Cross Roller Guide and Ball Guide

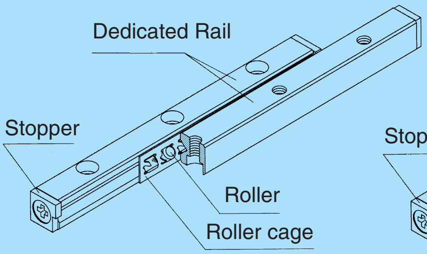


Fig. 1 Construction of Cross Roller Guide Type VR

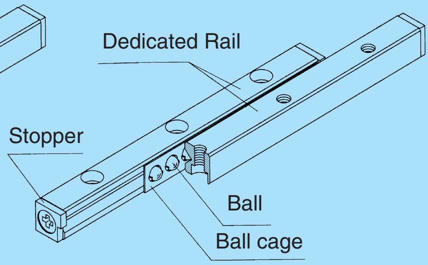
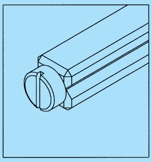


Fig. 2 Construction of Ball Guide Type VB



Stoppers for types V1 through V4 are round in shape.

The unique roller-holding mechanism of Cross Roller Guide type VR enables the realization of an increased effective contact length for rollers. Designed by combining Roller Cage type R with a shortened roller pitch, and Dedicated Rail type V, which is precision-ground after receiving special heat treatment, type VR is a highly rigid, high-precision, compact finite linear-motion system.

The Cross Roller Guide can be applied to a wide range of equipment: office automation equipment and peripherals, various measuring instruments, printed-circuit-board drilling machines and similar precision equipment, optical measuring instruments, optical stages and handling mechanisms, and slides used in X-ray equipment, to name just a few.

Designed by combining Ball Cage type B, in which precision steel balls are arranged at a short pitch, and Dedicated Rail type V, Ball Guide type VB is a low-friction, high-precision finite linear-motion system.

Construction and Features

Cross Roller Guide type VR is ready for use when the roller cage, in which precision rollers are incorporated at right angles to one another, is fitted into the 90° V-grooved raceway machined on the Dedicated Rail. When two Roller Guides are installed in parallel, the resulting system can bear loads in all directions perpendicular to the rails. Moreover, since a preload can be applied easily, the system can be a highly rigid, nimble slide mechanism with no clearance.

Long service life and high rigidity

The unique roller-holding method has increased the roller's effective contact length to 1.7 times that of conventional types. The increased effective contact length, shortened roller pitch, and greater number of rollers combine to double the rigidity and increase the service life by six times those of conventional types. These features permit a design with ample consideration given to safety measures against the vibration and impact to which the LM components are likely to be exposed.

Smooth movement

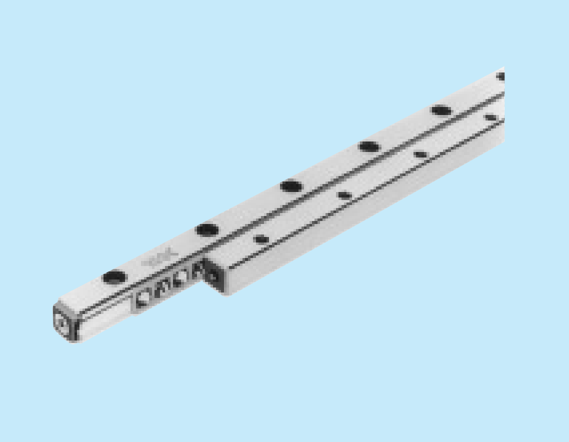
In Cross Roller Guide type VR, rollers are held in place and separated from one another by a cage. In addition, the roller pockets machined into the cage create surface contact with the rollers and therefore help ensure excellent lubricant retention. Thus, the guide provides smooth roller-based movement that does not cause wear and is low in friction.

High corrosion resistance

For Cross Roller Guide type VR and Ball Guide type VB, stainless steel types with high corrosion resistance are also available.

