Linear Guide

1-1 Features of *TBI MOTION* Linear Guide

■ 1-1-1 High Accuracy

Linear Guide has little friction, only a small driving force is needed to move the load. Low friction helps the temperature rising effect to stay low. Thus, the friction is decreased and the accuracy can be maintained for a long period than tradition slide system.

■ 1-1-2 High Rigidity

The design of Linear Guide features an equal load rating in all directions that provide sufficient rigidity load in all directions, self-aligning capability to absorb installation-error. Moreover, a sufficient preload can be achieved to increase rigidity and makes it suitable for any kind of installation.

■ 1-1-3 Easy for Maintenance

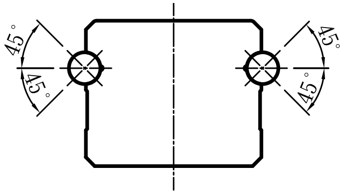
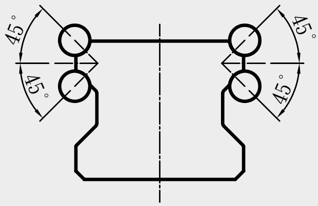
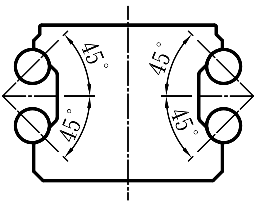
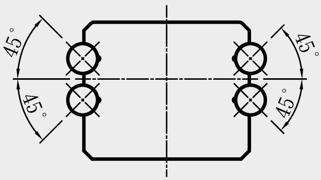
Compared with high-skill required scrapping process of traditional slide system, the Linear Guide can offer high precision even if the mounting surface is machined by milling or grinding. Moreover, the interchangeability of Linear Guide gives a convenience for installation and future maintenance.

■ 1-1-4 High Speed

Linear Guide block, rail and ball apply by contact point of rolling system. Due to the characteristic of low friction, the required driving force is much lower than that in other systems, thus the power consumption is low. Moreover the temperature rising effect is lower even under high speed operation.

■ 1-1-5 High Mechanical Efficiency without Clearance

Table 1.1.1

Drawing	Characteristics, Performance
	● Two trains of balls. ● In a Gothic-arch groove, each ball contacts the raceway at four points 45°- 45°. ● It has constant contact point between ball and arc groove. ● Rigidity has high stability. ● Two-row design is able to perform an equal load rating in four directions.
	● Four trains of balls. ● The circular-arc groove has two contact points at 45°- 45°(DF)-Four-Row Design features an equal load rating in all four directions with high rigidity. ● Four-row design is able to perform an equal load rating in four directions. ● Self-Aligning to absorb installation-error.
	● Four trains of balls. ● The circular-arc groove has two contact points at 45°- 45° (DB). ● Four-Row Design features an equal load rating in all four directions with high rigidity. ● Low friction promotes smooth operating condition.
	● Four trains of balls. ● In the Gothic-arch groove, each ball contacts the raceway at two points 45°- 45°, Light preload, two contact points, Heavy preload, four contact points. ● Compared with traditional DB type, it has higher rigidity.

1-1 Features of *TBI MOTION* Linear Guide

The Contract table of four-row design with equal load rating and two-row Gothic design.

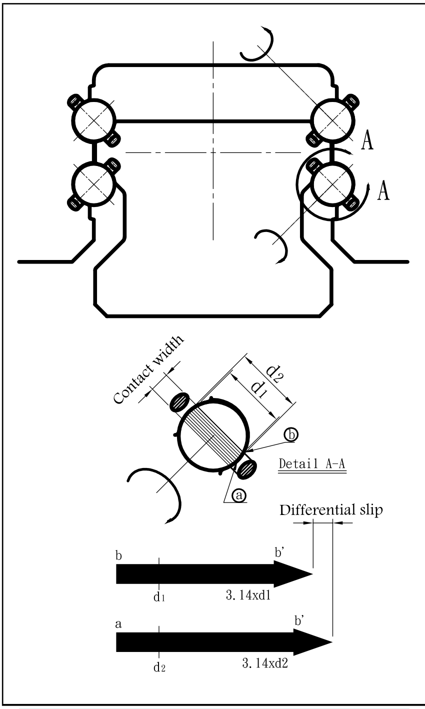


Fig 1.1.1 Four-Row Equal Load Ratting Design

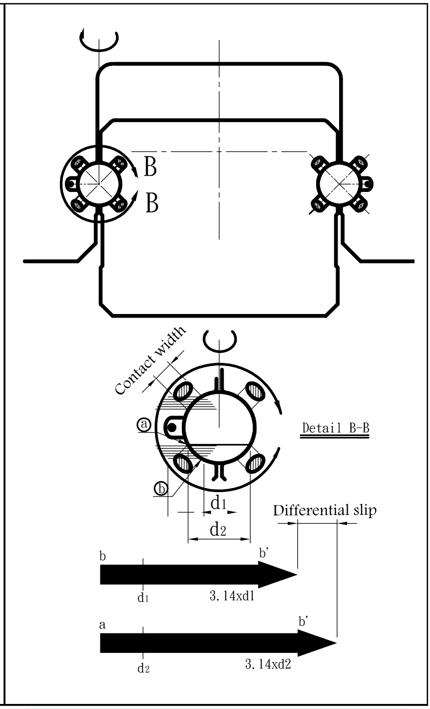


Fig 1.1.2 Two-Row Equal Load Ratting Design

As shown in the diagram, the difference between inner surface circumference(πd_1)and outer surface circumference(πd_2)which is the contact point of ball, it is the slip that will occur while the ball rolling, this is called differential slip.. if the differential slip is larger, the ball will rotate while rolling, increasing the friction coefficient and friction resistance. Under the condition with preload and loading, due to the two point of contact the difference between d_1 and d_2 is little, the differential slip is little as well, the smoothness of rolling can be achieved and thus increase efficiency.

1-2 The Procedure of Select Linear Guide

■ 1-2-1 Flowchart

1 Set the operating conditions	Set the conditions for the design of loads on the Linear Guide. • Space available for the guide part. • Dimensions (span, No. of blocks, No. of rails, and thrust). • Installation direction (horizontal, vertical, tilted, wall-hung, or suspended). • Magnitude of the applied load, direction, and location. • Frequency of use (duty cycle). • Velocity (acceleration). • Stroke length. • Required service life. • Service environment. • Motion precision .
2 Select the correct type	• Select proper type, size and quantity (If applied with ballscrew, the size of guideway should be similar to diameter of ballscrew).
3 Calculate the applied load	• Calculate the load that a Linear Guide block exerts on the Linear Guide.
4 Calculate the equivalent load	• Convert the load that Linear Guide blocks exert in each direction into an equivalent load.
5 Calculate the static safety factor	• Verify the value of the static safety factor for the basic static-load rating and Maximum applied load.
Is the static safety factor verified?	NO → return (Span, No. of blocks, and No. of rails changed → 1; Type or size changed → 2) YES → 6
6 Calculate the mean load	• Average the applied loads which fluctuate during operation, and convert them into a mean load.
7 Calculate the nominal life	• Calculate the running distance using the service-life equation.
8 Calculate the service life in hours	• Using the service-life equation to calculate the running distance or hours
Convert the running distance obtained into the service life in hours. Does the value obtained satisfy the enquired Service life?	NO → return (Span, No. of blocks, and No. of rails changed → 1; Type or size changed → 2) YES → 9
9 Forecast the rigidity	• Determine the radial clearance to be used. • Determine the fastening methods to be used. • Determine the rigidity at the fastened areas.
10 Select the accuracy and preload	• Determine the accuracy grade to be applied. • Determine the mounting surface precision to be used. • Select the preload level.
11 Safety design	• Determine the lubricants (grease, oil, special lubrication, etc.) to be used. • Determine the lubrication method (periodic greasing, forced lubrication, etc.) to be used. • Determine the material (Standard, stainless steel, etc.) to be used. • Completion of selection. • Determine the surface treatment (anti-corrosion, appearance protection, etc.) to be provided. • Design contaminant protection (bellows, telescopic cover, etc.)
12 Completion of selection	

1-3 Basic Load Rating and Service Life of Linear Guide

When determining a model that would suit your service conditions for a linear motion system, the load carrying capacity and service life of the model must be considered. To consider the load carrying capacity you should know the static safety factor of the model calculation based on the basic static load rating. Service life can be assessed by calculating the nominal life based on the basic dynamic load rating and checking to see if the obtained value meet your requirements.

The service life of a linear motion system refers to the total running distance that the linear motion system travels until flaking (the disintegration of a metal surface in scale-like pieces) occurs there to as a result of the rolling fatigue of the material caused by repeated stress on raceways and rolling elements.

Basic Load Rating : There are two basic load ratings for linear motion systems : basic static load rating (C_0), which sets the static permissible limits, and basic dynamic load rating (C).

■ 1-3-1 Basic Static Load Rating (C_0)

If a linear motion system, whether at rest or in low speed motion, receives an excessive load or a large impact, a partial permanent deformation develops between the raceway and rolling elements. If the magnitude of the permanent deformation exceeds a certain limit, it hinders the smoothness of the motion system.

The basic static load rating refers to a static load in a given direction with given magnitude such that the sum of the permanent set of the rolling elements and that of the raceway at the contact area under the most stress is 0.0001 times greater than the rolling element diameter.

In linear motion systems, the basic static load rating is defined as the radial load. Thus the basic static load rating provides a limit on the static permissible load.

■ 1-3-2 Basic Permissible Moment (M_x, M_y, M_z)

When a Linear Guide gets a force that makes the balls distorted to 1/10,000 of their diameter, we call the force as basic static permissible moment. Values of M_x, M_y, M_z are shown on Fig 1.3.1, which suggest 3 axis of moment on a Linear Guide slide.

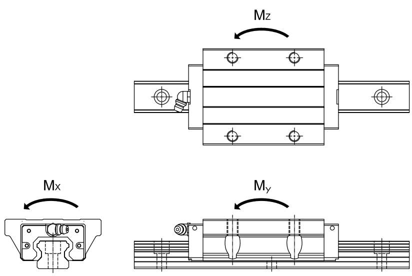


Fig 1.3.1

■ 1-3-3 Static Safety Factor f_s

$$f_s = \frac{C_0}{P} \text{ or } \frac{M_0}{M}$$

f_s : static safety factor
C_0 : basic static load rating (kg)
M_0 : static permissible moment (kg-mm)
P : calculated load (kg)
M : calculated moment (kg-mm)

A linear motion system may possibly receive an unpredictable external force due to vibration and impact while it is at rest or is moving or due to inertia resulting from start and stop. It is therefore necessary to consider the static safety factor against operating loads like these. The static safety factor (f_s) indicates the ratio of a linear motion system load carrying capacity 【basic static load rating C_0】 to the load exerted there on.

To calculate the applied load on Linear Guide, mean load and static safety factor must be obtained in advance. In the working environment with high intensity while start and stop, cantilever or cutting, a unexpected heavy load may occurs, therefore the maximum load must be acquired. Datum values of static safety factor are shown below;

Table 1.3.1 Static Safety Factor f_s

Machine Used	Loading Conditions	f_s lower limit
Ordinary Industrial Machine	Receives no vibration or impact	1.0-1.3
	Receives vibration and impact	2.0-3.0
Machine Tool	Receives no vibration or impact	1.0-1.5
	Receives vibration and impact	2.5-7.0

For large radial loads	$\frac{f_h \cdot f_t \cdot f_c \cdot C_0}{P_R} \geqq f_s$
For large reverse-radial loads	$\frac{f_h \cdot f_t \cdot f_c \cdot C_{0L}}{P_L} \geqq f_s$
For large lateral loads	$\frac{f_h \cdot f_t \cdot f_c \cdot C_{0T}}{P_T} \geqq f_s$

f_s : Static safety factor
C_0 : Basic static-load rating (radial) (kg)
C_{0L} : Basic static-load rating (reverse-radial) (kg)
C_{0T} : Basic static-load rating (lateral) (kg)
P_R : Calculated load (radial) (kg)
P_L : Calculated load (reverse-radial) (kg)
P_T : Calculated load (lateral) (kg)
f_h : Hardness factor (Fig1.3.2)
f_t : Temperature factor (Fig1.3.3)
f_c : Contact factor (Table1.3.2)

1-3 Basic Load Rating and Service Life of Linear Guide

■ 1-3-4 Service Life (L)

Even when identical linear guideways in a group are manufactured in the same way or applied under the same condition, the service life may be varied. Thus, the service life is used as an indicator for determining the service life of a linear guideway system. The nominal life (L) is defined as the total running distance that 90% of identical linear guideways in a group, when they are applied under the same conditions, can work without developing flaking.

■ 1-3-5 Basic Dynamic Load Rating (C)

Basic dynamic load rating (C) can be used to calculate the service life when linear guideway system response to a load. The basic dynamic load rating (C) is defined as a load in a given direction and with a given magnitude that when a group of linear guideways operate under the same conditions. As the rolling element is a ball, the nominal life of the linear guideway is 50 km. Moreover, as the rolling element is a roller, the nominal life is 100 km.

■ 1-3-6 Calculation of Nominal Life

The service lives of linear motion system more or less various from system to system even if they are manufactured to the same specifications and remain in service under the same operating conditions. Hence, a guideline for determining the service life of a linear motion system is based on nominal life, which is defined as follows. The nominal life refers to the total running distance that 90% of identical linear motion systems in a group, when interlocked with one another under the same conditions, can achieve without developing flaking. The nominal life (L) of a linear motion system can be obtained from the basic dynamic load rating (C) and load imposed (P_c) using the following equations.

For a linear motion system with balls

$$L = \left(\frac{f_h \cdot f_t \cdot f_c}{f_W} \cdot \frac{C}{P_C} \right)^3 \cdot 50$$

For a linear motion system with rollers

$$L = \left(\frac{f_h \cdot f_t \cdot f_c}{f_W} \cdot \frac{C}{P_C} \right)^{\frac{10}{3}} \cdot 100$$

Service-Life Equation

The service life of the Linear Guide can be obtained using the following equation :

$$L = \left(\frac{f_h \cdot f_t \cdot f_c}{f_W} \cdot \frac{C}{P_C} \right)^3 \cdot 50\ \text{km}$$

(total distance that can be traveled by at least 90% of a group of Linear Guide operated under the same conditions)

C : basic dynamic-load rating	(kg)
P_c : calculated load	(kg)
f_h : hardness factor	(Fig 1.3.2)
f_t : temperature factor	(Fig 1.3.3)
f_c : contact factor	(Table 1.3.2)
f_w : load factor(N)	(Table 1.3.3)

(Once nominal life (L) is obtained using this equation. The Linear Guide service life can be calculated by using the following equation if the stroke length and the number of reciprocating cycles are constant)

$$L_h = \frac{L \cdot 10^6}{2 \cdot \ell_s \cdot N_1 \cdot 60}$$

L_h : service life in hours (h)
ℓ_s : stroke length (mm)
N_1 : No. of reciprocating cycles per min (min^{-1})

【f_h : Hardness factor】

To ensure achievement of the optimum load-bearing capacity of the Linear Guide, the raceway hardness must be 58~64 HRC. At a hardness below this range, the basic dynamic and static-load ratings decrease. The ratings must therefore be multiplied by the respective hardness factors (f_h). As the Linear Guide has sufficient hardness, fh for the Linear Guide is 1.0 unless otherwise specified.

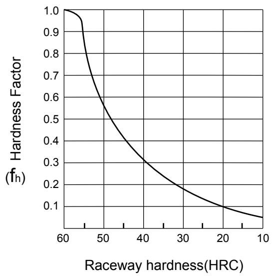


Fig 1.3.2 Hardness Factor (f_h)

【f_t : Temperature factor】

For Linear Guide used at ambient temperatures over 100°C, a temperature factor corresponding to the ambient temperature, selected from the diagram below, must be taken into consideration. In addition, please note that selected Linear Guide itself must be a model with high-temperature specifications.

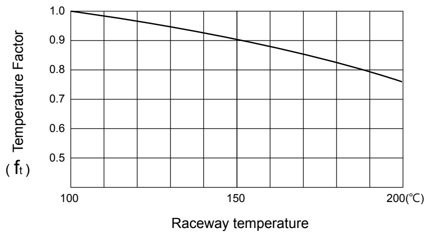


Fig 1.3.3 Temperature Factor (f_t)

※When used at ambient temperatures higher than 80°C, the seals, end caps, and ball cages used must be changed to those with high-temperature specifications.

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Linear Guide

1-3 Basic Load Rating and Service Life of Linear Guide

【f_c : Contact factor】

When multiple Linear Guide blocks are laid by each other, moments and mounting-surface precision will affect operation, making it difficult to achieve uniform load distribution. For Linear Guide blocks used laid over one another, multiply the basic load rating (C), (C_0) by a contact factor selected from the table below.

Table 1.3.2 Contact factor (f_c)

No. of Blocks Used	Contact Factor (f_c)
In normal use	1
2	0.81
3	0.72
4	0.66
5	0.61
6 or more	0.6

※When the non-uniform load distribution can be predicted, as in a large system, consider using a contact factor.

【f_w : Load factor】

In general, machines in reciprocal motion are likely to cause vibration and impact during operation, and it is particularly difficult to determine the magnitude of vibration that develops during high-speed operation as well as that of impact during repeated starting and stopping in normal use. Therefore, where the effects of speed and vibration are estimated to be significant divide the basic dynamic-load rating (C) by a load factor selected from the table below.

Table 1.3.3 Load Factor (f_w)

Vibration and Impact	Velocity (V)	f_w
Very Slight	Very Low $V \le 0.25$ m/s	1~1.2
Slight	Low $0.25 < V \le 1$ m/s	1.2~1.5
Moderate	Medium $1 < V \le 2$ m/s	1.5~2
Strong	High $V > 2$ m/s	2~3.5

Calculation Examples :

Application : Machine Center
Block model number : TRH30FE
(Basic static load C_0 = 9004 kg, Basic dynamic load C = 4791 kg)
The calculated load P_c = 266.5 kg
The formula of calculating the life time by travel is

$$L = \left(\frac{f_h \cdot f_t \cdot f_c}{f_w} \cdot \frac{C}{P_c} \right)^3 \cdot 50 \text{ km}$$

Since using only one block in this application, we take f_c = 1
Supposed the speed is not very high between 0.25~1 m/s, so we take f_w = 1.5
The temperature of working environment is under 100°C. The temperature factor f_t = 1
The hardness of raceway is HRC 58~62, so the hardness f_h = 1

With all above data, the life time by travel of this application L = 86,112 km

To calculate the life time by using hours :
We supposed the distance of travel Ls = 3000 mm
Times (Back and forth) per mins N1 = 4 (min^{-1})
The life time by travel is 86,112 km, the distance of travel is 3 m (3000 mm), so each back and forth is 6 m.
The total times of back and forth would be 86,112 x 1000/6 = 14,352,000
The life time by using minutes is 14,352,000/4 = 3,588,000 mins = 59,800 hours

■ 1-3-7 Service-Life Equation L_h

The Service Life can be calculated by operating term and velocity Nominal Life.

$$L_h = \left(\frac{L \cdot 10^3}{V_e \cdot 60}\right) = \frac{\left(\frac{C}{P}\right)^3 \cdot 50 \cdot 10^3}{V_e \cdot 60} \cdot hr$$

L_h : Service Life in Hour L : Nominal life (km)

V_e : Velocity (m/min) C/P : Load Ratio

Calculating Life Time

Formula (A) calculating hour

L_h **:** Lifetime (h)
L **:** Nominal life (km)
L_S **:** Distance of travel (mm)
N_1 **:** Times of travel per minute (min^{-1})

$$L_h = \frac{L \cdot 10^6}{2 \cdot L_s \cdot N_1 \cdot 60}$$

Formula (B) calculating year

L_y **:** Lifetime (year)
L **:** Nominal life (km)
L_S **:** Distance of travel (mm)
N_1 **:** Times of travel per minute (min^{-1})
M_n **:** Minutes of running per day (min/hr)
H_n **:** Hours of running per day (hr/day)
D_n **:** Days of running per year (day/year)

$$L_y = \frac{L \cdot 10^6}{2 \cdot L_s \cdot N_1 \cdot M_n \cdot H_n \cdot D_n}$$

Notes : The service life is verified by different environments and other usage conditions. Please confirm this information with the costumer. For environment factors, please refer to page A08~A10.

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1-3 Basic Load Rating and Service Life of Linear Guide

Example 1 :

There is a working station using linear guides with a nominal life of 45000 km, how should we calculate its service life in hours.

Known :
L_S : Distance of travel = 3000 mm (mm)
N_1 : 4 times of travel per minute (min^{-1})

$$L_h = \frac{L \cdot 10^6}{2 \cdot L_s \cdot N_1 \cdot 60} = \frac{45000 \cdot 10^6}{2 \cdot 3000 \cdot 4 \cdot 60} = 31250 \text{ hr}$$

Example 2 :

There is a working station using linear guides with a nominal life 71231.5 km, how should we calculate its service life in year.

Known :
L_S : Distance of travel = 4000 mm (mm)
N_1 : 5 times of travel per minute (min^{-1})
M_S : Running 60 mins per hour (min/hr)
H_S : Running 24 hours per day (hr/day)
D_S : Running 360 days per year (day/year)

$$L_y = \frac{L \cdot 10^6}{2 \cdot L_s \cdot N_1 \cdot M_s \cdot H_s \cdot D_s} = \frac{71231.5 \cdot 10^6}{2 \cdot 4000 \cdot 5 \cdot 60 \cdot 24 \cdot 360} = 3.435 \text{ year}$$

1-4 Friction

The construction of Linear Guide are block, rail and motion system which has rolling elements, such as balls and rollers, placed between two raceways. The rolling motion that rolling elements give rise to reduce the frictional resistance to 1/20 th to 1/40 th of that in a slide guide. Static friction, in particular, is much lower in a linear motion system than in other system, and there is little difference between static and dynamic friction, so that stick-slip does not occur. Therefore, Linear Guide could apply in various precision motion system. Frictional resistance in a linear motion system varies with the type of linear motion system, the magnitude of the preload, the viscosity resistance of the lubricant used the load exerted on the system, and other factors. Table shows Friction of Linear Guide.

Table 1.4.1 Friction Coefficient u of Various Linear Motion Systems μ

Type of Linear Motion System	Friction Coefficient
Linear Guide	0.002~0.003
Ball Spline	0.002~0.003
Linear Guide Roller	0.0050~0.010
Cross Roller Guide	0.0010~0.0025
Linear Ball Slide	0.0006~0.0012

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Linear Guide

1-5 Working Load

■ 1-5-1 Working Load

The load applied to the Linear Guide, varies with the external force exerted thereon, such as the location of the center of gravity of an object been moved, the location of the thrust developed, inertia due to acceleration and deceleration during starting and stopping, and the machining resistance. To select the correct type of Linear Guide, the magnitude of applied loads must be determined in consideration of the above conditions to calculate accurate applied load.

To obtain the magnitude of an applied load and the service life in hours, the operating conditions of the Linear Guide system must first be set.

(1) Mass : m (kg)
(2) Direction of the action load
(3) Location of the action point
(e.g., center of gravity) : L_2, L_3, h_1 (mm)
(4) Location of the thrust developed : L_4, h_2 (mm)
(5) Linear Guide system arrangement : L_0, L_1 (mm)
(6) Velocity diagram
Velocity : V (mm/s)
Time : t_n (s)
Acceleration : a_n (mm/s^2)

$$a_n = \left(\frac{\Delta V}{t_n}\right)$$

Gravitational acceleration g = 9.8 m/s^2

(7) Duty cycle (No : of reciprocating cycles per min) : N_1 (min^{-1})
(8) Stroke length : L (mm)
(9) Mean velocity : V_m (mm/s)
(10) Required service life in hours : L_h (h)

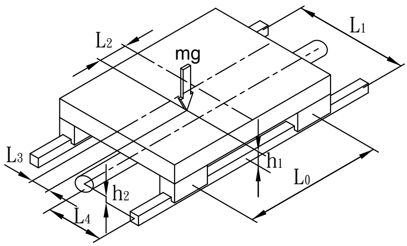


Fig 1.5.1

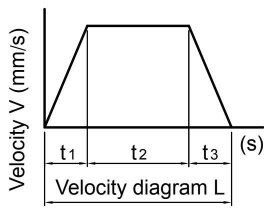


Fig 1.5.2

Calculating the Working Load

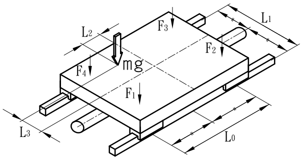
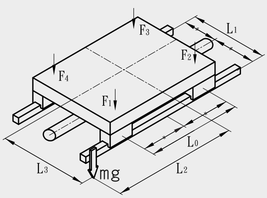
The load applied to the Linear Guide varies with the external force exerted thereon, such as the location of the center of gravity of an object being moved, the location of the thrust developed, inertia due to acceleration and deceleration during starting and stopping, and the machining resistance.To select the correct type of Linear Guide, the magnitude of applied loads must be determined in consideration of the above conditions. Using the following Table 1.5.1, we will now calculate the loads applied to the Linear Guide.

m : Mass (kg)
L_n : Distance (mm)
F_n : External force (kg)
P_n : Applied load (kg)
(radial and reverse-radial directions)
P_{nT} : Applied load (kg)

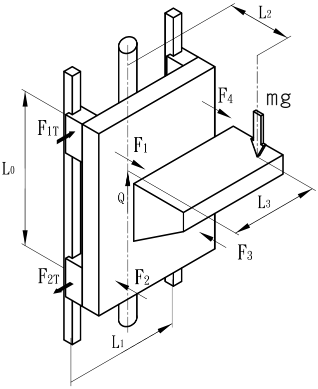
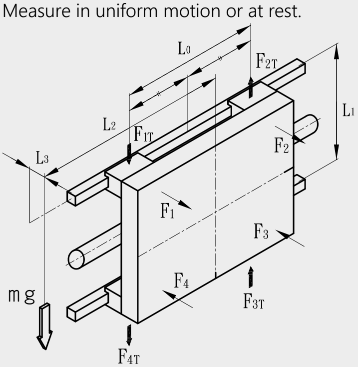
g : Gravitational acceleration (m/s²)
(g=9.8 m/s²)
V : Velocity (m/s)
t_n : Time (s)
a_n : Acceleration (m/s²)

$$a_n = \left(\frac{\Delta V}{t_n} \right)$$

Table 1.5.1 Calculation Load

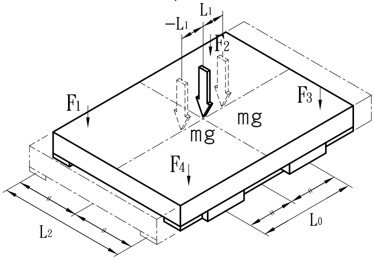
No.	Opearating Conditions	Equation for Calculating Applied Load
1	Install in a horizontal position. (Move the block) Measure in uniform motion or at rest.  	$F_1 = \frac{mg}{4} + \frac{mg \cdot L_2}{2 \cdot L_0} - \frac{mg \cdot L_3}{2 \cdot L_1}$ $F_2 = \frac{mg}{4} - \frac{mg \cdot L_2}{2 \cdot L_0} - \frac{mg \cdot L_3}{2 \cdot L_1}$ $F_3 = \frac{mg}{4} - \frac{mg \cdot L_2}{2 \cdot L_0} + \frac{mg \cdot L_3}{2 \cdot L_1}$ $F_4 = \frac{mg}{4} + \frac{mg \cdot L_2}{2 \cdot L_0} + \frac{mg \cdot L_3}{2 \cdot L_1}$
2	Install in an overhung horizontal positon. (Move the block) Measure in uniform motion or at rest.  	$F_1 = \frac{mg}{4} + \frac{mg \cdot L_2}{2 \cdot L_0} + \frac{mg \cdot L_3}{2 \cdot L_1}$ $F_2 = \frac{mg}{4} - \frac{mg \cdot L_2}{2 \cdot L_0} + \frac{mg \cdot L_3}{2 \cdot L_1}$ $F_3 = \frac{mg}{4} - \frac{mg \cdot L_2}{2 \cdot L_0} - \frac{mg \cdot L_3}{2 \cdot L_1}$ $F_4 = \frac{mg}{4} + \frac{mg \cdot L_2}{2 \cdot L_0} - \frac{mg \cdot L_3}{2 \cdot L_1}$

1-5 Working Load

No.	Opearating Conditions	Equation for Calculating Applied Load
3	Install in a vertical position. Measure in uniform motion or at rest.  (EX) On the vertical axis of industrial robots in automatic painting machines and lifters	$F_1=F_2=F_3=F_4=\dfrac{mg\cdot L_2}{2\cdot L_0}$ $F_{1T}=F_{2T}=F_{3T}=F_{4T}=\dfrac{mg\cdot L_3}{2\cdot L_0}$
4	On a wall. Measure in uniform motion or at rest.  (EX) On cross rails loader travel axis	$F_1=F_2=F_3=F_4=\dfrac{mg\cdot L_3}{2\cdot L_1}$ $F_{1T}=F_{4T}=\dfrac{mg}{4}-\dfrac{mg\cdot L_2}{2\cdot L_0}$ $F_{2T}=F_{3T}=\dfrac{mg}{4}+\dfrac{mg\cdot L_2}{2\cdot L_0}$

<table>
<tr><th>No.</th><th>Opearating Conditions</th><th>Equation for Calculating Applied Load</th></tr>
<tr><td>5</td><td>

Move on Linear Guide rail
Install in a horizontal position.



(EX) X - Y table/Sliding fork

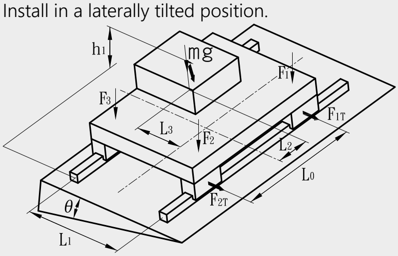
</td><td>

$$F_{1max}=F_{2max}=F_{3max}=F_{4max}=\frac{mg}{4}+\frac{mg\cdot L_1}{2\cdot L_0}$$

$$F_{1min}=F_{2min}=F_{3min}=F_{4min}=\frac{mg}{4}-\frac{mg\cdot L_1}{2\cdot L_0}$$

</td></tr>
<tr><td>6</td><td>

Install in a laterally tilted position.



(EX) NC lathe/Carriage (for the lathe)

</td><td>

$$F_1=+\frac{mg\cdot\cos\theta}{4}+\frac{mg\cdot\cos\theta\cdot L_2}{2\cdot L_0}-\frac{mg\cdot\cos\theta\cdot L_3}{2\cdot L_1}+\frac{mg\cdot\sin\theta\cdot h_1}{2\cdot L_1}$$

$$F_{1T}=\frac{mg\cdot\sin\theta}{4}+\frac{mg\cdot\sin\theta\cdot L_2}{2\cdot L_0}$$

$$F_2=+\frac{mg\cdot\cos\theta}{4}-\frac{mg\cdot\cos\theta\cdot L_2}{2\cdot L_0}-\frac{mg\cdot\cos\theta\cdot L_3}{2\cdot L_1}+\frac{mg\cdot\sin\theta\cdot h_1}{2\cdot L_1}$$

$$F_{2T}=\frac{mg\cdot\sin\theta}{4}-\frac{mg\cdot\sin\theta\cdot L_2}{2\cdot L_0}$$

$$F_3=+\frac{mg\cdot\cos\theta}{4}-\frac{mg\cdot\cos\theta\cdot L_2}{2\cdot L_0}+\frac{mg\cdot\cos\theta\cdot L_3}{2\cdot L_1}-\frac{mg\cdot\sin\theta\cdot h_1}{2\cdot L_1}$$

$$F_{3T}=\frac{mg\cdot\sin\theta}{4}-\frac{mg\cdot\sin\theta\cdot L_2}{2\cdot L_0}$$

$$F_4=+\frac{mg\cdot\cos\theta}{4}+\frac{mg\cdot\cos\theta\cdot L_2}{2\cdot L_0}+\frac{mg\cdot\cos\theta\cdot L_3}{2\cdot L_1}-\frac{mg\cdot\sin\theta\cdot h_1}{2\cdot L_1}$$

$$F_{4T}=\frac{mg\cdot\sin\theta}{4}+\frac{mg\cdot\sin\theta\cdot L_2}{2\cdot L_0}$$

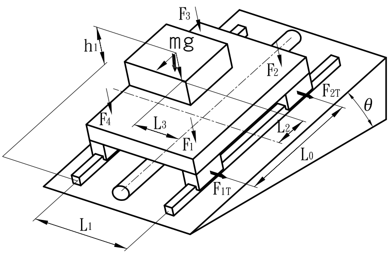
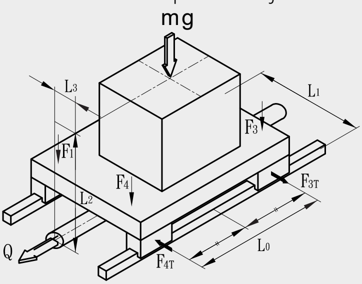
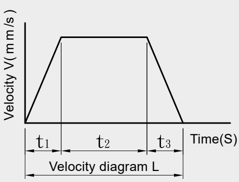
</td></tr>
</table>

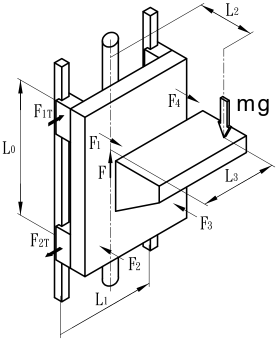
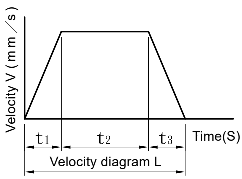
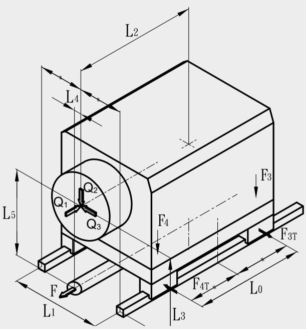
A

Linear Guide

A Linear Guide

1-5 Working Load

No.	Opearating Conditions	Equation for Calculating Applied Load
7	Install in a longitudinally tilted position.  (EX) NC lathe/Tool res (for the lathe)	$F_1=+\frac{mg\cdot\cos\theta}{4}+\frac{mg\cdot\cos\theta\cdot L_2}{2\cdot L_0}-\frac{mg\cdot\cos\theta\cdot L_3}{2\cdot L_1}+\frac{mg\cdot\sin\theta\cdot h_1}{2\cdot L_0}$ $F_{1T}=+\frac{mg\cdot\sin\theta\cdot L_3}{2\cdot L_0}$ $F_2=+\frac{mg\cdot\cos\theta}{4}-\frac{mg\cdot\cos\theta\cdot L_2}{2\cdot L_0}-\frac{mg\cdot\cos\theta\cdot L_3}{2\cdot L_1}-\frac{mg\cdot\sin\theta\cdot h_1}{2\cdot L_0}$ $F_{2T}=-\frac{mg\cdot\sin\theta\cdot L_3}{2\cdot L_0}$ $F_3=+\frac{mg\cdot\cos\theta}{4}-\frac{mg\cdot\cos\theta\cdot L_2}{2\cdot L_0}+\frac{mg\cdot\cos\theta\cdot L_3}{2\cdot L_1}-\frac{mg\cdot\sin\theta\cdot h_1}{2\cdot L_0}$ $F_{3T}=-\frac{mg\cdot\sin\theta\cdot L_3}{2\cdot L_0}$ $F_4=+\frac{mg\cdot\cos\theta}{4}+\frac{mg\cdot\cos\theta\cdot L_2}{2\cdot L_0}+\frac{mg\cdot\cos\theta\cdot L_3}{2\cdot L_1}+\frac{mg\cdot\sin\theta\cdot h_1}{2\cdot L_0}$ $F_{4T}=+\frac{mg\cdot\sin\theta\cdot L_3}{2\cdot L_0}$
8	Install in a horizontal position subjected to inertia.   $a_n=\frac{\Delta V}{t_n}$ (EX) Wagon Truck	$F_1=F_4=\frac{mg}{4}-\frac{mg\cdot a_1\cdot L_2}{2\cdot L_0\cdot g}$ $F_2=F_3=\frac{mg}{4}+\frac{mg\cdot a_1\cdot L_2}{2\cdot L_0\cdot g}$ $F_{1T}=F_{4T}=\frac{mg\cdot a_1\cdot L_3}{2\cdot L_0\cdot g}$ $F_{2T}=F_{3T}=\frac{-mg\cdot a_1\cdot L_3}{2\cdot L_0\cdot g}$ $F_1=F_2=F_3=F_4=\frac{mg}{4}$ $F_1=F_4=\frac{mg}{4}-\frac{mg\cdot a_3\cdot L_2}{2\cdot L_0\cdot g}$ $F_2=F_3=\frac{mg}{4}+\frac{mg\cdot a_3\cdot L_2}{2\cdot L_0\cdot g}$ $F_{1T}=F_{4T}=\frac{mg\cdot a_3\cdot L_3}{2\cdot L_0\cdot g}$ $F_{2T}=F_{3T}=\frac{-mg\cdot a_3\cdot L_3}{2\cdot L_0\cdot g}$

No.	Opearating Conditions	Equation for Calculating Applied Load
9	Mount in a vertical position subjected to inertia.   $a_n=\frac{\Delta V}{t_n}$ (EX) Elevator.	$F_1=F_2=F_3=F_4=\frac{(mg+mg\cdot a_1/g)\cdot L_2}{2\cdot L_0}$ $F_{1T}=F_{2T}=F_{3T}=F_{4T}=\frac{(mg+mg\cdot a_1/g)\cdot L_3}{2\cdot L_0}$ $F_1=F_2=F_3=F_4=\frac{mg\cdot L_2}{2\cdot L_0}$ $F_{1T}=F_{2T}=F_{3T}=F_{4T}=\frac{mg\cdot L_3}{2\cdot L_0}$ $F_1=F_2=F_3=F_4=\frac{(mg-mg\cdot a_3/g)\cdot L_2}{2\cdot L_0}$ $F_{1T}=F_{2T}=F_{3T}=F_{4T}=\frac{(mg-mg\cdot a_3/g)\cdot L_3}{2\cdot L_0}$
10	Install on a horizontal position subjected to external force.  	$F_1=F_4=\frac{Q_1\cdot L_5}{2\cdot L_0}$ $F_2=F_3=\frac{-Q_1\cdot L_5}{2\cdot L_0}$ $F_{1T}=F_{2T}=F_{3T}=F_{4T}=\frac{Q_1\cdot L_4}{2\cdot L_0}$ $F_1=F_4=\frac{Q_2}{4}+\frac{Q_2\cdot L_2}{2\cdot L_0}$ $F_2=F_3=\frac{Q_2}{4}-\frac{Q_2\cdot L_2}{2\cdot L_0}$ $F_1=F_2=F_3=F_4=\frac{Q_3\cdot L_3}{2\cdot L_1}$ $F_{1T}=F_{4T}=\frac{Q_3}{4}+\frac{Q_3\cdot L_2}{2\cdot L_0}$ $F_{2T}=F_{3T}=\frac{Q_3}{4}-\frac{Q_3\cdot L_2}{2\cdot L_0}$

1-6 Safety Factor and Load

■ 1-6-1 Equivalent Factors of Linear Guide Block

Where a sufficient installation space is not available you may be obliged to use just one Linear Guide block or two Linear Guide blocks laid over one another for the Linear Guide. In such a setting, the load distribution cannot be uniform, as a result, an excessive load is exerted in localized areas (e.g., rail ends). Continued use under such conditions may result in flaking in those areas, consequently shortening the service life. In such a case, calculating true load by multiplying the moment value by any one of the moment-equivalent factors specified in Tables.

