OP



### SELF-ALIGNING BALL BUSHINGS – OPEN TYPE WITH SEALS (Pages 8 - 9)

Shaft Diameter (inch)	Designation				
	PLC	Thomson	NB	Star	INA
1/2	SA8OPNDD	SUPER8OPNDD*	TW8UU-OP	0756-208-00	KNZ 08 OP PP
5/8	SA10OPNDD	SUPER10OPNDD*	TW10UU-OP	0756-210-00	KNZ 10 OP PP
3/4	SA12OPNDD	SUPER12OPNDD*	TW12UU-OP	0756-212-00	KNZ 12 OP PP
1	SA16OPNDD	SUPER16OPNDD*	TW16UU-OP	0756-216-00	KNZ 16 OP PP

\* The "DD" type's overall length is longer in comparison to PLC pre-sealed SA series

### STANDARD BALL BUSHINGS (Pages 24 - 25)

Shaft Diameter (inch)	Designation				
	PLC	Thomson	NB	Star	INA
1/4	A4812	A4812	SW4	0750-004-15	KBZ 04**
3/8	A61014	A61014	SW6	0750-006-15	KBZ 06**
1/2	A81420	A81420	SW8	0750-008-15	KBZ 08**
5/8	A101824	A101824	SW10	0750-010-15	KBZ 10**
3/4	A122026	A122026	SW12	0750-012-15	KBZ 12**
1	A162536	A162536	SW16	0750-016-15	KBZ 16**
1-1/4	A203242	A203242	SW20	0750-020-15	KBZ 20**
1-1/2	A243848	A243848	SW24	0750-024-15	KBZ 24**
2	A324864	A324864	SW32	0750-032-15	KBZ 32**
2-1/2	A406080	A406080	SW40	0750-040-15	–
3	A487296	A487296	SW48	0750-048-15	–
4	A6496128	A6496128	SW64	0750-064-15	–

\*\* Resin retainer

### STANDARD BALL BUSHINGS WITH SEALS (Pages 24 - 25)

Shaft Diameter (inch)	Designation				
	PLC	Thomson	NB	Star	INA
1/2	A81420DD	A81420DD	SW8UU	0750-208-15	KBZ 08 PP**
3/4	A122026DD	A122026DD	SW12UU	0750-212-15	KBZ 12 PP**
1	A162536DD	A162536DD	SW16UU	0750-216-15	KBZ 16 PP**

\*\* Resin retainer

**STANDARD STAINLESS STEEL BALL BUSHINGS** (Pages 24 - 25)

Shaft Diameter (inch)	Designation				
	PLC	Thomson	NB	Star	INA
1/4	A4812SS	A4812SS	SWS4	0750-004-53	–
3/8	A61014SS	A61014SS	SWS6	0750-006-53	–
1/2	A81420SS	A81420SS	SWS8	0750-008-53	–
5/8	A101824SS	A101824SS	SWS10	0750-010-53	–
3/4	A122026SS	A122026SS	SWS12	0750-012-53	–
1	A162536SS	A162536SS	SWS16	0750-016-53	–

**INSTRUMENT BALL BUSHINGS** (Pages 24 - 25)

Shaft Diameter (inch)	Designation				
	PLC	Thomson	NB	Star	INA
1/8	INST258SS	INST258SS	SWS2	0750-002-53	–
3/16	INST369SS	INST369SS	SWS3	0750-003-53	–

**PRECISION BALL BUSHINGS** (Pages 24 - 25)

Shaft Diameter (inch)	Designation				
	PLC	Thomson	NB	Star	INA
1/4	XA4812	XA4812	SW4-P	0751-004-15	–
3/8	XA61014	XA61014	SW6-P	0751-006-15	–
1/2	XA81420	XA81420	SW8-P	0751-008-15	–
5/8	XA101824	XA101824	SW10-P	0751-010-15	–
3/4	XA122026	XA122026	SW12-P	0751-012-15	–
1	XA162536	XA162536	SW16-P	0751-016-15	–
1-1/4	XA203242	XA203242	SW20-P	0751-020-15	–
1-1/2	XA243848	XA243848	SW24-P	0751-024-15	–
2	XA324864	XA324864	SW32-P	0751-032-15	–
2-1/2	XA406080	XA406080	SW40-P	0751-040-15	–
3	XA487296	XA487296	SW48-P	0751-048-15	–
4	XA6496128	XA6496128	SW64-P	0751-064-15	–



**PRECISION STAINLESS STEEL BALL BUSHINGS** (Pages 24 - 25)

Shaft Diameter (inch)	Designation				
	PLC	Thomson	NB	Star	INA
1/4	XA4812SS	XA4812SS	SWS4-P	0751-004-53	–
3/8	XA61014SS	XA61014SS	SWS6-P	0751-004-53	–
1/2	XA81420SS	XA81420SS	SWS8-P	0751-004-53	–
5/8	XA101824SS	XA101824SS	SWS10-P	0751-004-53	–
3/4	XA122026SS	XA122026SS	SWS12-P	0751-004-53	–
1	XA162536SS	XA162536SS	SWS16-P	0751-004-53	–

**STANDARD BALL BUSHINGS – ADJUSTABLE TYPE** (Pages 26 - 27)

Shaft Diameter (inch)	Designation				
	PLC	Thomson	NB	Star	INA
1/2	ADJ81420	ADJ81420	SW8-AJ	0752-008-15	–
5/8	ADJ101824	ADJ101824	SW10-AJ	0752-010-15	–
3/4	ADJ122026	ADJ122026	SW12-AJ	0752-012-15	–
1	ADJ162536	ADJ162536	SW16-AJ	0752-016-15	–
1-1/4	ADJ203242	ADJ203242	SW20-AJ	0752-020-15	–
1-1/2	ADJ243848	ADJ243848	SW24-AJ	0752-024-15	–
2	ADJ324864	ADJ324864	SW32-AJ	0752-032-15	–
2-1/2	ADJ406080	ADJ406080	SW40-AJ	0752-040-15	–
3	ADJ487296	ADJ487296	SW48-AJ	0752-048-15	–
4	ADJ6496128	ADJ6496128	SW64-AJ	0752-064-15	–

**STANDARD STAINLESS STEEL BALL BUSHINGS – ADJUSTABLE TYPE** (Pages 26 - 27)

Shaft Diameter (inch)	Designation				
	PLC	Thomson	NB	Star	INA
1/2	ADJ81420SS	ADJ81420SS	SWS8-AJ	0752-008-53	–
5/8	ADJ101824SS	ADJ101824SS	SWS10-AJ	0752-010-53	–
3/4	ADJ122026SS	ADJ122026SS	SWS12-AJ	0752-012-53	–
1	ADJ162536SS	ADJ162536SS	SWS16-AJ	0752-016-53	–