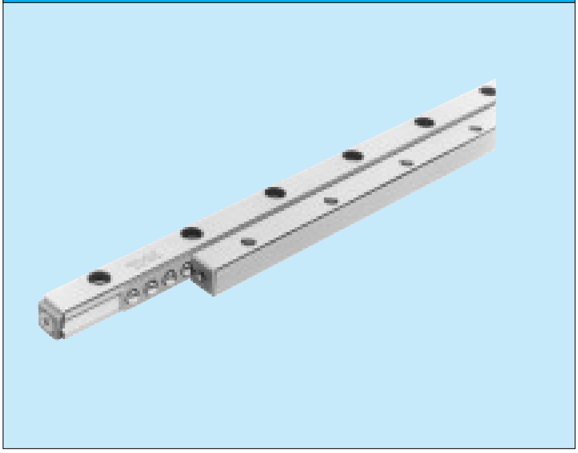
Types and Features

Cross Roller Guide Type VR



Compact, highly rigid LM system. The cage in which precision rollers are incorporated at right angles to one another moves along the V-groove machined on the rail, over only half the full stroke.

Ball Guide Type VB



Low-friction, high-precision LM system. The ball cage, in which precision steel balls are arranged at a short pitch, moves among the V-groove machined on the rail, over only half the full stroke.

Accuracy Standards

The accuracy of the Cross-Roller-Guide Dedicated Rail is divided into high and precision grades, as shown in Table 1.

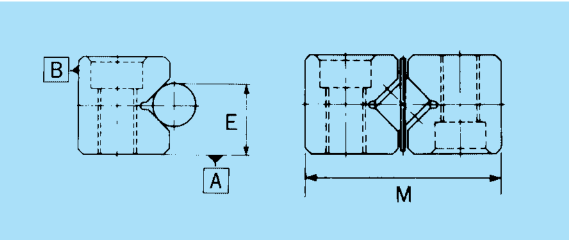


Table 1 Accuracy Standards for Dedicated Rail Type V

Unit : mm

Accuracy grade	High grade	Precision grade
Item / Symbol	H	P
Raceway parallelism to surfaces [A] and [B]	See Fig. 3	
Dimensional tolerance for height E	±0.02	±0.01
Height E difference among rails (Note)	0.01	0.005
Dimensional tolerance for width M	0 – 0.2	0 – 0.1

Note: "Height E difference among rails" applies to four rails installed on the same plane.

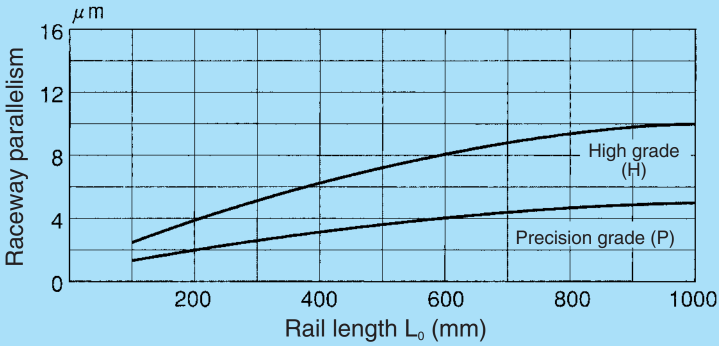
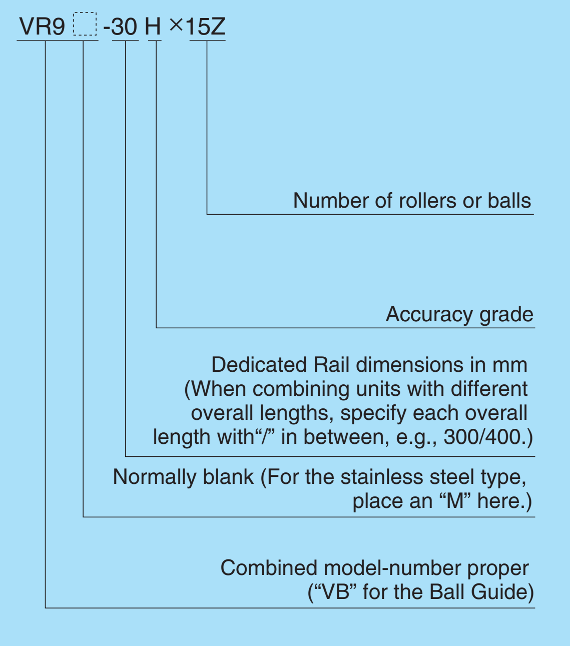