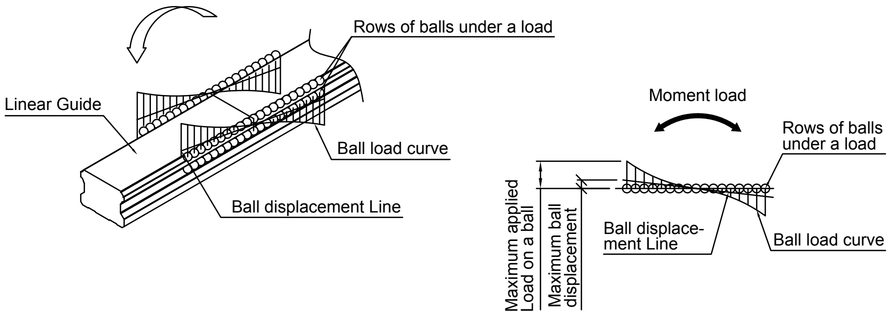


Fig 1.6.1 Ball Load Effected by a Moment

An equivalent-load equation applicable when a moment acts on a Linear Guides is shown below.

$P=K \cdot M$

P : Equivalent load per Linear Guide (kg)

K : Equivalent moment factor

M : Developed moment (kg-mm)

K_x, K_y, K_z represent the equivalent moment factors in directions M_x, M_y, M_z respectively.

Calculation Examples

Two Linear Guide blocks are used laid over one another.
Model No : TRH30FE
Gravitational Acceleration g = 9.8 m/s^2
Mass w = 5 kg
M_x = 5 • 150 = 750 (kg-mm)
M_y = 5 • 200 = 1000 (kg-mm)

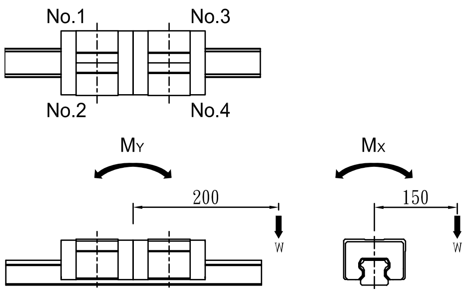


Fig 1.6.2

$$P_1 = K_x \cdot \frac{M_x}{2} + K_y \cdot M_y + \frac{W}{2} = 7.15 \cdot 10^{-2} \cdot \frac{750}{2} + 1.3 \cdot 10^{-2} \cdot 1000 + \frac{5}{2} = 42.3 \text{ (kgf)}$$

$$P_2 = -K_x \cdot \frac{M_x}{2} + K_y \cdot M_y + \frac{W}{2} = -7.15 \cdot 10^{-2} \cdot \frac{750}{2} + 1.3 \cdot 10^{-2} \cdot 1000 + \frac{5}{2} = -11.3 \text{ (kgf)}$$

$$P_3 = K_x \cdot \frac{M_x}{2} - K_y \cdot M_y + \frac{W}{2} = 7.15 \cdot 10^{-2} \cdot \frac{750}{2} - 1.3 \cdot 10^{-2} \cdot 1000 + \frac{5}{2} = 16.3 \text{ (kgf)}$$

$$P_4 = -K_x \cdot \frac{M_x}{2} - K_y \cdot M_y + \frac{W}{2} = -7.15 \cdot 10^{-2} \cdot \frac{750}{2} - 1.3 \cdot 10^{-2} \cdot 1000 + \frac{5}{2} = -37.3 \text{ (kgf)}$$

※Note.1
Since a Linear Guide in a vertical position receives only a moment load, there is no need to apply other loads (w).

※Note.2
In some models, load ratings differ depending on the direction of the applied load. With such a model, calculate an equivalent load in a direction in which conditions are comparably bad.

1-6 Safety Factor and Load

Table 1.6.1 TR / SRH-V

ModelNo.	Equivalent Factors K_y(mm^{-1})		Equivalent Factors K_z(mm^{-1})		Equivalent Factors K_x(mm^{-1})
	Equivalent Load Calculation for a system Using One Linear Guide Block	Equivalent Load Calculation for a system Using Two Linear Guide Blocks laid Over One-Another	Equivalent Load Calculation for a system Using One Linear Guide Block	Equivalent Load Calculation for a system Using Two Linear Guide Blocks laid Over One-Another	
TR / SRH15VN	1.48×10^{-1}	3.11×10^{-2}	1.48×10^{-1}	3.11×10^{-2}	1.34×10^{-1}
TR / SRH20VN	1.11×10^{-1}	2.35×10^{-2}	1.11×10^{-1}	2.35×10^{-2}	9.90×10^{-2}
TR / SRH20VE	8.00×10^{-2}	1.78×10^{-2}	8.00×10^{-2}	1.78×10^{-2}	9.90×10^{-2}
TR / SRH25VN	1.04×10^{-1}	2.17×10	1.04×10^{-1}	2.17×10	8.62×10^{-2}
TR / SRH25VE	7.35×10^{-2}	1.60×10^{-2}	7.35×10^{-2}	1.60×10^{-2}	8.62×10^{-2}
TR / SRH30VN	6.52×10^{-2}	1.34×10^{-2}	6.52×10^{-2}	1.34×10^{-2}	7.69×10^{-2}
TR / SRH30VE	6.12×10^{-2}	1.33×10^{-2}	6.12×10^{-2}	1.33×10^{-2}	7.15×10^{-2}
TR / SRH35VN	6.95×10^{-2}	1.43×10^{-2}	6.95×10^{-2}	1.43×10^{-2}	6.29×10^{-2}
TR / SRH35VE	5.25×10^{-2}	1.15×10^{-2}	5.25×10^{-2}	1.15×10^{-2}	5.85×10^{-2}
TR / SRH45VL	5.80×10^{-2}	1.24×10^{-2}	5.80×10^{-2}	1.24×10^{-2}	4.38×10^{-2}
TR / SRH45VE	4.59×10^{-2}	1.00×10^{-2}	4.59×10^{-2}	1.00×10^{-2}	4.38×10^{-2}
TRH55VL	5.25×10^{-2}	1.07×10^{-2}	5.25×10^{-2}	1.07×10^{-2}	3.78×10^{-2}
TRH55VE	4.08×10^{-2}	8.69×10^{-3}	4.08×10^{-2}	8.69×10^{-3}	3.78×10^{-2}
TRH65VL	4.52×10^{-2}	8.76×10^{-3}	4.52×10^{-2}	8.76×10^{-3}	3.24×10^{-2}
TRH65VE	3.27×10^{-2}	6.77×10^{-3}	3.27×10^{-2}	6.77×10^{-3}	3.24×10^{-2}

K_x : Equivalent moment factor in the rolling direction.
K_y : Equivalent moment factor in the pitching direction.
K_z : Equivalent moment factor in the deflection direction.

Table 1.6.2 TR / SRH-F

Model No.	Equivalent Factors $K_y(mm^{-1})$		Equivalent Factors $K_z(mm^{-1})$		Equivalent Factors $K_x(mm^{-1})$
	Equivalent Load Calculation for a system Using One Linear Guide Block	Equivalent Load Calculation for a system Using Two Linear Guide Blocks laid Over One-Another	Equivalent Load Calculation for a system Using One Linear Guide Block	Equivalent Load Calculation for a system Using Two Linear Guide Blocks laid Over One-Another	
TR / SRH15FN	1.48×10^{-1}	3.11×10^{-2}	1.48×10^{-1}	3.11×10^{-2}	1.34×10^{-1}
TR / SRH20FN	1.11×10^{-1}	2.35×10^{-2}	1.11×10^{-1}	2.35×10^{-2}	9.90×10^{-2}
TR / SRH20FE	8.00×10^{-2}	1.78×10^{-2}	8.00×10^{-2}	1.78×10^{-2}	9.90×10^{-2}
TR / SRH25FN	1.04×10^{-1}	2.17×10	1.04×10^{-1}	2.17×10	8.62×10
TR / SRH25FE	7.35×10^{-2}	1.60×10^{-2}	7.35×10^{-2}	1.60×10^{-2}	8.62×10^{-2}
TR / SRH30FN	6.52×10^{-2}	1.34×10^{-2}	6.52×10^{-2}	1.34×10^{-2}	7.69×10^{-2}
TR / SRH30FE	6.12×10^{-2}	1.33×10^{-2}	6.12×10^{-2}	1.33×10^{-2}	7.15×10^{-2}
TR / SRH35FN	6.95×10^{-2}	1.43×10^{-2}	6.95×10^{-2}	1.43×10^{-2}	6.29×10^{-2}
TR / SRH35FE	5.25×10^{-2}	1.15×10^{-2}	5.25×10^{-2}	1.15×10^{-2}	5.85×10^{-2}
TR / SRH45FL	5.80×10^{-2}	1.24×10^{-2}	5.80×10^{-2}	1.24×10^{-2}	4.38×10^{-2}
TR / SRH45FE	4.59×10^{-2}	1.00×10^{-2}	4.59×10^{-2}	1.00×10^{-2}	4.38×10^{-2}
TRH55FL	5.25×10^{-2}	1.07×10^{-2}	5.25×10^{-2}	1.07×10^{-2}	3.78×10^{-2}
TRH55FE	4.08×10^{-2}	8.69×10^{-3}	4.08×10^{-2}	8.69×10^{-3}	3.78×10^{-2}
TRH65FL	4.52×10^{-2}	8.76×10^{-3}	4.52×10^{-2}	8.76×10^{-3}	3.24×10^{-2}
TRH65FE	3.27×10^{-2}	6.77×10^{-3}	3.27×10^{-2}	6.77×10^{-3}	3.24×10^{-2}

K_x : Equivalent moment factor in the rolling direction.
K_y : Equivalent moment factor in the pitching direction.
K_z : Equivalent moment factor in the deflection direction.

1-6 Safety Factor and Load

Table 1.6.3 TR / SRS-V

Model No.	Equivalent Factors K_y(mm^{-1})		Equivalent Factors K_z(mm^{-1})		Equivalent Factors K_x(mm^{-1})
	Equivalent Load Calculation for a system Using One Linear Guide Block	Equivalent Load Calculation for a system Using Two Linear Guide Blocks laid Over One-Another	Equivalent Load Calculation for a system Using One Linear Guide Block	Equivalent Load Calculation for a system Using Two Linear Guide Blocks laid Over One-Another	
TR / SRS15VS	2.29×10^{-1}	4.39×10^{-2}	2.29×10^{-1}	4.39×10^{-2}	1.34×10^{-1}
TR / SRS15VN	1.48×10^{-1}	3.11×10^{-2}	1.48×10^{-1}	3.11×10^{-2}	1.34×10^{-1}
TR / SRS20VS	2.00×10^{-1}	3.58×10^{-2}	2.00×10^{-1}	3.58×10^{-2}	9.90×10^{-2}
TR / SRS20VN	1.25×10^{-1}	2.60×10^{-2}	1.25×10^{-1}	2.60×10^{-2}	9.90×10^{-2}
TR / SRS25VS	1.60×10^{-1}	3.07×10^{-2}	1.60×10^{-1}	3.07×10^{-2}	8.62×10^{-2}
TR / SRS25VN	1.04×10^{-1}	2.17×10^{-2}	1.04×10^{-1}	2.17×10^{-2}	8.62×10^{-2}
TR / SRS30VS	1.47×10^{-1}	2.57×10^{-2}	1.47×10^{-1}	2.57×10^{-2}	7.15×10^{-2}
TR / SRS30VN	8.65×10^{-2}	1.82×10^{-2}	8.65×10^{-2}	1.82×10^{-2}	7.15×10^{-2}
TR / SRS35VN	7.87×10^{-2}	1.61×10^{-2}	7.87×10^{-2}	1.61×10^{-2}	5.85×10^{-2}
TR / SRS35VE	5.25×10^{-2}	1.15×10^{-2}	5.25×10^{-2}	1.15×10^{-2}	5.85×10^{-2}
TR / SRS45VN	6.89×10^{-2}	1.39×10^{-2}	6.89×10^{-2}	1.39×10^{-2}	4.38×10^{-2}

K_x : Equivalent moment factor in the rolling direction.
K_y : Equivalent moment factor in the pitching direction.
K_z : Equivalent moment factor in the deflection direction.

Table 1.6.4 TR / SRS-F

Model No.	Equivalent Factors K_y(mm^{-1})		Equivalent Factors K_z(mm^{-1})		Equivalent Factors K_x(mm^{-1})
	Equivalent Load Calculation for a system Using One Linear Guide Block	Equivalent Load Calculation for a system Using Two Linear Guide Blocks laid Over One-Another	Equivalent Load Calculation for a system Using One Linear Guide Block	Equivalent Load Calculation for a system Using Two Linear Guide Blocks laid Over One-Another	
TR / SRS15FS	2.29×10^{-1}	4.39×10^{-2}	2.29×10^{-1}	4.39×10^{-2}	1.34×10^{-1}
TR / SRS15FN	1.48×10^{-1}	3.11×10^{-2}	1.48×10^{-1}	3.11×10^{-2}	1.34×10^{-1}
TR / SRS20FS	2.00×10^{-1}	3.58×10^{-2}	2.00×10^{-1}	3.58×10^{-2}	9.90×10^{-2}
TR / SRS20FN	1.25×10^{-1}	2.60×10^{-2}	1.25×10^{-1}	2.60×10^{-2}	9.90×10^{-2}
TR / SRS25FN	1.04×10^{-1}	2.17×10^{-2}	1.04×10^{-1}	2.17×10^{-2}	8.62×10^{-2}

K_x : Equivalent moment factor in the rolling direction.
K_y : Equivalent moment factor in the pitching direction.
K_z : Equivalent moment factor in the deflection direction.

Table 1.6.5 TR / SRC-V

Model No.	Equivalent Factors K_y(mm^{-1})		Equivalent Factors K_z(mm^{-1})		Equivalent Factors K_x(mm^{-1})
	Equivalent Load Calculation for a system Using One Linear Guide Block	Equivalent Load Calculation for a system Using Two Linear Guide Blocks laid Over One-Another	Equivalent Load Calculation for a system Using One Linear Guide Block	Equivalent Load Calculation for a system Using Two Linear Guide Blocks laid Over One-Another	
TR / SRC25VE	7.35×10^{-2}	1.60×10^{-2}	7.35×10^{-2}	1.60×10^{-2}	8.62×10^{-2}

K_x : Equivalent moment factor in the rolling direction.
K_y : Equivalent moment factor in the pitching direction.
K_z : Equivalent moment factor in the deflection direction.

1-6 Safety Factor and Load

Table 1.6.6 TH-N

Model No.	Equivalent Factors K_y(mm^{-1})		Equivalent Factors K_z(mm^{-1})		Equivalent Factors K_x(mm^{-1})
	Equivalent Load Calculation for a system Using One Linear Guide Block	Equivalent Load Calculation for a system Using Two Linear Guide Blocks laid Over One-Another	Equivalent Load Calculation for a system Using One Linear Guide Block	Equivalent Load Calculation for a system Using Two Linear Guide Blocks laid Over One-Another	
TH07NN	8.88×10^{-1}	6.31×10^{-2}	8.88×10^{-1}	6.31×10^{-2}	2.74×10^{-1}
TH07NL	4.41×10^{-1}	5.16×10^{-2}	4.41×10^{-1}	5.16×10^{-2}	2.74×10^{-1}
TH09NN	4.41×10^{-1}	5.26×10^{-2}	4.41×10^{-1}	5.26×10^{-2}	2.19×10^{-1}
TH09NL	2.76×10^{-1}	4.08×10^{-2}	2.76×10^{-1}	4.08×10^{-2}	2.19×10^{-1}
TH12NN	4.90×10^{-1}	4.32×10^{-2}	4.90×10^{-1}	4.32×10^{-2}	1.64×10^{-1}
TH12NL	2.67×10^{-1}	3.42×10^{-2}	2.67×10^{-1}	3.42×10^{-2}	1.64×10^{-1}
TH15NN	3.60×10^{-1}	3.61×10^{-2}	3.60×10^{-1}	3.61×10^{-2}	1.32×10^{-1}
TH15NL	1.94×10^{-1}	2.76×10^{-2}	1.94×10^{-1}	2.76×10^{-2}	1.32×10^{-1}

K_x : Equivalent moment factor in the rolling direction.
K_y : Equivalent moment factor in the pitching direction.
K_z : Equivalent moment factor in the deflection direction.

■ 1-6-2 Calculating the Equivalent Load

The Linear Guide can bear loads and moments from all directions, including a radial load (P_R), reverse-radial load (P_L), and lateral load (P_T), simultaneously.

P_R : Radial load
P_L : Reverse-radial load
P_T : Lateral load

M_X : Moment in the rolling direction
M_y : Moment in the pitching direction
M_Z : Moment in the deflection direction

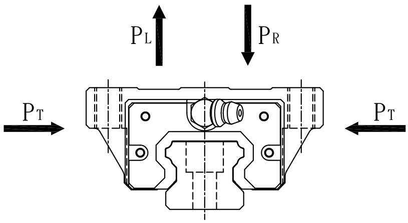


Fig 1.6.3 Directions of the Load and Moment Exerted on the Linear Guide

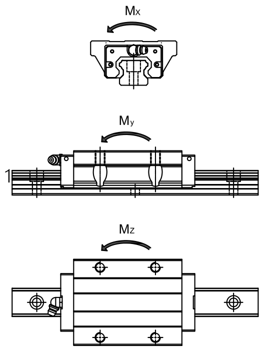


Fig 1.6.4

Equivalent load P_E

When more than one load (e.g., radial and lateral loads) is exerted on the Linear Guide simultaneously, the service life and static safety factors should be calculated by using equivalent load values obtained by converting all loads involved into radial, lateral, and other loads involved.

Equivalent-load equation

The Linear Guide can bear loads and moments from all directions, including a radial load (P_R), reverse-radial load (P_L) and lateral load (P_T) simultaneously.

When a radial load ($P_{R(L)}$) and a lateral (P_T) are applied simultaneously the equivalent load can be obtained by using the following equation.
P_E : (equivalent load) = $X \cdot P_{R(L)} + Y \cdot P_T$
$P_{R(L)}$: Radial load
P_T : Lateral load
X, Y = 1

1-7 Calculation of Average Working Load

■ 1-7-1 Calculating the Mean Load

An industrial robot grasp a workpiece by its arm as it advances, moving forward with the load, when it returns, the arm has no load other than its tare. In a machine tool, Linear Guide blocks receive variable loads according to the host-system operating conditions. Therefore, the calculation of service life should take such fluctuation into consideration.

When the service life of a Linear Guide with variable load is equal to the one with certain load then that certain load is called the Mean Load (P_m).

$$P_m = \sqrt[3]{\frac{1}{L} \cdot \Sigma \left(P_n^3 \cdot L_n \right)}$$

P_m : Mean load (kg)
P_n : Varying load (kg)
L_C : Total running distance (mm)
L_n : Running distance under load Pn(mm)

(1) For Loads with Stepwise Change

$$P_m = \sqrt[3]{\frac{1}{L} \left(P_1^3 \cdot L_1 + P_2^3 \cdot L_2 \cdot ... + P_n^3 \cdot L_n \right)} \quad ....(1)$$

P_m : Mean load (kg)
P_n : Varying load (kg)
L_C : Total running distance (mm)
L_n : Running distance under load Pn(mm)

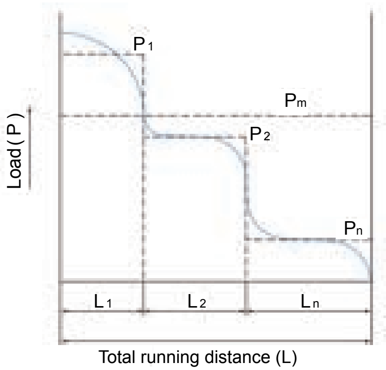


Fig 1.7.1

※This equation and equation (1) below apply in cases in which therolling elements are balls.

(2) For Loads with Monotonous Changes

$$P_m \fallingdotseq \frac{1}{3}\left(P_{min} + 2 \cdot P_{max}\right) \ldots\ldots\ldots (2)$$

P_{min} : minimum load (kg)
P_{max} : maximum load (kg)

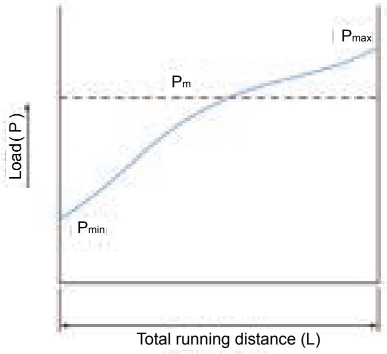


Fig 1.7.2

(3) For Loads with Sinusoidal Changes

$P_m \fallingdotseq 0.65P_{max}$ ....(3)

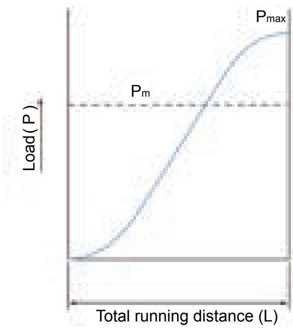


Fig 1.7.3

$P_m \fallingdotseq 0.75P_{max}$ ....(4)

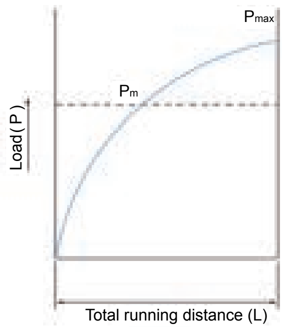


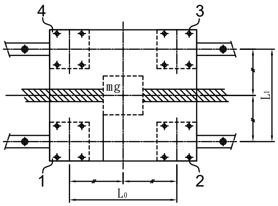
Fig 1.7.4

A
Linear Guide

1-7 Calculation of Average Working Load

■ 1-7-2 Mean Load Calculation Example (I)

(1) Horizontal Installations are subjected to Acceleration and Deceleration



$$\alpha_1 = \frac{V}{t_1} \ m/s^2$$

Fig 1.7.5

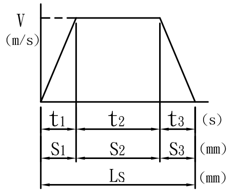


Fig 1.7.6

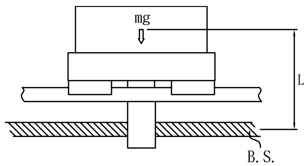


Fig 1.7.7

(2) Load Applied to the Linear Guide Block

1. During uniform motion

$$P_1 = +\frac{mg}{4}$$
$$P_2 = +\frac{mg}{4}$$
$$P_3 = +\frac{mg}{4}$$
$$P_4 = +\frac{mg}{4}$$

2. During acceleration

$$P_{a_1} = P_1 + \frac{m \cdot \alpha_1 \cdot L_2}{2 \cdot L_0}$$
$$P_{a_2} = P_2 - \frac{m \cdot \alpha_1 \cdot L_2}{2 \cdot L_0}$$
$$P_{a_3} = P_3 - \frac{m \cdot \alpha_1 \cdot L_2}{2 \cdot L_0}$$
$$P_{a_4} = P_4 + \frac{m \cdot \alpha_1 \cdot L_2}{2 \cdot L_0}$$

3. During deceleration

$$P_{d_1} = P_1 - \frac{m \cdot \alpha_1 \cdot L_2}{2 \cdot L_0}$$
$$P_{d_2} = P_2 + \frac{m \cdot \alpha_1 \cdot L_2}{2 \cdot L_0}$$
$$P_{d_3} = P_3 + \frac{m \cdot \alpha_1 \cdot L_2}{2 \cdot L_0}$$
$$P_{d_4} = P_4 - \frac{m \cdot \alpha_1 \cdot L_2}{2 \cdot L_0}$$

(3) Mean Load

$$P_{m_1} = \sqrt[3]{\frac{1}{L_s}\left(P_{a_1}^3 \cdot S_1 + P_1^3 \cdot S_2 + P_d^3 \cdot S_3\right)} \qquad P_{m_3} = \sqrt[3]{\frac{1}{L_s}\left(P_{a_3}^3 \cdot S_1 + P_3^3 \cdot S_2 + P_{d_3}^3 \cdot S_3\right)}$$

$$P_{m_2} = \sqrt[3]{\frac{1}{L_s}\left(P_{a_2}^3 \cdot S_1 + P_2^3 \cdot S_2 + P_{d_2}^3 \cdot S_3\right)} \qquad P_{m_4} = \sqrt[3]{\frac{1}{L_s}\left(P_{a_4}^3 \cdot S_1 + P_4^3 \cdot S_2 + P_{d_4}^3 \cdot S_3\right)}$$

※Pan1・Pdn represent loads exerted on the Linear Guide block. The suffix "n" indicates the block number in the diagram above.

Mean Load Calculation Example (II)

(1) Operating conditions-Installations on Rails.

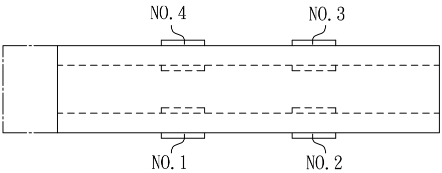


Fig 1.7.8

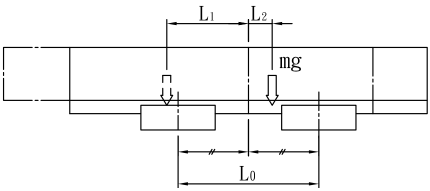


Fig 1.7.9

(2) Load applied to the Linear Guide block

1. At the left of the arm

$$P_{L1}=+\frac{mg}{4}+\frac{mg\cdot L_1}{2\cdot L_0}$$

$$P_{L2}=+\frac{mg}{4}-\frac{mg\cdot L_1}{2\cdot L_0}$$

$$P_{L3}=+\frac{mg}{4}-\frac{mg\cdot L_1}{2\cdot L_0}$$

$$P_{L4}=+\frac{mg}{4}+\frac{mg\cdot L_1}{2\cdot L_0}$$

2. At the right of the arm

$$P_{r1}=+\frac{mg}{4}-\frac{mg\cdot L_1}{2\cdot L_0}$$

$$P_{r2}=+\frac{mg}{4}+\frac{mg\cdot L_1}{2\cdot L_0}$$

$$P_{r3}=+\frac{mg}{4}+\frac{mg\cdot L_1}{2\cdot L_0}$$

$$P_{r4}=+\frac{mg}{4}-\frac{mg\cdot L_1}{2\cdot L_0}$$

(3) Mean load

$$P_{m1}=\frac{1}{3}\left(2\cdot|P_{L1}|+|P_{r1}|\right)$$

$$P_{m1}=\frac{1}{3}\left(2\cdot|P_{L2}|+|P_{r2}|\right)$$

$$P_{m1}=\frac{1}{3}\left(2\cdot|P_{L3}|+|P_{r3}|\right)$$

$$P_{m1}=\frac{1}{3}\left(2\cdot|P_{L4}|+|P_{r4}|\right)$$

※PLn・Pm represent loads exerted on the Linear Guide block. The suffix "n" indicates the block number in the diagram above.

1-8 Calculation Example

■ 1-8-1 Calculation Examples (I)

(1) Operating conditions-Horizontal installations subjected to high acceleration and deceleration.

Model number : TRH30FE
Basic dynamic-load rating C = 4791 kg
Basic static-load rating C_0 = 9004 kg
Gravitational acceleration : g = 9.8 (m/s^2)
Load : m_1 = 600 kg
Load : m_2 = 380 kg
Velocity : V = 0.5 m/s
Time : t_1 = 0.05 s
Time : t_2 = 2.8 s
Time : t_3 = 0.15 s

Acceleration : a_1 = 10 m/s^2
Deceleration : a_3 = 3.333 m/s^2
Stroke : L_s = 1450 mm
Distance : L_0 = 600 mm
L_1 = 400 mm
L_2 = 100 mm
L_3 = 50 mm
L_4 = 200 mm
L_5 = 400 mm

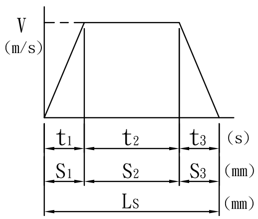


Fig 1.8.1

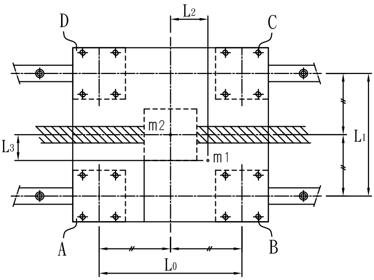


Fig 1.8.2

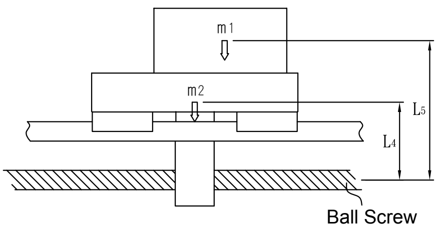


Fig 1.8.3

(2) Load Exerted on the Linear Guide by the Linear Guide Block

The calculations of blocks' load distribution under various circumstances.

1. In uniform motion Load applied in radial direction P_n (Base on the first condition of load exerted (please refer to page A15, No.1), taking m_1 and m_2 into consideration.

$$P_A = \frac{m_1}{4} - \frac{m_1 \cdot L_2}{2 \cdot L_0} + \frac{m_1 \cdot L_3}{2 \cdot L_1} + \frac{m_2}{4} = 232.5\,kg \qquad P_C = \frac{m_1}{4} + \frac{m_1 \cdot L_2}{2 \cdot L_0} - \frac{m_1 \cdot L_3}{2 \cdot L_1} + \frac{m_2}{4} = 257.5\,kg$$

$$P_B = \frac{m_1}{4} + \frac{m_1 \cdot L_2}{2 \cdot L_0} + \frac{m_1 \cdot L_3}{2 \cdot L_1} + \frac{m_2}{4} = 332.5\,kg \qquad P_D = \frac{m_1}{4} - \frac{m_1 \cdot L_2}{2 \cdot L_0} - \frac{m_1 \cdot L_3}{2 \cdot L_1} + \frac{m_2}{4} = 157.5\,kg$$

2. During acceleration to the left Load applied in radial direction P_nL_a and lateral direction $P_{nt}L_a$ (Base on the 8th condition of load exerted (please refer to page A18. No.8). The load should allocate on the central of table, and $\frac{m_1}{4}$ should be re-placed (please refer to page A15. No.1) by P_n).

$$P_AL_a = P_A - \frac{m_1 \cdot a_1 \cdot L_5}{2 \cdot L_0 \cdot g} - \frac{m_2 \cdot a_1 \cdot L_4}{2 \cdot L_0 \cdot g} = -36.206\,kg \qquad P_CL_a = P_C - \frac{m_1 \cdot a_1 \cdot L_5}{2 \cdot L_0 \cdot g} - \frac{m_2 \cdot a_1 \cdot L_4}{2 \cdot L_0 \cdot g} = -11.206\,kg$$

$$P_BL_a = P_B - \frac{m_1 \cdot a_1 \cdot L_5}{2 \cdot L_0 \cdot g} - \frac{m_2 \cdot a_1 \cdot L_4}{2 \cdot L_0 \cdot g} = 63.794\,kg \qquad P_DL_a = P_D - \frac{m_1 \cdot a_1 \cdot L_5}{2 \cdot L_0 \cdot g} - \frac{m_2 \cdot a_1 \cdot L_4}{2 \cdot L_0 \cdot g} = -111.206\,kg$$

$$P_{At}L_a = -\frac{m_1 \cdot a_1 \cdot L_3}{2 \cdot L_0 \cdot g} = -25.51\,kg \qquad P_{Ct}L_a = \frac{m_1 \cdot a_1 \cdot L_3}{2 \cdot L_0 \cdot g} = 25.51\,kg$$

$$P_{Bt}L_a = \frac{m_1 \cdot a_1 \cdot L_3}{2 \cdot L_0 \cdot g} = 25.51\,kg \qquad P_{Dt}L_a = -\frac{m_1 \cdot a_1 \cdot L_3}{2 \cdot L_0 \cdot g} = -25.51\,kg$$

3. During deceleration to the left Load applied in radial direction P_nL_d

$$P_AL_d = P_A + \frac{m_1 \cdot a_3 \cdot L_5}{2 \cdot L_0 \cdot g} + \frac{m_2 \cdot a_3 \cdot L_4}{2 \cdot L_0 \cdot g} = 334.53\,kg \qquad P_CL_d = P_C - \frac{m_1 \cdot a_3 \cdot L_5}{2 \cdot L_0 \cdot g} - \frac{m_2 \cdot a_3 \cdot L_4}{2 \cdot L_0 \cdot g} = 155.47\,kg$$

$$P_BL_d = P_B - \frac{m_1 \cdot a_3 \cdot L_5}{2 \cdot L_0 \cdot g} - \frac{m_2 \cdot a_3 \cdot L_4}{2 \cdot L_0 \cdot g} = 230.47\,kg \qquad P_DL_d = P_D + \frac{m_1 \cdot a_3 \cdot L_5}{2 \cdot L_0 \cdot g} + \frac{m_2 \cdot a_3 \cdot L_4}{2 \cdot L_0 \cdot g} = 259.53\,kg$$

Load applied in lateral direction $P_{nt}L_d$

$$P_{At}L_d = \frac{m_1 \cdot a_3 \cdot L_3}{2 \cdot L_0 \cdot g} = 2.721\,kg \qquad P_{Ct}L_d = -\frac{m_1 \cdot a_3 \cdot L_3}{2 \cdot L_0 \cdot g} = -2.721\,kg$$

$$P_{Bt}L_d = -\frac{m_1 \cdot a_3 \cdot L_3}{2 \cdot L_0 \cdot g} = -2.721\,kg \qquad P_{Dt}L_d = \frac{m_1 \cdot a_3 \cdot L_3}{2 \cdot L_0 \cdot g} = 2.721\,kg$$

1-8 Calculation Example

4. During acceleration to the right Load applied in radial direction P_nR_a

$$P_AR_a = P_A + \frac{m_1 \cdot a_1 \cdot L_5}{2 \cdot L_0 \cdot g} + \frac{m_2 \cdot a_1 \cdot L_4}{2 \cdot L_0 \cdot g} = 501.206\ kg$$

$$P_CR_a = P_C - \frac{m_1 \cdot a_1 \cdot L_5}{2 \cdot L_0 \cdot g} - \frac{m_2 \cdot a_1 \cdot L_4}{2 \cdot L_0 \cdot g} = -21.206\ kg$$

$$P_BR_a = P_B - \frac{m_1 \cdot a_1 \cdot L_5}{2 \cdot L_0 \cdot g} - \frac{m_2 \cdot a_1 \cdot L_4}{2 \cdot L_0 \cdot g} = 63.794\ kg$$

$$P_DR_a = P_D + \frac{m_1 \cdot a_1 \cdot L_5}{2 \cdot L_0 \cdot g} + \frac{m_2 \cdot a_1 \cdot L_4}{2 \cdot L_0 \cdot g} = 426.206\ kg$$

Load applied in lateral direction P_nR

$$P_{At}R_d = \frac{m_1 \cdot a_1 \cdot L_3}{2 \cdot L_0 \cdot g} = 25.51\ kg$$

$$P_{Ct}R_d = -\frac{m_1 \cdot a_1 \cdot L_3}{2 \cdot L_0 \cdot g} = -25.51\ kg$$

$$P_{Bt}R_d = -\frac{m_1 \cdot a_1 \cdot L_3}{2 \cdot L_0 \cdot g} = -25.51\ kg$$

$$P_{Dt}R_d = \frac{m_1 \cdot a_1 \cdot L_3}{2 \cdot L_0 \cdot g} = 25.51\ kg$$

5. During deceleration to the right Load applied in radial direction P_nR_d and Load applied in lateral direction P_nR_d

$$P_AR_d = P_A - \frac{m_1 \cdot a_3 \cdot L_5}{2 \cdot L_0 \cdot g} - \frac{m_2 \cdot a_3 \cdot L_4}{2 \cdot L_0 \cdot g} = 130.47\ kg$$

$$P_BR_d = P_B + \frac{m_1 \cdot a_3 \cdot L_5}{2 \cdot L_0 \cdot g} + \frac{m_2 \cdot a_3 \cdot L_4}{2 \cdot L_0 \cdot g} = 434.53\ kg$$

$$P_CR_d = P_C + \frac{m_1 \cdot a_3 \cdot L_5}{2 \cdot L_0 \cdot g} + \frac{m_2 \cdot a_3 \cdot L_4}{2 \cdot L_0 \cdot g} = 359.53\ kg$$

$$P_DR_d = P_D - \frac{m_1 \cdot a_3 \cdot L_5}{2 \cdot L_0 \cdot g} - \frac{m_2 \cdot a_3 \cdot L_4}{2 \cdot L_0 \cdot g} = 55.47\ kg$$

Load applied in lateral direction $P_{nt}R_d$

$$P_{At}R_d = -\frac{m_1 \cdot a_3 \cdot L_3}{2 \cdot L_0 \cdot g} = -2.721\ kg$$

$$P_{Ct}R_d = \frac{m_1 \cdot a_3 \cdot L_3}{2 \cdot L_0 \cdot g} = 2.721\ kg$$

$$P_{Bt}R_d = \frac{m_1 \cdot a_3 \cdot L_3}{2 \cdot L_0 \cdot g} = 2.721\ kg$$

$$P_{Dt}R_d = -\frac{m_1 \cdot a_3 \cdot L_3}{2 \cdot L_0 \cdot g} = -2.721\ kg$$

(3) Combined radial and thrust load P_{En}

1. In uniform motion P_{En}

$P_{EA}=P_A=232.5$ kg
$P_{EB}=P_B=332.5$ kg
$P_{EC}=P_C=257.5$ kg
$P_{ED}=P_D=157.5$ kg

2. During acceleration to the left $P_{En}L_a$

$P_{EA}L_a=|P_AL_a|+|P_{At}L_a|=61.716$ kg
$P_{EB}L_a=|P_BL_a|+|P_{Bt}L_a|=89.304$ kg
$P_{EC}L_a=|P_CL_a|+|P_{Ct}L_a|=36.716$ kg
$P_{ED}L_a=|P_DL_a|+|P_{Dt}L_a|=136.716$ kg

3. During deceleration to the left $P_{En}L_d$

$P_{EA}L_d=|P_AL_d|+|P_{At}L_d|=337.251$ kg
$P_{EB}L_d=|P_BL_d|+|P_{Bt}L_d|=233.191$ kg
$P_{EC}L_d=|P_CL_d|+|P_{Ct}L_d|=158.191$ kg
$P_{ED}L_d=|P_DL_d|+|P_{Dt}L_d|=262.251$ kg

4. During acceleration to the right $P_{En}R_a$

$P_{EA}R_a=|P_AR_a|+|P_{At}R_a|=526.716$ kg
$P_{EB}R_a=|P_BR_a|+|P_{Bt}R_a|=89.304$ kg
$P_{EC}R_a=|P_CR_a|+|P_{Ct}R_a|=46.716$ kg
$P_{ED}R_a=|P_DR_a|+|P_{Dt}R_a|=451.716$ kg

5. During deceleration to the right $P_{En}L_d$

$P_{EA}R_d=|PAR_d|+|P_{At}R_d|=133.191$ kg
$P_{EB}R_d=|P_BR_d|+|P_{Bt}R_d|=437.261$ kg
$P_{EC}R_d=|P_CR_d|+|P_{Ct}R_d|=360.251$ kg
$P_{ED}R_d=|P_DR_d|+|P_{Dt}R_d|=58.191$ kg

(4) Static Safety Factor

As shown above, it is during acceleration of the A Linear Guide to the right when the maximum load is exerted on the Linear Guide. Therefore, the static safety factor (f_s) becomes as follows :

$$f_s = \frac{C_0}{526.716} = \frac{9004}{526.716} = 17.09$$

A Linear Guide

1-8 Calculation Example

(5) Mean Load P_{mn}

For each block, load is different under uniform speed, acceleration and deceleration circumstances. To acquire service life, mean load must be calculated by acquiring the travel distance of each block during uniform speed, acceleration and deceleration in advance.