**STANDARD BALL BUSHINGS – OPEN TYPE** (Pages 28 - 29)

Shaft Diameter (inch)	Designation				
	PLC	Thomson	NB	Star	INA
1/2	OPN81420	OPN81420	SW8-OP	0753-008-15	KBZ-08 OP**
5/8	OPN101824	OPN101824	SW10-OP	0753-010-15	KBZ-10 OP**
3/4	OPN122026	OPN122026	SW12-OP	0753-012-15	KBZ-12 OP**
1	OPN162536	OPN162536	SW16-OP	0753-016-15	KBZ-16 OP**
1-1/4	OPN203242	OPN203242	SW20-OP	0753-020-15	KBZ-20 OP**
1-1/2	OPN243848	OPN243848	SW24-OP	0753-024-15	KBZ-24 OP**
2	OPN324864	OPN324864	SW32-OP	0753-032-15	KBZ-32 OP**
2-1/2	OPN406080	OPN406080	SW40-OP	0753-040-15	–
3	OPN487296	OPN487296	SW48-OP	0753-048-15	–
4	OPN6496128	OPN6496128	SW64-OP	0753-064-15	–

\*\* Resin retainer

**STANDARD STAINLESS STEEL BALL BUSHINGS – OPEN TYPE** (Pages 28 - 29)

Shaft Diameter (inch)	Designation				
	PLC	Thomson	NB	Star	INA
1/2	OPN81420SS	OPN81420SS	SWS8-OP	0753-008-53	–
5/8	OPN101824SS	OPN101824SS	SWS10-OP	0753-010-53	–
3/4	OPN122026SS	OPN122026SS	SWS12-OP	0753-012-53	–
1	OPN162536SS	OPN162536SS	SWS16-OP	0753-016-53	–

**SELF-ALIGNING BALL BUSHING PILLOW BLOCKS** (Page 10)

Shaft Diameter (inch)	Designation				
	PLC	Thomson	NB	Star	INA
1/4	SPB4	SPB4	TWA 4UU	0755-704-00	KGNZ 04 PP
3/8	SPB6	SPB6	TWA 6UU	0755-706-00	KGNZ 06 PP
1/2	SPB8	SPB8	TWA 8UU	0755-708-00	KGNZ 08 PP
5/8	SPB10	SPB10	TWA 10UU	0755-710-00	KGNZ 10 PP
3/4	SPB12	SPB12	TWA 12UU	0755-712-00	KGNZ 12 PP
1	SPB16	SPB16	TWA 16UU	0755-716-00	KGNZ 16 PP
1-1/4	SPB20	SPB20	TWA 20UU	0755-720-00	KGNZ 20 PP
1-1/2	SPB24	SPB24	TWA 24UU	0755-724-00	KGNZ 24 PP
2	SPB32	SPB32	TWA 32UU	0755-732-00	KGNZ 32 PP



**SELF-ALIGNING BALL BUSHING PILLOW BLOCKS – ADJUSTABLE TYPE** (Page 12)

Shaft Diameter (inch)	Designation				
	PLC	Thomson	NB	Star	INA
1/4	SPB4ADJ	SPB4ADJ	TWJ 4UU	0756-704-00	KGNZ 04 ADJ PP
3/8	SPB6ADJ	SPB6ADJ	TWJ 6UU	0756-706-00	KGNZ 06 ADJ PP
1/2	SPB8ADJ	SPB8ADJ	TWJ 8UU	0756-708-00	KGNZ 08 ADJ PP
5/8	SPB10ADJ	SPB10ADJ	TWJ 10UU	0756-710-00	KGNZ 10 ADJ PP
3/4	SPB12ADJ	SPB12ADJ	TWJ 12UU	0756-712-00	KGNZ 12 ADJ PP
1	SPB16ADJ	SPB16ADJ	TWJ 16UU	0756-716-00	KGNZ 16 ADJ PP
1-1/4	SPB20ADJ	SPB20ADJ	TWJ 20UU	0756-720-00	KGNZ 20 ADJ PP
1-1/2	SPB24ADJ	SPB24ADJ	TWJ 24UU	0756-724-00	KGNZ 24 ADJ PP
2	SPB32ADJ	SPB32ADJ	TWJ 32UU	0756-732-00	KGNZ 32 ADJ PP

**SELF-ALIGNING BALL BUSHING PILLOW BLOCKS – OPEN TYPE** (Page 14)

Shaft Diameter (inch)	Designation				
	PLC	Thomson	NB	Star	INA
1/2	SPB8OPN	SPB8OPN	TWD 8UU	0757-708-00	KGNZ 08 OP PP
5/8	SPB10OPN	SPB10OPN	TWD 10UU	0757-710-00	KGNZ 10 OP PP
3/4	SPB12OPN	SPB12OPN	TWD 12UU	0757-712-00	KGNZ 12 OP PP
1	SPB16OPN	SPB16OPN	TWD 16UU	0757-716-00	KGNZ 16 OP PP
1-1/4	SPB20OPN	SPB20OPN	TWD 20UU	0757-720-00	KGNZ 20 OP PP
1-1/2	SPB24OPN	SPB24OPN	TWD 24UU	0757-724-00	KGNZ 24 OP PP
2	SPB32OPN	SPB32OPN	TWD 32UU	0757-732-00	KGNZ 32 OP PP

**TWIN SELF-ALIGNING BALL BUSHING PILLOW BLOCKS** (Page 11)

Shaft Diameter (inch)	Designation				
	PLC	Thomson	NB	Star	INA
1/4	TWN4	TWN4	TWA 4WUU	1760-704-00	KTNZ 04 PP
3/8	TWN6	TWN6	TWA 6WUU	1760-706-00	KTNZ 06 PP
1/2	TWN8	TWN8	TWA 8WUU	1760-708-00	KTNZ 08 PP
5/8	TWN10	TWN10	TWA 10WUU	1760-710-00	KTNZ 10 PP
3/4	TWN12	TWN12	TWA 12WUU	1760-712-00	KTNZ 12 PP
1	TWN16	TWN16	TWA 16WUU	1760-716-00	KTNZ 16 PP
1-1/4	TWN20	TWN20	TWA 20WUU	1760-720-00	KTNZ 20 PP
1-1/2	TWN24	TWN24	TWA 24WUU	1760-724-00	KTNZ 24 PP



**TWIN SELF-ALIGNING BALL BUSHING PILLOW BLOCKS – ADJUSTABLE TYPE** (Page 13)

Shaft Diameter (inch)	Designation				
	PLC	Thomson	NB	Star	INA
1/4	TWN4ADJ	TWN4ADJ	TWJ 4WUU	1762-704-00	KTNZ 04 ADJ PP
3/8	TWN6ADJ	TWN6ADJ	TWJ 6WUU	1762-706-00	KTNZ 06 ADJ PP
1/2	TWN8ADJ	TWN8ADJ	TWJ 8WUU	1762-708-00	KTNZ 08 ADJ PP
5/8	TWN10ADJ	TWN10ADJ	TWJ 10WUU	1762-710-00	KTNZ 10 ADJ PP
3/4	TWN12ADJ	TWN12ADJ	TWJ 12WUU	1762-712-00	KTNZ 12 ADJ PP
1	TWN16ADJ	TWN16ADJ	TWJ 16WUU	1762-716-00	KTNZ 16 ADJ PP
1-1/4	TWN20ADJ	TWN20ADJ	TWJ 20WUU	1762-720-00	KTNZ 20 ADJ PP
1-1/2	TWN24ADJ	TWN24ADJ	TWJ 24WUU	1762-724-00	KTNZ 24 ADJ PP

