MISUMI USA

Mastering Linear Bushing -1:

Linear Bushing and Other Linear Motion Products

Linear motion products are the most commonly used motion elements in automation of transfer / locating / assembly. Here, three types of linear guides, [1] Linear Bushing, [2] Slide Guide, and [3] Oil Free Bushing will be compared and explained as we master linear bushings.

(1)Comparison of Linear Motion Products Characteristics

The characteristics of the three types of linear motion products are shown in the table below.

Type	Load Capacity	Friction Coefficient	Guidance Accuracy	Environmental Conditions	Ease of Maintenance	Cost
Linear Bushing	Medium	Low	Medium to High	Medium	Medium to High	Low
Linear Slide Guide	High	Low	High	Medium	Medium to High	High
Oil Free Bushing	Medium	High	Medium	High	High	Medium

The characteristics and structure of each type are explained below.

(2)The characteristics and structure of linear motion

(1) About the difference in performance of load capacity

■Linear Bushing and Oil Free Bushing

a) A unit using Linear Bushings or Oil Free Bushings which moves on a Shaft where both-ends are supported, a heavy load can elastically deform the Shaft. (see **Photo 1**).
(In the case of vertical-directional linear motion mechanism, the Shaft does not need to support the load of the unit, thus load capacity can be ignored.)

■Linear Slide Guide

b) Excellent load capacity because unit moves on rails assembled on the base plate. (see **Photo 2**)

Linear Bushing, Oil free Bushing ⇒ Shaft supported at both ends ⇒Light to medium load
Slide Guide ⇒ Fixed rail on base⇒Light to heavy load

Photo 1 Example of Linear (or Oil-Free) Bushing use

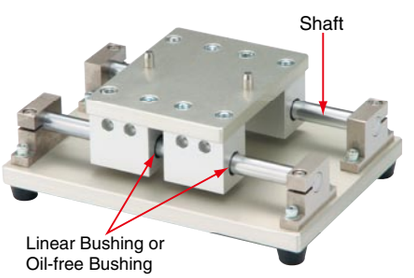
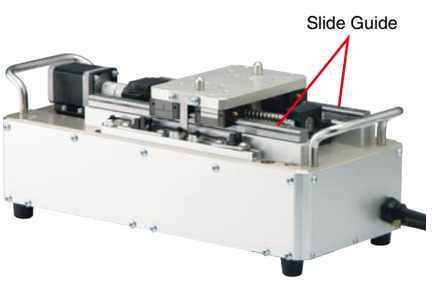


Photo 2 Example of Slide Guide use



(2) About the difference in performance of friction coefficient

Difference of performance depends on how motion is achieved. In Linear Bushing and Linear Guides, rolling steel balls are accurately guided by retainer so low frictional resistance is achieved. Where as in Oil Free Bushing two surfaces are sliding against each other, which result in higher friction.

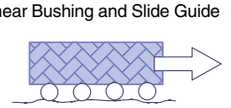
a) Low friction = low frictional force = low turning torque = rotatry motion can be turned into linear motion

b) High friction = high frictional force = high turning torque or thrust force is required= Linear Cylinder is recommended

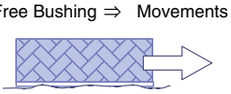
■Notes

1. Value of friction coefficient can influence the capacity of actuator and heat generation during movement. Oil Free Bushings are inappropriate because of heat dissipated by continuous high-speed operation.
2. In the case of using Air Cylinders, speed control of the start / stop is not possible. Mechanisms such as Shock Absorption Dampers need to be set to stop the speed softly. It can shorten the cycle time.

Linear Bushing and Slide Guide ⇒ Movements are made by rolling of balls ⇒ Low friction coefficient (0.002 to 0.006)
⇓
Motor or Air cylinder should be used as actuator



Oil Free Bushing ⇒ Movements are made by slidings of two surfaces ⇒ High friction coefficient (0.1 to 0.3)
⇓
Air or oil cylinders should be used as actuator



(3) About performance difference of guide accuracy

The performance depends on the clearance of bearing and rail/shaft.

a) Shafts are used for the rail with a Linear Bushing. The fit between Shafts and bushing is clearance fit (when g6 tolerance Shaft is used we have normal clearance, when h5 tolerance Shaft is used we have smaller clearance fit).

b) Linear Guide uses profile rail (or track rail) and bearing block (or slide unit). Fit ranges for 0-3μm for clearance fit types to -3-0 μm for preload types.

c) Oil Free Bushing is used with a Shaft, where the clearance is larger than a Linear Bushing therefore guide precision is lower.