Fig. 3 Rail Length and Raceway Parallelism

C

Model-number coding

Whenever you contact us for a quotation, to order a cross roller guide or ball guide product, or for any other reason, please specify the model number in question to ensure a prompt reply.



"1 set" of the above model number refers to the product combined with four rails and two cages.

Basic Static Load Rating C_0

If type VR or VB, whether at rest or in motion, receives an excessive load or a major impact, localized permanent set develops between the raceway and rolling elements (rollers and balls). The load that causes the sum of the permanent set of the raceway and rolling elements to be 0.0001 times the rolling-element diameter is called the basic static load rating C_0 (see page C-7 for the load ratings in various directions). When the sum of the permanent set exceeds 0.0001 times the rolling-element diameter, the load hinders smooth motion. To prevent this, safety factor f_s should be taken into consideration (see "Static Safety Factor f_s" on page C-8).

Basic dynamic load rating C

The basic dynamic load rating (C) refers to the load in a direction with nonvarying magnitude such that when identical units of type VR in a group are operated independently of one another under the same conditions, 90% of the grouped units register a nominal life of 100 km (L = 100 km; for type VB, L = 50 km). The basic dynamic load rating C is necessary for estimating service life (see "Nominal life" on page C-8). Basic load ratings (C_Z and C_{0Z}) presented in the

Load Ratings in Various Directions

dimension tables are values per rolling element in the direction indicated in Fig. 4. When determining the service life of a bearing, calculate the basic load ratings (C and C_0) for the number of rolling elements in actual use, using the equation shown below.

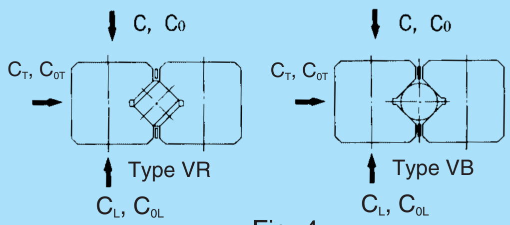


Fig. 4

● **For the Cross Roller Guide**

$$C = C_L = \left(\frac{Z}{2}\right)^{\frac{3}{4}} \times C_Z,\quad C_T = 2C$$

$$C_O = C_{OL} = \frac{Z}{2} \times C_{OZ},\quad C_{OT} = 2C_O$$

[For $\frac{Z}{2}$, discard the digits after the decimal point.]

● **For the Ball Guide**

$$C = C_L = Z^{\frac{2}{3}} \times C_Z,\quad C_T = 2C$$

$$C_0 = C_{OL} = Z \times C_{0Z},\quad C_{OT} = 2C_0$$

where

C_Z: basic dynamic load rating in the dimension table (kN)

C_{0Z}:basic static load rating in the dimension table (kN)

Z: number of rolling elements used (within the effective load-bearing range)

Static Safety Factor f_s

Types VR and VB may receive an unpredictable external force due to vibration and impact while it is at rest or in motion, or due to inertia resulting from starting and stopping. It is therefore necessary to take the static safety factor against operating loads such as these into consideration.

$$f_S = \frac{C_O}{P_C}$$

f_s: Static safety factor

C_o: Basic static load rating

P_C: Calculated load (N)

Table 2 Static Safety Factor (f_s) Standard Value

Host machine	Basic dynamic load rating	f_s lower limit
General industrial machine	When not subjected to vibration or impact	1.0～1.3
	When subjected to vibration and impact	2.0～3.0
Machine tool	When not subjected to vibration or impact	1.0～1.5
	When subjected to vibration and impact	2.5～7.0

Nominal life L

Once the basic dynamic load rating is achieved, the nominal life of the Cross Roller Guide and Ball Guide can be calculated using the equations shown below.