**TWIN SELF-ALIGNING BALL BUSHING PILLOW BLOCKS – OPEN TYPE** (Page 15)

Shaft Diameter (inch)	Designation				
	PLC	Thomson	NB	Star	INA
1/4	TWN4OPN	TWN4OPN	TWD 4WUU	–	–
3/8	TWN6OPN	TWN6OPN	TWD 6WUU	–	–
1/2	TWN8OPN	TWN8OPN	TWD 8WUU	1763-708-00	KTNZ 08 OP PP
5/8	TWN10OPN	TWN10OPN	TWD 10WUU	1763-710-00	KTNZ 10 OP PP
3/4	TWN12OPN	TWN12OPN	TWD 12WUU	1763-712-00	KTNZ 12 OP PP
1	TWN16OPN	TWN16OPN	TWD 16WUU	1763-716-00	KTNZ 16 OP PP
1-1/4	TWN20OPN	TWN20OPN	TWD 20WUU	1763-720-00	KTNZ 20 OP PP
1-1/2	TWN24OPN	TWN24OPN	TWD 24WUU	1763-724-00	KTNZ 24 OP PP

**SHAFT SUPPORT RAILS (STANDARD 24-INCH LENGTHS)** (Page 34)

Shaft Diameter (inch)	Designation				
	PLC	Thomson	NB	Star	INA
1/2	SR8	SR8	WA 8-24	1767-008-00	TSWZ 08
5/8	SR10	SR10	WA10-24	1767-010-00	TSWZ 10
3/4	SR12	SR12	WA12-24	1767-012-00	TSWZ 12
1	SR16	SR16	WA16-24	1767-016-00	TSWZ 16
1-1/4	SR20	SR20	WA20-24	1767-020-00	TSWZ 20
1-1/2	SR24	SR24	WA24-24	1767-024-00	TSWZ 24
2	SR32	SR32	WA32-24	1767-032-00	TSWZ 32



**SHAFT SUPPORT RAILS WITH MOUNTING HOLES (STANDARD 24-INCH LENGTHS)** (Page 34)

Shaft Diameter (inch)	Designation				
	PLC	Thomson	NB	Star	INA
1/2	SR8PD	SR8PD	WA 8-24PD	1767-108-00	TSWZ 08PD
5/8	SR10PD	SR10PD	WA10-24PD	1767-110-00	TSWZ 10PD
3/4	SR12PD	SR12PD	WA12-24PD	1767-112-00	TSWZ 12PD
1	SR16PD	SR16PD	WA16-24PD	1767-116-00	TSWZ 16PD
1-1/4	SR20PD	SR20PD	WA20-24PD	1767-120-00	TSWZ 20PD
1-1/2	SR24PD	SR24PD	WA24-24PD	1767-124-00	TSWZ 24PD
2	SR32PD	SR32PD	WA32-24PD	1767-132-00	TSWZ 32PD

**LOW SHAFT SUPPORT RAILS (STANDARD 48-INCH LENGTHS)** (Page 35)

Shaft Diameter (inch)	Designation				
	PLC	Thomson	NB	Star	INA
1/2	LSR8	LSR8	LWA 8-48	-	TSUZ 08
5/8	LSR10	LSR10	LWA 10-48	-	TSUZ 10
3/4	LSR12	LSR12	LWA 12-48	-	TSUZ 12
1	LSR16	LSR16	LWA 16-48	-	TSUZ 16
1-1/4	LSR20	LSR20	LWA 20-48	-	TSUZ 20
1-1/2	LSR24	LSR24	LWA 24-48	-	TSUZ 24
2	LSR32	LSR32	LWA 32-48	-	TSUZ 32

**LOW SHAFT SUPPORT RAILS WITH MOUNTING HOLES (STANDARD 48 INCH LENGTHS)** (Page 35)

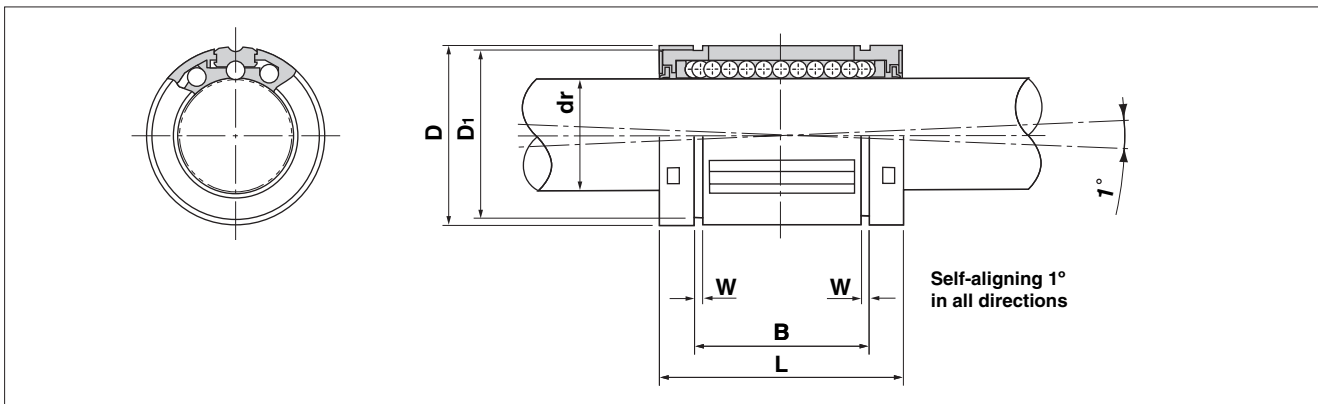
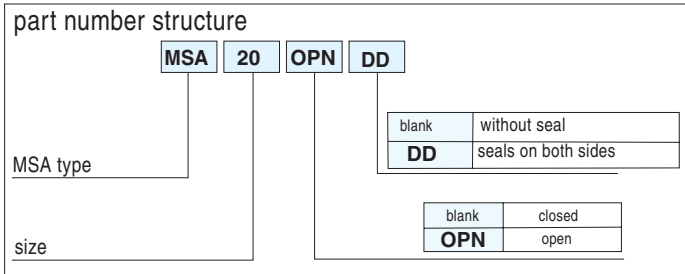
Shaft Diameter (inch)	Designation				
	PLC	Thomson	NB	Star	INA
1/2	LSR8PD	LSR8PD	LWA 8-48PD	-	TSUZ 08PD
5/8	LSR10PD	LSR10PD	LWA 10-48PD	-	TSUZ 10PD
3/4	LSR12PD	LSR12PD	LWA 12-48PD	-	TSUZ 12PD
1	LSR16PD	LSR16PD	LWA 16-48PD	-	TSUZ 16PD
1-1/4	LSR20PD	LSR20PD	LWA 20-48PD	-	TSUZ 20PD
1-1/2	LSR24PD	LSR24PD	LWA 24-48PD	-	TSUZ 24PD
2	LSR32PD	LSR32PD	LWA 32-48PD	-	TSUZ 32PD