$_1=\frac{1}{2}t_1V=\frac{1}{2}(0.05)(0.5)$ m=0.0125 m=12.5 mm $S_3=\frac{1}{2}t_3V=(0.15)(0.5)$ m=0.0375 m=37.5 mn

$S_2=t_2V=(2.8)(0.5)$ m=1.4 m=1400 mm Nominal Life $L_s=S_1+S_2+S_3=1450$ mm

The mean load on each LM block is as follows :

$$P_{mA}=\sqrt[3]{\frac{1}{2\cdot L_s}(P_{EA\ell a}^3\cdot S_1+P_{EA}^3\cdot S_2+P_{EA\ell d}^3\cdot S_3+P_{EARa}^3\cdot S_1+P_{EA}^3\cdot S_2+P_{EARd}^3\cdot S_3)}=236.88\text{ kg}$$

$$P_{mB}=\sqrt[3]{\frac{1}{2\cdot L_s}(P_{EB\ell a}^3\cdot S_1+P_{EB}^3\cdot S_2+P_{EB\ell d}^3\cdot S_3+P_{EBRa}^3\cdot S_1+P_{EB}^3\cdot S_2+P_{EBRd}^3\cdot S_3)}=332.45\text{ kg}$$

$$P_{mC}=\sqrt[3]{\frac{1}{2\cdot L_s}(P_{EC\ell a}^3\cdot S_1+P_{EC}^3\cdot S_2+P_{EC\ell d}^3\cdot S_3+P_{ECRa}^3\cdot S_1+P_{EC}^3\cdot S_2+P_{ECRd}^3\cdot S_3)}=257.84\text{ kg}$$

$$P_{mD}=\sqrt[3]{\frac{1}{2\cdot L_s}(P_{ED\ell a}^3\cdot S_1+P_{ED}^3\cdot S_2+P_{ED\ell d}^3\cdot S_3+P_{EDRa}^3\cdot S_1+P_{ED}^3\cdot S_2+P_{EDRd}^3\cdot S_3)}=164.07\text{ kg}$$

(6) Nominal life Ln (Assume f_w = 1.5)

$$(L_A=\frac{C}{f_w\cdot P_{mA}})^3\cdot 50=122568.85\text{ km}\qquad (L_C=\frac{C}{f_w\cdot P_{mC}})^3\cdot 50=95044.15\text{ km}$$

$$(L_B=\frac{C}{f_w\cdot P_{mB}})^3\cdot 50=44339.87\text{ km}\qquad (L_D=\frac{C}{f_w\cdot P_{mD}})^3\cdot 50=368902.68\text{ km}$$

※From these calculations, 44339.87 km (the running distance of Linear Guide No.B) is obtained as the service life of the Linear Guide used in a machine or system under the operating conditions specified above.

In the example above, we assume that we have two loads(W_1 and W_2). If there is only one load W_1, simply take W_2 as zero. The appropriate formula determined by condition of loading.

Example (II)

(1) Operation Conditions-Vertical Installations Table (L type) has combined blocks weight w_1 and w_2. Furthermore, the mass w_0 is applied during uniform ascent by Distance 1000 mm. After the mass is dropped, empty table is removed during uniform descent. The table has total four Linear Guide blocks.

Model number : TRH30FE	
(dynamic-load rating : C = 4791 kg)	L_0 =300 mm
(static-load rating : C_0 = 9004 kg)	L_1 =80 mm
Gravitational Acceleration : g = 9.8 (m/s^2)	L_2 =50 mm
Mass : m_0 = 200 kg	L_3 =280 mm
Weight of Table1 : m_1 = 400 kg	L_4 =150 mm
Weight of Table2 : m_2 = 200 kg	L_5 =250 mm

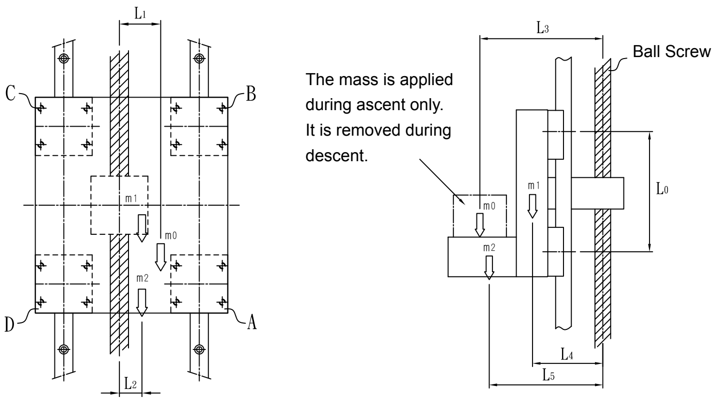


Fig 1.8.4

1-8 Calculation Example

(2) Calculation of blocks load distribution under various circumstances.

When the Linear Guide move vertically, take M_0, M_1 and M_2 into consideration individually by using the third condition shown in 1.5.1【please refer to A16. No.3】

1. The radial load(P_m) of blocks while ascending with load M_0.

$$P_{AU} = \frac{m_1 \cdot L_4}{2 \cdot L_0} + \frac{m_2 \cdot L_5}{2 \cdot L_0} + \frac{m_0 \cdot L_3}{2 \cdot L_0} = 276.7\ kg \qquad P_{CU} = -\frac{m_1 \cdot L_4}{2 \cdot L_0} - \frac{m_2 \cdot L_5}{2 \cdot L_0} - \frac{m_0 \cdot L_3}{2 \cdot L_0} = -276.7\ kg$$

$$P_{BU} = -\frac{m_1 \cdot L_4}{2 \cdot L_0} - \frac{m_2 \cdot L_5}{2 \cdot L_0} - \frac{m_0 \cdot L_3}{2 \cdot L_0} = -276.7\ kg \qquad P_{DU} = \frac{m_1 \cdot L_4}{2 \cdot L_0} + \frac{m_2 \cdot L_5}{2 \cdot L_0} + \frac{m_0 \cdot L_3}{2 \cdot L_0} = 276.7\ kg$$

Lateral load PnTu of blocks while ascending.

$$P_{A}T_{U} = \frac{m_1 \cdot L_2}{2 \cdot L_0} + \frac{m_2 \cdot L_2}{2 \cdot L_0} + \frac{m_0 \cdot L_1}{2 \cdot L_0} = 76.7\ kg \qquad P_{C}T_{U} = -\frac{m_1 \cdot L_2}{2 \cdot L_0} - \frac{m_2 \cdot L_2}{2 \cdot L_0} - \frac{m_0 \cdot L_1}{2 \cdot L_0} = -76.7\ kg$$

$$P_{B}T_{U} = -\frac{m_1 \cdot L_2}{2 \cdot L_0} - \frac{m_2 \cdot L_2}{2 \cdot L_0} - \frac{m_0 \cdot L_1}{2 \cdot L_0} = -76.7\ kg \qquad P_{D}T_{U} = \frac{m_1 \cdot L_2}{2 \cdot L_0} + \frac{m_2 \cdot L_2}{2 \cdot L_0} + \frac{m_0 \cdot L_1}{2 \cdot L_0} = 76.7\ kg$$

2. Radial load of each block while descending with no load.

$$P_{AD} = \frac{m_1 \cdot L_4}{2 \cdot L_0} + \frac{m_2 \cdot L_5}{2 \cdot L_0} = 183.3\ kg \qquad P_{CD} = -\frac{m_1 \cdot L_4}{2 \cdot L_0} - \frac{m_2 \cdot L_5}{2 \cdot L_0} = -183.3\ kg$$

$$P_{BD} = -\frac{m_1 \cdot L_4}{2 \cdot L_0} - \frac{m_2 \cdot L_5}{2 \cdot L_0} = -183.3\ kg \qquad P_{DD} = \frac{m_1 \cdot L_4}{2 \cdot L_0} + \frac{m_2 \cdot L_5}{2 \cdot L_0} = 183.3\ kg$$

Lateral load of block while descending.

$$P_{A}T_{D} = \frac{m_2 \cdot L_2}{2 \cdot L_0} + \frac{m_0 \cdot L_2}{2 \cdot L_0} = 33.3\ kg \qquad P_{C}T_{D} = -\frac{m_2 \cdot L_2}{2 \cdot L_0} - \frac{m_0 \cdot L_2}{2 \cdot L_0} = -33.3\ kg$$

$$P_{B}T_{D} = -\frac{m_2 \cdot L_2}{2 \cdot L_0} - \frac{m_0 \cdot L_2}{2 \cdot L_0} = -33.3\ kg \qquad P_{D}T_{D} = \frac{m_2 \cdot L_2}{2 \cdot L_0} + \frac{m_0 \cdot L_2}{2 \cdot L_0} = 33.3\ kg$$

(3) Combined radial and thrust load P_{En}

1. During ascent

$P_{EAU} = |P_{AU}| + |P_{A}T_{U}| = 353.4$ kg
$P_{EBU} = |P_{BU}| + |P_{B}T_{U}| = 353.4$ kg
$P_{ECU} = |P_{CU}| + |P_{C}T_{U}| = 353.4$ kg
$P_{EDU} = |P_{DU}| + |P_{D}T_{U}| = 353.4$ kg

$P_{EAD} = |P_{AD}| + |P_{A}T_{D}| = 216.6$ kg
$P_{EBD} = |P_{BD}| + |P_{B}T_{D}| = 216.6$ kg
$P_{ECD} = |P_{CD}| + |P_{C}T_{D}| = 216.6$ kg
$P_{EDD} = |P_{DD}| + |P_{D}T_{D}| = 216.6$ kg

(4) Static Safety Factor

The static safety factor (f_s) of a machine or system under the operating conditions shown above becomes the following :

$$f_s = \frac{C_0}{353.4\text{kg}} = \frac{9004}{353.4} = 25.48$$

(5) Mean Load P_{mn}

$$P_{mA} = \sqrt[3]{\frac{1}{2\ell s}\left(P_{EAU}^3 \cdot \ell_s + P_{EAD}^3 \cdot \ell_s\right)} = 300.6\text{ kg} \quad P_{mC} = \sqrt[3]{\frac{1}{2\ell s}\left(P_{ECU}^3 \cdot \ell_s + P_{ECD}^3 \cdot \ell_s\right)} = 300.6\text{ kg}$$

$$P_{mB} = \sqrt[3]{\frac{1}{2\ell s}\left(P_{EBU}^3 \cdot \ell_s + P_{EBD}^3 \cdot \ell_s\right)} = 300.6\text{ kg} \quad P_{mD} = \sqrt[3]{\frac{1}{2\ell s}\left(P_{EDU}^3 \cdot \ell_s + P_{EDD}^3 \cdot \ell_s\right)} = 300.6\text{ kg}$$

(6) Nominal life L_n (Assume $f_w = 1.2$)

$$L_A = \left(\frac{C}{f_w \cdot P_{mA}}\right)^3 \cdot 50\text{km} = 117148.8\text{ km} \qquad L_C = \left(\frac{C}{f_w \cdot P_{mC}}\right)^3 \cdot 50\text{km} = 117148.8\text{ km}$$

$$L_B = \left(\frac{C}{f_w \cdot P_{mB}}\right)^3 \cdot 50\text{ km} = 117148.8\text{ km} \qquad L_D = \left(\frac{C}{f_w \cdot P_{mD}}\right)^3 \cdot 50\text{km} = 117148.8\text{ km}$$

A

Linear Guide

1-9 Accuracy

■ 1-9-1 Accuracy Standards

The accuracy of rail is determined by the tolerance of its parallelism, height and width, if there is multiple blocks on a rail or multiple Linear Guide on a surface, the difference of height and width between each block and Linear Guide are standardized and shown in the catalogue.

Running Parallelism

Mount a Linear Guide on a datum surface and measure the parallelism difference of block while operating its full travel distance.

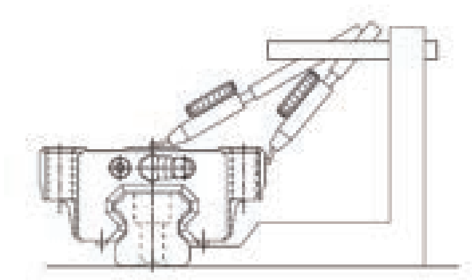


Fig 1.9.1 Running Parallelism

Difference in Height M among Linear Guide Blocks

On the same datum surface, the difference between maximum and minimum height of each block.

Difference in Rail-to-Block Lateral Distance W_2 among Linear Guide Blocks

On the same rail, the difference between maximum and minimum width of each block.

※Note.1
With two or more sets of Linear Guide installed in parallel on the same plane, the tolerance for the rail-to-block lateral distance (W2) and the differences therein among Linear Guide blocks apply to the master – rail side only.

※Note.2
Accuracy measurements indicate mean values of measurements taken at the center or central area of each Linear Guide block.

※Note.3
Linear Guide rails are smoothly curved so that when they are installed on a machine they are easily straightened, and pressing them onto the machine reference base enables the design accuracy to be achieved. If installed on a base lacking rigidity, such as an aluminum base, the bend of LinearGuide rails may affect machine precision. In such a case, the straightness should be set in advance.

■ 1-9-2 Averaging Effect

The Linear Guide incorporates precision balls with high circularity, enabling a constrained structure with no clearance. Moreover, in a multiple-axis configuration with the axis arranged in parallel to one another, the component Linear Guides therein combine to form an entire constrained guideway.

The effect of equalization is different, due to the error of length, size, preload of rail, axis constrained structure and etc, as the table shown below; adding one rail a straightness error and its actual operating accuracy is shown in the diagram below. Through the feature of equalization, a high operating accuracy structure can be provided.

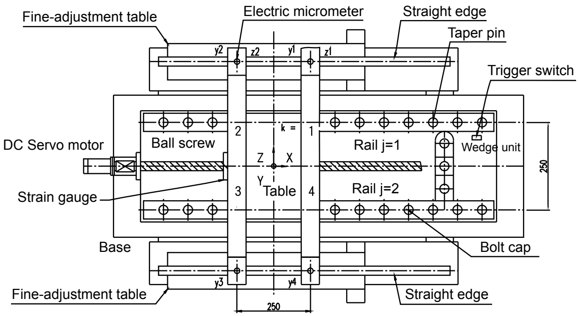


Fig 1.9.2

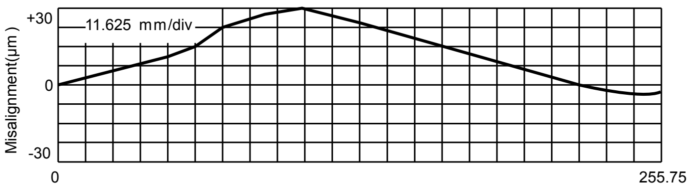


Fig 1.9.3 Misalignment profile

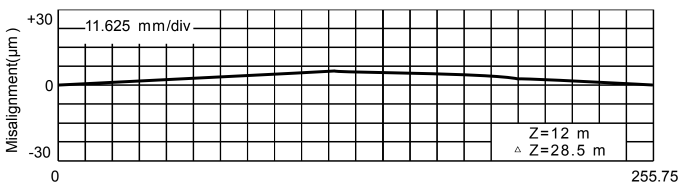


Fig 1.9.4 Horizontal displacement of the table

1-10 Predicting the Rigidity

■ 1-10-1 Determining Radial Clearance and the Magnitude of a Preload Radial Clearance

The radial clearance of the Linear Guide is the displacement of Linear Guide block caused by the vertical plane when the block is lightly pushed forward or backward at the longitudinal center of the Linear Guide rail secured in place.

The radial clearance is divided into ZF (Slight Clearance), Z0 (No Preload), Clearance Z1 (light preload), Z2 (medium preload) and Z3 (heavy preload).The most appropriate clearance can be selected in accordance with the intended applications. The radial clearances and preload values are standardized for each type of Linear Guide.

The radial clearance of the Linear Guide significantly affects its running precision, load-withstanding performance, and rigidity. It is therefore particularly important to select the correct clearance for your purpose. In generally, a negative clearance has a favorable effect on service life and precision, if the Linear Guide is subjected to significant vibration and impact due to reciprocal motion.

Preload

The preload is an internal load exerted on rolling elements in the Linear Guide block, for the purpose of increasing the block rigidity and reducing clearance. Clearance symbol for the Liner Guide, ZF, Z0, Z1, Z2 and Z3 represent negative clearance resulting from a preload and are expressed in negative values. All Linear Guide models (excluding the separate type) are shipped with their clearance adjusted to user specifications. Therefore, it is not necessary for users to adjust the preload themselves. We will select the clearance suited to your operating conditions. Please contact us.

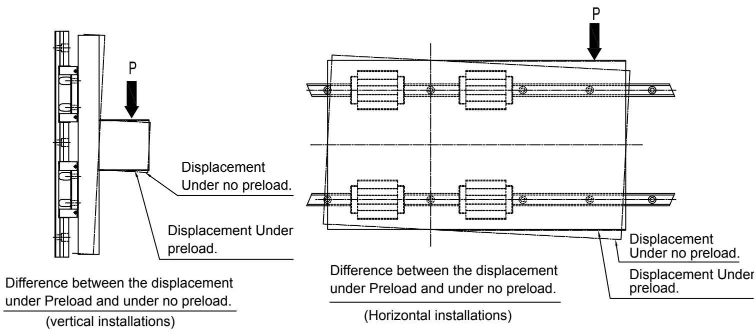


Fig 1.10.1 Relationship Between Preload and Displacement

Table 1.10.1

	Preload		
	ZF~Z0 Slight Clearance, Zero Preload.	Z1 Zero Clearance, Light Preload.	Z2 Zero Clearance, Medium preload.
OperatingConditions	The loading direction is fixed; impact and vibration are slight; two axes are installed in parallel. High precision is not required and the sliding resistance must be low.	The location in under an overhang and a moment load. The Linear Guide is used in a one-axis configuration. The location with light load and high precision requirement.	The location requires light rigidity and is subjected to vibration and impact. The application is a heavy-cutting machine tool or the like.
SampleApplications	◆ Beam-welding machine. ◆ Book-binding machine. ◆ Automatic packing machine. ◆ General-industrial-machine ◆ X-axis and Y-axis. ◆ Automatic sash-bar finishing machine. ◆ Welding machine. ◆ Circuit breaker. ◆ Tool changer. ◆ Various kinds of maternal feedeer.	◆ Grinding-machine table feed shaft. ◆ Automatic painting machine. ◆ Industrial robot. ◆ Various kinds of high-speed material feeder. ◆ NC drilling machine. ◆ General-industrial-machine ◆ Z-axis. ◆ Printed-cricuit-board drilling machine. ◆ Electric discharge machine. ◆ Measuring instrument. ◆ Precision XY table.	◆ Machining center. ◆ NC lathe. ◆ Grinding-machine grinding-wheel feed shaft. ◆ Milling machine. ◆ Vertical-and horizontal-boring machines. ◆ Tool rest guide. ◆ Machine-tool Z-axis.

Applied Load and Service Life Considering

When the Linear Guide is used under a preload (medium), the Linear Guide block receives an internal load. Therefore, the service life should be calculated in consideration of the preload. For preload considerations, please contact us, specifying the model numbers you have selected.

■ 1-10-2 Rigidity

When the Linear Guide receives a load, the steel balls, Linear Guide blocks, and rails undergo elastic deformation within a permissible range. The ratio of deformation to the load is the rigidity value. The rigidity of the Linear Guide increases as the preload increases. The Fig below shows the differences among the ordinary clearance Z1 and clearance Z2, Z3. As shown, in the case of the four-way equal-load type, the effect of preloading remains valid until the load increases to some 2.8 times the preload applied.

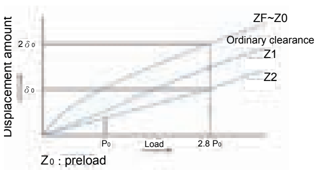


Fig 1.10.2 Rigidity Data

$$K = \frac{P}{\delta}$$

δ : Displacement (μm)
P : Load (kg)
K : Rigidity Value (kg/μm)

A Linear Guide

1-11 Installation of Linear Guide

■ 1-11-1 Datum Representation

The reference side of a rail is pointed by the ↑ at the end of TBI label, and the reference side for a carriage is at the opposite side TBI label, please see the picture below :

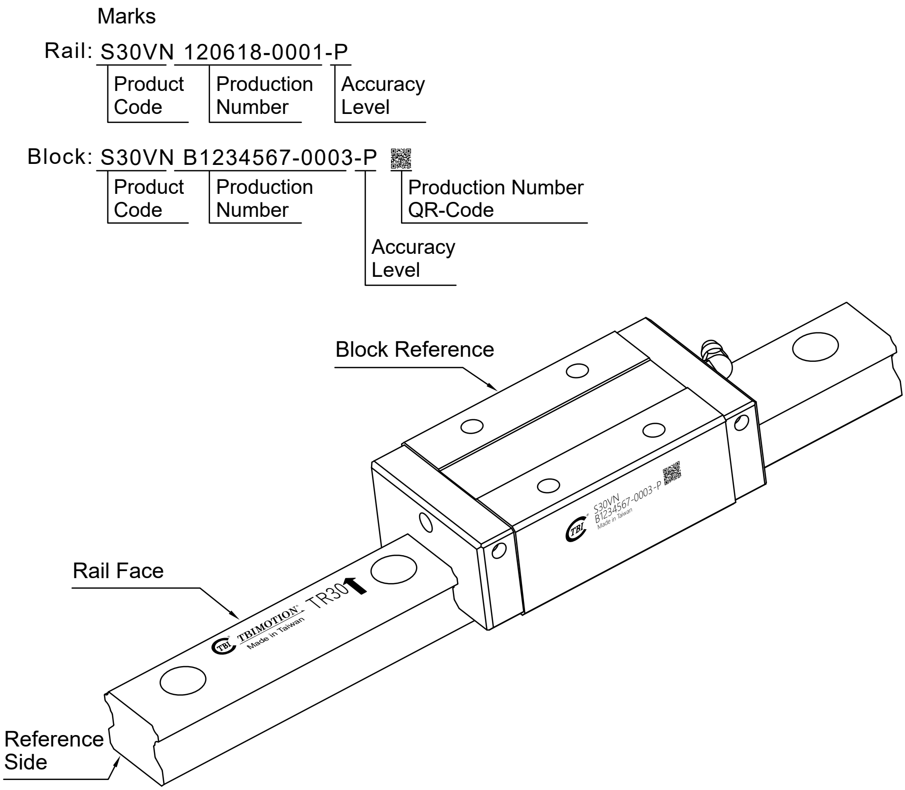


Fig 1.11.1 Datum Representation

■ 1-11-2 Recognizing of Master Rail

Linear rails to be applied on the same plane are all marked with the same serial number, and "M" is marked at the end of serial number for indicating the master rail, shown as the figure below. The reference side of carriage is the surface where is ground to a specified accuracy. For normal grade (N), it has no mark "M" on rail which means any one of rails with same serial number could be the master rail.

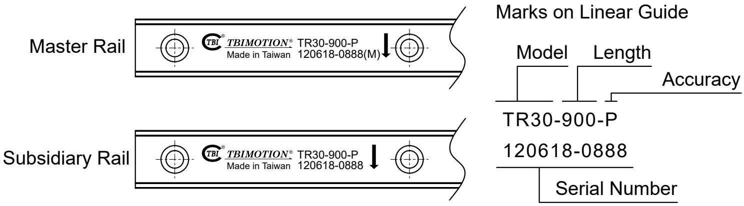


Fig 1.11.2 Recognizing of Master Rail

Combined Use of Rail and Carriage

For combined use, the rail and carriage must have the same serial number. When reinstalling the carriage back to the rail, make sure they have the same serial number and the reference side of carriage should be in accordance with that of rail.

1-11 Installation of Linear Guide

■ 1-11-3 For Butt-joint Rail

Accuracy may deviate at joints when carriages pass the joint simultaneously. Therefore, the joints should be interlaced for avoiding such accuracy problem.

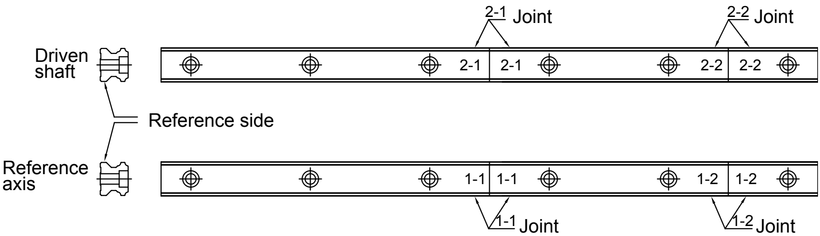


Fig 1.11.3 Butt-joint

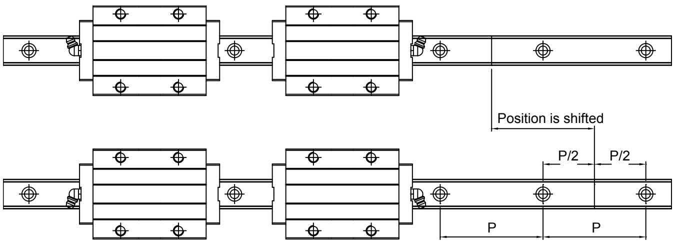
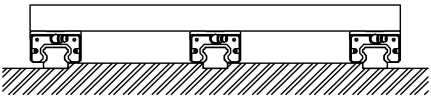
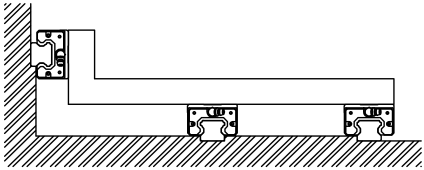
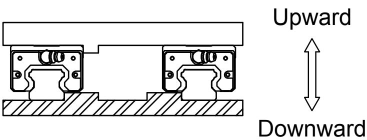
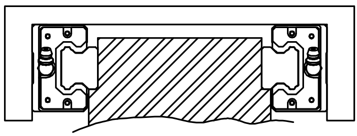
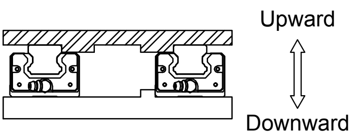
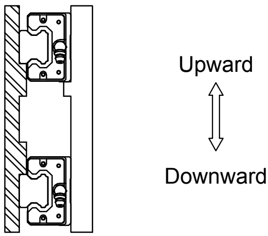
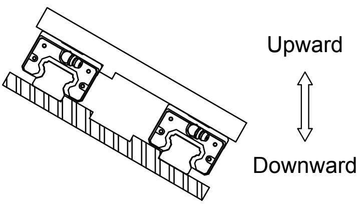
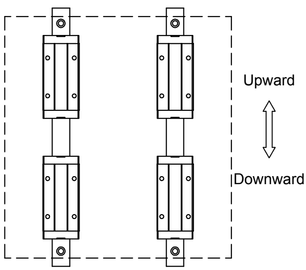


Fig 1.11.4

■ 1-11-4 Mounting Methods

Linear rail is designed to absorb the load of four dimensions; therefore, it can be mounted according to the load and structure of the equipment.

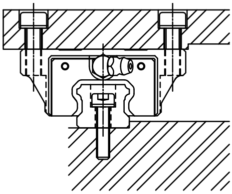
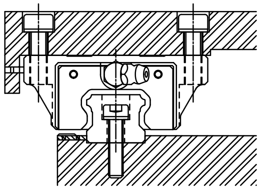
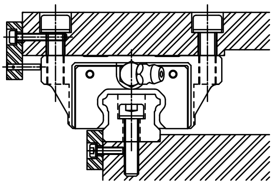
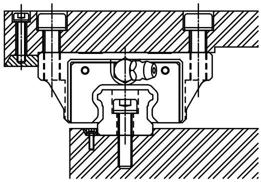
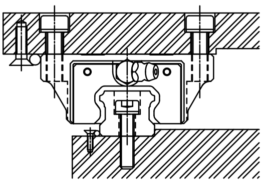
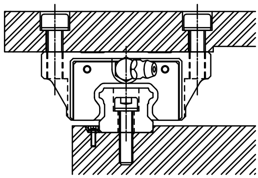
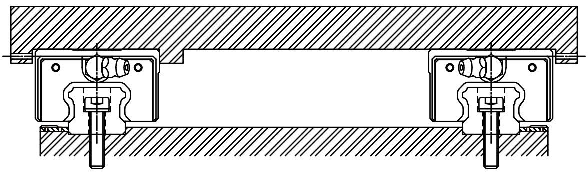
Table 1.11.1

(A)Three-Axis Configuration.	(B)Three-Axis Configuration.
	
Horizontal Configuration.	Two-Axis External Configuration.
	
Upside down Configuration.	Vertical Configuration.
	
Tilted Configuration.	Install on the wall.
	

1-11 Installation of Linear Guide

■ 1-11-5 Common Fastening Method of Linear Guide

Table 1.11.2

Fastened by pressing both Linear Guide blocks and rail against their respective reference surfaces.	Fastened by using push screws.
	
Fastened by using a hold-down plate.	Fastened by using a tapered gib.1
	
Fastened by using screws.	Fastened by using a tapered gib.2
	
A Setting Where the Host Machine is Subjected to Impact and Vibration.	
	

■ 1-11-6 Mounting the Linear Guide

Mounting Procedures

※Sample Installation of the Linear Guide on a Vibration-and-Impact Susceptible Machine that Requires Rigidity and High Precision.

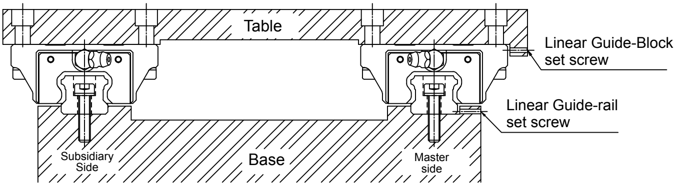


Fig 1.11.5 Mounting the Linear Guide on a Machine Susceptible to Vibration and Impact

Mounting the Linear Guide Rail

(A) Prior to assembly, always remove all burrs, dents and dust that are likely to form on the mounting surface of the machine on which Linear Guide is to be installed. (Fig 1.11.6)

CAUTION : The Linear Guide is delivered with an anticorrosive oil applied. Prior to assembly, be sure to remove the oil from the reference surface using a wash oil. If the anticorrosive oil is removed, the surface is likely to rust. The application of a low-viscosity spindle oil or the like is therefore recommended.

(B) Gently place a Linear Guide rail on the base, and temporarily tighten the bolts so that the rail lightly contacts the mounting surface. Hold the line marked side of the Linear Guide rail against matching the base-side reference surface (Fig 1.11.7)

CAUTION : Use clean bolts to fasten the Linear Guide. When inserting bolts into the Linear Guide rail mounting holes, make sure the threads of the bolt and nut are properly aligned. (Fig 1.11.8)

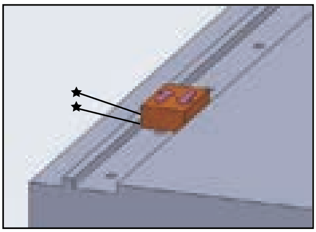


Fig 1.11.6 Checking the Mounting Surface.