Figure 1 Contact and load distribution of Linear Bushing

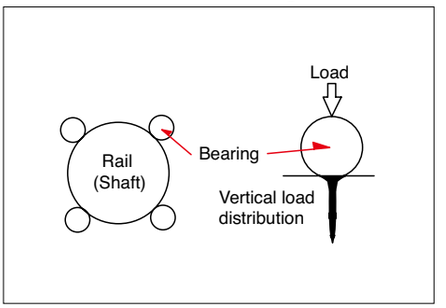
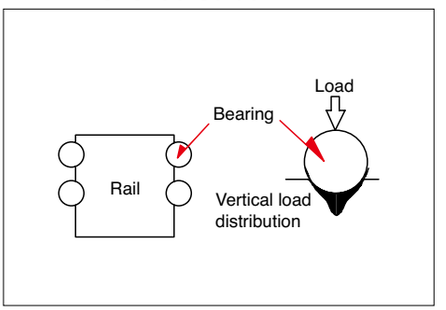


Figure 2 Contact and load distribution of Slide Guide



■Notes

Because of the raceway design, steel balls inside linear ball guides can have 2 or 4 contact points. This allows even distribution of complex load. Steel balls inside Linear Bushing have only one (or single) contact point with the Shaft, which results in centered load distribution. (see **Figure 1** and **Figure 2**)

Linear motion ⇒ Point contact ⇒ Concentrated vertical load distribution ⇒ Not applicable to heavy load
Slide guide ⇒ Surface contact ⇒ Distributed vertical load distribution ⇒ Applicable to heavy load

(4) About Environmental Conditions and Ease of Maintenance

The performance difference depends on materials used.

a) Linear Bushings and Linear Slide Guides maintain long term reliability with the use of lubricating grease. Therefore they are not applicable to be used in an environment that exceeds the environmental performance of it.

b) Oil Free Bushings provide higher performance because they do not require the use of lubricating grease.

Mastering Linear Bushing -2:

Straight and Flanged type Bushing

(1) Bushing structure and features

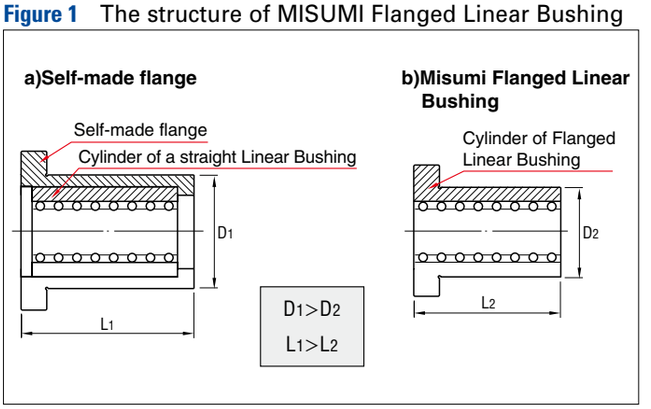
Both straight (**Photo 1**) and flanged (**Photo 2**) follow similar structural design. Main advantage of Flanged Linear Bushing lies in its compact design (**Figure 1**):

1. Integrated structure of Flanged Linear Bushing saves space. Outer cylinder with flange allows direct mount of the bushing, in addition it allows flanged bushings to maintain higher load capacity than standard Linear Bushing.
2. Hardened, precision flanged outer cylinder (housing) made out of chrome steel or corrosion resistant steel is advanced in its quality, and lower in cost compared to "self made" flanged housing.

Photo 1 Straight Linear Bushing

Photo 2 Flanged Linear Bushing

Figure 1 The structure of MISUMI Flanged Linear Bushing



(2) Using straight and flanged types

The following should be considered when making Linear Bushing selection.