**SHAFT SUPPORT BLOCKS** (Page 37)

Shaft Diameter (inch)	Designation				
	PLC	Thomson	NB	Star	INA
1/4	SB4	SB4	WH 4A	–	–
3/8	SB6	SB6	WH 6A	–	–
1/2	SB8	SB8	WH 8A	1759-108-00	GWZ 08
5/8	SB10	SB10	WH 10A	1759-110-00	GWZ 10
3/4	SB12	SB12	WH 12A	1759-112-00	GWZ 12
1	SB16	SB16	WH 16A	1759-116-00	GWZ 16
1-1/4	SB20	SB20	WH 20A	1759-120-00	GWZ 20
1-1/2	SB24	SB24	WH 24A	1759-124-00	GWZ 24
2	SB32	SB32	WH 32A	1759-132-00	GWZ 32

# MSA TYPE

## Self-Aligning (Euro Metric)



part number										
closed type			open type			dr		D	L	
	no. of ball circuits	mass		no. of ball circuits	mass	mm	tolerance*	mm	mm	tolerance
		g			g	μ	m	mm	mm	mm
**MSA10	5	14				10	+8	19	29	±0.2
MSA12	5	21	MSA12OPN	4	17	12	0	22	32	
MSA16	5	43	MSA16OPN	4	35	16	+9	26	36	
MSA20	6	58	MSA20OPN	5	48	20	-1	32	45	
MSA25	6	123	MSA25OPN	5	103	25	+11	40	58	
MSA30	6	216	MSA30OPN	5	177	30	-1	47	68	
MSA40	6	333	MSA40OPN	5	275	40	+13 / -2	62	80	

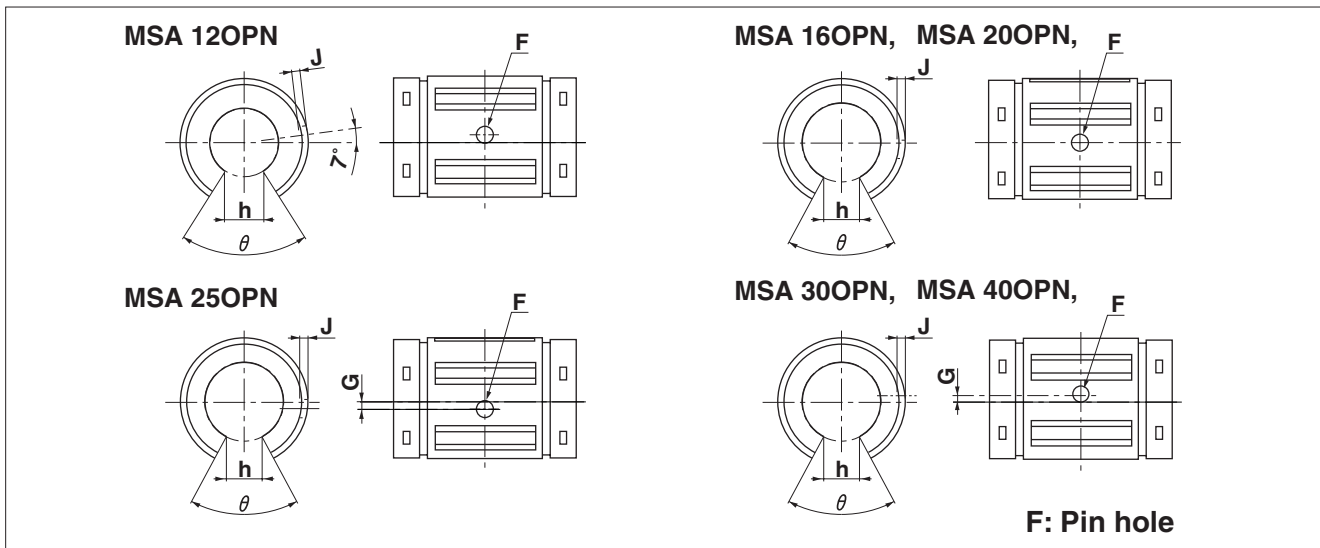
\* Based on nominal housing bore.

\*\*Call NSK for availability.

### Recommended Tolerances

part number	shaft diameter		housing bore	
	dr mm	tol. (h6) μm	D mm	tol. (H7) μm
MSA10	10	0	19	+21
MSA12	12	-11	22	0
MSA16	16	-11	26	0
MSA20	20	0	32	+25
MSA25	25	-13	40	0
MSA30	30	-13	47	0
MSA40	40	0/-16	62	+30/0

# SELF-ALIGNING BALL BUSHINGS

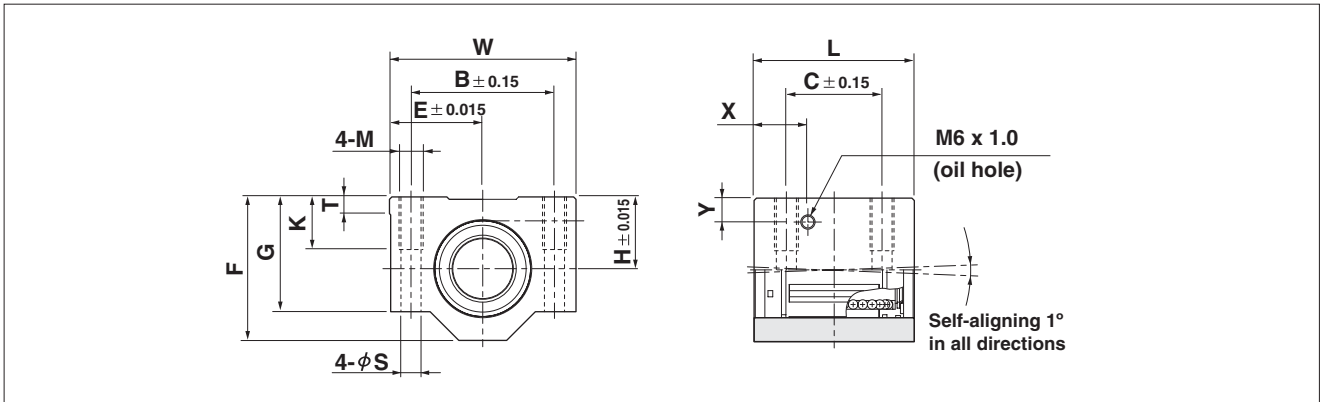
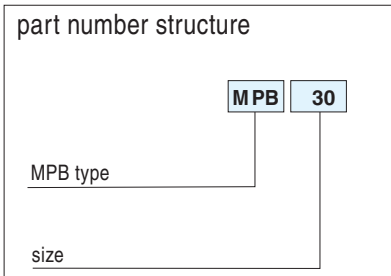


major dimensions									basic load rating		nom. shaft dia. mm
B mm	tolerance mm	W mm	D <sub>1</sub> mm	open type					dynamic	static	
				h mm	φ	F <sup>H 11</sup> mm	G mm	J mm	C N	Co N	
22.0		1.3	18	-	-	-	-	-	750	935	10
22.9	0 -0.2	1.3	21	6.5	66	3	-	0.7	1020	1290	12
24.9		1.3	24.9	9	68		-	1.0	1250	1550	16
31.5		1.6	30.3	9	55		-	1.0	2090	2630	20
44.1	0 -0.3	1.85	37.5	11.5	57		1.5	1.5	3780	4720	25
52.1		1.85	44.5	14	57		2	2.2	5470	6810	30
60.6		2.15	59	19.5	56		1.5	2.7	6590	8230	40