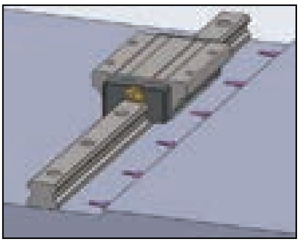


Fig 1.11.7 Holding an Linear Guide rail against the Reference Surface

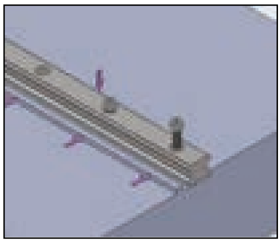


Fig 1.11.8 Checking Bolt Play

A

Linear Guide

1-11 Installation of Linear Guide

Table 1.11.3 Tightening Torque for Allen Bolt Unit : N-cm

ModelNo.	TighteningTorque		
	Iron	Casting	Aluminum
M2	57	39.2	29.4
M2.3	78.4	53.9	39.2
M2.6	118	78.4	58.8
M3	186	127	98.0
M4	392	274	206
M5	882	588	441
M6	1370	921	686
M8	3040	2010	1470
M10	6760	4510	3330
M12	11800	7840	5880
M14	15700	10500	7840
M16	19600	13100	9800
M20	38200	25500	19100
M22	51900	34800	26000
M24	65700	44100	32800
M30	130000	87200	65200

(C) Tighten the Linear Guide rail set screws in sequence, until they lightly contact the rail-mounting side surface.(Fig 1.11.9)

(D) Using a torque wrench, tightening the mounting bolts to the specific torque.(Fig 1.11.10)
CAUTION : The sequence for tightening the Linear Guide rail mounting bolts should start from the center to the end. Following this sequence to maintain accuracy.

(E) Following the same procedures for the remaining Linear Guide rails, complete Linear Guide rail installation.

(F) Drive caps into the bolt holes on the Linear Guide rails so that they are flush with the rail top surface.

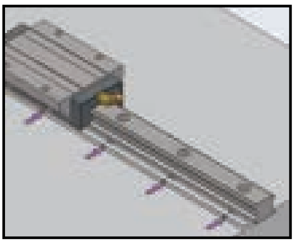


Fig 1.11.9 Tightening Set Screws

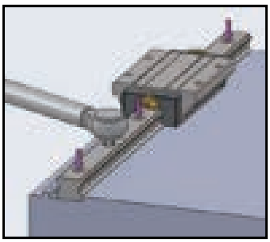


Fig 1.11.10 Full Tightening of Mounting Bolts

Mounting the Linear Guide Block

(A) Gently place a table on the Linear Guide blocks and temporarily tighten the mounting bolts.

(B) Using set screws, hold the master-rail Linear Guide block against the table reference-side surface, and position the table.

(C) Fully tighten the mounting bolts on both the master and subsidiary sides. This completes Linear Guide block installation.
CAUTION：To ensure uniform fastening of the table, tighten the mounting bolts diagonally, as shown in (Fig 1.11.11) in accordance with the numbers.

(D) Using a torque wrench, tightening the mounting bolts to the specified torque.(Fig 1.11.10)
CAUTION : The sequence for tightening the Linear Guide rail mounting bolts should start from the center to the end. Following this sequence to maintain.

The method specified above minimizes the time required to ensure the straightness of the Linear Guide-rail. Moreover, there is no need to use the fastening knock pins, thereby greatly reducing the required assembly man-hours.

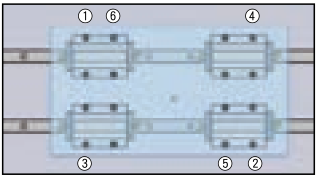


Fig 1.11.11

※Sample Installation of the Linear Guide without Set Screws on the Master Linear Guide Rail.

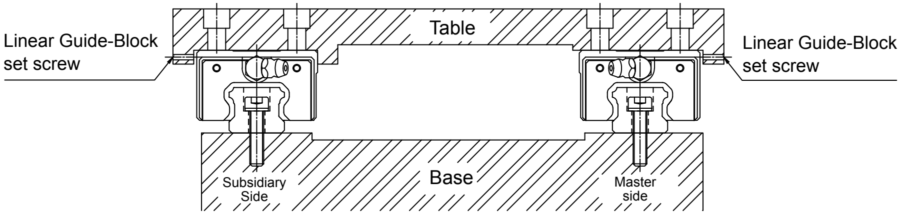


Fig 1.11.12 Mounting the Linear Guide without Set Screws on the Master Linear Guide Rail

1-11 Installation of Linear Guide

Mounting the Master Linear Guide Rail

After temporarily tightening the mounting bolts, use a small device or the like to firmly press the rail to the side, against the reference section. Fully tighten the mounting bolts. Repeat this for each mounting bolt in sequence. (Fig 1.11.13)

Mounting the Subsidiary Linear Guide Rail

To ensure parallelism of the subsidiary Linear Guide rail with the master Linear Guide rail properly mounted, the following methods are recommended.

Use a Straight Edge

Position a straight edge between the two rails then confirm parallelism with a dial gauge. Using the straight edge as a reference to confirm subsidiary rail straightness from one end to the other, tightening the mounting bolts in sequence as you go. (Fig 1.11.14)

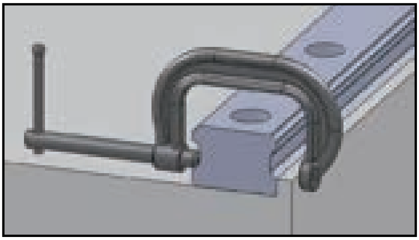


Fig 1.11.13 Mounting the master Linear Guide rail

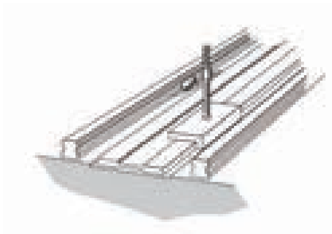


Fig 1.11.14 Use a straight edge

Move the Table

Fasten two Linear Guide blocks on the master side to the table (or a temporary measurement table). Temporary fasten the subsidiary Linear Guide rail and block to the base and table. From the dial-gauge stand, with a dial gauge contact the subsidiary rail Linear Guide block side, move the table from the rail end and check the parallelism between the block and the subsidiary Linear Guide rail, fastening the bolts on sequences as you go. (Fig 1.11.15)

Compare to the Master Linear Guide Rail

Make sure the master Linear Guide rail is properly installed.Temporarily fasten the subsidiary Linear Guide rail in place.Place a table on the Linear Guide blocks mounted on the master rail and on the temporarily fastened subsidiary Linear Guide rail. Fully tighten the mounting bolts on the two Linear Guide blocks on the subsidiary rail. With the remaining Linear Guide block on the subsidiary rail temporarily fastened, correct the position of the subsidiary Linear Guide rail, fully tightening its mounting bolts in sequence as you go. (Fig 1.11.16)

Method Using a Jig

Using a jig as shown in (Fig 1.11.17) confirm parallelism between the master-rail-side reference surface and that of the subsidiary rail at each mounting hole, and fully tighten the mounting bolt there.

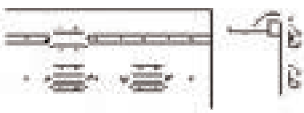


Fig 1.11.15 Move the table

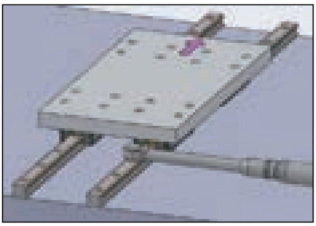


Fig 1.11.16 Compare to the master Linear Guide rail

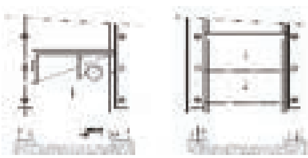


Fig 1.11.17

※Sample Installation of the Linear Guide without a Reference Section for the Master Linear Guide Rail.

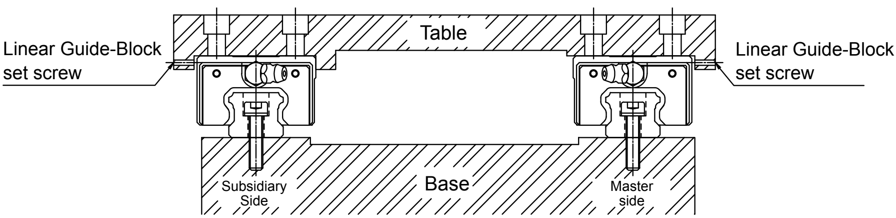


Fig 1.11.18 Installation of the Linear Guide without a Reference Section for the Master Linear Guide Rail

1-11 Installation of Linear Guide

Mounting the Master Linear Guide Rail

Use a Temporary Reference Surface from end to end to acquire Linear Guide rail straightness. For this method, however, two Linear Guide block must be fastened together, positioned on the top of each other while attached to a measurement plate, as shown in (Fig1.11.19).

Use a Straight Edge

After temporarily tightening the mounting bolts, use a dial gauge to check the straightness of the Linear Guide-rail-side reference surface from end to end, fully tightening the mounting bolts in sequence as you go, as shown in (Fig 1.11.20).

To mount the subsidiary Linear Guide rail, follow the procedures specified in the second paragraph on the previous page.

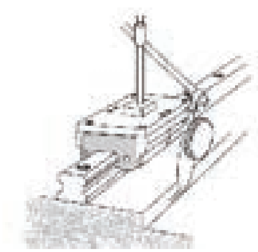


Fig 1.11.19 Use a Temporary Reference Surface

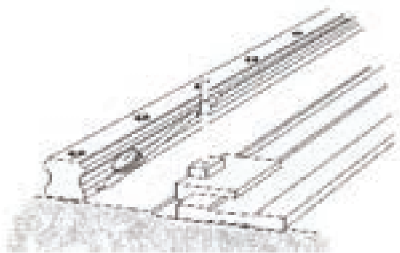


Fig 1.11.20 Use a Straight Edge

Shoulder Heights and Chamfers

Improper shoulder heights and chamfers of mounting surfaces will cause deviations in accuracy and rail or block interference with the chamfered part. When recommended shoulder heights and chamfers are used, problems with installation accuracy should be eliminated.

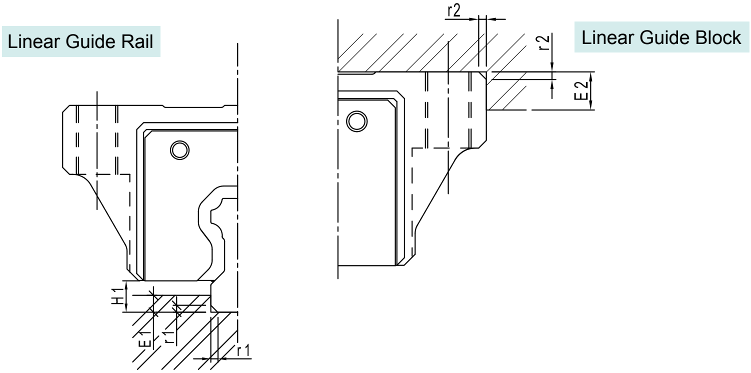


Fig 1.11.21

Table 1.11.4 Shoulder Height and Chamfer

Unit : mm

Model No.	Max.chamfer of the rail r1	Max.chamfer of the block r2	Max.chamfer of the rail E1	Max.chamfer of the rail E2	Max.chamfer of the block H1
TR / SR15	0.5	0.5	3	4	3.2
TR / SR20	0.5	0.5	3.5	5	4.6
TR / SR25	1.0	0.9	5	5	5.8
TR / SR30	1.0	1	5	5	7
TR / SR35	1.0	1	6	6	7.5
TR / SR45	1.0	1	8	8	8.9
TR55	1.5	1.5	10	10	13
TR65	1.5	1.5	8	10	14.3

1-12 Lubrication

Lubrication

Lubrication is essential to linear motion system. Without lubrication, the friction of rolling parts increases and might be the main factor of service life shortening.

A lubricant :

(1) Reduces friction on moving parts, thereby to prevent wearing due to raise in temperature.
(2) Forms an oil film on rolling surfaces, thus decreasing stress that develops on the surfaces and safeguarding the system against rolling fatigue.
(3) Covers metal surfaces with an oil film, thereby preventing rust.

To tap the full function of a linear motion system, lubrication is essential to meet the system service conditions.

※Even the linear motion system is sealed, it cannot completely prevent the leakage of lubricants no matter how negligible the amount of leakage is at any given time. It is therefore necessary to replenish the lubricant periodically according to the operating conditions.

Classification of Lubricants

Primarily grease and sliding surface oil are used as lubricants for linear motion systems.

In general a lubricant must :

(1) Form a strong oil film.
(2) Reduce wear as much as possible.
(3) Have high wear resistance.
(4) Have high thermal stability.
(5) Be non-corrosive.
(6) Be highly rust-preventive.
(7) Be free from dust and some moisture.
(8) Be free from significant fluctuations in consistency against repeated agitation of grease.

Table1.12.1 Lubricants in General Use

Lubricant	Classification	Item
Grease	Lithium-based grease (JIS No.2) Urea-base grease (JIS No.2)	※4FB Grease (TBI MOTION) Daphne Eponex Grease No.2 (Idemitsu Kosan) or equivalent.
Oil	Sliding surface oil or turbine oil ISO VG32~68	Super Multi 32 to 68 (Idemitsu Kosan) Vactra No.2S (Mobile Oil) DT Oil (Mobile Oil) Tonner Oil (Showa Shell Sekiyu) or equivalent

※Feeding Should be performed every 100 km of travel under normal usage conditions to prevent incomplete lubrication by exhausted lubrication.

1-13 Precautions of Linear Guide

Handling

(1) Tilting the linear guideway may cause the block falling out from the rail by their own weight.
(2) Hitting or Dropping the linear guideway may cause its function to be damaged, even if the product looks intact.
(3) Do not disassemble the block, this may cause contamination to enter into the carriage or decrease the installation accuracy.

Lubrication

(1) Please remove the anti-rust oil.
(2) Please do not mix different kinds of lubricants.
(3) Lubrication can be varied, please consult TBI Motion before use.

Usage

(1) The temperature of the place where linear guideways are used should not exceed 80°C. A higher temperature may damage the plastic end cap, do not exceed 100°c in friction.
(2) Using under special conditions, such as constant vibration, high contamination or the temperature exceed our suggested...etc., please contact TBI MOTION.

Storage

When storing the linear guideway, enclose it in a package and store it in a horizontal orientation while avoiding high temperature, low temperature and high humidity.

2-1 The Types of *TBI MOTION* Linear Guide

In an effort to meet customer's requirement, TBI MOTION offers several different types of guides. Except for TR international standard series, TBI MOTION develops TR series with self lubrication system which is designed for environment with high contamination and miniature TM series for small machines and semiconductor industry.The intelligent SR Series can be optionally equipped with sensor components.

Table 2.1.1 ***TBI MOTION*** Linear guide table with all series

Type	Height of Assembly Type	Square	Flange Mounting from Above, Mounting from Below
TR / SR	High-Assembly	TRH-V / SRH-V	TRH-F / SRH-F
	Low-Assembly	TRS-V / SRS-V	TRS-F / SRS-F
	Middle-Assembly	TRC-V / SRC-V	-

Table 2.1.2 ***TBI MOTION*** Linear Guide - Type & Series

Type	Accessory	Characteristics	EndCap
TR SR	XN : Strong Bottom Seal+Strong Double-lip end seals	Strong dust-proof Environment with high pollution	Reinforcement Type
	XNC : Strong Bottom Seal+Low Resistance End Seal		
	UN : Strong Top Seal+Strong Bottom Seal+Double-lip end seals		
	ZN : Strong Top Seal+Strong Bottom Seal+Strong Two Double-lip end seals		
	WW : Strong Bottom Seal+Felt+Strong Double-lip end seals	Self-lubrication/ Strong dust-proof Application with low rating load	
	WU : Strong Top Seal+Strong Bottom Seal+Felt+Strong Double-lip end seals		
	WZ : Strong Top Seal+Strong Bottom Seal+Felt+Strong Two Double-lip end seals		
	SU：Strong Top Seal+Strong Bottom Seal+Strong Double-lip end seals+Strong Metal Scraper	Strong dust-proof / Application with low rating load	
	SZ：Strong Top Seal+Strong Bottom Seal+Strong Two Double-lip end seals+Strong Metal Scraper		
	DU：Strong Top Seal+Strong Bottom Seal+Strong Double-lip end seals+Felt+Strong Metal Scraper	Self-lubrication/ Strong dust-proof / Application with low rating load	
	DZ：Strong Top Seal+Strong Bottom Seal+Strong Two Double-lip end seals+Felt+Strong Metal Scraper		
	BN : Strong Bottom Seal+Strong Double-lipendseals+Oil Reservoir	Long effects Self-lubrication/ Strong dust-proof	

※If Strengthen seals and Felt is required, please upgrade the block with enhanced end cap.
※XNC(Low Resistance End Seal) can be applied to TR15 to TR30.

2-2 TR International Standard Linear Guide / SR Intelligent Linear Guide

■ 2-2-1 *TBI MOTION* The Characteristics of TR / SR Series

Smooth Movement

TBI MOTION circulation system of Linear Guide block is designed to perform smooth movement.

High Stability

TBI MOTION Linear Guide block is designed under TBI's exclusive patent that can increases depth of material to improve the strength capacity, prevent deflection and provide high rigidity.

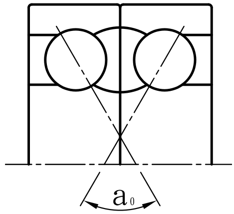


Fig 2.2.1

High Durability

TBI MOTION the exclusive contact point design promotes high rigidity. Moreover, self-aligning balances load rating in all directions. This design also improves performance in running accuracy and service life of the Linear Guide.

Easy Installation with Interchangeability

TBI MOTION Linear Guide is easy for installation even without fixture. The design of seal is able to combine with side seal or inner seal to save material.

■ 2-2-2 The Structure of TR / SR Series

Circulation unit :
① Block, ② Rail, ③ End Cap, ④ Steel Balls,
⑤ Circulation tube.

Lubrication unit :
⑥ Grease nipple.

Anti-Dust Unit :
⑦ End Seal, ⑧ Bottom Seal, ⑨ Mounting Hole Cap.

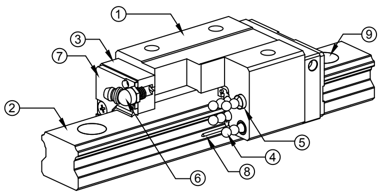


Fig 2.2.2 TR / SR Series Linear Guide

Fig 2.2.2 Material

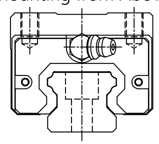
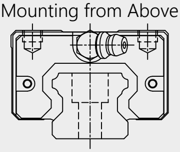
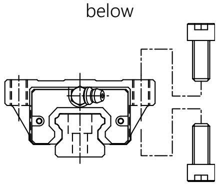
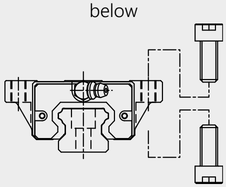
Item	Material	Hardness
TR / SR Rail	S55C	HRC 58°~62°
TR / SR Block	SCM420H	

2-2 TR International Standard Linear Guide / SR Intelligent Linear Guide

■ 2-2-3 TR / SR-Series

TBI MOTION offers standard and flange type. The assembly height and category are listed below :

Table 2.2.2

Type	Model	Shape	Height	Rail Length	Main Application
Standard	TRH-V TRC-V SRH-V SRC-V	Mounting from Above 	28 ↓ 90	100 ↓ 4000	● Machine Centers. ● NC Lathes. ● Food Machine. ● Grinding Machines. ● CNC Machine. ● Heavy Cutting Machines. ● Punching Machine. ● Injection Molding Machine. ● Automation Equipment. ● Transportation Equipment. ● Sealing machine.
	TRS-V SRS-V	Mounting from Above 	24 ↓ 60	100 ↓ 4000	
Flange	TRH-F SRH-F	Mounting from above and below 	24 ↓ 90	100 ↓ 4000	
	TRS-F SRS-F	Mounting from above and below 	24 ↓ 60	100 ↓ 4000	

■ 2-2-4 Nominal Model Code for Non-Interchangeable TR / SR Type

TR / SR series can be classified into Separated and Assembled types. The sizes are identical; the only difference between the two types is that the accuracy of non-interchangeable types could reach up to UP grade since ***TBI MOTION*** makes the linear guide set under strict international regulation. Interchangeable blocks and rails can be freely exchanged; however, the accuracy could be up to H grade only due to technical issue. It is much more convenient for customers who do not need linear guides with high accuracy to have interchange blocks and rails.

Non-interchangeable Type code :

T	R	H	20	F	N	-	2	-		-	1200	-	N	-	Z0	-	II	-	K	+	N3	N3
①	②	③	④	⑤	⑥		⑦		⑧		⑨		⑩		⑪		⑫		⑬		⑭	⑮

①

Nominal Model
T : Standard
S : Intelligent

②

Block Type
R : Standard
X : Special

③

Height of Assembly Type
S : Low-Assembly
C : Middle-Assembly
H : High-Assembly

④

Dimension
15, 20, 25, 30, 35, 45, 55, 65

⑤

Flange Type
F : With Flange
V : Without Flange

⑥

Length of Block
S : Short
N : Normal
L : Long
E : Extra-Long

⑦

Number of Block Per Rail
EX : 2

⑧

Accessory Code
□ : Standard (Please refer to page A58)

⑨

Length of Rail
Unit : mm

⑩

Accuracy Grade
N : Normal
H : High
P : Precision
SP : Super-Precision
UP : Ultra-Precision

⑪

Preload
ZF : Slight Clearance
Z0 : No Preload
Z1 : Light Preload
Z2 : Medium Preload
Z3 : Heavy Preload

⑫

Two Sets per Axis
II

⑬

Rail Special Machining
□ : Mounting from Top
K : Mounting from Bottom
X : Rail with Special Machining

⑭

Block Surface Treatment
S : Standard
B1 : Black Oxidation
N1 : Hard Chrome Plating
P : Phosphating
N3 : Nickel Plating
N4 : Raydent
N5 : Chrome Plating

⑮

Rail Surface Treatment
S : Standard
B1 : Black Oxidation
N1 : Hard Chrome Plating
P : Phosphating
N3 : Nickel Plating
N4 : Raydent
N5 : Chrome Plating

※No symbol required when plating is not needed.

2-2 TR International Standard Linear Guide / SR Intelligent Linear Guide

■ 2-2-5 Nominal Model Code for Interchangeable TR / SR Type

Interchangeable Type of Block :

T	R	H	20	F	N	-		-	N	-	Z0	+	B1
①	②	③	④	⑤	⑥		⑦		⑧		⑨		⑩

①

Nominal Model
T : Standard
S : Intelligent

②

Block Type
R : Standard
X : Special

③

Height of Assembly Type
S : Low-Assembly
C : Middle-Assembly
H : High-Assembly

④

Dimension
15, 20, 25, 30, 35, 45, 55, 65

⑤

Flange Type
F : With Flange
V : Without Flange

⑥

Length of Block
S : Short
N : Normal
L : Long
E : Extra-Long

⑦

Accessory Code
□ : Standard

⑧

Accuracy Grade
N : Normal

⑨

Preload
ZF : Slight Clearance
Z0 : No Preload

⑩

Block Surface Treatment
□ : Standard
B1 : Black Oxidation
N1 : Hard Chrome Plating
P : Phosphating
N3 : Nickel Plating
N4 : Raydent
N5 : Chrome Plating

Interchangeable Type of Rail :

T R 20 - 4000 - N - K + B1

① ② ③ ④ ⑤ ⑥ ⑦

①

Nominal Model
T : Standard

②

Block Type
R : Standard
X : Special

③

Dimension
15, 20, 25, 30, 35, 45, 55, 65

④

Length of Rail
Unit : mm

⑤

Accuracy Grade
N : Normal

⑥

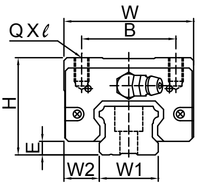
Rail Special Machining
□ : Mounting from Top
K : Mounting from Bottom
X : Rail with Special Machining

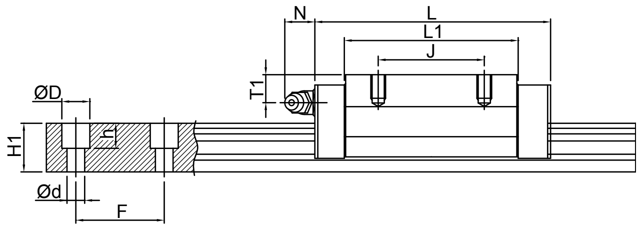
⑦

Rail Surface Treatment
□ : Standard
B1 : Black Oxidation
N1 : Hard Chrome Plating
P : Phosphating
N3 : Nickel Plating
N4 : Raydent
N5 : Chrome Plating

2-2 TR International Standard Linear Guide / SR Intelligent Linear Guide

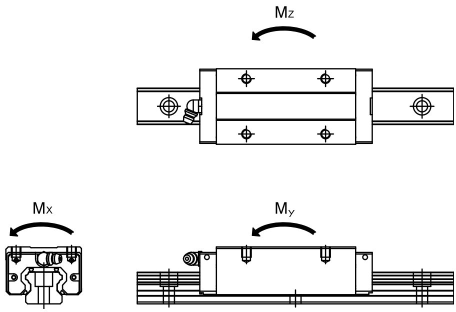
TRH-V Series Specifications





Model No.	Assembly (mm)			Block Dimension (mm)									Rail (mm)					
	H	W2	E	W	B	J	L	L1	QXℓ	T1	Oil Hole	N	W1	H1	ØD	h	Ød	F
TRH15VN	28	9.5	3.2	34	26	26	56.9	39.5	M4X8	9.5	M4X0.7	7	15	13	7.5	6	4.5	60
TRH20VN	30	12	4.6	44	32	36	75.6	54	M5X7	6.5	M6X1	14	20	16.5	9.5	8.5	6	60
TRH20VE						50	99.6	78										
TRH25VN	40	12.5	5.8	48	35	35	81	59	M6X8	11.5	M6X1	14	23	20	11	9	7	60
TRH25VE						50	110	88										
TRH30VN	45	16	7	60	40	40	96.3	69.3	M8X10	11	M6X1	14	28	23	14	12	9	80
TRH30VE						60	132	105										
TRH35VN	55	18	7.5	70	50	50	109	79	M8X10	15	M6X1	14	34	26	14	12	9	80
TRH35VE						72	153	123										
TRH45VL	70	20.5	8.9	85.5	60	60	140	106	M10X15	20.5	PT1/8	12.5	45	32	20	17	14	105
TRH45VE						80	174	140										
TRH55VL	80	23.5	13	100	75	75	162	118	M12X18	21	PT1/8	12.5	53	44	23	20	16	120
TRH55VE						95	200.1	156.1										
TRH65VL	90	31.5	14	126	76	70	197	147	M16X20	19	PT1/8	12.5	63	53	26	22	18	150
TRH65VE						120	256.5	206.5										

※The above specifications provided are dedicated to XN, UN, please check table 2.10.1 for detail, if other accessories is required, please refer to page A94.



Model No.	Load Rating (kgf)		Static Permissible Moment					Weight	
			Mx (kg-mm)	My (kg-mm)		Mz (kg-mm)		Block (kg)	Rail (kg/m)
	C	Co	Single Block	Single Block	Double Block	Single Block	Double Block		
TRH15VN	1206	2206	16,436	14,884	70,960	14,884	70,960	0.15	1.32
TRH20VN	2050	3696	37,334	33,268	157,298	33,268	157,298	0.31	2.28
TRH20VE	2553	5058	51,089	63,229	284,163	63,229	284,163	0.44	
TRH25VN	2581	4503	52,239	43,407	207,324	43,407	207,324	0.52	3.17
TRH25VE	3248	6255	72,554	85,112	391,311	85,112	391,311	0.77	
TRH30VN	3807	6483	90,722	74,970	355,321	74,970	355,321	0.85	4.54
TRH30VE	4791	9004	126,003	147,000	677,068	147,000	677,068	1.3	
TRH35VN	5090	8346	142,722	106,070	519,799	106,070	519,799	1.47	6.27
TRH35VE	6667	12274	209,885	233,977	1,070,533	233,977	1,070,533	2.26	
TRH45VL	7572	12808	292,657	220,751	1,030,183	220,751	1,030,183	3.00	10.4
TRH45VE	8852	16010	365,821	348,554	1,598,703	348,554	1,598,703	3.90	
TRH55VL	14703	21613	571,342	411,729	2,019,184	411,729	2,019,184	4.42	16.1
TRH55VE	17349	27377	723,699	670,530	3,148,637	670,530	3,148,637	5.50	
TRH65VL	22526	31486	973,074	695,840	3,594,277	695,840	3,594,277	8.66	22.54
TRH65VE	27895	42731	1,320,601	1,307,568	6,312,759	1,307,568	6,312,759	10.30	

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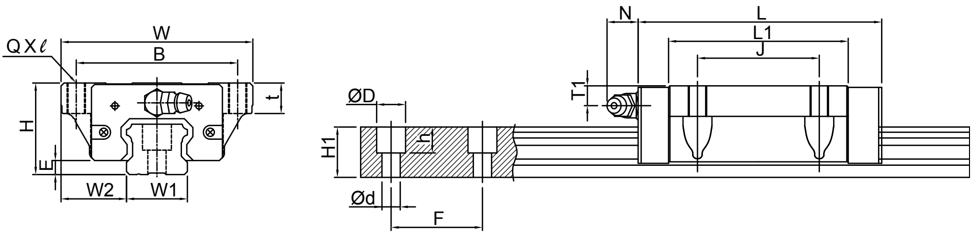
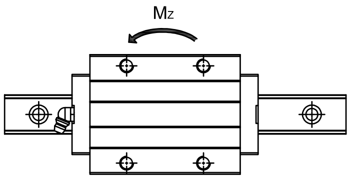
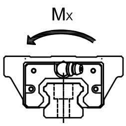
TRH-F Series Specifications

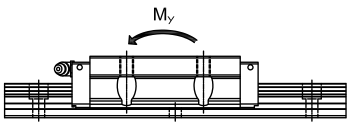


Model No.	Assembly (mm)			Block Dimension (mm)										Rail (mm)					
	H	W2	E	W	B	J	t	L	L1	QXℓ	T1	Oil Hole	N	W1	H1	ØD	h	Ød	F
TRH15FN	24	16	3.2	47	38	30	8	56.9	39.5	M5X8	5.5	M4X0.7	7	15	13	7.5	6	4.5	60
TRH20FN	30	21.5	4.6	63	53	40	10	75.6	54	M6X10	6.5	M6X1	14	20	16.5	9.5	8.5	6	60
TRH20FE								99.6	78										
TRH25FN	36	23.5	5.8	70	57	45	12	81	59	M8X12	7.5	M6X1	14	23	20	11	9	7	60
TRH25FE								110	88										
TRH30FN	42	31	7	90	72	52	15	96.3	69.3	M10X15	8	M6X1	14	28	23	14	12	9	80
TRH30FE								132	105										
TRH35FN	48	33	7.5	100	82	62	15	109	79	M10X15	8	M6X1	14	34	26	14	12	9	80
TRH35FE								153	123										
TRH45FL	60	37.5	8.9	120	100	80	18	140	106	M12X18	10.5	PT1/8	12.5	45	32	20	17	14	105
TRH45FE								174	140										
TRH55FL	70	43.5	13	140	116	95	29	162	118	M14X17	11	PT1/8	12.5	53	44	23	20	16	120
TRH55FE								200.1	156.1										
TRH65FL	90	53.5	14	170	142	110	37	197	147	M16X23	19	PT1/8	12.5	63	53	26	22	18	150
TRH65FE								256.5	206.5										

※The above specifications provided are dedicated to XN, UN, please check table 2.10.1 for detail, if other accessories is required, please refer to page A94.







Model No.	Load Rating (kgf)		Static Permissible Moment					Weight	
			Mx (kg-mm)	My (kg-mm)		Mz (kg-mm)		Block (kg)	Rail (kg/m)
	C	Co	Single Block	Single Block	Double Block	Single Block	Double Block		
TRH15FN	1206	2206	16,436	14,884	70,960	14,884	70,960	0.18	1.32
TRH20FN	2050	3696	37,334	33,268	157,298	33,268	157,298	0.39	2.28
TRH20FE	2553	5058	51,089	63,229	284,163	63,229	284,163	0.58	
TRH25FN	2581	4503	52,239	43,407	207,324	43,407	207,324	0.60	3.17
TRH25FE	3248	6255	72,554	85,112	391,311	85,112	391,311	0.85	
TRH30FN	3807	6483	90,722	74,970	355,321	74,970	355,321	1.01	4.54
TRH30FE	4791	9004	126,003	147,000	677,068	147,000	677,068	1.54	
TRH35FN	5090	8346	142,722	106,070	519,799	106,070	519,799	1.47	6.27
TRH35FE	6667	12274	209,885	233,977	1,070,533	233,977	1,070,533	2.29	
TRH45FL	7572	12808	292,657	220,751	1,030,183	220,751	1,030,183	2.80	10.4
TRH45FE	8852	16010	365,821	348,554	1,598,703	348,554	1,598,703	3.79	
TRH55FL	14703	21613	571,342	411,729	2,019,184	411,729	2,019,184	4.22	16.1
TRH55FE	17349	27377	723,699	670,530	3,148,637	670,530	3,148,637	5.6	
TRH65FL	22526	31486	973,074	695,840	3,594,277	695,840	3,594,277	9.31	22.54
TRH65FE	27895	42731	1,320,601	1,307,568	6,312,759	1,307,568	6,312,759	12.98	

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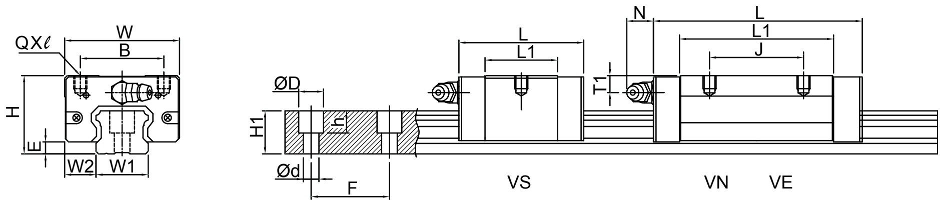
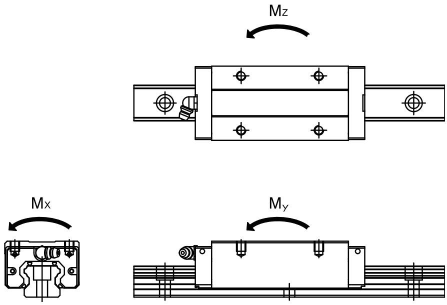
TRS-V Series Specifications



Model No.	Assembly(mm)			Block Dimension(mm)									Rail(mm)					
	H	W2	E	W	B	J	L	L1	QXℓ	T1	Oil Hole	N	W1	H1	ØD	h	Ød	F
TRS15VS	24	9.5	3.2	34	26		40.3	22.9	M4X5	5.5	M4X0.7	7	15	13	7.5	6	4.5	60
TRS15VN						26	56.9	39.5										
TRS20VS	28	11	4.6	42	32		49.4	27.8	M5X6	4.5	M6X1	14	20	16.5	9.5	8.5	6	60
TRS20VN						32	68.3	46.7										
TRS25VS	33	12.5	5.8	48	35		57.2	35.2	M6X6.5	4.5	M6X1	14	23	20	11	9	7	60
TRS25VN						35	81	59										
TRS30VS	42	16	7	60	40		67.4	40.4	M8X10	8	M6X1	14	28	23	14	12	9	80
TRS30VN						40	96.3	69.3										
TRS35VN	48	18	7.5	70	50	50	109	79	M8X10	8	M6X1	14	34	26	14	12	9	80
TRS35VE						72	153	123										
TRS45VN	60	20.5	8.9	85.5	60	60	124.5	90.5	M10X15	10.5	PT1/8	12.5	45	32	20	17	14	105

※The above specifications provided are dedicated to XN, UN, please check table 2.10.1 for detail, if other accessories is required, please refer to page A94.