● **For the Cross Roller Guide**

$$L = \left(\frac{f_T}{f_W} \cdot \frac{C}{P_C}\right)^{\frac{10}{3}} \times 100$$

● **For the Ball Guide**

$$L = \left(\frac{f_T}{f_W} \cdot \frac{C}{P_C}\right)^{3} \times 50$$

where

L: nominal life (km)

(Total running distance that 90% of identical units of type VR (VB) in a group, when operated independently of one another under the same conditions, can achieve without developing flaking)

C: basic dynamic load rating (kN)

P_C: calculated load (kN)

f_T: temperature factor (see Fig. 5 on page C-8)

f_W: load factor (see Table 3 on page C-9)

Once the nominal life (L) is obtained using these equations, the service life in hours can be calculated using the equation shown below if the stroke length and the number of reciprocal operations are constant.

$$L_h = \frac{L \times 10^6}{2 \times \ell_s \times n_1 \times 60}$$

where

L_h: service life in hours (h)

ℓ_s:stroke length (mm)

n_1: number of reciprocal operations per minute (min^{-1})

f_T: Temperature factor

When the ambient temperature for an LM system exceeds 100°C, the service life must be multiplied by a temperature factor to offset any adverse effects of the high temperature.

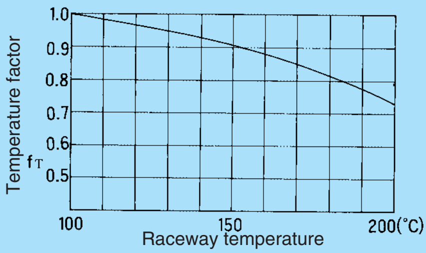


Fig. 5 Temperature Factor (f_T)

Note: If your ambient temperature exceeds 100°C, please contact us.

f_W: Load factor

In general, reciprocal machines are likely to be subjected to vibration and impact. It is very difficult to accurately determine the magnitudes of vibration during high-speed operation and of the impact at each starting and stopping. Therefore, when loads exerted on a linear-motion system cannot be determined, or when the effect of velocity and vibration is extraordinary, divide the basic load rating (C or C_0) by one of the empirically established load factors given in the table below.

Table 3 Load Factor (f_W)

Vibration and impact	Velocity (V)	f_W
Very light	Very low: $V \leqq 0.25$m/s	1～1.2
Light	Low: $0.25 < V \leqq 1.0$m/s	1.2～1.5
Medium	Intermediate: $1.0 < V \leqq 2.0$m/s	1.5～2.0
Heavy	High: $V > 2.0$m/s	2.0～3.5

Mounting Procedures for the Cross Roller Guide

When clearance-adjustment bolts are used

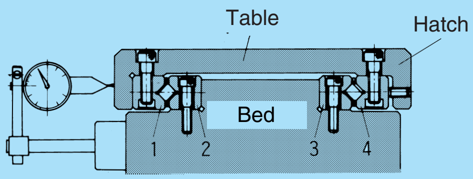


Fig. 6 Mounting the Cross Roller Guide

1. Press rails 2 and 3 firmly against the base and rail 1 against the table, while correctly positioning the mounting surfaces. Firmly tighten the rail-mounting bolts.
2. Temporarily fasten rail 4 to the table.
   Note: When designing your system, make sure rail-mounting bolts can be fully tightened after assembly.
3. Position the base and table as shown in Fig. 6. Insert roller cages from the rail ends. If the cages cannot be inserted due to insufficient clearance, slide rail 4 toward the adjustment bolt and retry.
4. Position a dial gauge as shown in Fig. 6. While gently pressing the table from the right and left, tighten all adjustment bolts uniformly until there is no slack.
5. Attach stoppers to the rail ends.
6. While sliding the table, correct the cage position so as to obtain the desired stroke.