1N ≙ 0.102kgf

# MPB TYPE

## Block Type with Seals (Euro Metric)



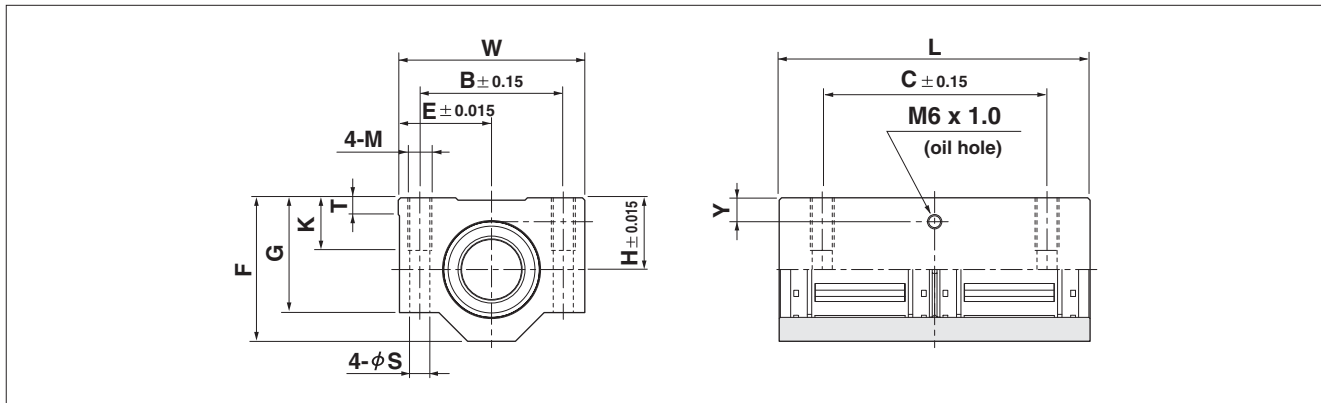
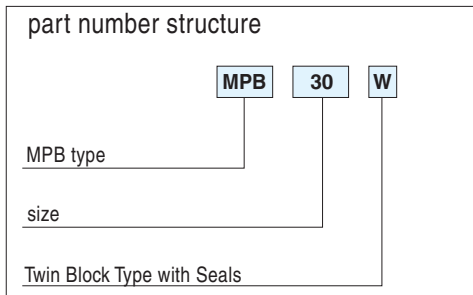
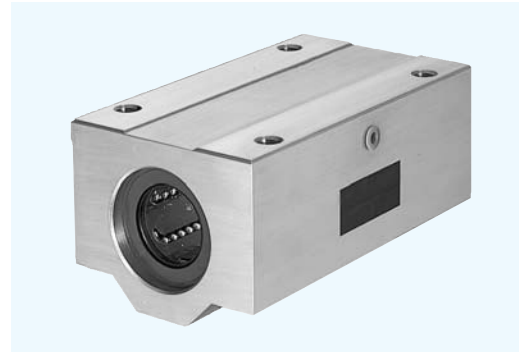
part number	nom. shaft dia. mm	major dimensions									mounting dimensions					load rating		mass g
		H	E	W	L	F	G	T	X	Y	B	C	M	K	S	dynamic C N	static Co N	
		mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm			
MPB12	12	18	21.5	43	39	35	28	5	—	—	32	23	M5	11	4.3	1020	1290	116
MPB16	16	22	26.5	53	43	42	35	5	—	—	40	26	M6	13	5.3	1250	1550	205
MPB20	20	25	30	60	54	50	42	5	19	9	45	32	M8	18	6.6	2090	2630	326
MPB25	25	30	39	78	67	60	48	7	22.5	10	60	40	M10	22	8.4	3780	4720	624
MPB30	30	35	43.5	87	79	70	58	8	26	11.5	68	45	M10	22	8.4	5470	6810	980
MPB40	40	45	54	108	91	90	72	10	26.5	14	86	58	M12	26	10.5	6590	8230	1670

Recommended shaft tolerance is h6.

1N ≙ 0.102kgf

## MPB-W TYPE

**Twin Block Type with Seals  
(Euro Metric)**

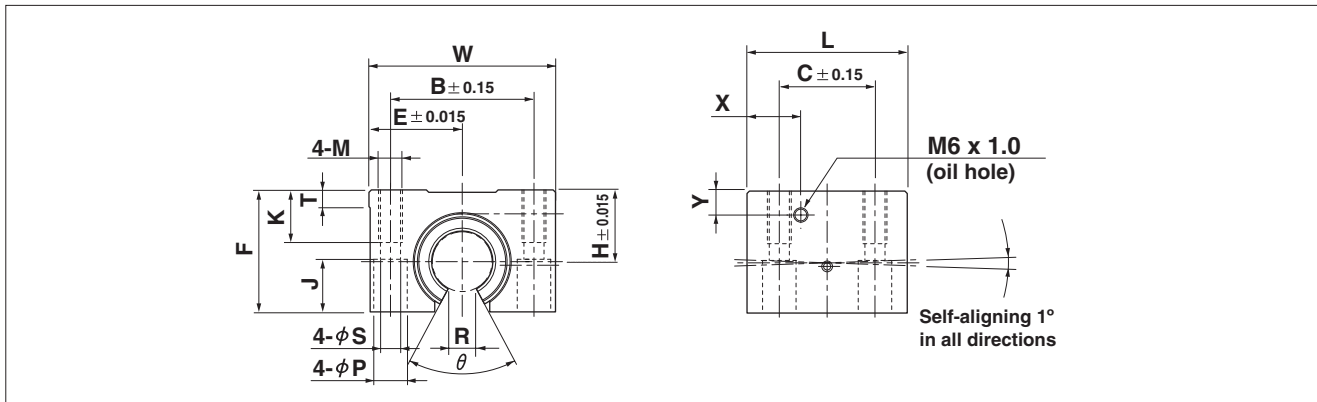
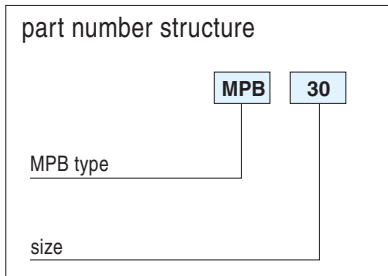


part number	nom. shaft dia. mm	major dimensions								mounting dimensions					load rating		mass g
		H	E	W	L	F	G	T	Y	B	C	M	K	S	dynamic C N	static Co N	
		mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	
MPBW12	12	18	21.5	43	76	35	28	5	7.5	32	56	M5	11	4.3	1652	2580	227
MPBW16	16	22	26.5	53	84	42	35	5	9.5	40	64	M6	13	5.3	2025	3100	390
MPBW20	20	25	30	60	104	50	42	5	9	45	76	M8	18	6.6	3390	5260	630
MPBW25	25	30	39	78	130	60	48	7	10	60	94	M10	22	8.4	6120	9440	1210
MPBW30	30	35	43.5	87	152	70	58	8	11.5	68	106	M10	22	8.4	8860	13620	1880
MPBW40	40	45	54	108	176	90	72	10	14	86	124	M12	26	10.5	10680	16460	3280