Model No.	Load Rating (kgf)		Static Permissible Moment					Weight	
			Mx (kg-mm)	My (kg-mm)		Mz (kg-mm)		Block (kg)	Rail (kg/m)
	C	Co	Single Block	Single Block	Double Block	Single Block	Double Block		
TRS15VS	908	1471	10,957	6,420	33,531	6,420	33,531	0.09	1.32
TRS15VN	1206	2206	16,436	14,884	70,960	14,884	70,960	0.15	
TRS20VS	1398	2140	21,615	10,700	59,798	10,700	59,798	0.15	2.28
TRS20VN	1896	3307	33,404	26,459	126,998	26,459	126,998	0.23	
TRS25VS	1943	3002	34,826	18,725	97,890	18,725	97,890	0.25	3.17
TRS25VN	2581	4503	52,239	43,407	207,324	43,407	207,324	0.39	
TRS30VS	2697	3962	55,442	26,950	154,224	26,950	154,224	0.48	4.54
TRS30VN	3807	6483	90,722	74,970	355,321	74,970	355,321	0.77	
TRS35VN	5090	8346	142,722	106,070	519,799	106,070	519,799	1.15	6.27
TRS35VE	6667	12274	209,885	233,977	1,070,533	233,977	1,070,533	1.54	
TRS45VN	6758	10887	248,758	158,011	782,271	158,011	782,271	1.98	10.4

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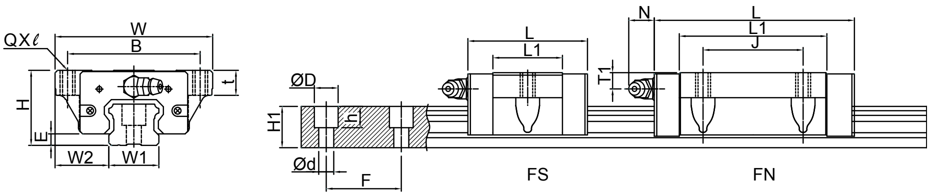
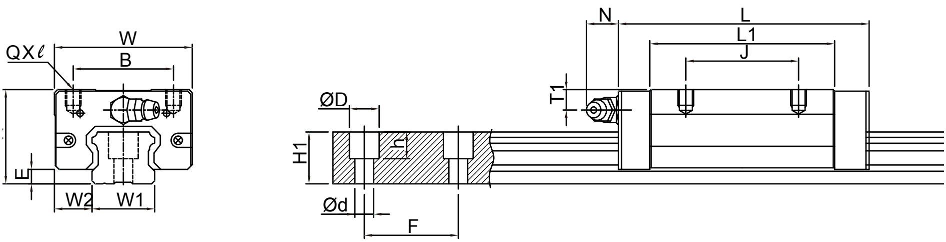
TRS-F Series Specifications



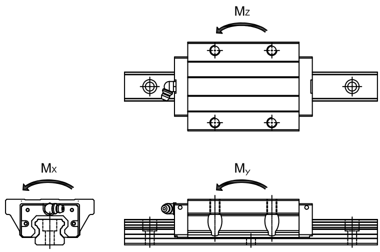
Model No.	Assembly(mm)			Block Dimension(mm)										Rail(mm)					
	H	W2	E	W	B	J	t	L	L1	QXℓ	T1	Oil Hole	N	W1	H1	ØD	h	Ød	F
TRS15FS	24	18.5	3.2	52	41	/	7	40.3	22.9	M5X7	5.5	M4X0.7	7	15	13	7.5	6	4.5	60
TRS15FN						26		56.9	39.5										
TRS20FS	28	19.5	4.6	59	49	/	9	49.4	27.8	M6X9	4.5	M6X1	14	20	16.5	9.5	8.5	6	60
TRS20FN						32		68.3	46.7										
TRS25FN	33	25	5.8	73	60	35	10	81	59	M8X10	4.5	M6X1	14	23	20	11	9	7	60

※The above specifications provided are dedicated to XN, UN, please check table 2.10.1 for detail, if other accessories is required, please refer to page A94.

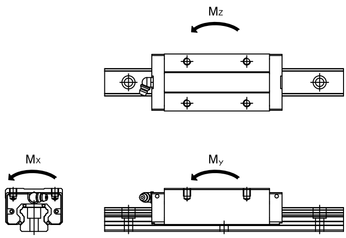


Model No.	Assembly(mm)			Block Dimension(mm)									Rail(mm)					
	H	W2	E	W	B	J	L	L1	QXℓ	T1	Oil Hole	N	W1	H1	ØD	h	Ød	F
TRC25VE	36	12.5	5.8	48	35	50	110	88	M6X6.5	7.5	M6X1	14	23	20	11	9	7	60

※The above specifications provided are dedicated to XN, UN, please check table 2.10.1 for detail, if other accessories is required, please refer to page A94.



Model No.	Load Rating (kgf)		Static Permissible Moment					Weight	
			Mx (kg-mm)	My (kg-mm)		Mz (kg-mm)		Block (kg)	Rail (kg/m)
	C	Co	Single Block	Single Block	Double Block	Single Block	Double Block		
TRS15FS	908	1471	10,957	6,420	33,531	6,420	33,531	0.12	1.32
TRS15FN	1206	2206	16,436	14,884	70,960	14,884	70,960	0.19	
TRS20FS	1398	2140	21,615	10,700	59,798	10,700	59,798	0.19	2.28
TRS20FN	1896	3307	33,404	26,459	126,998	26,459	126,998	0.29	
TRS25FN	2581	4503	52,239	43,407	207,324	43,407	207,324	0.51	3.17



Model No.	Load Rating (kgf)		Static Permissible Moment					Weight	
			Mx (kg-mm)	My (kg-mm)		Mz (kg-mm)		Block (kg)	Rail (kg/m)
	C	Co	Single Block	Single Block	Double Block	Single Block	Double Block		
TRC25VE	3248	6255	72,554	85,112	391,311	85,112	391,311	0.65	3.17

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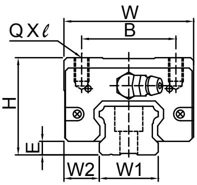
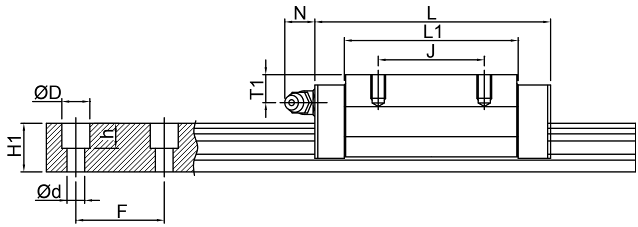
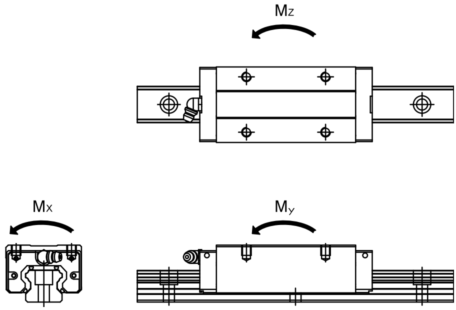
SRH-V Series Specifications





Model No.	Assembly (mm)			Block Dimension(mm)									Rail(mm)					
	H	W2	E	W	B	J	L	L1	QXℓ	T1	Oil Hole	N	W1	H1	ØD	h	Ød	F
SRH15VN	28	9.5	3.2	34	26	26	55.9	39.5	M4x8	9.5	M4x0.7	7	15	13	7.5	6	4.5	60
SRH20VN	30	12	4.6	44	32	36	74	54	M5x7	6.5	M6x1	14	20	16.5	9.5	8.5	6	60
SRH20VE						50	98	78										
SRH25VN	40	12.5	5.8	48	35	35	80	59	M6x8	11.5	M6x1	14	23	20	11	9	7	60
SRH25VE						50	109	88										
SRH30VN	45	16	7	60	40	40	94.7	69.3	M8x10	11	M6x1	14	28	23	14	12	9	80
SRH30VE						60	130.4	105										
SRH35VN	55	18	7.5	70	50	50	107.4	79	M8x10	15	M6x1	14	34	26	14	12	9	80
SRH35VE						72	151.4	123										
SRH45VL	70	20.5	8.9	85.5	60	60	137.4	106	M10x15	20.5	PT1/8	12.5	45	32	20	17	14	105
SRH45VE						80	171.4	140										

※The above specifications provided are dedicated to XNC, please check table 2.10.1 for detail, if other accessories is required, please refer to page A94.



Model No.	Load Rating (kgf)		Static Permissible Moment					Weight	
			Mx (kg-mm)	My (kg-mm)		Mz (kg-mm)		Block (kg)	Rail (kg/m)
	C	Co	Single Block	Single Block	Double Block	Single Block	Double Block		
SRH15VN	1206	2206	16,436	14,884	70,960	14,884	70,960	0.15	1.32
SRH20VN	2050	3696	37,334	33,268	157,298	33,268	157,298	0.31	2.28
SRH20VE	2553	5058	51,089	63,229	284,163	63,229	284,163	0.44	
SRH25VN	2581	4503	52,239	43,407	207,324	43,407	207,324	0.52	3.17
SRH25VE	3248	6255	72,554	85,112	391,311	85,112	391,311	0.77	
SRH30VN	3807	6483	90,722	74,970	355,321	74,970	355,321	0.85	4.54
SRH30VE	4791	9004	126,003	147,000	677,068	147,000	677,068	1.3	
SRH35VN	5090	8346	142,722	106,070	519,799	106,070	519,799	1.47	6.27
SRH35VE	6667	12274	209,885	233,977	1,070,533	233,977	1,070,533	2.26	
SRH45VL	7572	12808	292,657	220,751	1,030,183	220,751	1,030,183	3	10.4
SRH45VE	8852	16010	365,821	348,554	1,598,703	348,554	1,598,703	3.9	

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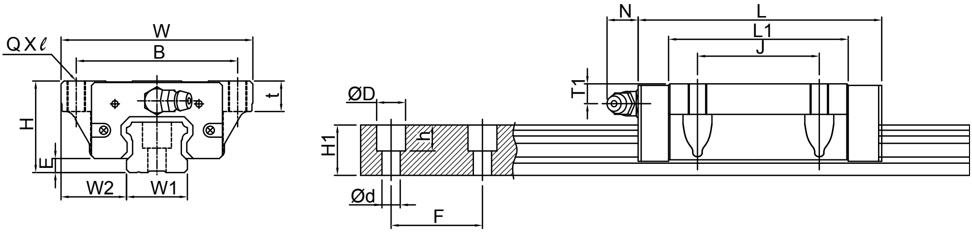
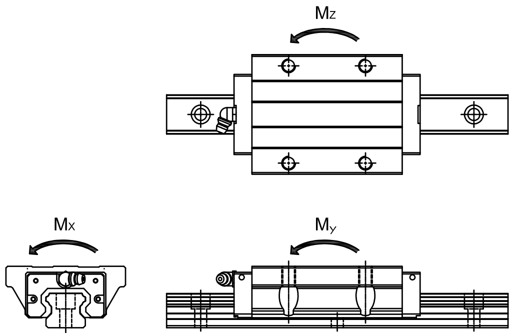
SRH-F Series Specifications



Model No.	Assembly(mm)			Block Dimension(mm)										Rail(mm)					
	H	W2	E	W	B	J	t	L	L1	QXℓ	T1	Oil Hole	N	W1	H1	ØD	h	Ød	F
SRH15FN	24	16	3.2	47	38	30	8	55.9	39.5	M5x8	5.5	M4x0.7	7	15	13	7.5	6	4.5	60
SRH20FN	30	21.5	4.6	63	53	40	10	74	54	M6x10	6.5	M6x1	14	20	16.5	9.5	8.5	6	60
SRH20FE								98	78										
SRH25FN	36	23.5	5.8	70	57	45	12	80	59	M8x12	7.5	M6x1	14	23	20	11	9	7	60
SRH25FE								109	88										
SRH30FN	42	31	7	90	72	52	15	94.7	69.3	M10x15	8	M6x1	14	28	23	14	12	9	80
SRH30FE								130.4	105										
SRH35FN	48	33	7.5	100	82	62	15	107.4	79	M10x15	8	M6x1	14	34	26	14	12	9	80
SRH35FE								151.4	123										
SRH45FL	60	37.5	8.9	120	100	80	18	137.4	106	M12x18	10.5	PT1/8	12.5	45	32	20	17	14	105
SRH45FE								171.4	140										

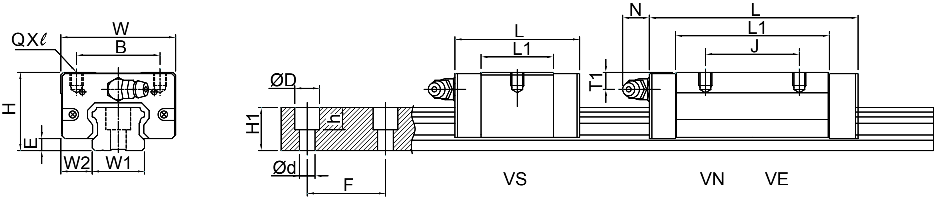
※The above specifications provided are dedicated to XNC, please check table 2.10.1 for detail, if other accessories is required, please refer to page A94.



Model No.	Load Rating(kgf)		Static Permissible Moment					Weight	
			Mx (kg-mm)	My (kg-mm)		Mz (kg-mm)		Block (kg)	Rail (kg/m)
	C	Co	Single Block	Single Block	Double Block	Single Block	Double Block		
SRH15FN	1206	2206	16,436	14,884	70,960	14,884	70,960	0.18	1.32
SRH20FN	2050	3696	37,334	33,268	157,298	33,268	157,298	0.39	2.28
SRH20FE	2553	5058	51,089	63,229	284,163	63,229	284,163	0.58	
SRH25FN	2581	4503	52,239	43,407	207,324	43,407	207,324	0.6	3.17
SRH25FE	3248	6255	72,554	85,112	391,311	85,112	391,311	0.85	
SRH30FN	3807	6483	90,722	74,970	355,321	74,970	355,321	1.01	4.54
SRH30FE	4791	9004	126,003	147,000	677,068	147,000	677,068	1.54	
SRH35FN	5090	8346	142,722	106,070	519,799	106,070	519,799	1.47	6.27
SRH35FE	6667	12274	209,885	233,977	1,070,533	233,977	1,070,533	2.29	
SRH45FL	7572	12808	292,657	220,751	1,030,183	220,751	1,030,183	2.8	10.4
SRH45FE	8852	16010	365,821	348,554	1,598,703	348,554	1,598,703	3.79	

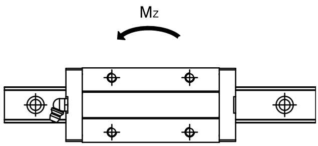
2-2 TR International Standard Linear Guide / SR Intelligent Linear Guide

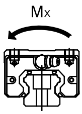
SRS-V Series Specifications

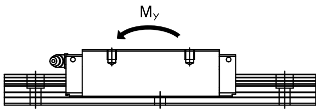


Model No.	Assembly (mm)			Block Dimension(mm)									Rail(mm)					
	H	W2	E	W	B	J	L	L1	QXℓ	T1	Oil Hole	N	W1	H1	ØD	h	Ød	F
SRS15VS	24	9.5	3.2	34	26		39.3	22.9	M4x5	5.5	M4x0.7	7	15	13	7.5	6	4.5	60
SRS15VN						26	55.9	39.5										
SRS20VS	28	11	4.6	42	32		47.8	27.8	M5x6	4.5	M6x1	14	20	16.5	9.5	8.5	6	60
SRS20VN						32	66.7	46.7										
SRS25VS	33	12.5	5.8	48	35		56.2	35.2	M6x6.5	4.5	M6x1	14	23	20	11	9	7	60
SRS25VN						35	80	59										
SRS30VS	42	16	7	60	40		65.8	40.4	M8x10	8	M6x1	14	28	23	14	12	9	80
SRS30VN						40	94.7	69.3										
SRS35VN	48	18	7.5	70	50	50	107.4	79	M8x10	8	M6x1	14	34	26	14	12	9	80
SRS35VE						72	151.4	123										
SRS45VN	60	20.5	8.9	85.5	60	60	121.9	90.5	M10x15	10.5	PT1/8	12.5	45	32	20	17	14	105

※The above specifications provided are dedicated to XNC, please check table 2.10.1 for detail, if other accessories is required, please refer to page A94.



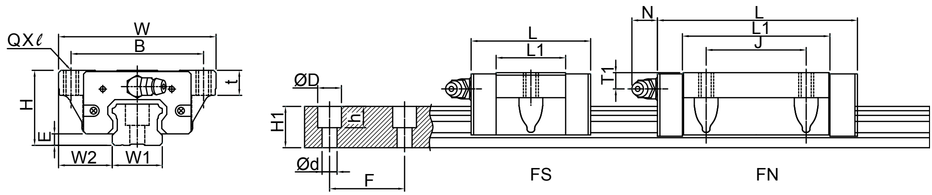




Model No.	Load Rating (kgf)		Static Permissible Moment					Weight	
			Mx (kg-mm)	My (kg-mm)		Mz (kg-mm)		Block (kg)	Rail (kg/m)
	C	Co	Single Block	Single Block	Double Block	Single Block	Double Block		
SRS15VS	908	1471	10,957	6,420	33,531	6,420	33,531	0.09	1.32
SRS15VN	1206	2206	16,436	14,884	70,960	14,884	70,960	0.15	
SRS20VS	1398	2140	21,615	10,700	59,798	10,700	59,798	0.15	2.28
SRS20VN	1896	3307	33,404	26,459	126,998	26,459	126,998	0.23	
SRS25VS	1943	3002	34,826	18,725	97,890	18,725	97,890	0.25	3.17
SRS25VN	2581	4503	52,239	43,407	207,324	43,407	207,324	0.39	
SRS30VS	2697	3962	55,442	26,950	154,224	26,950	154,224	0.48	4.54
SRS30VN	3807	6483	90,722	74,970	355,321	74,970	355,321	0.77	
SRS35VN	5090	8346	142,722	106,070	519,799	106,070	519,799	1.15	6.27
SRS35VE	6667	12274	209,885	233,977	1,070,533	233,977	1,070,533	1.54	
SRS45VN	6758	10887	248,758	158,011	782,271	158,011	782,271	1.98	10.4

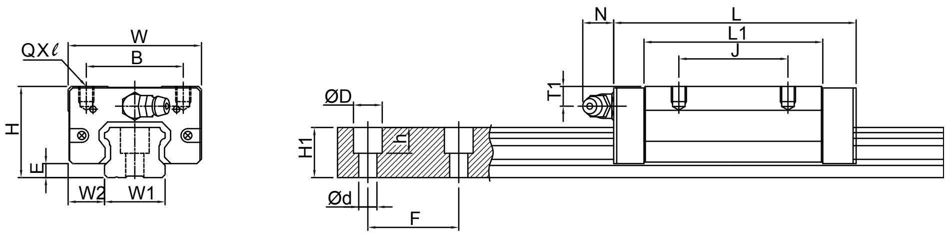
2-2 TR International Standard Linear Guide / SR Intelligent Linear Guide

SRS-F Series Specifications



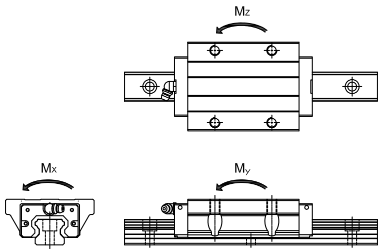
Model No.	Assembly(mm)			Block Dimension(mm)										Rail(mm)					
	H	W2	E	W	B	J	t	L	L1	QXℓ	T1	Oil Hole	N	W1	H1	ØD	h	Ød	F
SRS15FS	24	18.5	3.2	52	41	/	7	39.3	22.9	M5x7	5.5	M4x0.7	7	15	13	7.5	6	4.5	60
SRS15FN	24	18.5	3.2	52	41	26	7	55.9	39.5	M5x7	5.5	M4x0.7	7	15	13	7.5	6	4.5	60
SRS20FS	28	19.5	4.6	59	49	/	9	47.8	27.8	M6x9	4.5	M6x1	14	20	16.5	9.5	8.5	6	60
SRS20FN	28	19.5	4.6	59	49	32	9	66.7	46.7	M6x9	4.5	M6x1	14	20	16.5	9.5	8.5	6	60
SRS25FN	33	25	5.8	73	60	35	10	80	59	M8x10	4.5	M6x1	14	23	20	11	9	7	60

※The above specifications provided are dedicated to XNC, please check table 2.10.1 for detail, if other accessories is required, please refer to page A94.

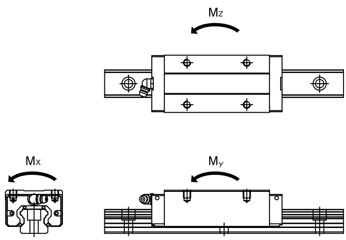


Model No.	Assembly(mm)			Block Dimension(mm)									Rail(mm)					
	H	W2	E	W	B	J	L	L1	QXℓ	T1	Oil Hole	N	W1	H1	ØD	h	Ød	F
SRC25VE	36	12.5	5.8	48	35	50	109	88	M6X6.5	7.5	M6X1	14	23	20	11	9	7	60

※The above specifications provided are dedicated to XNC, please check table 2.10.1 for detail, if other accessories is required, please refer to page A94.



Model No.	Load Rating (kgf)		Static Permissible Moment					Weight	
			Mx (kg-mm)	My (kg-mm)		Mz (kg-mm)		Block (kg)	Rail (kg/m)
	C	Co	Single Block	Single Block	Double Block	Single Block	Double Block		
SRS15FS	908	1471	10,957	6,420	33,531	6,420	33,531	0.12	1.32
SRS15FN	1206	2206	16,436	14,884	70,960	14,884	70,960	0.19	
SRS20FS	1398	2140	21,615	10,700	59,798	10,700	59,798	0.19	2.28
SRS20FN	1896	3307	33,404	26,459	126,998	26,459	126,998	0.29	
SRS25FN	2581	4503	52,239	43,407	207,324	43,407	207,324	0.51	3.17



Model No.	Load Rating(kgf)		Static Permissible Moment					Weight	
			Mx (kg-mm)	My (kg-mm)		Mz (kg-mm)		Block (kg)	Rail (kg/m)
	C	Co	Single Block	Single Block	Double Block	Single Block	Double Block		
SRC25VE	3248	6255	72,554	85,112	391,311	85,112	391,311	0.65	3.17

2-3 The Standard Length and Maxima Length of Linear Rail

TBI MOTION offer our customers standard and customized rail length to meet the requirement of our customers. TBI suggests that when ordering customized rail length, to prevent unstable running performance after mounting, the end cap value G should be no greater than 1/2F.

L = [n-1] • F+2 • G

L : Total Length of Rail (mm)
n : Number of Mounting Holes
F : Distance Between Any Two Holes (mm)
G : Distance from the Center of the Last Hole to the Edge (mm)

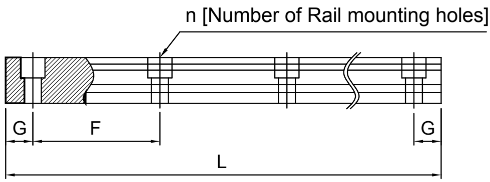


Fig 2.3.1

Table 2.3.1

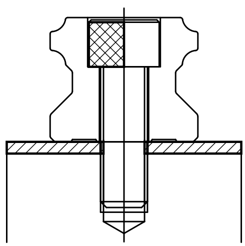
Unit : mm

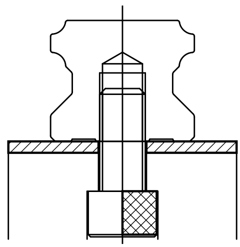
Item	TR / SR15	TR / SR20	TR / SR25	TR / SR30	TR / SR35	TR / SR45	TR55	TR65
F：Pitch	60	60	60	80	80	105	120	150
G：Suggested Distance to End	20	20	20	20	20	22.5	30	35
L：Max. Length	4000	4000	4000	4000	4000	4000	4000	4000

■ 2-4 Mounting Type of Linear Rail

Besides the standard top mounting type, ***TBI MOTION*** also offers bottom mounting type rails.

Table 2.4.1


Mounting from Above


Mounting from Below

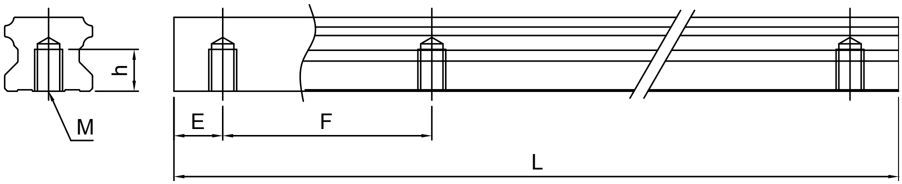


Fig 2.4.1 Mounting from below

Table 2.4.2 Rail Size Chart

Unit : mm

	M	h	E	F
TR / SR15	M5×0.8	8	20	60
TR / SR20	M6×1	10	20	60
TR / SR25	M6×1	12	20	60
TR / SR30	M8×1.25	15	20	80
TR / SR35	M8×1.25	17	20	80
TR / SR45	M12×1.75	24	22.5	105
TR55	M14×2	24	30	120
TR65	M20×2.5	30	35	150

2-5 Accuracy Standard

The accuracy standards of TR / SR Series range, from normal (N), high (H), precision (P), super-precision (SP) and ultra-precision (UP). It allows our user to choose according to the accuracy standards of the equipment.

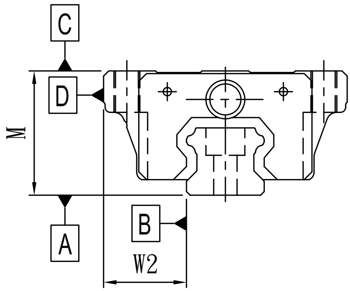


Fig 2.5.1 Accuracy Standard

Table 2.5.1 TR / SR Accuracy of Running Parallelism

TR / SR Rail Length (mm)	Accuracy (μm)				
	N	H	P	SP	UP
0~125	5	3	2	1.5	1
125~200	5	3.5	2	1.5	1
200~250	6	4	2.5	1.5	1
250~315	7	4.5	3	1.5	1
315~400	8	5	3.5	2	1.5
400~500	9	6	4.5	2.5	1.5
500~630	16	11	6	2.5	1.5
630~800	18	12	7	3	2
800~1000	20	14	8	4	2
1000~1250	22	16	10	5	2.5
1250~1600	25	18	11	6	3
1600~2000	28	20	13	7	3.5
2000~2500	30	22	15	8	4
2500~3000	32	24	16	9	4.5
3000~3500	33	25	17	11	5
3500~4000	34	26	18	12	6

Table 2.5.2

Unit : mm

Accuracy Standard										
	TR / SR 15 20					TR / SR 25 30 35				
Accuracy Standard	Normal	High	Precision	Super Precision	Ultra Precision	Normal	High	Precision	Super Precision	Ultra Precision
Item	N	H	P	SP	UP	N	H	P	SP	UP
Tolerance for height M	±0.1	±0.03	0 -0.03	0 -0.015	0 -0.008	±0.1	±0.04	0 -0.04	0 -0.02	0 -0.01
Tolerance for height M difference among Linear Guide Block	0.02	0.01	0.006	0.004	0.003	0.02	0.015	0.007	0.005	0.003
Tolerance for rail-to-block lateral distance W2	±0.1	±0.03	0 -0.03	0 -0.015	0 -0.008	±0.1	±0.04	0 -0.04	0 -0.02	0 -0.01
Tolerance for rail-to-block lateral distance W2 difference among Linear Guide Block	0.02	0.01	0.006	0.004	0.003	0.03	0.015	0.007	0.005	0.003
Running parallelism of Linear Guide Block surface C with respect to surface A	Δ C, TR Rail Length and Running Accuracy (Fig 2.5.2)					Δ C, TR Rail Length and Running Accuracy (Fig 2.5.2)				
Running parallelism of Linear Guide Block surface D with respect to surface B	Δ D, TR Rail Length and Running Accuracy (Fig 2.5.2)					Δ D, TR Rail Length and Running Accuracy (Fig 2.5.2)				

Accuracy Standard										
	TR 45 55 / SR 45					TR 65				
Accuracy Standard	Normal	High	Precision	Super Precision	Ultra Precision	Normal	High	Precision	Super Precision	Ultra Precision
Item	N	H	P	SP	UP	N	H	P	SP	UP
Tolerance for height M	±0.1	±0.05	0 -0.05	0 -0.03	0 -0.02	±0.1	±0.07	0 -0.07	0 -0.05	0 -0.03
Tolerance for height M difference among Linear Guide Block	0.03	0.015	0.007	0.005	0.003	0.03	0.02	0.01	0.007	0.005
Tolerance for rail-to-block lateral distance W2	±0.1	±0.05	0 -0.05	0 -0.03	0 -0.02	±0.1	±0.07	0 -0.07	0 -0.05	0 -0.03
Tolerance for rail-to-block lateral distance W2 difference among Linear Guide Block	0.03	0.02	0.01	0.007	0.005	0.03	0.025	0.015	0.01	0.007
Running parallelism of Linear Guide Block surface C with respect to surface A	Δ C, TR Rail Length and Running Accuracy (Fig 2.5.2)					Δ C, TR Rail Length and Running Accuracy (Fig 2.5.2)				
Running parallelism of Linear Guide Block surface D with respect to surface B	Δ D, TR Rail Length and Running Accuracy (Fig 2.5.2)					Δ D, TR Rail Length and Running Accuracy (Fig 2.5.2)				

2-6 Determining the Magnitude of a Preload

What's Preload

Using larger rolling elements helps strengthen the entire rigidity of the block while there exists clearance within ball circulation.

Increasing preload would decrease the vibration and reduce the corrosion caused by running back and forth. However, it would also add the workload within those rolling elements. The greater the preload is, the greater the inner workload is. Therefore, choosing preload has to consider the effect carefully between vibration and preload.

Table 2.6.1 Preload Grade

C : Dynamic load rating

Grade	Symbol	Preload Force
Slight Clearance	ZF	0
No Preload	Z0	0
Light Preload	Z1	0.02C
Medium Preload	Z2	0.05C
Heavy Preload	Z3	0.07C

Table 2.6.2 TR / SR Series Radial Clearances

Unit : μm

Preload / Model No.	ZF	Z0	Z1	Z2	Z3
TR / SR15	5~12	-4~4	-12~-5	-20~-13	-28~-21
TR / SR20	6~14	-5~5	-14~-6	-23~-15	-32~-24
TR / SR25	7~16	-6~6	-16~-7	-26~-17	-36~-27
TR / SR30	8~18	-7~7	-18~-8	-29~-19	-40~-30
TR / SR35	9~20	-8~8	-20~-9	-32~-21	-44~-33
TR / SR45	10~22	-9~9	-22~-10	-35~-23	-48~-36
TR55	11~24	-10~10	-24~-11	-38~-25	-52~-39
TR65	12~26	-11~11	-26~-12	-41~-27	-56~-42

Table 2.6.3 The Difference between Interchageability and Non-Interchageability

	Non-Interchangeable					Interchangeable
Slight Clearance	UP	SP	P	H	N	N
Preload	Z1 Z2 Z3	Z1 Z2 Z3	Z0 Z1 Z2 Z3	Z0 Z1 Z2 Z3	ZF Z0 Z1 Z2	ZF Z0 Z1

■ 2-7 Mounting Location of Grease Nipples

The standard location of the grease nipple is at both ends of the block, but the nipple can be mounted at each side of block. For lateral installation, we recommend that the nipple be mounted at the non-reference side, otherwise please contact us. It is possible to perform lubrication by using the oil-piping joint.

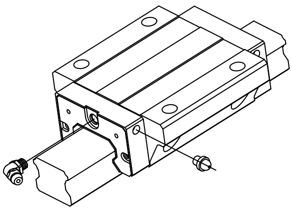


Fig 2.7.1 Mounting Location

Table 2.7.1 The Lubricant Amount for a Block Filled with Grease

Size	Grease (c.c.)
TR / SR15	1.3
TR / SR20	2.5
TR / SR25	2.5
TR / SR30	7
TR / SR35	9
TR / SR45	15.2
TR55	40
TR65	75

Table 2.7.2 Oil Refilling Rate

Size	Oil refilling rate (cm^2/hr)
TR / SR15	0.2
TR / SR20	0.2
TR / SR25	0.3
TR / SR30	0.3
TR / SR35	0.3
TR / SR45	0.4
TR55	0.5
TR65	0.6

A Linear Guide

2-8 Grease Nipples

Table 2.8.1 Grease Nipples

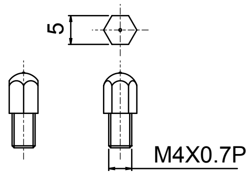
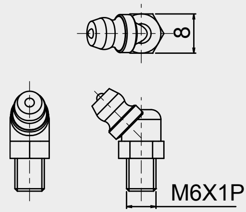
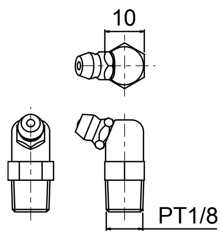
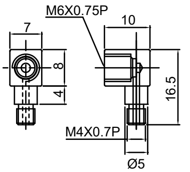
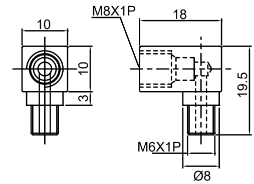
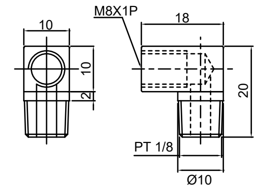
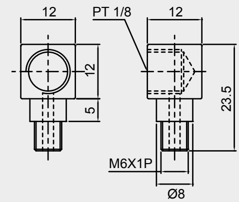
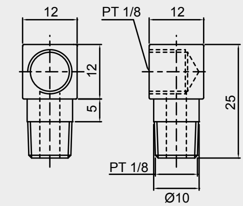
Model	Accessory Code	Grease Nipple Code	Size
TR / SR15	XN, XNC, UN	SD-020	M4X0.7P 
	SU, ZN	SD-024	
	SZ	SD-066	
	WW, WU, WZ, DU, DZ	-	
TR / SR20 TR / SR25 TR / SR30	XN, XNC, UN	SD-021	M6X1P 
	SU	SD-025	
	SZ	SD-026	
	ZN	SD-075	
	WW, WU, WZ, DU, DZ	-	
TR / SR35	XN, UN	SD-021	
	SU, ZN	SD-026	
	SZ	SD-060	
	WW, WU, WZ, DU, DZ	-	
TR / SR45	XN, XNC, UN	SD-011	PT1/8 
	SZ, ZN	SD-027	
	SU	SD-068	
	WW, WU, WZ, DU, DZ	-	
TR55	XN, XNC, UN	SD-011	
	SZ, ZN	SD-059	
	SU	SD-068	
	WW, WU, WZ	-	
TR65	XN, XNC, UN	SD-011	
	SU	SD-059	
	SZ, ZN	SD-058	
	WW, WU, WZ	-	

Table 2.8.2 Types of Lubrication Coupler

<table>
<tr><th>Model</th><th>TR / SR15</th><th>TRH / SRH20, 25
TR / SR30, 35</th><th>TR / SR45
TR55, 65</th></tr>
<tr><td rowspan="4">Types of Lubrication Coupler</td><td rowspan="4">SD-037
</td><td>SD-038
</td><td>SD-039
</td></tr>
<tr><td>SD-029
</td><td>SD-040
</td></tr>
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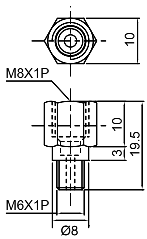
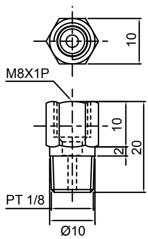
</td><td>SD-042
</td></tr>
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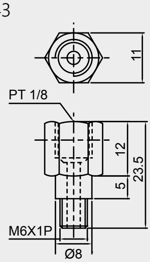
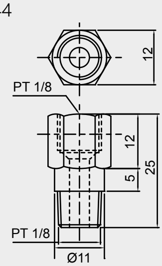
</td><td>SD-044
</td></tr>
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※If the types of lubrication coupler in TR / SRS20, TR / SRS25 are needed, please contact TBI MOTION.

2-9 Strong Dust-proof/Self-Lubricating Linear Guide Series Accessory

TBI MOTION Linear Guide with Double-lip End Seal

Characteristics of ***TBI MOTION*** Dust-proof End Seal

1. Seal Function : Seal design from single-lip to double-lip is to prevent more dust from going into the block.
2. Hardness : Heat treatment harden the end seal to absorb impact while operating.
3. Environment : Better solution for dust-proof when using double seals in environment with high contamination.
4. Lifetime Extension : Double-lip seal prevents dust go into the block and provides a solution for block damage due to dust issue.

Characteristics of ***TBI MOTION*** Metal Scraper

The scraper decreases the possibility of high temperature iron chip or dust entering the block.

Characteristics of ***TBI MOTION*** Self-Lubricating Linear Guide Series

There is a Felt accessory between end cap and seals. Felt with oil lubricates the rail when operating and grease nipple is not needed. The design is shown below. (Fig 2.9.1)

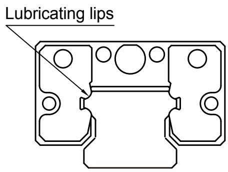


Fig 2.9.1

Example

WZ (Top Seal+Bottom Seal+Two Double-lip end seals+Felt)

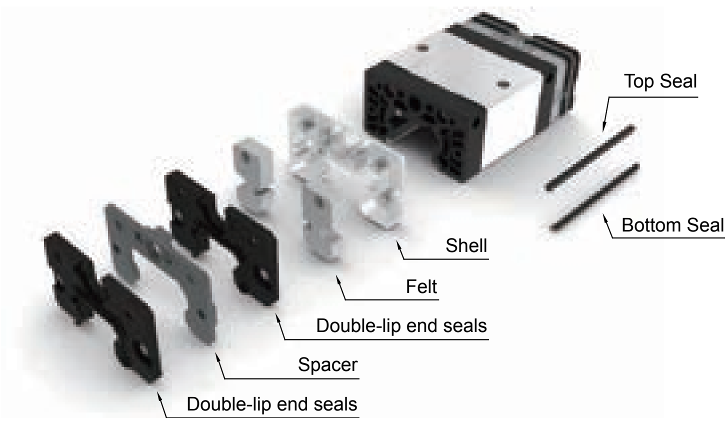


Fig 2.9.2

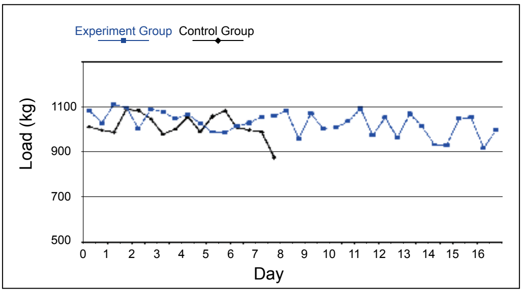
Extended Maintenance Interval

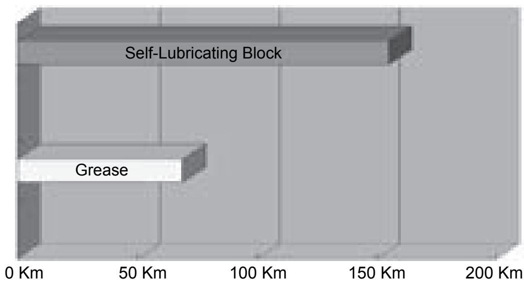
As shown in the chart below, the use of self-lubricating polymer oil-reservoir components extends the maintenance interval compared with the condition using only initial grease lubrication.