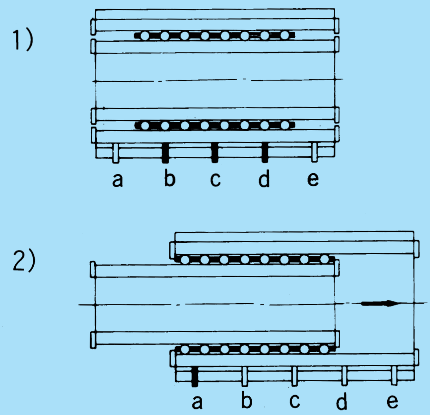


Fig. 7 Adjustment-Bolt Tightening Sequence

7. Position roller cages at the center of rails. Uniformly tighten adjustment bolts within the area containing the rollers (bolts b, c, and d) using a torque wrench or the like, until the dial gauge shows the specified displacement. Then, fully tighten the mounting bolts within the adjusted area.
   Note: The displacement showing on the dial gauge is equal to the preload to be applied to one roller cage.
8. Slide the table as shown in 2), Fig. 7 and likewise tighten the remaining adjustment bolts, a and e.
   Note: When assembling more than one unit, measure the tightening torque of the adjustment bolts or the table sliding resistance of the first unit. Assemble the second unit onwards so that the bolt tightening torque or table sliding resistance is equal to the measurement taken for the first unit. This ensures a virtually equal preload.

Sample clearance adjustment

Design adjustment bolts so that they press on the same line as the rollers.

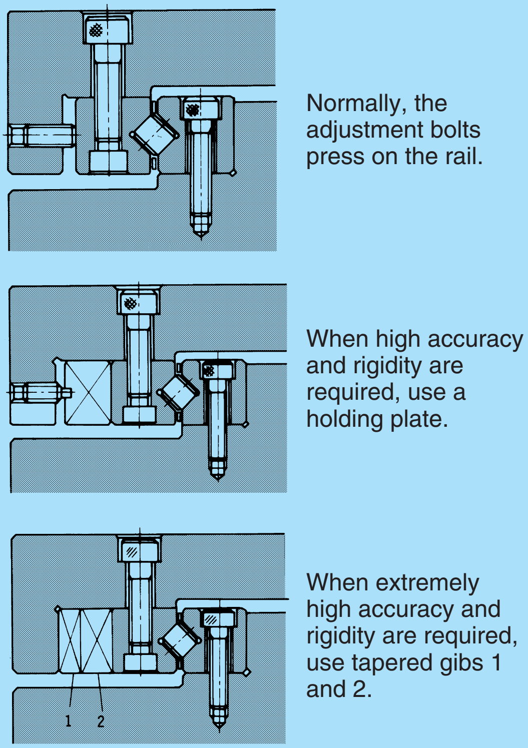


Fig. 8 Sample Clearance Adjustment

Preload on the Cross Roller Guide

The application of an excessive preload may cause dents, shorten the service life, and lead to similar problems. The dimension tables specify the permissible preload levels per roller cage. In accordance with the values, tighten the adjustment bolts while checking the roller contact-area dislocation.

Mounting-surface precision

To ensure high running accuracy, the rail mounting surface must be accurate in terms of parallelism and perpendicularity. The rail mounting surface should be finished by grinding or a similar method, to a degree of parallelism and flatness equivalent to or greater than that of the rails (page C-6). When installing rails, be sure to press them firmly against the mounting surface.