1N  $\approx$  0.102kgf

# MPB TYPE

## Open Block Type with Seals (Euro Metric)



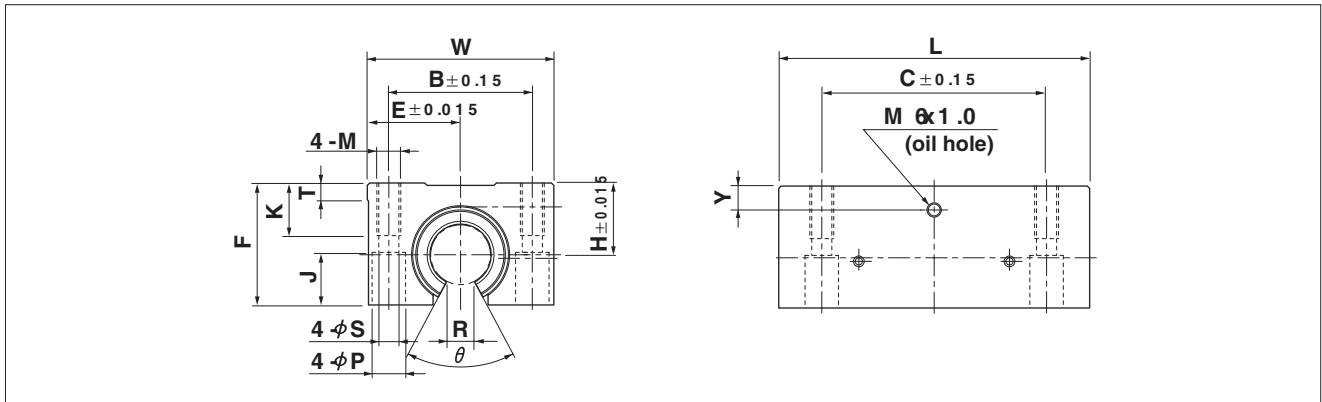
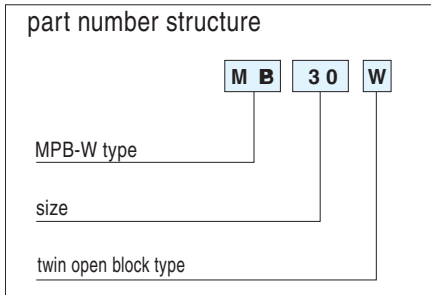
part number	nom. shaft dia. mm	major dimensions									mounting dimensions							load rating		mass g	
		H	E	W	L	F	T	R	φ	X	Y	B	C	M	K	S	P	J	dynamic C N		static Co N
		mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm		mm
MPB12OPN	12	18	21.5	43	39	28	5	6.5	66°	14.5	7.5	32	23	M5	11	4.3	8	4.5	1020	1290	99
MPB16OPN	16	22	26.5	53	43	35	5	9	68°	15.5	9.5	40	26	M6	13	5.3	9.5	5.5	1250	1550	175
MPB20OPN	20	25	30	60	54	42	5	9	55°	19	9	45	32	M8	18	6.6	11	6.5	2090	2630	275
MPB25OPN	25	30	39	78	67	51	7	11.5	57°	22.5	10	60	40	M10	22	8.4	14	8.6	3780	4720	558
MPB30OPN	30	35	43.5	87	79	60	8	14	57°	26	11.5	68	45	M10	22	8.4	14	8.6	5470	6810	860
MPB40OPN	40	45	54	108	91	77	10	19.5	56°	26.5	14	86	58	M12	26	10.5	17.5	10.8	6590	8230	1490

1N ≅ 0.102kgf



## MPB-W TYPE

**Twin Open Block Type with Seals  
(Euro Metric)**



part number	nom. shaft dia. mm	major dimensions									mounting dimensions							load rating		mass g
		H	E	W	L	F	T	R	θ	Y	B	C	M	K	S	P	J	dynamic C <sub>N</sub>	static C <sub>0N</sub>	
		mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	N	N	
MPBW12OPN	12	18	21.5	43	76	28	5	6.5	66°	7.5	32	56	M5	11	4.3	8	4.5	1652	2580	190
MPBW16OPN	16	22	26.5	53	84	35	5	9	68°	9.5	40	64	M6	13	5.3	9.5	5.5	2025	3100	312
MPBW20OPN	20	25	30	60	104	42	5	9	55°	9	45	76	M8	18	6.6	11	6.5	3390	5260	505
MPBW25OPN	25	30	39	78	130	51	7	11.5	57°	10	60	94	M10	22	8.4	14	8.6	6120	9440	1050
MPBW30OPN	30	35	43.5	87	152	60	8	14	57°	11.5	68	106	M10	22	8.4	14	8.6	8860	13620	1630
MPBW40OPN	40	45	54	108	176	77	10	19.5	56°	14	86	124	M12	26	10.5	17.5	10.8	10680	16460	2880