Table 2.9.1 Test

	Control Group	Experiment Group
Test Environment	**Standard**	**Self-Lubricating**
Model No.	TRH20VN	TRH20VN
Load Rating	1000 kg	1000 kg
Speed	6 m/min	6 m/min
Travel Length	600 mm	600 mm

※ No extra grease is added during the test for both standard series and self-lubricating series.





2-9 Strong Dust-proof/Self-Lubricating Linear Guide Series Accessory

Instructions of Self-Lubricating Block Felt

The felt has already filled in with lubricant. It is suggested to soak the whole felt in the oil tank for more than 8 hours before using.

Characteristics of Suggested Oil :

(1) Form a strong oil film.
(2) Reduce wear as much as possible.
(3) Have high wear resistance.
(4) Have high thermal stability.
(5) Be noncorrosive.
(6) Be highly rust-preventive.
(7) Be free from dust and some moisture.

Characteristics of Block Felt

(1) Easy Assembly and Removal - Only screws are needed when assembling and disassembling the accessory.
(2) Environmental Friendly - No need of grease nipple and other equipment to save energy.
(3) Low Maintenance - Prevents oil leaking, making it a ideal solution for clean working environments.
(4) Strong Dust-Proof - With dust-proof accessory, service life is extended.

The Suggested Operating Temperature

The suggested operating temperature is between -10°C to 60°C. If operating temperature is over suggested criteria, please contact TBI MOTION.

Self-Lubricating Linear Guide Oil Cassette Units

Self lubrication system is designed with lubrication mechanism between end cap and wiper. The structure units are shown as follow. The Cassette unit is comprised with fluid channel which is soaked with oil and act to release the lubricants thoroughly during operation. With this smart and simple design, the linear guide can be lubricated without extra oil feeding units thus minimize unnecessary parts and waste which triggers higher cost and higher risk in mounting error.

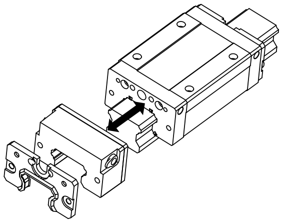


Fig 2.9.3 Installation Method

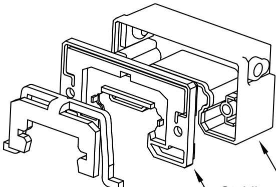


Fig 2.9.4 Cassette Unit

Characteristics of Self-Lubricating Units

(1) No extra oil feeding unit is required.
(2) Applicable in highly required clean envirionment.
(3) May maintain lubrication for a period of time.
(4) Lubricates thoroughly in any operating positions.
(5) Interchangeable to any grease/oil.
(6) Improves dust-proof effiencIency when assembled to the block.

Applications

(1) Machine Tool
(2) Industrial Automation : Plastic and rubber manufacturers, Typography, Paper, Textiles, Food.
(3) Electronic and Component manufacturing : Semiconductor, X-Y Platform, Measurement, Equipment
(4) Others : Medical Equipment, Conveyers

2-9 Strong Dust-proof/Self-Lubricating Linear Guide Series Accessory

Characteristics of Lubrication Oil

The Self lubrication cassette is filled in with Synthetic Hydro Carbon oil (SHC). The performance of the oil is list as follows :
(1) Solvent refined oil without wax and impurity.
(2) High grade of consistency in extreme temperature.
(3) Corrosion free to metal and high polymer.
(4) Unique woven texture provides oil film on the contact point to prevent wear.
(5) High chemical stability and durability.

2-10 Dust-proof/Accessory

If the following accessories are needed, please add the code followed by the model number.

Special Option：Steel end seal, Steel end cap, Cover Strip, please contact TBI Motion.

Standard Accessories :

End seal and Bottom seal
To prevent life reduction caused by iron chips or dust entering the block.

Other Accessories :

Top Seal
Efficiently prevents dust from the surface of rail or tapping hole getting inside the block.

Double end seal
Enhances the wiping effect, foreign matter can be completely wiped off.

Double-lip end seals
Double-lip end seal is suitable for environment with high contamination.

Characteristics of ***TBI MOTION*** Metal Scraper
The scraper decreases the possibility of high temperature iron chip or dust entering the block.

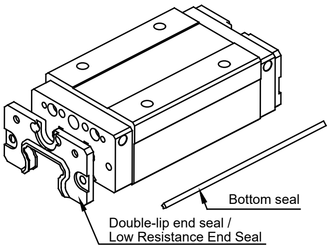
Felt
Double-lip end seal is suitable for environment with high contamination. Felt lubricates the ball track of the rail extending the lifetime. This accessory is suitable for light rating load environment.

Oil Reservoir
After installation, oil reservoir can extend lubricating effect.

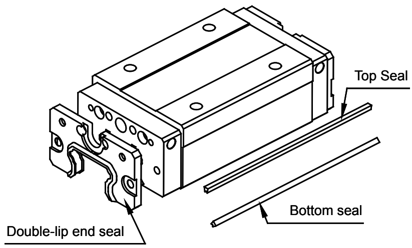
2-10 Dust-proof/Accessory

Table 2.10.1 Codes of Accessories

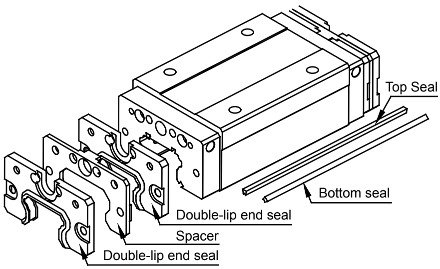
**XN (Double-lip end seals+Bottom Seal)
XNC (Low Resistance End Seal+Bottom Seal)**



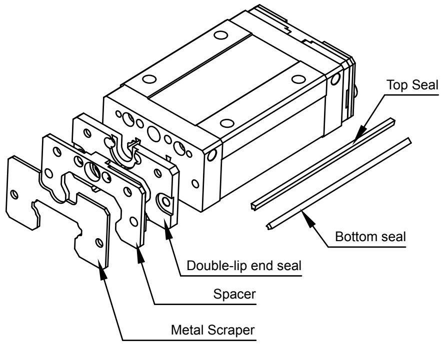
UN (Double-lip end seals+Bottom seals+Top seals)



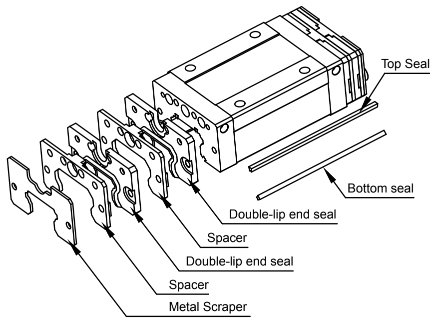
ZN (Two Double-lip end seals+Bottom seals+Top seals)



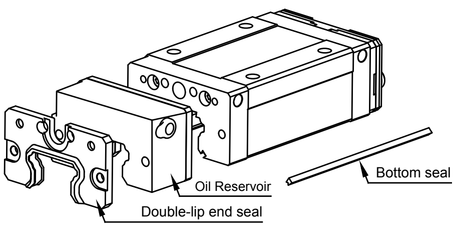
SU (Double-lip end seals+Bottom seals+Top seals+ Metal Scraper)



SZ (Two Double-lip end seals+Bottom seals+Top seals +Metal Scraper)

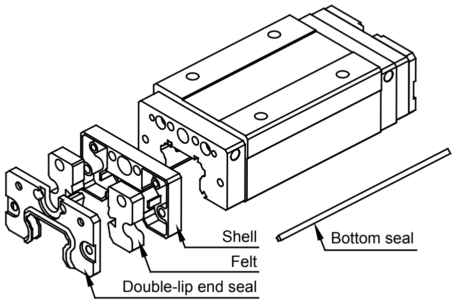


BN (Double-lip end seals+Bottom seals+Oil Reservior)

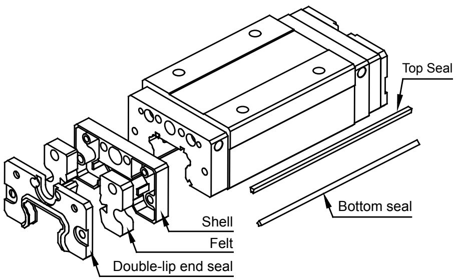


※After selection of different accessories increase the overall length of the slider, see table 2.10.2.

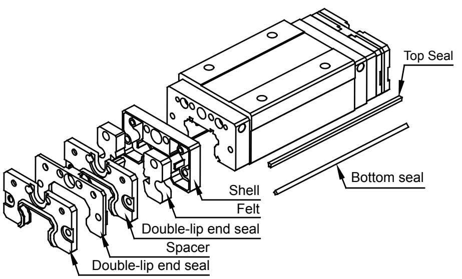
WW (Double-lip end seals+Bottom seals+Felts)



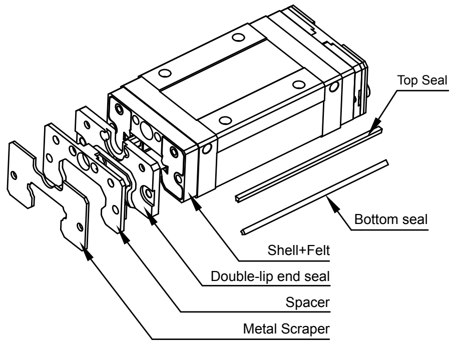
WU (Double-lip end seals+Bottom seals+Top Seals+Felts)



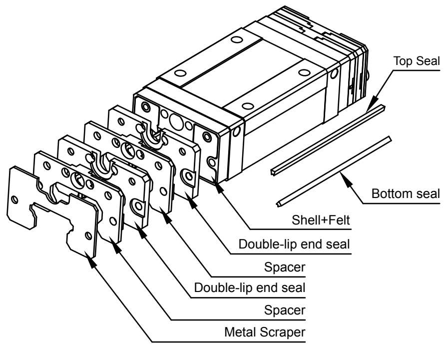
WZ (Two Double-lip end seals+Bottom seals+Top Seals+Felts)



DU (Double-lip end seals+Bottom seals+Top seals+Felts+Metal Scraper)



DZ (Two Double-lip end seals+Bottom seals+Top seals+Felts+Metal Scraper)



2-10 Dust-proof/Accessory

Table 2.10.2 TR/SR Type Block Length of Accessories

Unit : mm

Double-lip end seals (XN)

Type / Length of Block Code	SR15	SR20	SR25	SR30	SR35	SR45
S	40.3	49.4	57.2	67.4	-	-
N	56.9	SRS(68.3) SRH(75.6)	81	96.3	109	124.5
L	-	-	-	-	-	140
E	-	99.6	110	132	153	174

Low Resistance end seal (XNC)

Type / Length of Block Code	TR15	TR20	TR25	TR30	TR35	TR45	TR55	TR65
S	39.3	47.8	56.2	65.8	-	-	-	-
N	55.9	TRS (66.7) TRH (74)	80	94.7	107.4	121.9	-	-
L	-	-	-	-	-	137.4	158.4	193.3
E	-	98	109	130.4	151.4	171.4	196.5	252.8

Two Double-lip end seals (ZN)

Type / Length of Block Code	TR15 SR15	TR20 SR20	TR25 SR25	TR30 SR30	TR35 SR35	TR45 SR45	TR55 SR55	TR65
S	47.9	58.4	65.6	76.4	-	-	-	-
N	64.5	TRS/SRS (77.3) TRH/SRH (84.6)	89.4	105.3	118	134.5	-	-
L	-	-	-	-	-	150	173	207.9
E	-	108.6	118.4	141	162	184	211.1	267.4

Double-lip end seals+Metal Scraper (SU)

Type / Length of Block Code	TR15 SR15	TR20 SR20	TR25 SR25	TR30 SR30	TR35 SR35	TR45 SR45	TR55 SR55	TR65
S	44.5	54.4	62.2	72.4	-	-	-	-
N	61.1	TRS/SRS (73.3) TRH/SRH (80.6)	86	101.3	114	129.5	-	-
L	-	-	-	-	-	145	167	201.9
E	-	104.6	115	137	158	179	205.1	261.4

Two Double-lip end seals+Metal Scraper (SZ)

Type / Length of Block Code	TR15 SR15	TR20 SR20	TR25 SR25	TR30 SR30	TR35 SR35	TR45 SR45	TR55 SR55	TR65
S	52.1	63.4	70.6	81.4	-	-	-	-
N	68.7	TRS/SRS (82.3) TRH/SRH (89.6)	94.4	110.3	123	139.5	-	-
L	-	-	-	-	-	155	178	212.9
E	-	113.6	123.4	146	167	189	216.1	272.4

Table 2.10.2 TR/SR Type Block Length of Accessories

Unit : mm

Double-lip end seals+Oil Reservoir (BN)								
Length of Block Code \ Type	TR15 SR15	TR20 SR20	TR25 SR25	TR30 SR30	TR35 SR35	TR45 SR45	TR55 SR55	TR65
S	55.8	66.4	73.2	83.4	-	-	-	-
N	72.4	TRS/SRS (85.3) TRH/SRH (92.6)	97	112.3	125	144	-	-
L	-	-	-	-	-	159.5	-	-
E	-	116.6	126	148	169	193.5	-	-

Double-lip end seals+Felt (WW, WU)								
Length of Block Code \ Type	TR15 SR15	TR20 SR20	TR25 SR25	TR30 SR30	TR35 SR35	TR45 SR45	TR55	TR65
S	51.8	60.9	68.7	78.9	-	-	-	-
N	68.4	TRS/SRS (79.8) TRH/SRH (87.1)	92.5	107.8	120.5	136	-	-
L	-	-	-	-	-	151.5	-	-
E	-	111.1	121.5	143.5	164.5	185.5	-	-

Two Double-lip end seals+Felt (WZ)								
Length of Block Code \ Type	TR15 SR15	TR20 SR20	TR25 SR25	TR30 SR30	TR35 SR35	TR45 SR45	TR55	TR65
S	59.4	69.9	77.1	87.9	-	-	-	-
N	76	TRS/SRS (88.8) TRH/SRH (96.1)	100.9	116.8	129.5	146	-	-
L	-	-	-	-	-	161.5	-	-
E	-	120.1	129.9	152.5	173.5	195.5	-	-

Double-lip end seals+Felt+Metal Scraper (DU)								
Length of Block Code \ Type	TR15 SR15	TR20 SR20	TR25 SR25	TR30 SR30	TR35 SR35	TR45 SR45	TR55	TR65
S	56	65.9	73.7	83.9	-	-	-	-
N	72.6	TRS/SRS (84.8) TRH/SRH (92.1)	97.5	112.8	125.5	141	-	-
L	-	-	-	-	-	156.5	-	-
E	-	116.1	126.5	148.5	169.5	190.5	-	-

Two Double-lip end seals+Felt+Metal Scraper (DZ)								
Length of Block Code \ Type	TR15 SR15	TR20 SR20	TR25 SR25	TR30 SR30	TR35 SR35	TR45 SR45	TR55	TR65
S	63.6	74.9	82.1	92.9	-	-	-	-
N	80.2	TRS/SRS (93.8) TRH/SRH (101.1)	105.9	121.8	134.5	151	-	-
L	-	-	-	-	-	166.5	-	-
E	-	125.1	134.9	157.5	178.5	200.5	-	-

2-10 Dust-proof/Accessory

Dust-proof Rails
Once the Linear Guide is operating in a cutting machine, dust and foreign matter that enter the Linear Guide may cause abnormal wear and shorten the service life.

Linear Guide rail mounting-hole cap
Chips and foreign matter clogging the mounting holes of a Linear Guide rail may enter the Linear Guide block. To prevent this situation, the mounting holes must be closed with dedicated caps, which must be installed to flush with the Linear Guide rail top surface. To insert a dedicated cap into a mounting hole, drive the cap in using a plastic hammer with a flat metal pad placed over the cap until it matches with the Linear Guide rail top surface. (Fig 2.10.1)

Rail with tapped holes
Fixing a rail with tapped hole is different from fixing a standard one. A major strength of it is the shape of the tapped hole ; dust and chippings would not enter. (Fig 2.10.1)

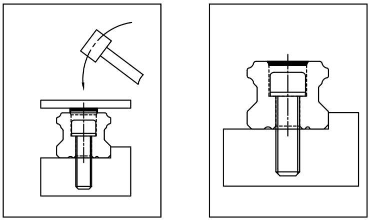


Fig 2.10.1- Dust-proof

■ 2-11 Friction

The figure showed in the chart is the maximum friction. (Table 2.11.1)

Table 2.11.1 End Cap friction rate Unit : kgf

Model No.	Double-lip end seals XN	Low Resistance End Seal XNC
	End Cap friction rate (Max)(Kgf)	End Cap friction rate (Max)(Kgf)
TR / SR15	0.3	0.18
TR / SR20	0.4	0.25
TR / SR25	0.6	0.34
TR / SR30	0.8	0.45
TR / SR35	1.7	-
TR / SR45	2.3	-
TR55	2.5	-
TR65	4.1	-

2-12 Mounting-Surface Dimensional Tolerance

TR / SR series Linear Guide is a Four-Way Equal-Load design, a slight dimensional error in the mounting surface can be absorbed by the self-adjusting capability, thus ensuring smooth linear motion. In the table below are the dimensional tolerances for the mounting surface of TR Linear Guide.

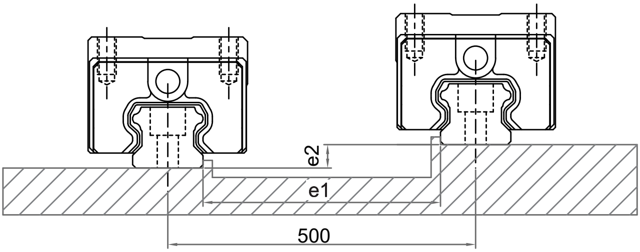


Fig 2.12.1

Table 2.12.1

Unit : µm

Model No.	Tolerance for Parallelism Between Two Axis(e1)					Tolerance for Parallelism Between Two Axis(e2)				
	Z3	Z2	Z1	Z0	ZF	Z3	Z2	Z1	Z0	ZF
TR / SR15	-	-	18	25	35	-	-	85	130	190
TR / SR20	-	18	20	25	35	-	50	85	130	190
TR / SR25	15	20	22	30	42	60	70	85	130	195
TR / SR30	20	27	30	40	55	80	90	110	170	250
TR / SR35	22	30	35	50	68	100	120	150	210	290
TR / SR45	25	35	40	60	85	110	140	170	250	350
TR55	34	45	50	70	98	130	170	210	300	410
TR65	42	55	60	80	105	150	200	250	350	460

3-1 TH Miniature Linear Guide

■ 3-1-1 The Characteristics of TH Series

Dust-Proof Design

TH Series Standard end seals provide extreme protection from dust, metal scrapers to maintain long service life and shorten maintenance period. Unique low friction seal lips provide best smoothness and lower friction.

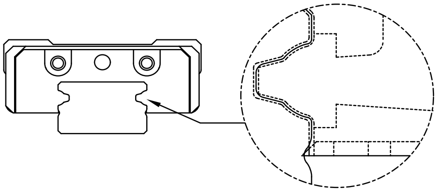


Fig 3.1.1

High Loading and Moment Capacity Performance

TH Miniature Linear Guide series uses two row circulation with Gothic 45° contact angle on the rail groove to achieve equal load capacity in four directions. Larger steel balls are used to enhance the loading and torsion resistance performance in limited space.

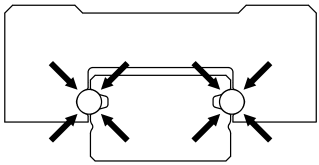


Fig 3.1.2 The Gothic 45° four-direction load structure

■ 3-1-2 The Structure of TH-series

Recirculation system : End cap + Recirculation tube + Ball retainer
Sealing system : Side + Bottom system

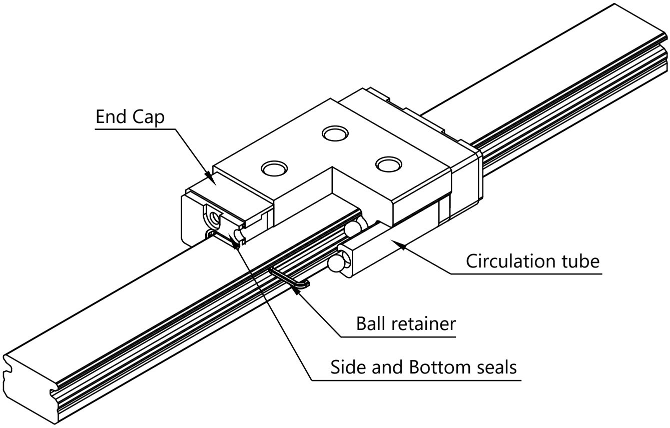
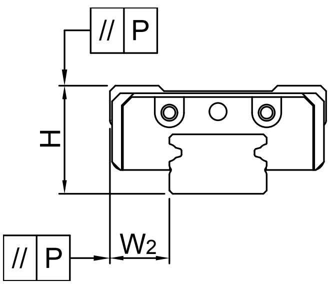


Fig 3.1.3

■ 3-1-3 Accuracy

Miniature Linear Guide TH-series provides P, H, N three accuracy grades for customer to choose.

Table 3.1.1

	Accuracy (μm)		Precision P	High H	Normal N
	Tolerance of Height H	H	±10	±20	±40
	Variation of height with different block on same spot of the rail	△H	7	15	25
	Tolerance of width W2	W2	±15	±25	±40
	Variation with width on different block on same spot of the rail	△W2	10	20	30

3-1 TH Miniature Linear Guide

Speed

The maximum acceleration of TH-series can reach V_{max} > 5 m/s, α_{max} = 300 m/s^2 (60 m/s^2 without preload).

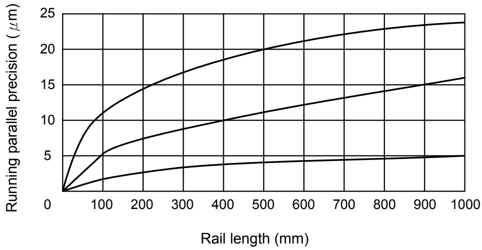


Fig 3.1.4 Running parallel precision slide relative to the rails datum

■ 3-1-4 Preload

Preload Value

Miniature Linear Guide TH-series offers three preloading level, ZF, Z0, Z1. A proper preload enhances performance on rigidity, precision, and torsion resistance; However, an improper preload shorten service life and increase friction.

Table 3.1.2 Table

Preload Grade	Pressure	Preload(μm)				Applications
		7	9	12	15	
ZF	Slight Clearance	+4~0	+4~0	+5~0	+6~0	Running smoothly
Z0	Zero Preload	+2~0	+2~0	+2~0	+3~0	Precision applications, Running smoothly
Z1	Light Preload	0~-3	0~-4	0~-5	0~-6	High steel, Precision applications, Running smoothly

Permissible Operational Temperature

The Miniature Linear Guide TH-series is sufficient to operate between -20°C~+80°C. For sudden temperature rise the temperature can reach up to +100°C.

■ 3-1-5 Types of Lubrication

Grease

When a linear guide is well lubricated, the contact point between rail and rolling steel balls will be separated by 1 micro meter. Therefore, a good lubrication increases the service life of linear guide.

Clean room Lubrication
Suitable for low contamination environment.

Lubrication
General usage, ISO VG32~68.

※If Special oil is required please contact ***TBI MOTION***.

Table 3.1.3

Model	Lubrication amount (cc)
TH07NN	0.3
TH07NL	0.4
TH09NN	0.4
TH09NL	0.6
TH12NN	0.9
TH12NL	1.3
TH15NN	1.4
TH15NL	2.0

■ 3-1-6 Order Information

Customized Requirement :

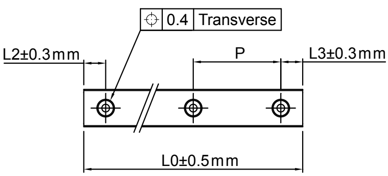


Table 3.1.4

Rail Length	Dimension			
	TH7	TH9	TH12	TH15
Pitch (mm)	15	20	25	40
Wide Pitch (mm)	—	30	40	40
L2, L3 min	3	4	4	4
L2, L3 max	10	20	20	35
Lmax	1300	1300	1300	1300

※If special dimension is required please contact ***TBI MOTION***.

3-1 TH Miniature Linear Guide

Height of Shoulder on Mounting Surface and Chamfering

Height of shoulder should be taken into consideration when installing a Linear Guide, if the block or rail is over-chamfered, the tip part has the possibility to effect the accuracy of Linear Guide, or if the height of shoulder is too high, it interferes the operation of block. Install the Linear Guide as suggested, the accuracy of Linear Guide can be maintained.

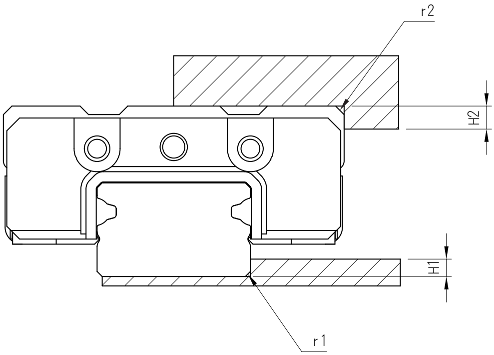


Table 3.1.5 Height of shoulder and chamfer

Model No.	Corner Radius of Mounting Surface r1	Corner Radius of Mounting Surface r2	Shoulder height on rail side H1	Shoulder height on rail side H2
TH07N	0.3	0.2	1	3
TH09N	0.3	0.3	1.7	3
TH12N	0.5	0.4	2.5	4
TH15N	0.5	0.5	2.5	5

Table 3.1.6 Condition with Hexagonal Head Bolt

Model No.	Screw No.	Fasten Torque		
		Steel	Casting	Aluminum Alloy
TH07N	M2	57	39.2	29.4
TH09N	M3	186	127	98
TH12N	M3	186	127	98
TH15N	M3	186	127	98

■ 3-1-7 Nominal Model Code for Non-Interchangeable TH Type

Length of Block

Perform joint treatment when required lengths exceed 1300. Please contact TBI MOTION for detailed information.

T	H	07	N	L	S	-	2	-		-	1000	-	N	S	-	Z0	-	II	-	X
①	②	③	④	⑤	⑥		⑦		⑧		⑨		⑩	⑪		⑫		⑬		⑭

①

Nominal Model
T

②

Block Type
H : Mini
X : Special

(Drawing will be provided for special item in order to distinguish the height of the rail.)

③

Dimension
07, 09, 12, 15

④

Width of Rail
N : Standard

⑤

Length of Block
N : Standard
L : Long

⑥

Material of Block
S : Stainless steel

⑦

Quantity of Block
(Mark 1 when there is only 1 runner block)

⑧

Accessory Code
□ : Standard (End seal + Side seal)
NW : Self-Lubricating

(Please refer to page A108)

⑨

Length of Rail
Unit : mm

⑩

Accuracy Grade
N : Normal
H : High
P : Precision

⑪

Material of Rail
S : Stainless steel

⑫

Preload
ZF : Slight Clearance
Z0 : No Preload
Z1 : Light Preload

※No symbol required when no plating is need.

⑬

Two Sets per Axis
(No need to be marked when there is only one rail) II

⑭

Rail Special Machining
□ : Mounting from Top
X : Rail with Special Machining

A Linear Guide

3-1 TH Miniature Linear Guide

■ 3-1-8 Nominal Model Code for Interchangeable TH Type

Interchangeable Type of Block :

T	H	07	N	L	-		-	N	S	-	ZF
①	②	③	④	⑤		⑥		⑦	⑧		⑨

① Nominal Model

Nominal Model
T

② Block Type

Block Type
H : Mini
X : Special

(Drawing will be provided for special item in order to distinguish the height of the rail.)

③ Dimension

Dimension
07, 09, 12, 15

④ Width of Rail

Width of Rail
N : Standard

⑤ Length of Block

Length of Block
N : Standard
L : Long

⑥ Accessory Code

Accessory Code
□ : Standard (End seal + Side seal)
NW : Self-Lubricating

⑦ Accuracy Grade

Accuracy Grade
N : Normal

⑧ Material of Rail

Material of Rail
S : Stainless steel

⑨ Preload

Preload
ZF : Slight Clearance
Z0 : No Preload

Interchangeable Type of Rail :

T	M	07	N	-	1000	-	N	S	-	X
①	②	③	④		⑤		⑥	⑦		⑧

① Nominal Model

Nominal Model
T

② Block Type

Block Type
M : Mini

(Drawing will be provided for special item in order to distinguish the height of the rail.)

③ Dimension

Dimension
07, 09, 12, 15

④ Width of Rail

Width of Rail
N : Standard

⑤ Length of Rail

Length of Rail
Unit : mm

⑥ Accuracy Grade

Accuracy Grade
N : Normal

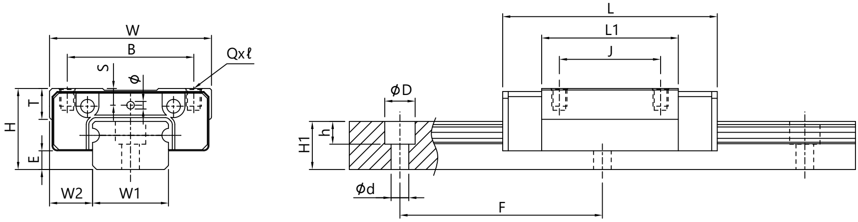
⑦ Material of Rail

Material of Rail
S : Stainless steel

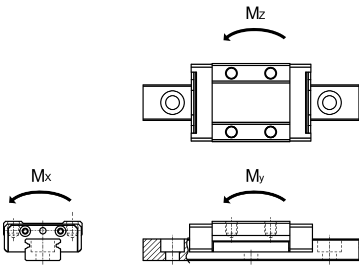
⑧ Rail Special Machining

Rail Special Machining
□ : Mounting from Top
X : Rail with Special Machining

TH-N Series Specifications



Model No.	Assembly (mm)			Block(mm)									Rail(mm)					
	H	W2	E	W	B	S	J	T	L	L1	Qxℓ	Ø	W1	H1	ØD	h	Ød	F
TH07NN	8	5	1.2	17	12	1.6	8	2.95	23.1	12.3	M2×2.1	1.2	7	4.7	4.1	2.3	2.4	15
TH07NL	8	5	1.2	17	12	1.6	13	2.95	31.1	20.3	M2×2.1	1.2	7	4.7	4.1	2.3	2.4	15
TH09NN	10	5.5	1.9	20	15	2.2	10	3.75	30.6	19.2	M3×2.7	1.2	9	5.9	5.9	3.3	3.5	20
TH09NL	10	5.5	1.9	20	15	2.2	16	3.75	40.9	29.5	M3×2.7	1.2	9	5.9	5.9	3.3	3.5	20
TH12NN	13	7.5	2.7	27	20	3	15	4.62	34.4	20.6	M3×3.2	1.3	12	7.5	6	4.5	3.5	25
TH12NL	13	7.5	2.7	27	20	3	20	4.62	46.9	33.1	M3×3.2	1.3	12	7.5	6	4.5	3.5	25
TH15NN	16	8.5	3.7	32	25	3.5	20	6.1	42.8	27	M3×3.5	1.5	15	9.5	6	4.5	3.5	40
TH15NL	16	8.5	3.7	32	25	3.5	25	6.1	59.8	44	M3×3.5	1.5	15	9.5	6	4.5	3.5	40



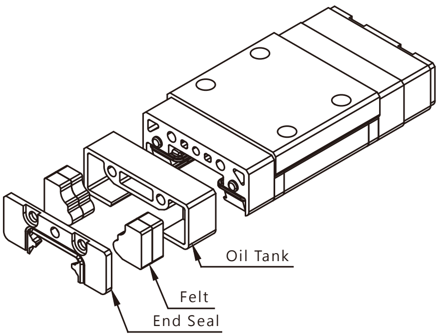
Model No.	Load Rating (kgf)		Static Permissible Moment					Weight	
			Mx (kg-mm)	My(kg-mm)		Mz(kg-mm)		Block (kg)	Rail (kg/m)
	C	Co	Single Block	Single Block	Double Block	Single Block	Double Block		
TH07NN	144	204	745	232	3,234	232	3,234	0.005	0.21
TH07NL	220	374	1,367	849	7,261	849	7,261	0.009	
TH09NN	220	374	1,713	849	7,117	849	7,117	0.013	0.32
TH09NL	299	579	2,648	2,099	14,174	2,099	14,174	0.020	
TH12NN	381	536	3,269	1,094	12,391	1,094	12,391	0.024	0.61
TH12NL	555	919	5,604	3,437	26,857	3,437	26,857	0.039	
TH15NN	581	834	6,336	2,316	23,096	2,316	23,096	0.048	1
TH15NL	860	1,459	11,088	7,527	52,908	7,527	52,908	0.080	

3-1 TH Miniature Linear Guide

■ 3-1-9 Self-Lubricating Accessory of TH Series

Table 3.1.7 Self-Lubricating Accessory Code of TH Series

Specifications : TH07N, 09N
Accessory Code : TH-NW



Specifications : TH12N, 15N
Accessory Code : TH-NW

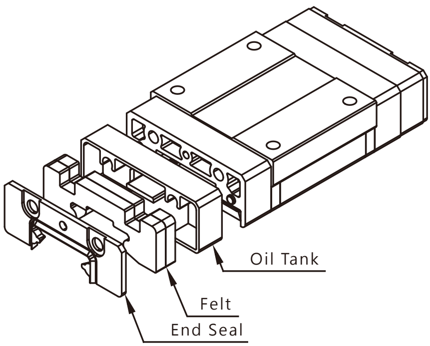


Table 3.1.8 Miniature TH Block with Self-Lubrication Accessory Unit : mm

Length of Block Code \ Type	TH07	TH09	TH12	TH15
N	33.1	40.6	44.4	54.8
L	41.1	50.9	56.9	71.8

4-1 TM Miniature Wide Linear Guide

■ 4-1-1 The Characteristics of TM Series

High Accuracy: The miniature linear guide is manufactured to high precision standards, which enables accurate positioning and motion control.

Excellent Stability: The surfaces of the miniature linear guide undergo specialized treatments that result in a low friction coefficient, ensuring smooth operation and extended service life.

Robust Load Capacity: Despite its compact size, the miniature linear guide features an enhanced load capacity due to material optimization and specialized surface treatments, allowing it to withstand significant forces.

Low Noise: The special surface treatment minimizes friction, ensuring smooth movement and reducing operational noise.

Space Efficiency: The compact design of the miniature linear guide facilitates the use of smaller actuators and motors, effectively saving space while supporting substantial loads.

Easy Maintenance: The simple design of the miniature linear guide makes maintenance convenient and improves the efficiency of the replacement and cleaning processes.

High Accuracy

Customized high-accuracy machining equipment and processes are utilized to manufacture linear guides with an accuracy of ±1μm/1000mm.

Interchangeability

Precision control of machining tolerances allows for interchangeability of rails and blocks across different batches, significantly reducing inventory pressure.

High Speed

Extremely low surface roughness provides a smooth rolling track, contributing to high durability and enabling exceptional smoothness and speed.

High Rigidity

The use of large steel balls enhances circulation smoothness, increasing rigidity and torque while extending service life.