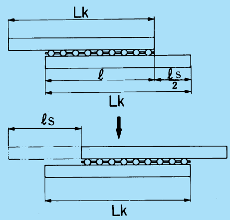
Precautions on Use

Rail length

Roller and ball cages move on rolling elements over a distance equal to half the table displacement in the same direction in which the table moves.

Now, let the cage length be ℓ and the stroke length be ℓ_s. Then, the rail length (Lk) that prevents the cage from overhanging from the rail must be:

$$Lk \geqq \ell + \frac{\ell_s}{2}$$



Cage dislocation

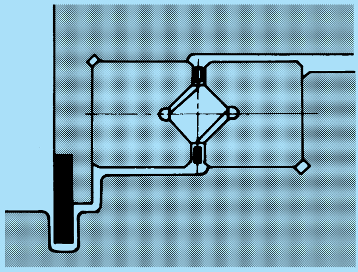
Although cages are designed to move very accurately, they may be dislocated due to an external force such as a moment, vertical installation, non-uniform contact, or machine vibration. To prevent such dislocation, use a Cross Roller Guide with dedicated stoppers attached to the rail ends. If cage dislocation cannot be prevented in any case, use of an infinite-motion LM system such as type RSR (page A-354) is recommended.

Stopper

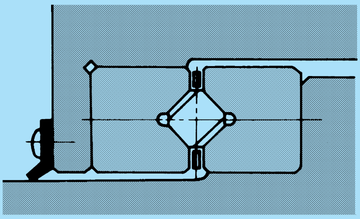
Stoppers are provided at the rail ends to prevent cages from falling off. However, if the cage repeatedly collides with a stopper as a result of overstroke or the like, a number of problems may occur, such as wear on the stopper and loosened stopper fastening screws. Even if stoppers are provided, overstroke and other causes of collision with a cage should be prevented.

Contamination protection

To prevent foreign matter from entering the Cross Roller Guide and Ball Guide through their sides, contamination protection measures such as those shown in Fig. 9 are available from us. Consider use of a bellows or telescopic cover to protect the guide ends.



Labyrinth cover



Wiper seal

Fig. 9 Contamination Protection Measures

Accessories

Normally, a rail to be installed where clearance adjustment is required is fastened using bolt holes drilled into the rail, as shown in Fig. 10. In such a case, bolt holes d_1 and D_1 should be drilled to a diameter greater than the bolt diameter by the amount required for adjustment.

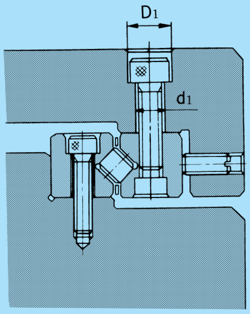


Fig. 10

If your system configuration requires use of a mounting method as shown in Fig. 11, mounting bolts (S) for rails for use under such conditions can be selected from those shown in Table 4.

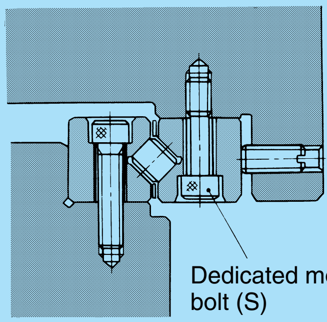


Fig. 11

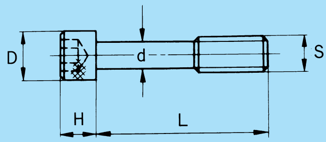


Table 4 Dedicated Mounting Bolt

Unit : mm

Desig-nation	S	d	D	H	L	Applicable rail
S3	M3×0.5	2.3	5	3	12	V3
S4	M4×0.7	3.1	5.8	4	15	V4
S6	M5×0.8	3.9	8	5	20	V6
S9	M6	4.6	8.5	6	30	V9
S12	M8	6.25	11.3	8	40	V12
S15	M10	7.9	13.9	10	45	V15
S18	M12	9.6	15.8	12	50	V18