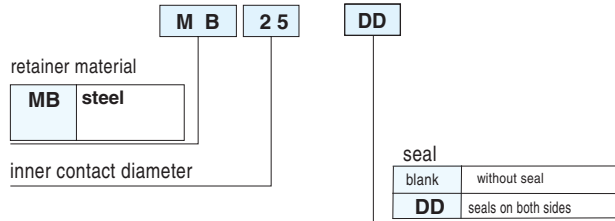
1N ≅ 0.102kgf

# TYPE MB

## Standard Type (Euro Metric)



part number structure

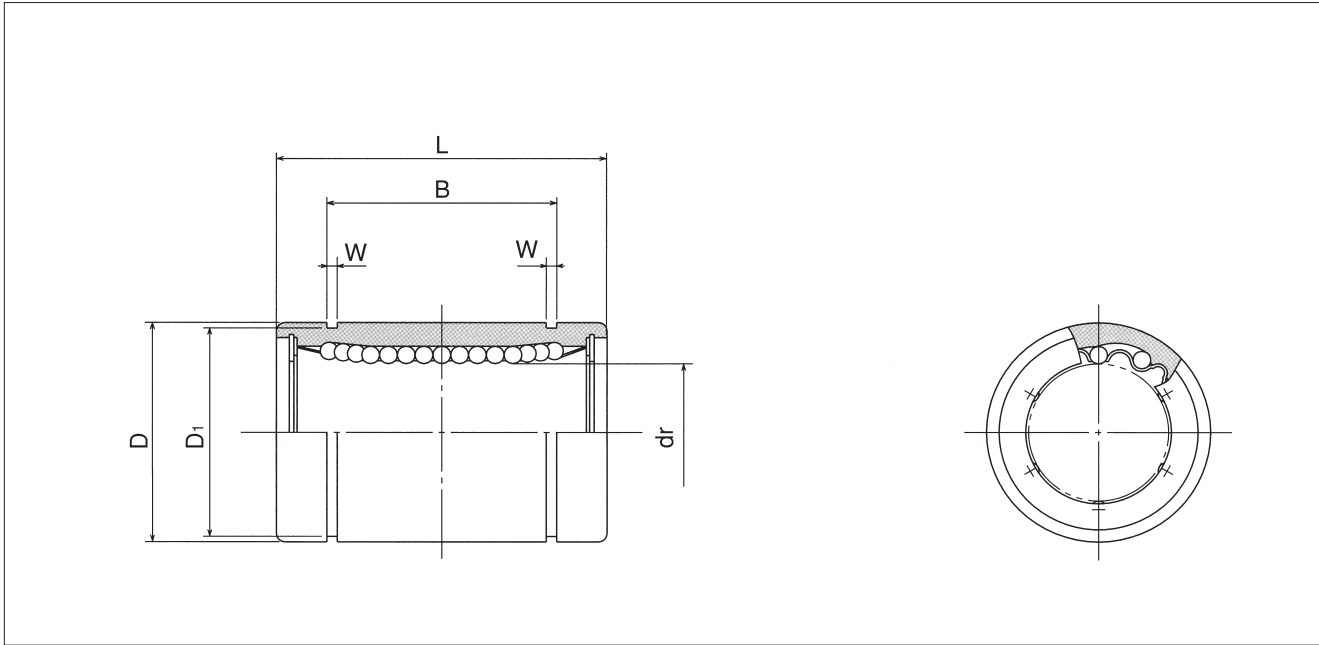


part number standard	no. of ball circuits	dr		D		
		mm	tolerance µm	mm	tolerance µm	
MB3	4	3	+ 8 0	7	0 - 8	
MB 4	4	4		8		
MB 5	4	5		12		
MB 8	4	8		16	0 - 9	
MB10	4	10		19		
MB12	4	12		22	0 - 11	
MB16	4	16		26		
MB20	5	20		- 1	32	0 - 11
MB25	6	25		+11	40	
MB30	6	30		- 1	47	0 - 13
MB40	6	40	+13	62		
MB50	6	50	- 2	75	0 - 15	
MB60	6	60	+16/-4	90		
MB80	6	80		120		

### Recommended Tolerances

accuracy grade	shaft	housing
		Normal
high	h6	H7

# BALL BUSHINGS



major dimensions						eccentricity	radial clearance (max.)	basic load rating		mass	shaft dia.
L	tolerance	B	tolerance	W	D <sub>1</sub>			dynamic	static		
mm		mm		mm	mm	mm	mm	C	C <sub>0</sub>	g	mm
10	0					10	-3	69	105	1.4	3
12	-0.12							88	127	2	4
22	0	14.5	0	1.1	11.5	12	-4	206	265	11	5
25		16.5		1.1	15.2			265	402	22	8
29	0	22	0	1.3	18	12	-4	372	549	36	10
32	-0.2	22.9	-0.2	1.3	21			510	784	45	12
36	0	24.9	0	1.3	24.9	12	-4	578	892	60	16
45		31.5		1.6	30.3			862	1,370	102	20
58	0	44.1	0	1.85	37.5	15	-6	980	1,570	235	25
68		52.1		1.85	44.5			1,570	2,740	360	30
80	-0.3	60.6	-0.3	2.15	59	17	-8	2,160	4,020	770	40
100	77.6	2.65	72	3,820	7,940			1,250	50		
125	0	101.7	0	3.15	86.5	20	-13	4,700	9,800	2,220	60
165	-0.4	133.7	-0.4	4.15	116			7,350	16,000	5,140	80

1N ≅ 0.102kgf

# BALL BUSHING

## Standard Type (Euro Metric) (Page 54)

DIAM. NOM.	PLC	NB	SKF	INA	THOMSON	STAR	THK	IKO
3	MB3	KB 3	-	-	-	-	-	-
4	MB4	KB 4	-	-	-	-	-	-
5	MB5	KB 5	LBAR 5	-	-	0600-305-00	LME 5A	-
	MB5DD	KB 5UU	LBAR 5 2LS	-	-	0602-305-10	LME 5AUU	-
8	MB8	KB 8	LBAR 8	-	MA M08	0600-308-00	LME 8A	LME 81625
	MB8DD	KB 8UU	LBAR 8 2LS	-	MA M08 WW	0602-308-10	LME 8AUU	LME 81625 UU
10	MB10	KB 10	-	-	-	-	-	-
	MB10DD	KB 10UU	-	-	-	-	-	-
12	MB12	KB 12	LBAR 12	-	MA M12	0600-012-00	LME 12A	LME 122232
	MB12DD	KB 12UU	LBAR 12 2LS	-	MA M12 WW	0602-012-10	LME 12AUU	LME 122232 UU
16	MB16	KB 16	LBAR 16	KB 1636	MA M16	0600-016-00	LME 16A	LME 162636
	MB16DD	KB 16UU	LBAR 16 2LS	KB 1636 PP	MA M16 WW	0602-016-10	LME 16AUU	LME 162636 UU
20	MB20	KB 20	LBAR 20	KB 2045	MA M20	0600-020-00	LME 20A	LME 203245
	MB20DD	KB 20UU	LBAR 20 2LS	KB 2045 PP	MA M20 WW	0602-020-10	LME 20AUU	LME 203245 UU
25	MB25	KB 25	LBAR 25	KB 2558	MA M25	0600-025-00	LME 25A	LME 254058
	MB25DD	KB 25UU	LBAR 25 2LS	KB 2558 PP	MA M25 WW	0602-025-10	LME 25AUU	LME 254058 UU
30	MB30	KB 30	LBAR 30	KB 3068	MA M30	0600-030-00	LME 30A	LME 304768
	MB30DD	KB 30UU	LBAR 30 2LS	KB 3068 PP	MA M30 WW	0602-030-10	LME 30AUU	LME 304768 UU
40	MB40	KB 40	LBAR 40	KB 4080	MA M40	0600-040-00	LME 40A	LME 406280
	MB40DD	KB 40UU	LBAR 40 2LS	KB 4080 PP	MA M40 WW	0602-040-10	LME 40AUU	LME 406280 UU
50	MB50	KB 50	LBAR 50	KB 50100	-	0600-050-00	LME 50A	LME 5075100
	MB50DD	KB 50UU	LBAR 50 2LS	KB 50100 PP	-	0602-050-10	LME 50AUU	LME 5075100 UU
60	MB60	KB 60	LBAR 60	-	-	0600-060-00	LME 60A	LME 6090125
	MB60DD	KB 60UU	LBAR 60 2LS	-	-	0602-060-10	LME 60AUU	LME 6090125 UU
80	MB80	KB 80	-	-	-	0600-080-00	LME 80A	LME 80120165
	MB80DD	KB 80UU	-	-	-	0602-080-10	LME 80AUU	LME 80120165UU