4-1 TM Miniature Wide Linear Guide

■ 4-1-2 Selection Process

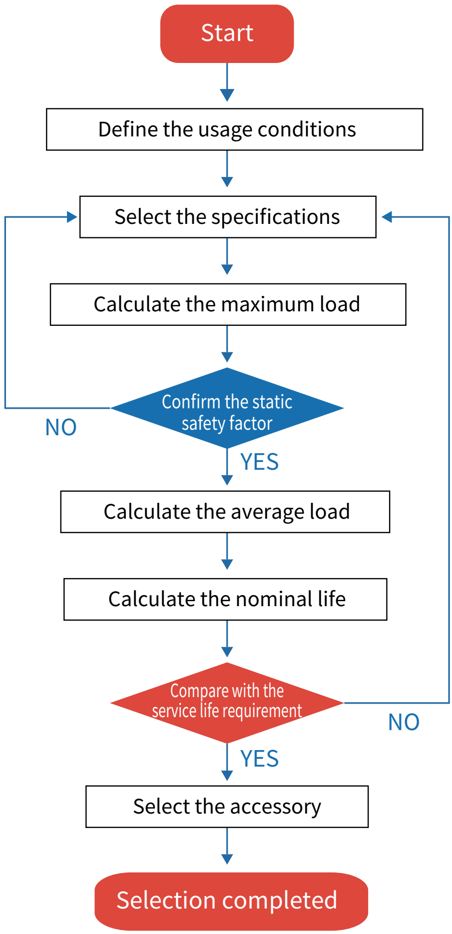
Please note the following information regarding usage requirements:

A. Combination Methods (span dimensions, number of blocks, number of rails)

B. Installation Directions (horizontal, vertical, tilted, wall-mounted)

C. Load Requirements (magnitude, direction, point of application; confirm if it includes fictitious forces)

D. Usage Frequency (load cycle)



A. Combination Methods

A-1 Span Dimensions:

Relative position of the blocks (as shown in Fig 4.1.1):

L0: Distance between blocks on the same rail

L1: Distance between dual rails

A-2. Number of blocks: Increasing the number of blocks enhances load capacity, rigidity, and service life, but shortens the available travel space.

A-3. Number of rails: Using dual rails can improve the MR capability for the system.

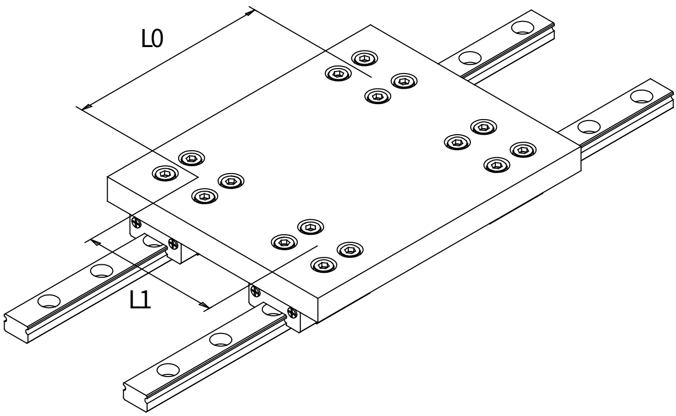


Fig 4.1.1 Span Dimensions

4-1 TM Miniature Wide Linear Guide

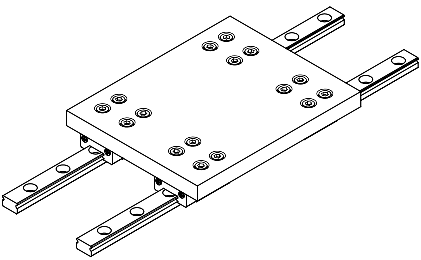
B. Installation Directions

Choosing the ideal installation type can significantly reduce the impact of load moments on the linear motion system. Generally, the rail and block assembly methods can be categorized into the following types:

1. Horizontal Position
2. Wall-Mounted Position
3. Vertical Position
4. Other Methods (such as tilted position, inverted position)

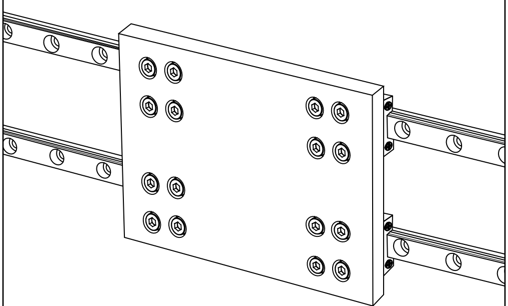
Horizontal Position

The most commonly used assembly method is the horizontal position, which better withstands vertical loads and is frequently employed in general positioning and feeding machines.



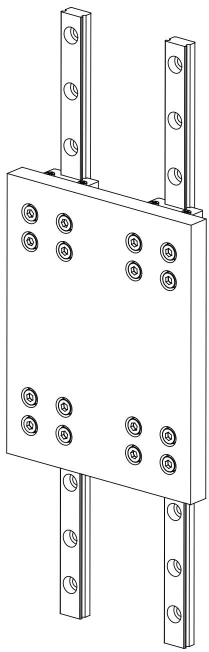
Wall-Mounted Position

It is important to consider the reactive moment caused by gravity when selecting this method. Increasing the distance between the rails can enhance load distribution.



Vertical Position

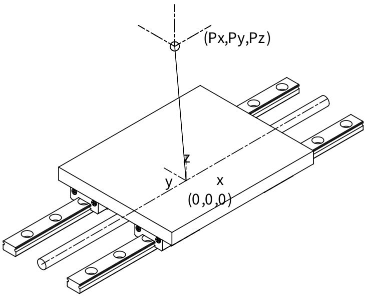
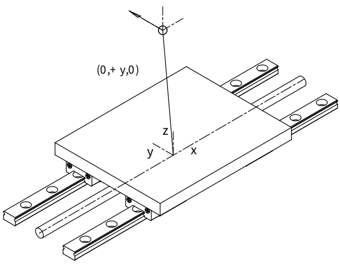
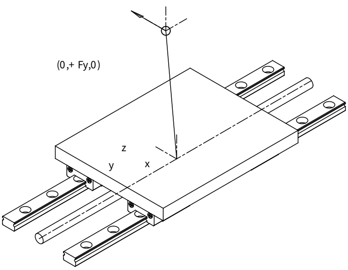
Typically used in lifting mechanisms. Attention should be paid to the gravitational load when extending the plate length. Increasing the distance between blocks on the same rail can enhance load distribution.



C. Load Requirements

Definition of a load requires three key elements:

1. Magnitude
2. Direction
3. Point of application

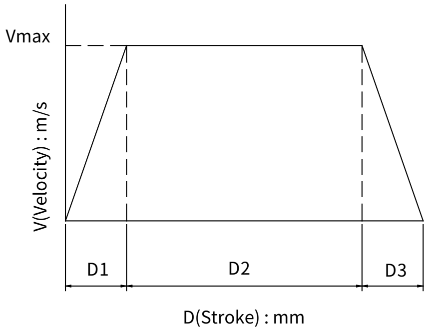
The point of application is shown as the right diagram.	
The direction is shown as the right diagram.	
The force and direction are shown as the right diagram.	

4-1 TM Miniature Wide Linear Guide

D. Velocity

V_{max}: Maximum speed during the process

D: Length of the travel (D1, D2, D3 are the distances for acceleration, constant speed and deceleration.)



Statistics on the usage of the mechanism within a unit of time help to evaluate whether the system meets actual demands.

Example:

There is a machine that operates 100 km daily with a service life requirement of three years and 300 working days per year.

Required service life: 3 years

Usage Frequency: 100 km/day

The required lifespan is calculated as follows:

3 years × 300 days/year × 100 km/day = 90,000 km

■ 4-1-3 Load and Service Life

During load movements on linear guides, the rolling elements and rolling surfaces experience compressive force and corresponding tensile force. When these forces are applied repeatedly over a certain number of cycles and distance, fatigue damage may occur in the rolling surfaces or rolling elements. This results in metal flakes resembling fish scales, referred to as metal flaking. When this happens, the system cannot maintain accuracy anymore, which means the product's lifespan has ended.

Below are explanations of the key parameters:

Nominal Life (km)

Linear guides are mass-produced products. Even under the same conditions, they may not have the same service life. The nominal life is defined as the operation of a batch of linear guides under the same conditions, where 90% of the products in the same batch meet the standard and do not experience the metal flaking over a specified total travel distance.

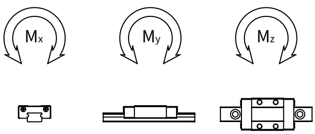
Basic Static Load Rating (N)

The load value that causes a permanent deformation of 0.0001 times the diameter of the rolling elements and the rolling surfaces, under constant direction and magnitude. This is used to calculate the static safety factor for the linear guide.

Basic Dynamic Load Rating (N)

The same specifications for each batch of linear guides with individual operational tests which are conducted under consistent conditions, where the load and direction remain unchanged. In this context, 90% of the products in the batch demonstrate a nominal life corresponding to a load value of 50 km.

M_x, M_y, M_z Permissible Moment (N-m):



The total moment value causes a permanent deformation of 0.0001 times the diameter of the rolling elements and the rolling surfaces, under constant direction and magnitude. Define M_x, M_y, and M_z in three axes when calculating the static safety factor.

4-1 TM Miniature Wide Linear Guide

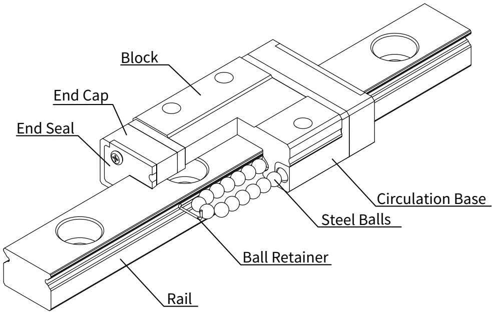


Fig 4.1.2 Structure of TM

fs : Static Safety Factor

It is the ratio of the load capacity of linear guides (basic static load rating) and the maximum calculated load.

The formula is as follows:

$$f_s = \frac{f_c \cdot C_0}{P} \qquad f_s = \frac{f_c \cdot M_0}{M}$$

f_s : Static Safety Factor
C_0 : Basic Static Load Rating
M_0 : Static Permissible Moment
P : Design Load
M : Design Moment
f_c : Contact Factor

Operating Conditions	Loading Conditions	Minimum fs
General Static Conditions	Minor impacts and offsets	1.0~1.3
	Heavy impacts and vibrations	2.0~3.0
General Motion Conditions	Minor impacts and twists	1.0~1.5
	Heavy impacts and vibrations	2.5~5.0

Additional Influence Parameters

Additional influence parameters mainly address variations in usage methods and environmental conditions, allowing for appropriate adjustments to correct calculation errors.

f_c : Contact Factor
f_h : Hardness Factor
f_t : Temperature Factor
f_w : Load Factor

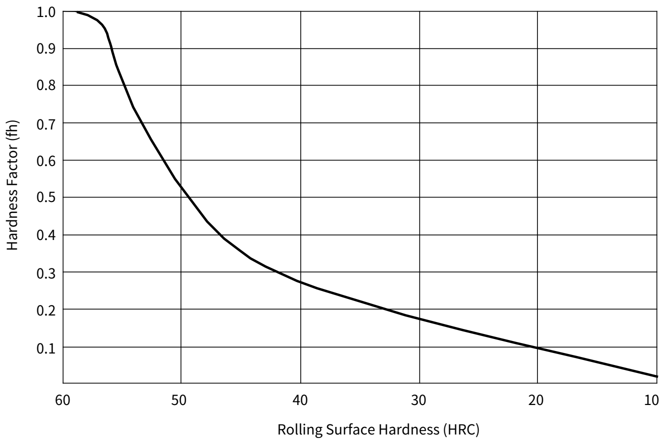
f_c : Contact Factor

Contact Factor: When multiple blocks are closely arranged with each other, the load distribution on the steel balls becomes uneven. Therefore, a correction factor needs to be included in the lifespan calculation.

Number of Used Blocks	Contact Factor fc
In normal use	1
2	0.81
3	0.72
4	0.66
5	0.61

f_h : Hardness Factor

Hardness Factor: The hardness for the rolling elements and rolling surfaces of linear guides is between 58~62 HRC. If any conditions lead to a decrease in hardness, a correction factor needs to be included in the lifespan calculation.

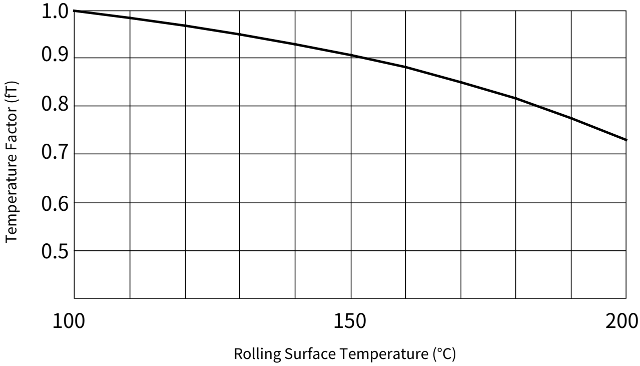


A Linear Guide

4-1 TM Miniature Wide Linear Guide

f_t: Temperature Factor

Temperature Factor: When rolling surfaces and rolling elements are in high-temperature environments, their lifespan diminishes as the operating temperature increases. If the ambient temperature exceeds the conditions shown in the diagram, it should be considered when evaluating lifespan. For linear guide with plastic components and end seals, it is advisable to keep the operating temperature below 80°C.



f_w: Load Factor

Load Factor: Reciprocating mechanisms can easily generate vibrations or impacts, especially during high-speed operations or frequent starts and stops, which produce inertial shocks. Estimating a reasonable load under these conditions can be quite challenging. Therefore, when the impact of speed vibrations is significant, please refer to the following load coefficients, based on empirical data, and divide them by the basic dynamic load rating (C).

Vibration and Impact	Velocity (V)	Measured Vibration (G)	fw
Very Slight	V≤15m/min	G≤0.5	1~1.5
Slight	15<V≤60m/min	0.5<G≤1.0	1.5~2.0
Strong	V>60m/min	1.0<G≤2.0	2.0~3.5

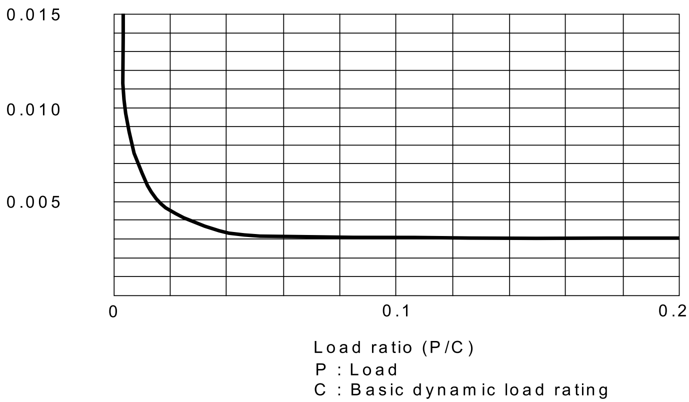
The formula is as follows:

$$L = \left[\frac{f_h \cdot f_t \cdot f_c}{f_w} \cdot \frac{C}{P} \right]^3 \cdot 50km$$

C : Basic Dynamic Load Rating
P : Calculated Load
f_h : Hardness Factor
f_t : Temperature Factor
f_c : Contact Factor
f_w : Load Factor

(The selection process section will provide a more in-depth introduction.)

Friction



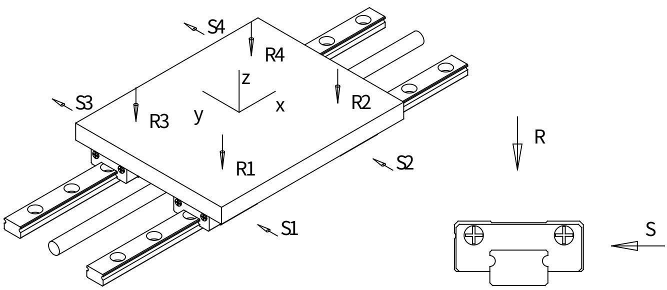
Linear guides enable load movement using rolling elements like balls or rollers, resulting in friction that is 1/40th of the one found in traditional sliding systems. The causes of friction include the viscous resistance of lubricants, preload friction resistance, and friction generated by the applied force. The diagram above illustrates the coefficient of friction when the linear guide is subjected to force.

F=uW+f
F : Friction
W : Load
u : Friction Factor
f : Friction Resistance from Block Accessory

4-1 TM Miniature Wide Linear Guide

Load Calculation

The definition of load calculation is shown in the diagram below. The letter “R” represents the radial load on the block, and “S” represents the lateral load on the block, with numbers indicating their positions. The load calculation for the block is as follows:



$$R_1=\frac{-F_z}{4}+\frac{(F_z\cdot P_y-F_y\cdot P_z)}{2\cdot L1}-\frac{(F_x\cdot P_z-F_z\cdot P_x)}{2\cdot L0}$$

$$R_2=\frac{-F_z}{4}+\frac{(F_z\cdot P_y-F_y\cdot P_z)}{2\cdot L1}-\frac{(F_x\cdot P_z-F_z\cdot P_x)}{2\cdot L0}$$

$$R_3=\frac{-F_z}{4}+\frac{(F_z\cdot P_y-F_y\cdot P_z)}{2\cdot L1}-\frac{(F_x\cdot P_z-F_z\cdot P_x)}{2\cdot L0}$$

$$R_4=\frac{-F_z}{4}+\frac{(F_z\cdot P_y-F_y\cdot P_z)}{2\cdot L1}-\frac{(F_x\cdot P_z-F_z\cdot P_x)}{2\cdot L0}$$

$$S_1=\frac{F_y}{4}+\frac{(F_y\cdot P_x-F_x\cdot P_y)}{2\cdot L0}$$

$$S_2=\frac{F_y}{4}+\frac{(F_y\cdot P_x-F_x\cdot P_y)}{2\cdot L0}$$

$$S_3=\frac{F_y}{4}+\frac{(F_y\cdot P_x-F_x\cdot P_y)}{2\cdot L0}$$

$$S_4=\frac{F_y}{4}+\frac{(F_y\cdot P_x-F_x\cdot P_y)}{2\cdot L0}$$

■ 4-1-4 Preload

Preload is crucial to the overall precision performance of the mechanism. The mechanism may experience overall oscillation due to external forces or inertia from accelerations. Below are reference preload levels for various types of machinery.

Preload	Slight Clearance	Zero Clearance	Light Preload
Operating Conditions	1. Slight impact	1. Slight impact	1. Cantilever
	2. One-axis usage	2. Two-axes usage in parallel	2. One-axis usage
	3. High smoothness requirement	3. High smoothness requirement	3. Light load
	4. Slight sliding resistance	4. Low sliding resistance	4. High accuracy
	5. Low reciprocating load case	5. Low reciprocating load case	
Application Examples	1. Conveyor	1. Welding machine	1. NC lathe
	2. Fully automatic sewing machine	2. Cutting machine	2. Electrical discharge machine
	3. Vending machine	3. Material feeding systems	3. Precision XY table
	4. Laser engraving machine	4. Automatic tool changer	4. Z-axis for general machinery
	5. Banner printing machine	5. XY-axis for general machinery	5. Industrial robotic arm
	6. Screen printing equipment	6. Packing machine	6. PCB drilling machine

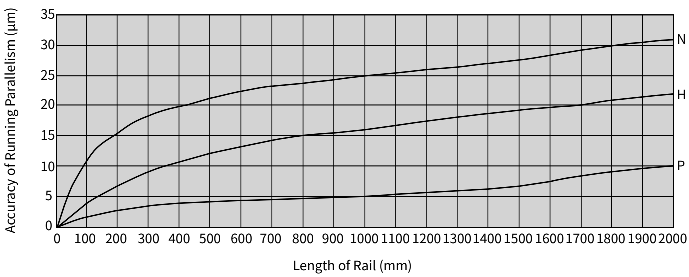
Preload and Clearance

When selecting preload, it is important to consider the potential for clearance or additional preload forces. Be sure to assess the impact on precision and lifespan during the selection process. Miniature linear guides are generally not suitable for medium to high preload applications involving heavier loads because of the limitations in its profile and rigidity.

Preload	Mark	Clearance or Preload Force
Slight Clearance	F	4~10μm
No Clearance	0	2μm~0.01C
Light Preload	1	0.01C~0.02C

Note. The letter "C" in preload force is Dynamic Load Rating.

The running parallelism of the block relative to the reference surface of the guide rail.



A
Linear Guide

4-1 TM Miniature Wide Linear Guide

A

Linear Guide

■ 4-1-5 Accuracy

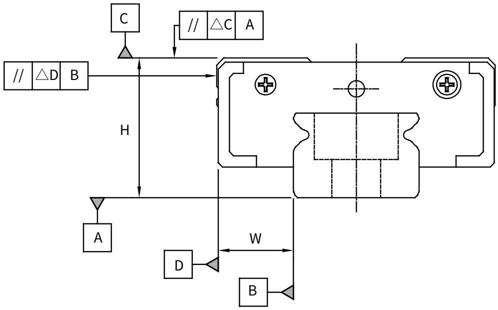


Table 4.1.1 Assembly Accuracy (Non-Interchangeable Type)

Type	Item	Accuracy Level		
		Normal "N"	High "H"	Precision "P"
07 09 12 15	Tolerance for Height H	±0.04	±0.02	±0.01
	Tolerance for Width W	±0.04	±0.025	±0.015
	Tolerance for Height H difference among the blocks	0.03	0.015	0.007
	Tolerance for Width W difference among the blocks	0.03	0.02	0.01
	Running parallelism of block surface "C" against surface "A"	Running parallelism (Table 4.1.3)		
	Running parallelism of block surface "D" against surface "B"	Running parallelism (Table 4.1.3)		

Flatness of the Mounting Surfaces of the Block and Guide Rail

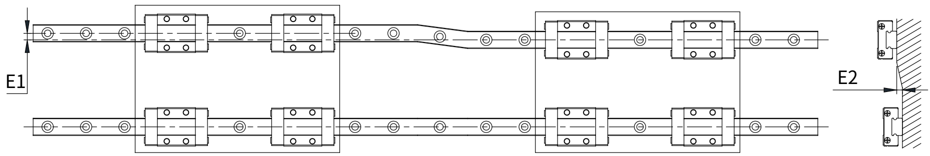
Due to the Gothic structure of miniature linear guides, any accuracy errors in the mounting surfaces may negatively affect their operation.

Table 4.1.2 Flatness of the Mounting Surfaces of the Block and Guide Rail

Unit: mm

Model No.	Flatness Tolerance
07	0.025/200
09	0.035/200
12	0.050/200
15	0.060/200

Note.1. For installation surfaces, accuracy can be influenced by a combination of factors in different cases. Therefore, it is recommended to use values below 70% of those listed in the table.
Note.2. The values mentioned above apply to slight clearances. When using a zero-clearance two-axes system, it is recommended to use values below 50% of those specified above.



Unit: μm

	Tolerance for Dual-Axis Parallelism Error E1			Tolerance for Dual-Axis Levelness Error E2		
Model No.	Slight Clearance	Zero Clearance	Light Preload	Slight Clearance	Zero Clearance	Light Preload
7	3	3	3	25	25	3
9	4	4	3	35	35	6
12	9	9	5	50	50	12
15	10	10	6	60	60	20

4-1 TM Miniature Wide Linear Guide

■ 4-1-6 Accuracy Standard

Table 4.1.3 Rail Length for TM Series and Running Parallelism

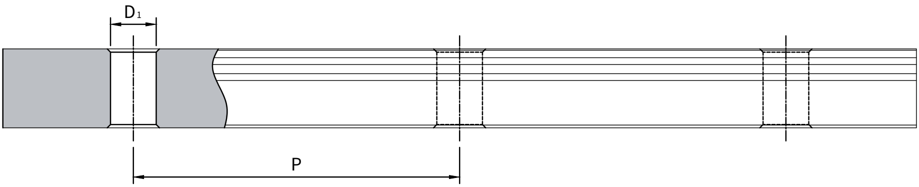
Rail Length for TM Series		Running Parallelism (μm)		
Above	Below	N	H	P
	40	8	4	1
40	70	10	4	1
70	100	11	4	2
100	130	12	5	2
130	160	13	6	2
160	190	14	7	2
190	220	15	7	3
220	250	16	8	3
250	2803	17	8	3
280	310	17	9	3
310	340	18	9	3
340	370	18	10	3
370	400	19	10	3
400	430	20	11	4
430	460	20	12	4
460	490	21	12	4
490	520	21	12	4
520	550	22	12	4
550	580	22	13	4
580	610	22	13	4
610	640	22	13	4
640	670	23	13	4
670	700	23	13	5
700	730	23	14	5
730	760	23	14	5
760	790	23	14	5
790	820	23	14	5
820	850	24	14	5
850	880	24	15	5
880	910	24	15	5
910	940	24	15	5
940	970	24	15	5
970	1000	25	16	5
1000	1030	25	16	5

Table 4.1.3 Rail Length for TM Series and Running Parallelism

Rail Length for TM Series		Running Parallelism (μm)		
Above	Below	N	H	P
1030	1060	25	16	6
1060	1090	25	16	6
1090	1120	25	16	6
1120	1150	25	16	6
1150	1180	26	17	6
1180	1210	26	17	6
1210	1240	26	17	6
1240	1270	26	17	6
1270	1300	26	17	6
1300	1330	26	17	6
1330	1360	27	18	6
1360	1390	27	18	6
1390	1420	27	18	6
1420	1450	27	18	7
1450	1480	27	18	7
1480	1510	27	18	7
1510	1540	28	19	7
1540	1570	28	19	7
1570	1600	28	19	7
1600	1700	29	20	8
1700	1800	30	21	9
1800	1900	30	21	9
1900	2000	31	22	10

4-1 TM Miniature Wide Linear Guide

■ 4-1-7 Mounting Type of Linear Rail



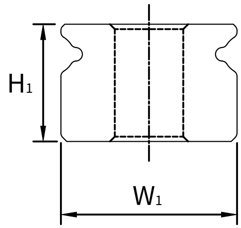


Fig 4.1.3 Mounting from Below

Table 4.1.4 Rail Size

Unit: mm

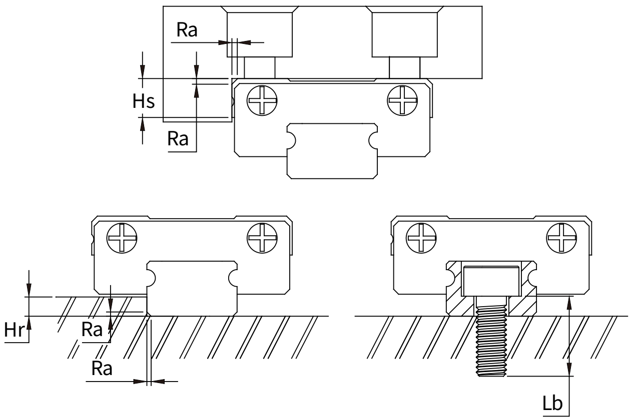
Model No.	Rail Size			
	H1	W1	P	D1
TM07W	5.2	14	30	M4*0.7
TM09W	6.5	18	30	M4*0.7
TM12W	8.5	24	40	M5*0.8
TM15W	9.5	42	40	M5*0.8

■ 4-1-8 Installation

Installation Process

Good installation quality is built on detailed planning during the design phase and the implementation of installation processes. The following are dimensions and design considerations that should be noted in the early design phase, as well as detailed tasks that need to be considered during the installation process.

Dimensions to Consider in the Design Phase

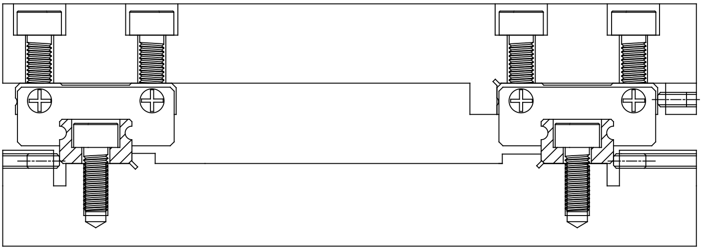


Item	Hr	Hs	Ra	Lb
TM07W	1.7	3	0.2	M3×10L
TM09W	2.5	3.2	0.2	M3×10L
TM12W	3.5	4	0.3	M4×12L
TM15W	3.5	4	0.4	M4×14L

Hr : Maximum height of the rail support surface (mm)
Hs : Recommended height for block support (mm)
Ra : Maximum fillet radius for the support corner (mm)
Lb : Recommended specifications for fixed screws

4-1 TM Miniature Wide Linear Guide

Basic Structure



The above image provides a basic introduction to the application of linear guides.

The basic structure is mainly divided into:

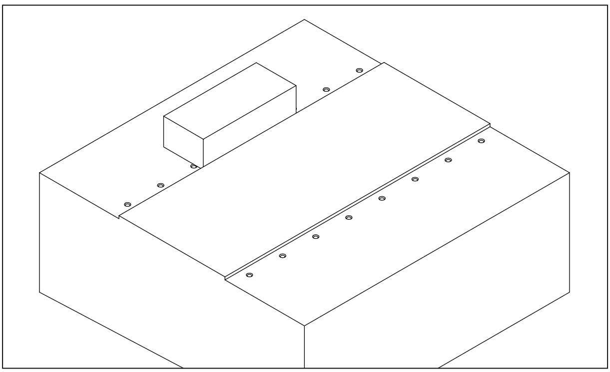
1. Fixed Platform: The above image features a rail mounting surface, with lateral set screws that securely align the rail with the reference surface.

2. Moving Platform: The above image includes a mounting surface for the block, with lateral set screws tightened to ensure the accuracy and stability between the block and the moving platform.

3. Rake Angle Design: Rails and blocks feature basic chamfers to prevent assembly interference. However, to facilitate maintenance, incorporating a rake angle design can also be beneficial.

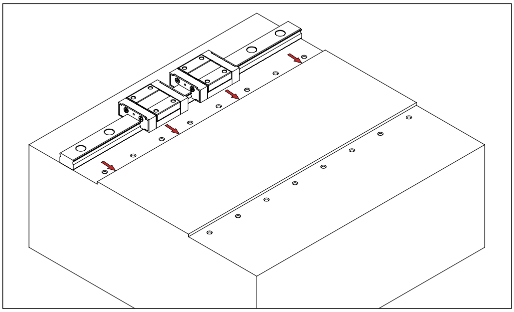
Step 1.

Basic Preparatory Work: To achieve good installation quality, use a cleaning oil to remove the rust-proof oil layer from the reference surface before installation. Additionally, use a honing stone to eliminate any machining burrs or surface defects.



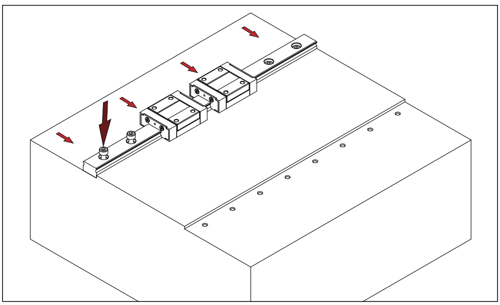
Step 2.

Installation Reference Surface Confirmation: Verify the installation orientation of the reference surface for the rail and block to ensure precise positioning accuracy.



Step 3.

Rail Pre-Positioning: Place the rail onto the reference surface, ensuring it rests against the side installation reference surface. Tighten the set screws to maintain clamping force without fully locking them. Follow the specified sequence for tightening screws, ensuring that the rotation direction aligns the linear guide with the holes of the adjacent reference surface. Proceed in sequence to avoid any misalignment.



4-1 TM Miniature Wide Linear Guide

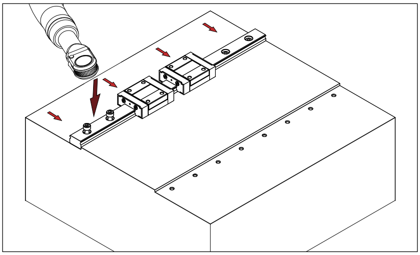
Step 4.

Selection of Tightening Torque: Please confirm the material of the installation platform and the size of the set screws. Then, select the appropriate tightening torque accordingly.

Model No.	Tightening Torque (kg-cm)		
	Steel	Cast Iron	Aluminum
M2	6.3	4.2	3.1
M2.3	8.4	5.7	4.2
M2.6	12.6	8.4	6.3
M3	21	13.6	10.5
M4	44.1	29.3	22
M5	94.5	63	47.2
M6	146.7	98.6	73.5
M8	325.7	215.3	157.5

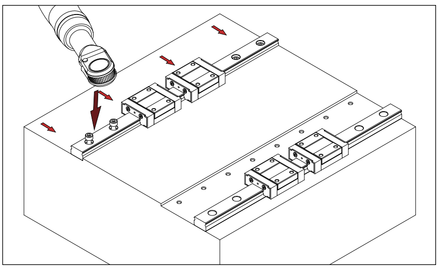
Step 5.

Tightening with Torque Wrench: Use a torque wrench to tighten the screws in stages for accurate positioning. This can be done in two or three stages (with a three-stage tightening distribution of 40%, 70%, and 100% of the final torque output).



Step 6.

Sub-Rail Installation: Follow the same steps as above, paying attention to the torque and the selected order of tightening for the supporting surfaces. Tighten in stages for accurate positioning.



Step 7.

Installation of Moving Platform:

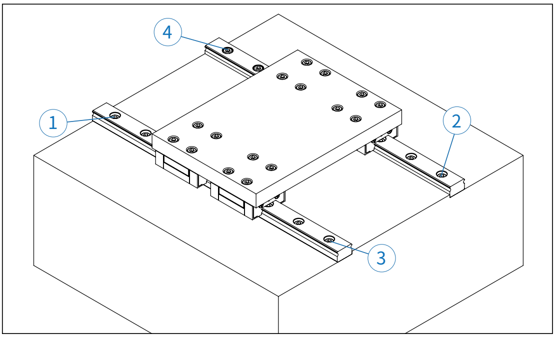
1.Carefully place the moving platform on the assembled block, ensuring that the mounting surface aligns with the lateral clamping position.

2. Tightening can be done in two or three stages (with a three-stage tightening distribution of 40%, 70%, and 100% of the final torque output).

3. Follow a diagonal tightening sequence for the set screws, proceeding in stages as shown in installation step 6.

4. After completing the first stage of tightening at 30%, proceed to apply lateral clamping for the first stage output.

5. After completing the first stage, continue to the next stage, progressing to 100% completion.



4-1 TM Miniature Wide Linear Guide

■ 4-1-9 Nominal Model Code for TM Series

Length of Rail

If the required length exceeds 1300 mm, it will be assembled using two or more sections. Please contact TBI MOTION for detailed information.

T	M	07	W	L	S	-	2	-		-	1000	-	N	S	-	Z0	-	II	-	K
①	②	③	④	⑤	⑥		⑦		⑧		⑨		⑩	⑪		⑫		⑬		⑭

①

Nominal Model
T

②

Block Type
M: Miniature
X: Special

(Drawing will be provided for special item in order to distinguish the height of the rail.)

③

Dimension
07, 09, 12, 15

④

Width of Rail
W: Wide

⑤

Length of Block
N: Standard
L: Long

⑥

Material of Block
S: Stainless Steel

⑦

Number of Block Per Rail
(Mark 1 when there is only 1 block)

⑧

Accessory Code
□ : Standard (End seal + Bottom seal)

⑨

Length of Rail
Unit: mm

⑩

Accuracy Grade
N: Normal
H: High
P: Precision

⑪

Material of Rail
S: Stainless steel

⑫

Preload
ZF: Slight Clearance
Z0: Zero Clearance
Z1: Light Preload

⑬

Two Sets per Axis
(No need to be marked when there is only one rail) II

⑭

Rail Special Machining
K: Mounting from Bottom
X: Rail with Special Machining
□: Mounting from Top

※There is no surface treatment for Miniature Wide Series.

Interchangeable Type of Block:

T	M	07	W	L	-	N	S	-	Z0
①	②	③	④	⑤		⑥	⑦		⑧

①

Nominal Model
T

②

Block Type
M: Miniature
X: Special

(Drawing will be provided for special item in order to distinguish the height of the rail.)

③

Dimension
07, 09, 12, 15

④

Width of Rail
W: Wide

⑤

Length of Block
N: Standard
L: Long

⑥

Accuracy Grade
N: Normal
H: High
P: Precision

⑦

Material of Block
S: Stainless steel

⑧

Preload
ZF: Slight Clearance
Z0: Zero Clearance
Z1: Light Preload

Interchangeable Type of Rail:

T	M	07	W	-	1000	-	N	S	-	K
①	②	③	④		⑤		⑥	⑦		⑧

①

Nominal Model
T

②

Block Type
M: Miniature
X: Special

(Drawing will be provided for special item in order to distinguish the height of the rail.)