1. Decide whether force will be applied to the Linear Bushing ⇒ Choose a flanged type if the Linear Bushing must bear to force.
2. Decide how much space is available on the surface to which the Linear Bushing is to be attached. ⇒ Refer to part (3)

As shown in **Figure 2**, depending on the design, Linear Bushings can either move while Shafts are fixed, or be stationary (fixed) while Shafts are in motion.

Figure 2 Uses of Linear Bushings

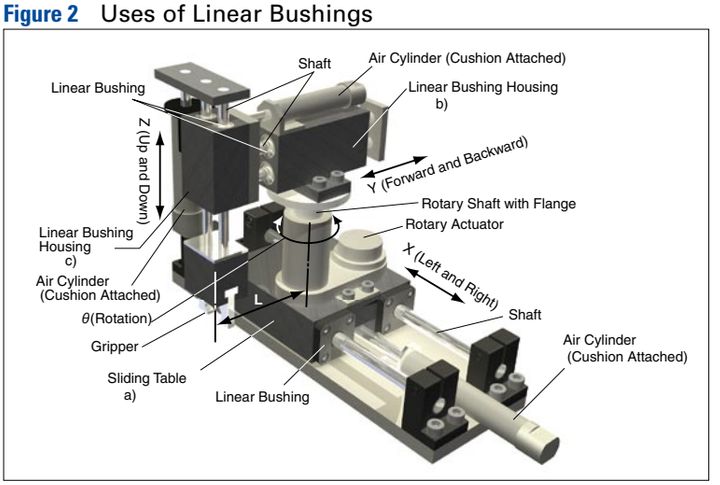


Figure 2 X-Y-Z-θ drive table

a) X-axis: Linear Bushing moves ⇒ Use flanged type.

b) Y-axis: Linear Bushing does not move
c) Z-axis: Linear Bushing does not move in Z direction } **⇒ Use straight type with Retaining Ring or Stopper Plate.**

The Linear Bushing in the component a) receives inertia force from the moving component, therefore the Linear Bushing must be firmly screwed to the housing. As for component b), an Air Cylinder moves the Shaft in the Linear Bushing. The Retaining Ring fixing the Linear Bushing only receives the frictional force from the Shaft. Therefore a compact design using a straight type is fine. The same can be said for c).

(3)Installing Linear Bushings

1. Fixing a Straight Linear Bushing, using Retaining Ring or Stopper Plate(Fixing Plate) (**Photo 3**) is shown in **Figure 3**.

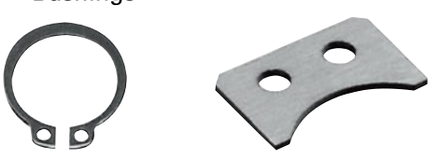
2. Notes on installation angle
   Load rating of Linear Bushing varies according to the load position on the circumference. Linear Bushing, usually has 4-6 rows/ball tracks, that are set on even angle. When installing, if possible avoid positioning Linear Bushing so that the ball track is under direct load (**Figure 4**), otherwise that row will directly bear the load (**Figure 4a**).

For example **Figure 4** shows a Linear Bushing with 5 rows. The variance of dynamic load rating is as follows. (right figure ÷ left figure). Therefore, angle should be installed as in the right picture.

Static Load Rating
(Right figure a ÷ left figure b)=1.46

Dynamic Load Rating
(Right figure a ÷ left figure b)=1.19

Photo 3 Installation parts for straight Linear Bushings



Retaining ring　　Stopper Plate (Fixing Plate)

Figure 3 Examples of Straight Linear Bushing installations

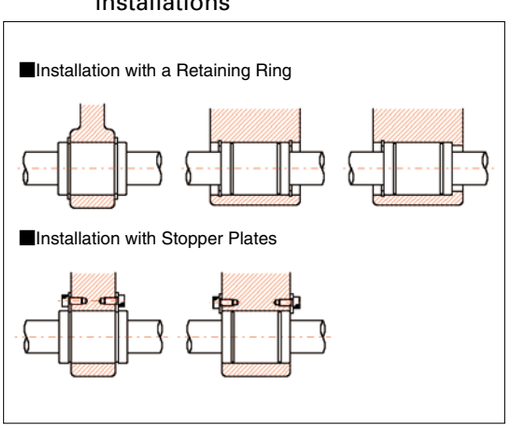


Figure 4 Bearing rows and dynamic load rating