# BALL BUSHING

## Self-Aligning Euro Metric (Page 48)

DIAM. NOM.	PLC	NB	SKF	INA	THOMSON	STAR
10	MSA10	TK 10	-	-	-	0670-010-00
	MSA10DD	TK 10UU	-	-	-	0670-210-40
12	MSA12	TK 12	LBCD12	KN 1232	SP M12	0670-012-00
	MSA12DD	TK 12UU	LBCD12-2LS	KN 1232 PP	SP M12 WW	0670-212-40
	MSA12OPN	TK 12-OP	LBCF12	KNO 1232	SP M12 OPN	0671-012-00
	MSA12OPNDD	TK 12UU-OP	LBCF12-2LS	KNO 1232 PP	SP M12 OPN WW	0671-212-40
16	MSA16	TK 16	LBCD16	KN 1636	SP M16	0670-016-00
	MSA16DD	TK 16UU	LBCD16-2LS	KN 1636 PP	SP M16 WW	0670-216-40
	MSA16OPN	TK 16-OP	LBCF16	KNO 1636	SP M16 OPN	0671-016-00
	MSA16OPNDD	TK 16UU-OP	LBCF16-2LS	KNO 1636 PP	SP M16 OPN WW	0670-216-40
20	MSA20	TK 20	LBCD20	KN 2045	SP M20	0670-020-00
	MSA20DD	TK 20UU	LBCD20-2LS	KN 2045 PP	SP M20 WW	0670-220-40
	MSA20OPN	TK 20-OP	LBCF20	KNO 2045	SP M20 OPN	0671-020-00
	MSA20OPNDD	TK 20UU-OP	LBCF20-2LS	KNO 2045 PP	SP M20 OPN WW	0671-220-40
25	MSA25	TK 25	LBCD25	KN 2558	SP M25	0670-025-00
	MSA25DD	TK 25UU	LBCD25-2LS	KN 2558 PP	SP M25 WW	0670-225-40
	MSA25OPN	TK25-OP	LBCF25	KNO 2558	SP M25 OPN	0671-025-00
	MSA25OPNDD	TK 25UU-OP	LBCF25-2LS	KNO 2558 PP	SP M25 OPN WW	0671-225-40
30	MSA30	TK 30	LBCD30	KN 3068	SP M30	0670-030-00
	MSA30DD	TK 30UU	LBCD30-2LS	KN 3068 PP	SP M30 WW	0670-230-40
	MSA30OPN	TK 30-OP	LBCF30	KNO 3068	SP M30 OPN	0671-030-00
	MSA30OPNDD	TK 30UU-OP	LBCF30-2LS	KNO 3068 PP	SP M30 OPN WW	0671-230-40
40	MSA40	TK 40	LBCD40	KN 4080	SP M40	0670-040-00
	MSA40DD	TK 40UU	LBCD40-2LS	KN 4080 PP	SP M40 WW	0670-240-40
	MSA40OPN	TK 40-OP	LBCF40	KNO 4080	SP M40 OPN	0671-040-00
	MSA40OPNDD	TK 40UU-OP	LBCF40-2LS	KNO 4080 PP	SP M40 OPN WW	0671-240-40

## BLOCK TYPE (Page 50)

DIAM. NOM.	PLC	NB	STAR	INA	THOMSON
12	MPB12	TKA 12UU	1035-612-00	KGN 12 BPP AS	SP PB M12
16	MPB16	TKA 16UU	1035-616-00	KGN 16 BPP AS	SSE PB M16 DD
20	MPB20	TKA 20UU	1035-620-00	KGN 20 BPP AS	SSE PB M20 DD
25	MPB25	TKA 25UU	1035-625-00	KGN 25 BPP AS	SSE PB M25 DD
30	MPB30	TKA 30UU	1035-630-00	KGN 30 BPP AS	SSE PB M30 DD
40	MPB40	TKA 40UU	1035-640-00	KGN 40 BPP AS	SSE PB M40 DD

## TWIN BLOCK TYPE (Page 51)

DIAM. NOM.	PLC	NB	STAR	INA	THOMSON
12	MPBW12	TKA 12WUU	1085-812-00	KTN 12 BPP AS	SP TWN M12
16	MPBW16	TKA 16WUU	1085-816-00	KTN 16 BPP AS	SSE TWN M16 DD
20	MPBW20	TKA 20WUU	1085-820-00	KTN 20 BPP AS	SSE TWN M20 DD
25	MPBW25	TKA 25WUU	1085-825-00	KTN 25 BPP AS	SSE TWN M25 DD
30	MPBW30	TKA 30WUU	1085-830-00	KTN 30 BPP AS	SSE TWN M30 DD
40	MPBW40	TKA 40WUU	1085-840-00	-	SSE TWN M40 DD

## OPEN TYPE WITHOUT CLEARANCE ADJUSTMENT (Page 52)

DIAM. NOM.	PLC	NB	STAR	INA	THOMSON
12	MPB12OPN	TKE 12UU	1037-612-00	KGNO 12 PP AS	SP PBO M12
16	MPB16OPN	TKE 16UU	1037-616-00	KGNO 16 PP AS	SSE PBO M16 DD
20	MPB20OPN	TKE 20UU	1037-620-00	KGNO 20 PP AS	SSE PBO M20 DD
25	MPB25OPN	TKE 25UU	1037-625-00	KGNO 25 PP AS	SSE PBO M25 DD
30	MPB30OPN	TKE 30UU	1037-630-00	KGNO 30 PP AS	SSE PBO M30 DD
40	MPB40OPN	TKE 40UU	1037-640-00	KGNO 40 PP AS	SSE PBO M40 DD

## TWIN OPEN BLOCK TYPE WITHOUT CLEARANCE ADJUSTMENT (Page 53)

DIAM. NOM.	PLC	NB	STAR	INA	THOMSON
12	MPBW12OPN	TKE 12WUU	1087-812-00	KTNO 12 PP AS	SP TWNO M12
16	MPBW16OPN	TKE 16WUU	1087-816-00	KTNO 16 PP AS	SSE TWNO M16 DD
20	MPBW20OPN	TKE 20WUU	1087-820-00	KTNO 20 PP AS	SSE TWNO M20 DD
25	MPBW25OPN	TKE 25WUU	1087-825-00	KTNO 25 PP AS	SSE TWNO M25 DD
30	MPBW30OPN	TKE 30WUU	1087-830-00	KTNO 30 PP AS	SSE TWNO M30 DD
40	MPBW40OPN	TKE 40WUU	1087-840-00	KTNO 40 PP AS	SSE TWNO M40 DD

## EURO METRIC SHAFTS

### Shaft Tolerance

PLC metric shafting is made to an h6 tolerance which is the European standard. This tolerance provides a slight clearance fit between the shaft and the bushing while maintaining the high accuracy grade of the PLC bushing. It is important to note that Euro metric bushings must be used with Euro metric shafts for proper setup and operation.

### Hardness & Case Depth

PLC 60 Case shafting is hardened to Rockwell 60-65. The case depth is uniformly controlled and is intentionally kept to a shallow level. While costly, this approach delivers a shaft that is supremely easy to cut relative to traditional methods of hardening. Bearing life and performance are unaffected.

### Straightness

The standard straightness tolerance is .001” — .002” per foot cumulative. Contact NSK for availability and pricing of other tolerances.

### Surface Finish

Surface finish is between 10 and 16 micro-inches RMS. Contact NSK for availability and pricing of other surface finishes.

### Chamfered Ends

To facilitate assembly with the bushing, chamfered ends are provided as standard for all PLC shafts.

NOM. DIA.	METRIC TOLERANCE (INCH)	WEIGHT PER INCH (lbs.)	MINIMUM DEPTH OF HARDNESS (INCHES)	*MAXIMUM LENGTH (INCH)
8mm	.3146/.3150	.022	.040	172
12mm	.4720/.4724	.050	.060	184
16mm	.6295/.6299	.088	.060	184
20mm	.7869/.7874	.138	.060	184
25mm	.9838/.9843	.216	.080	184
30mm	1.1806/1.1811	.311	.080	184
40mm	1.5743/1.5748	.553	.080	184
50mm	1.9679/1.9685	.864	.100	184

\* Shafts can be joined for longer lengths. Please contact Customer Service.











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