③

Dimension
07, 09, 12, 15

④

Width of Rail
W: Wide

⑤

Length of Rail
Unit: mm

⑥

Accuracy Grade
N: Normal
H: High
P: Precision

⑦

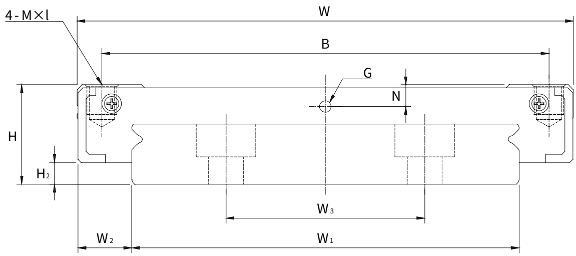
Material of Rail
S: Stainless steel

⑧

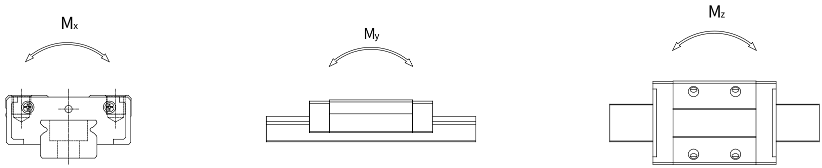
Rail Special Machining
K: Mounting from Bottom
X: Rail with Special Machining
□: Mounting from Top

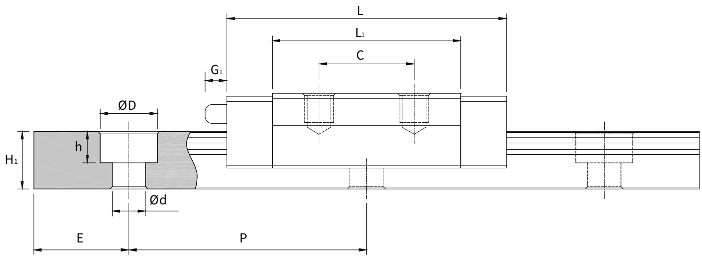
4-1 TM Miniature Wide Linear Guide

TM-W Series Specification



Model No.	Assembly (mm)			Block Dimension (mm)								
	H	H2	W2	W	L	L1	B	C	M×l	N	G	G1
TM07WN	9	2	5.5	25	30.6	21	19	10	M3x3	1.8	1.2	-
TM07WL	9	2	5.5	25	40.4	30.8	19	19	M3x3	1.8	1.2	-
TM09WN	12	3	6	30	38.7	26.1	21	12	M3x3	2.8	1.2	-
TM09WL	12	3	6	30	50.5	37.9	23	24	M3x3	2.8	1.2	-
TM12WN	14	4	8	40	44	29.4	28	15	M3x4	2.85	1.2	-
TM12WL	14	4	8	40	59	44.4	28	28	M3x4	2.85	1.2	-
TM15WN	16	4	9	60	54.8	37.8	45	20	M4x4.5	3	M3	4.5
TM15WL	16	4	9	60	73.8	56.8	45	35	M4x4.5	3	M3	4.5





Rail Dimension (mm)						Load Rating (kgf)		Static Permissible Moment (kg-mm)					Weight	
								M_x	M_y		M_z		Block (kg)	Rail (kg/m)
W1	W3	H1	P	D×h×d	E	C	C0	Single Block	Single Block	Double Block	Single Block	Double Block		
14	-	5.2	30	6x3.2x3.5	10	139	209	1601	728	3753	728	3753	0.02	0.52
14	-	5.2	30	6x3.2x3.5	10	180	320	2391	1581	8392	1581	8392	0.029	
18	-	6.5	30	6x3.5x3.5	10	279	368	4093	1935	9514	1935	9514	0.035	0.95
18	-	6.5	30	6x3.5x3.5	10	354	604	5588	3489	18385	3489	18385	0.048	
24	-	8.5	40	8x4.5x4.5	15	402	571	7174	2839	14918	2839	14918	0.06	1.53
24	-	8.5	40	8x4.5x4.5	15	525	847	10493	5864	29806	5864	29806	0.086	
42	23	9.5	40	8x4.5x4.5	15	694	942	20440	5919	31988	5919	31988	0.122	2.9
42	23	9.5	40	8x4.5x4.5	15	918	1375	30642	12634	61937	12634	61937	0.174	

5-1 Accessory list / Accessory combination list

Table 5.1.1 Accessory list

Type	Codes of Accessories	XN	XNC	UN	ZN	SU	SZ	BN	WW	WU	WZ	DU	DZ	NW
TR15S		O	O	O	O	O	O	O	O	O	O	O	O	-
TR15N		O	O	O	O	O	O	O	O	O	O	O	O	-
TR15L		O	O	O	O	O	O	O	O	O	O	O	O	-
TR20S		O	O	O	O	O	O	O	O	O	O	O	O	-
TR20N		O	O	O	O	O	O	O	O	O	O	O	O	-
TR20E		O	O	O	O	O	O	O	O	O	O	O	O	-
TR25S		O	O	O	O	O	O	O	O	O	O	O	O	-
TR25N		O	O	O	O	O	O	O	O	O	O	O	O	-
TR25E		O	O	O	O	O	O	O	O	O	O	O	O	-
TR30S		O	O	O	O	O	O	O	O	O	O	O	O	-
TR30N		O	O	O	O	O	O	O	O	O	O	O	O	-
TR30E		O	O	O	O	O	O	O	O	O	O	O	O	-
TR35N		O	O	O	O	O	O	O	O	O	O	O	O	-
TR35E		O	O	O	O	O	O	O	O	O	O	O	O	-
TR45N		O	O	O	O	O	O	O	O	O	O	O	O	-
TR45L		O	O	O	O	O	O	O	O	O	O	O	O	-
TR45E		O	O	O	O	O	O	O	O	O	O	O	O	-
TR55L		O	O	O	O	O	O	-	-	-	-	-	-	-
TR55E		O	O	O	O	O	O	-	-	-	-	-	-	-
TR65L		O	O	O	O	O	O	-	-	-	-	-	-	-
TR65E		O	O	O	O	O	O	-	-	-	-	-	-	-
TH07		-	-	-	-	-	-	-	-	-	-	-	-	O
TH09		-	-	-	-	-	-	-	-	-	-	-	-	O
TH12		-	-	-	-	-	-	-	-	-	-	-	-	O
TH15		-	-	-	-	-	-	-	-	-	-	-	-	O

Table 5.1.2 Accessory combination list

Type / Accessories	XN	XNC	UN	ZN	SU	SZ	BN	WW	WU	WZ	DU	DZ	NW
Strong Double-lip end seals	O	-	O	-	O	-	O	O	O	-	O	-	-
Strong Two Double-lip end seals	-	-	-	O	-	O	-	-	-	O	-	O	-
Low Resistance End Seal	-	O	-	-	-	-	-	-	-	-	-	-	O
Spacer	-	-	-	O	O	-	-	-	-	O	O	-	-
Double Spacer	-	-	-	-	-	O	-	-	-	-	-	O	-
Metal Scraper	-	-	-	-	O	O	-	-	-	-	O	O	-
Bottom Seal	O	O	O	O	O	O	O	O	O	O	O	O	O
Top Seal	-	-	O	O	O	O	-	-	O	O	O	O	-
Oil Reservoir	-	-	-	-	-	-	O	-	-	-	-	-	-
Oil Tank	-	-	-	-	-	-	-	O	O	O	O	O	O
Mounting Hole Cap	O	O	O	O	O	O	O	O	O	O	O	O	O
Grease Nipple SD-020	O	O	O	-	-	-	-	-	-	-	-	-	-
Grease Nipple SD-024	-	-	-	O	O	-	-	-	-	-	-	-	-
Grease Nipple SD-066	-	-	-	-	-	O	-	-	-	-	-	-	-
Grease Nipple SD-021	O	O	O	-	-	-	-	-	-	-	-	-	-
Grease Nipple SD-025	-	-	-	-	O	-	-	-	-	-	-	-	-
Grease Nipple SD-026	-	-	-	O	-	O	-	-	-	-	-	-	-
Grease Nipple SD-075	-	-	-	O	-	-	-	-	-	-	-	-	-
Grease Nipple SD-060	-	-	-	-	-	O	-	-	-	-	-	-	-
Grease Nipple SD-011	O	O	O	-	-	-	-	-	-	-	-	-	-
Grease Nipple SD-027	-	-	-	O	-	O	-	-	-	-	-	-	-
Grease Nipple SD-068	-	-	-	-	O	-	-	-	-	-	-	-	-
Grease Nipple SD-059	-	-	-	O	-	O	-	-	-	-	-	-	-
Grease Nipple SD-058	-	-	-	O	-	O	-	-	-	-	-	-	-
Grease Nipple SD-037	O	O	O	-	-	-	-	-	-	-	-	-	-
Grease Nipple SD-038	O	O	O	-	-	-	-	-	-	-	-	-	-
Grease Nipple SD-039	O	O	O	-	-	-	-	-	-	-	-	-	-
Grease Nipple SD-029	O	O	O	-	-	-	-	-	-	-	-	-	-
Grease Nipple SD-040	O	O	O	-	-	-	-	-	-	-	-	-	-
Grease Nipple SD-041	O	O	O	-	-	-	-	-	-	-	-	-	-
Grease Nipple SD-042	O	O	O	-	-	-	-	-	-	-	-	-	-
Grease Nipple SD-043	O	O	O	-	-	-	-	-	-	-	-	-	-
Grease Nipple SD-044	O	O	O	-	-	-	-	-	-	-	-	-	-

6-1 Ball Chain Type Linear Guide

■ 6-1-1 Terms of Ball Chain Type Linear Guide

Main Factors

a. Lifetime and Load of Linear Guide (L)

Selection of linear guide has to be made on the static safety factor that is derived by comparing the calculated load of each carriage according to its conditions and forces against the factors such as basic static load rating (C_0) or permissible static moment (M_x, M_y, M_z) to judge the reliability of the mechanism. To estimate the lifetime in long term, the basic dynamic load rating (C) has to be considered to calculate the distance durability.

b. Basic Static Load Rating (C_0)

When the linear guide receives excessive load, the grooves and the steel balls will be permanently deformed. The linear guide will no longer operate smoothly when the deformation exceeds the limitation. The basic static load rating (C_0) is defined as the static load that will cause the deformation of the grooves and steel ball to 1/10,000 of the steel ball diameter.

c. Permissible Static Moment (M_x, M_y, M_z)

When the linear guide receives a moment, the grooves and the steel balls will deform. A moment that causes deformation of the grooves and the steel balls to 1/10,000 of the steel ball diameter is called the permissible static moment. The permissible static moment in the X, Y and Z directions are Mx, My and Mz individually.

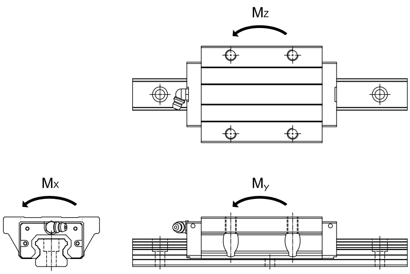


Fig. 6.1.1

d. Static Safety Factor (fs)

The static safety factor (fs) is the ratio of the basic static load rating (C_0) against the maximum equivalent load on the linear guide. This factor indicates the reliability of the linear guide. Applied load is the force applied to the groove. To calculate the equivalent load, we have to calculate the load applied to the carriage both vertical and parallel to the contact face of the groove. In the case of 4 symmetric loads at 45° contact, the equivalent load is the sum of the parallel load and the vertical load.

$$f_s = \frac{f_c \cdot C_0}{P} \qquad f_s = \frac{f_c \cdot M_0}{M}$$

f_s : Static safety factor
f_c : Contact factor
C_0 : Basic static load rating
M_0 : Permissible static moment
P : Equivalent load
M : Equivalent moment

Static safety factor values :

Operations Conditions	Loading Conditions	Minimum f_s
Standing	Light impact and shift	1.0 ~ 1.3
	Heavy impact and twist	2.0 ~ 3.0
Operation	Light impact and twist	1.0 ~ 1.5
	Heavy impact and twist	2.5 ~ 5.0

e. Nominal Life (L)

Linear guide is a mass production product. Even though the products are manufactured with the same materials via the same processes, durability of individual linear guide is never the same even under the same operation conditions. Nominal life is the distance that 90% linear guides could travel without flaking under the designated conditions.

f. Basic Dynamic Load Rating (C)

If the life distance of certain linear guide is defined as 50 km, and if more than 90 % of the linear guides would last for 50 km under a load of constant direction and magnitude that without flaking owing to fatigue, then the load is defined as the basic dynamic load rating of this type of linear guide.

6-1 Ball Chain Type Linear Guide

Subsidiary Factors

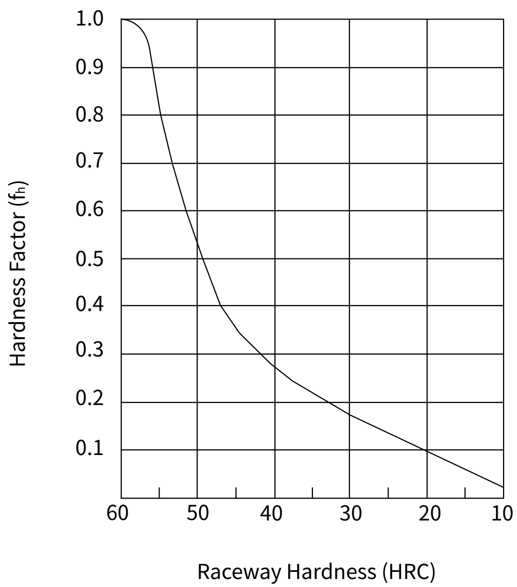
a. Contact Factor (f_c)

When carriages are arranged closely next to another, it is difficult to get even load distribution due to moment and the mounting accuracy. Hence, when multiple linear guides are used as a group, contact factor (fc) should be brought into consideration.

Number of Carriages Used	Contact Factor (fc)
2	0.81
3	0.72
4	0.66
5	0.61
Normal use	1

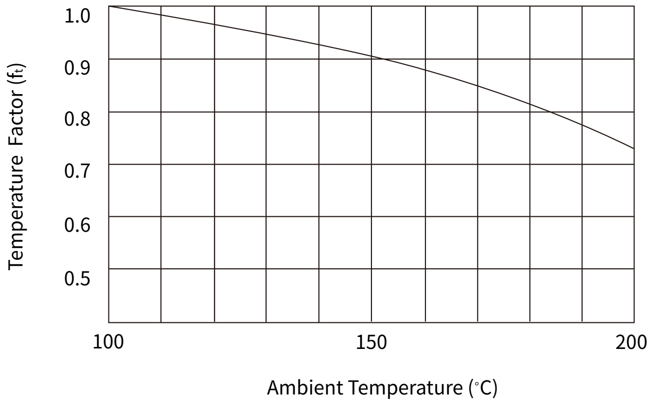
b. Hardness Factor(f_h)

To maximize the load capacity of the linear guide, the hardness of the raceways is the best in the range of HRC 58 to 62. If the hardness is lower than HRC 58, the hardness factor (fh) should be brought into consideration when calculating the life distance and the safety factor.



c. Temperature Factor (f_t)

The adverse impact of high temperature must be considered while the ambient temperature exceeds 100°C. At this condition, the temperature factor (ft) should be brought into calculation.



Note: If the ambient temperature exceeds 80°C, heat-resistant material must be used for the seals and the plastic parts.

d. Load Factor (f_w)

The operation of reciprocating mechanisms is easily inducing vibration or impact. Especially, the vibration caused by high-speed operation or inertial impact generated from the frequent turn on/off. One may refer to the experiential load factors (fw) in the table below when calculating life distance under high speed or vibration.

Vibration / Impact	Speed (V)	Vibration (G)	Load Factor (f_w)
Weak	Low speed V<=15 m/min	G<=0.5	1~1.5
Medium	Moderate speed 15<V<=60 m/min	0.5<G<=1.0	1.5~2.0
Strong	High speed V>60 m/min	1.0<G<=2.0	2.0~3.5

6-1 Ball Chain Type Linear Guide

Life Calculation Equation

Life distance (L) of linear guides can be calculated by applying the basic dynamic load rating (C) and the equivalent load (P) to the equation below:

$$L=\left(\frac{f_h \cdot f_t \cdot f_c}{f_w} \cdot \frac{C}{P}\right)^3 \cdot 50km$$

C: Basic dynamic load rating
f_h: Hardness factor
f_c: Contact factor
P: Equivalent load
f_t: Temperature factor
f_w: Load factor
L : Life distance(km)

When the life distance (L) is known, we can calculate the lifetime according to reciprocating stroke and frequency:

$$L_h=\frac{L \cdot 10^6}{2 \cdot L_s \cdot N_1 \cdot 60}$$

L_h= Lifetime (hr)
N_1= Reciprocation frequency (cycles/min)
L_s= Stroke (mm)

Friction

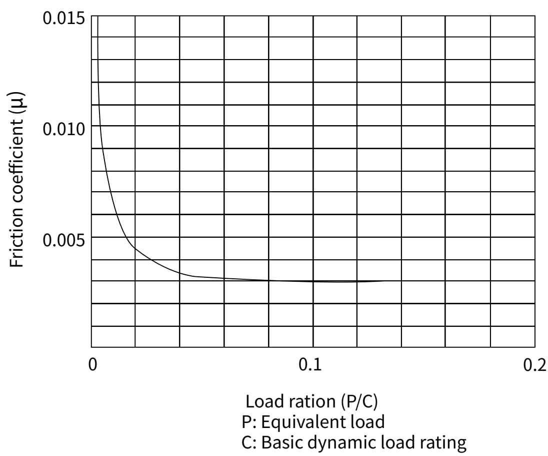
The linear guide is the integration of the carriage, the rail, and the rolling elements such as balls or rollers. Its movement is formed by the rolling elements rolling between the carriage and the rail, and the friction can be as minor as 1/40 of the sliding guide. The static friction of the linear guide is so small that the blank run phenomenon hardly occurs so it can be applied to all sorts of accurate applications. The friction of linear guide varies with the type of linear guide, the preload, the viscosity of lubricants, and the applied load. Friction increases especially when a moment is given or the preload is applied to increase rigidity. The friction characteristic of the linear guide is shown in table 6.1.1 below.

Friction can be calculated with the equation below,
$F=\mu \times W+f$

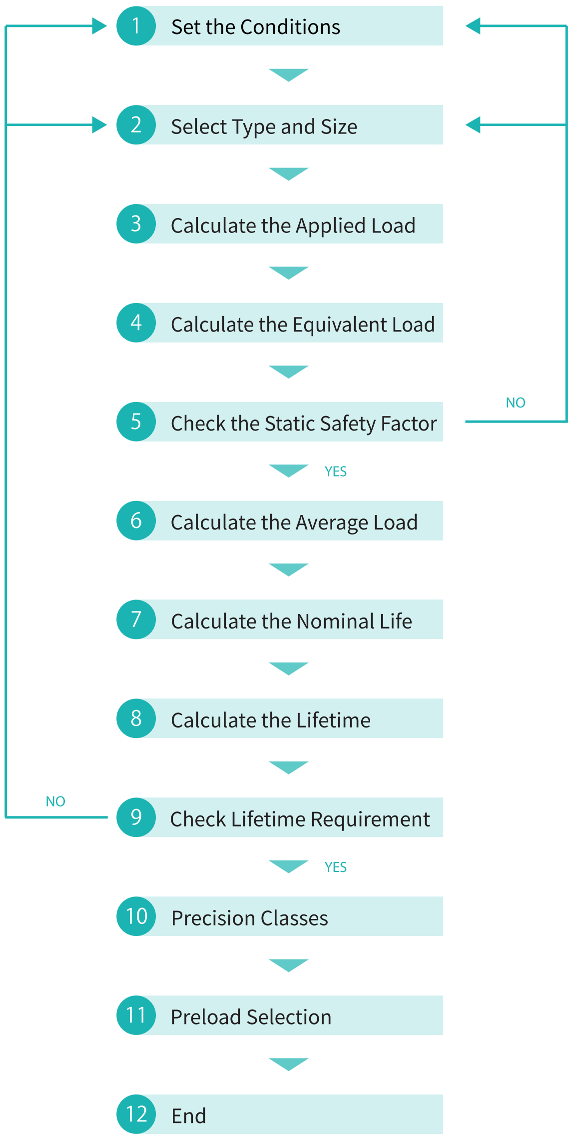
F: Friction
W: Load
μ: Friction coefficient
f: Friction of carriage

Table 6.1.1 Friction coefficient (μ)

Type	Friction coefficient(μ)
CR Series	0.002~0.003



■ 6-1-2 Linear Guide Selection Steps



6-1 Ball Chain Type Linear Guide

1. Set the Conditions

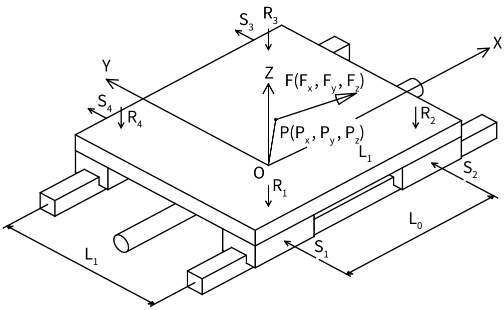
Selection of linear guide has to be based on calculation. The information required for such calculation is:

a. Mounting arrangements (span, number of carriages and number of rails)

b. Mounting orientation (horizontal, vertical, slant mount, wall mount or inverted)

c. Work load (magnitude, direction and applied point, and inertia under acceleration)

d. Operation frequency (load cycle)



a. Installation Combination

(1)Span: distance between the carriages and the rails such as L_0 and L_1 in the above figure.

L_0 distance between the carriages on single rail. (Unit: mm)

L_1 distance between two rails. (Unit: mm)

L_0 and L_1 are crucial to the rigidity and lifetime of the linear motion system.

(2)Number of carriages: how many carriages are mounted on the same rail. In the above figure, two carriages are mounted on one rail. Normally, loading capacity and rigidity are enhanced as the number of carriages increases, and so is the life. However, the operation space and the stroke must be considered.

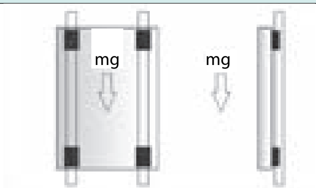
(3)Number of rails: how many rails are used in the system. In the above figure, two rails are used in the system. Normally, in moment capacity is increased as the number of rails increase, and so are rigidity and life.

b. Mounting Orientation

1. Horizontal

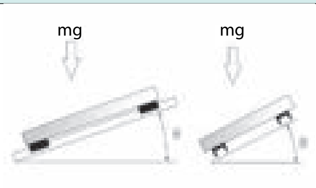
Horizontal
This is the most common way of mounting. It is most persistent to vertical load (mg) and is often used in normal positioning and feeding mechanism.
The load (mg) is parallel to the platform.
The load (mg) is perpendicular to the direction of movement.

2. Vertical



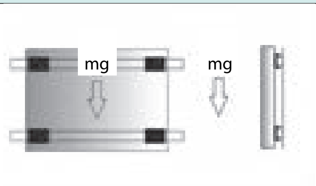
Vertical
The span in between the rails and the moment capacity are crucial. This is often seen in the elevator. Attention should be paid to the suspension of the load. The bigger the suspension is, the bigger the moment is.
The load (mg) is parallel to the platform.

3. Slant Mount



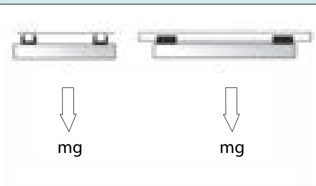
Slant Mount
There are lateral slant mount and longitudinal slant mount.
Lateral slant mount: the load (mg) is vertical to the direction of movement.
Longitudinal slant mount: the load (mg) is with an angle θ to the direction of movement.

4. Wall Mount



Wall Mount
Moment is crucial for wall mount and the span in between rails affects the load on the carriages and must be taken care of.
The load (mg) is parallel to the platform and vertical to the direction of movement.

5. Inverted



Inverted
Inverted mount is upside down of horizontal mount. The spans in between the rails, carriages and the moment capacity have to be considered.

6-1 Ball Chain Type Linear Guide

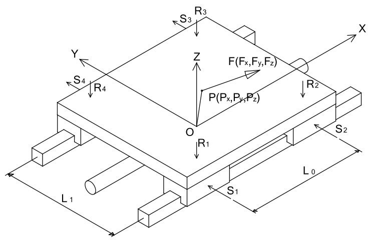
c. Work Load

The work load consists 3 elements - magnitude, direction and applied point.

1. Magnitude of work load:
Mass: The weight of the object gives inertia during movement.
External force: Mechanical forces such as hydraulic, pneumatic or electro-magnetic will not give inertia during the movement.

2. Direction of work load:
The external force can be divided into 3 components, F_x, F_y and F_z as indicated in the right figure.

F_x is the external force in the X-axis.
F_y is the external force in the Y-axis.
F_z is the external force in the Z-axis.



3. Applied point of work load:
As shown above figure, take Point "O" as the origin point of the XYZ coordinate. The source of external force can be a ball screw, a hydraulic cylinder or a linear motor.
The external force "F" applied on the object at point "P", then the applied point of the external force can be defined as:
P_x: Distance of applied point "P" to "O" in X axis.
P_y: Distance of applied point "P" to "O" in Y axis.
P_z: Distance of applied point "P" to "O" in Z axis.

4. Span:
L0 and L1 stand for the distances in between the carriages.

5. Velocity diagram:
Velocity (V): max operation velocity
Travel distance (D): total travel distance
Acceleration distance (D1): the distance from start to max velocity
Constant distance (D2): the distance in constant (max) velocity
Deceleration distance (D3): the distance from max velocity to stop

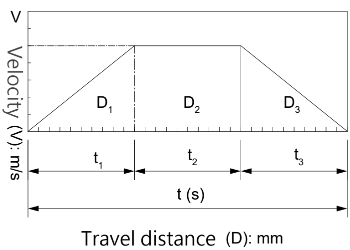


Fig. 6.1.2 Velocity Diagram

6. Work load on each carriage:
R_1, R_2, R_3 and R_4 are the vertical loads of each carriage.
S_1, S_2, S_3 and S_4 are the horizontal loads of each carriage.

d. Work Frequency:

To determine the lifetime is satisfied or not, the work frequency must be considered.

Ex. 1, if the calculated life is 1,000 km and the daily travel is 1 km, then the duration is 1,000 days.

Ex. 2, if the calculated life is 50,000 km and the daily travel is 500 km, then the duration is only 100 days.

2. Select Type and Size

a. Select the appropriate type (CR)

Select the appropriate series of linear guides according to the type of machine and the application. Please see our catalogues of CR series for relevant information.

b. Select an appropriate size

Select a size according to the installation space of machine without considering the work load. In the initial stage, it is difficult to judge load capacity and lifetime. Even if the safety factor is sufficient, it does not say that the lifetime is sufficient. Hence, it is recommended to consider the size as the initial selection objective, and then select the bigger type when life or load is insufficient in practice.

3. Calculate the Applied Load

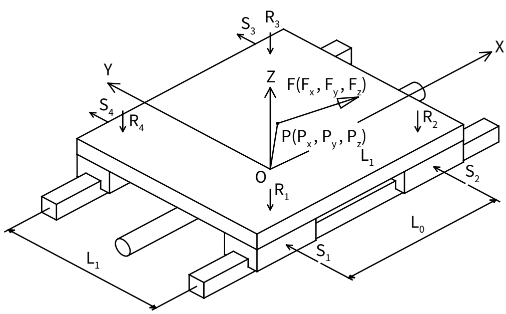
The vertical forces on the carriages are:

$$R_1 = \frac{-F_z}{4} + \frac{F_z \cdot P_x - F_z \cdot P_z}{2 \cdot L_0} + \frac{F_z \cdot P_y - F_y \cdot P_z}{2 \cdot L_1}$$

$$R_2 = \frac{-F_z}{4} + \frac{F_z \cdot P_x - F_z \cdot P_z}{2 \cdot L_0} + \frac{F_z \cdot P_y - F_y \cdot P_z}{2 \cdot L_1}$$

$$R_3 = \frac{-F_z}{4} + \frac{F_z \cdot P_x - F_z \cdot P_z}{2 \cdot L_0} + \frac{F_z \cdot P_y - F_y \cdot P_z}{2 \cdot L_1}$$

$$R_4 = \frac{-F_z}{4} + \frac{F_z \cdot P_x - F_z \cdot P_z}{2 \cdot L_0} + \frac{F_z \cdot P_y - F_y \cdot P_z}{2 \cdot L_1}$$



The horizontal forces on the carriages are:

$$S_1 = S_4 = \frac{F_y}{4} + \frac{F_y \cdot P_x - F_x \cdot P_y}{2 \cdot L_0}$$

$$S_2 = S_3 = \frac{F_y}{4} - \frac{F_y \cdot P_x - F_x \cdot P_y}{2 \cdot L_0}$$

6-1 Ball Chain Type Linear Guide

4. Calculate the Equivalent Load

The vertical and horizontal load capacities of a linear guide depend on the contact angle between the carriage and the rail. The contact angle of the linear guides is designed to be 45° to get equal load in the vertical and the horizontal direction. The equivalent load is the maximum effective load of the carriage against the raceway. Despite counteract, the equivalent load on the rail (Re) can be considered as the sum of vertical load magnitude (Rn) and horizontal load magnitude (Sn).

Vertical load: R_n
Horizontal load: S_n
The equivalent load can be calculated as: $R_e = | R_n | + |S_n |$

5. Check the Static Safety Factor

Definition of static safety factor:

Static safety factor calculation by static load rating:

$$f_s = \frac{f_c \cdot C_0}{R_e} = \frac{\text{(contact factor)} \cdot \text{(static load rating)}}{\text{max. individual equivalent load}}$$

Static safety factor calculation by permissible static moment:

$$f_s = \frac{f_c \cdot C_0}{M} = \frac{\text{(contact factor)} \cdot \text{(permissible static moment)}}{\text{calculated moment}}$$

Contact Factor:

When carriages are arranged tightly together, it is difficult to get even load distribution due to moment and assembly accuracy. Hence, when carriages are used tightly together, it is recommended to bring into consideration the contact factor (fc).

Number of Carriages Used	Contact Factor (fc)
2	0.81
3	0.72
4	0.66
5	0.61
Normal use	1

Reference static safety factor values

Operations Conditions	Loading Conditions	Minimum fs
Standing	Light impact and shift	1.0~1.3
	Heavy impact and twist	2.0~3.0
Operation	Light impact and twist	1.0~1.5
	Heavy impact and twist	2.5~5.0

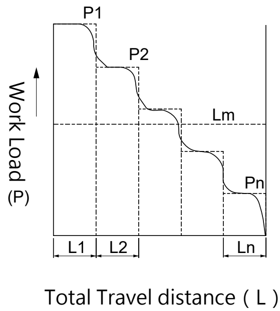
6. Calculate the Average Load

Calculation of average load:

There are several methods to calculate average load according to work load variation pattern in movement.

Stepwise load variation:
P_m: Average load (N)
P_n : Varying load (N)
L: Total travel distance (m)
L_n: Travel distance of each step (m)

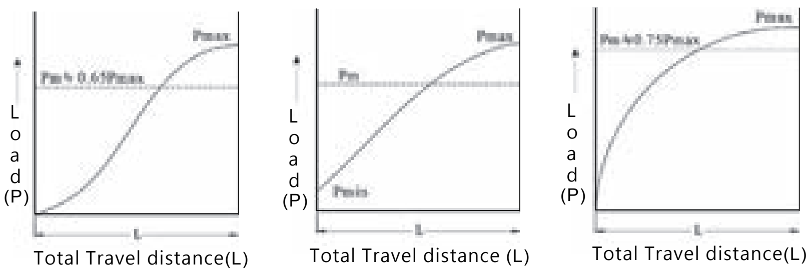
$$P_m = \left[\frac{(P_1^3 \cdot L_1 + P_2^3 \cdot L_2 \ldots\ldots P_n^3 \cdot L_n)}{L} \right]^{\frac{1}{3}}$$



Monotonic load variation:

$$P_m \fallingdotseq \left(\frac{P_{min} + 2P_{max}}{3} \right)$$

P_{min} : minimum load (kgf)
P_{max} : maximum load (kgf)



6-1 Ball Chain Type Linear Guide

7. Calculate the Nominal Life

$$L = \left[\frac{f_h \cdot f_t \cdot f_c}{f_w} \cdot \frac{C}{P} \right]^3 \cdot 50km$$

L: Nominal life (km)
C: Basic dynamic load rating (kN)
P: Calculated average load (kN)
f_c: Contact factor
f_h: Hardness factor
f_t: Temperature factor
f_w: Load factor

8. Calculate the Lifetime

Equation (A): Lifetime by Hours

$$L_h = \frac{L \cdot 10^6}{2 \cdot L_s \cdot N_1 \cdot 60}$$

L_h: Lifetime (h)
L: Nominal life (km)
L_s: Stroke length (mm)
N_1: Reciprocations per minute (min^{-1})

Equation (B): Lifetime by Years

$$L_y = \frac{L \cdot 10^6}{2 \cdot L_s \cdot N_1 \cdot M \cdot H \cdot D}$$

L_y: Lifetime (year)
L: Nominal life (km)
L_s: Stroke length (mm)
N_1: Reciprocations per minute (min^{-1})
M: Work minutes per hour (min/hr)
H: Work hours per day (hr/day)
D: Work days per year (day/year)

9. Check Lifetime Requirement

If the calculated lifetime does not meet the lifetime requirement, return and start from the beginning steps:

(1) Check the conditions again:

a. Mounting arrangements (span, number of carriages and number of rails): Is it necessary to change the span, the number of carriages or the number of rails?

b. Mounting position (horizontal, vertical, slant mount, wall mount or inverted): Is it necessary to modify current construction?

c. Work load: Can the load be reduced?

d. Work Frequency: Was the estimated usage frequency lower than the actual usage, resulting in a calculated lifetime shorter than the required lifetime?

(2) Select type and size:

If the conditions cannot be changed, then another type of linear guide has to be selected. It is recommended to keep the size of rail, and select a carriage with higher load rating.

Selecting a bigger rail may cause some drawbacks below:

a. The weight of the mechanism will be increased:

The weight increases more when selecting a bigger rail rather than selecting a carriage with higher load rating.

b. More changes in design:

When a bigger rail is selected,
1. The pitch of screw hole increased,
2. The screw size is bigger,
3. Contact area with base is increased,
4. The fastening mechanism has to be changed.

When a carriage with higher load rating is selected,
1. The span of screw holes have to be changed,
2. The length of the carriage may cause interference with mechanism.

c. More space is needed:

When a bigger rail is selected,
1. The total height is increased,
2. The total width is increased,
3. The fastening screw is bigger.

When a carriage with higher load rating is selected, the change of space will be little.

d. Cost will be increased:

The variable cost of the rail is higher than that of the carriage.

6-1 Ball Chain Type Linear Guide

10. Precision Classes

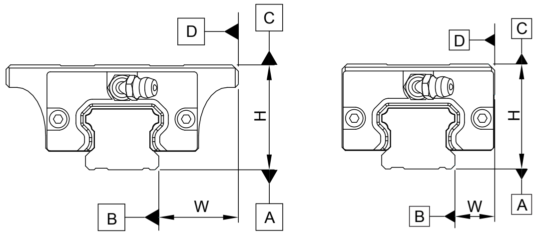


Fig. 6.1.3 Precision Classes

Table 6.1.2 Precision classes of non-interchangeable linear guide for CR series Unit: mm

Grade / Item	Normal (N)	High (H)	Precision (P)	Super Precision (SP)	Ultra Precision (UP)
Height tolerance (H)	±0.1	±0.04	0 -0.04	0 -0.02	0 -0.01
Width tolerance (W)	±0.1	±0.04	0 -0.04	0 -0.02	0 -0.01
Height difference(▵ H)	0.03	0.02	0.01	0.005	0.003
Width difference(▵ W)	0.03	0.02	0.01	0.005	0.003
Running parallelism between carriage surface C and the rail surface A	▵ C Refer to Running parallelism vs. rail (CR Series) length				
Running parallelism between the carriage reference surface D and the rail reference surface B	▵ D Refer to Running parallelism vs. rail (CR Series) length				

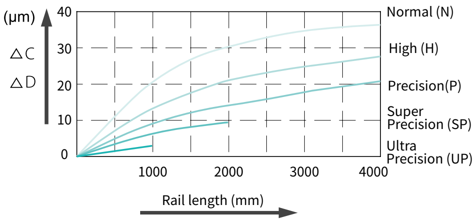
※Height difference (▵ H) refers to the difference between the maximum and minimum height dimensions of the blocks on the same rail.
※Width difference (▵ W) refers to the difference between the maximum and minimum width dimensions of the blocks on the same rail.

Table 6.1.3 Precision classes of interchangeable linear guide for CR series Unit: mm

Grade / Item	Normal (N)	High (H)
Height toleranc (H)	±0.1	±0.04
Width tolerance (W)	±0.1	±0.04

※Definition of interchangeable: For the carriages on a single rail, not including the carriages on different rails.

Running parallelism of various precision classes



CR Rail Length & Running parallelism

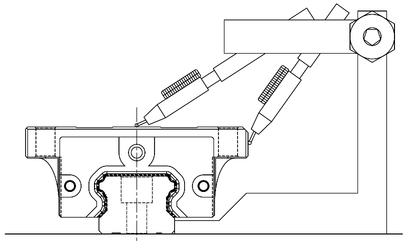


Fig. 6.1.4 Running parallelism vs. rail length

Notes:
1.Please contact us if SP (super precision) rail over 2000mm or UP (ultra precision) rail over 1000mm is required.
2.To make it easier to gain the required precision when mounting the rails against the datum plane, the rails are made slight curved with a big radius.
3.If the datum plane is non-rigid, machine accuracy is easily affected when mounting rails. Hence, it is necessary to inquire straightness of the rails.

Unit: mm/μm

Standard Type						
Rail Length (mm)		Running Parallelism Values (μm)				
Minimum	Maximum	N	H	P	SP	UP
0	100	12	7	3	2	2
100	200	14	9	4	2	2
200	300	15	10	5	3	2
300	500	17	12	6	3	2
500	700	20	13	7	4	2
700	900	22	15	8	5	3
900	1100	24	16	9	6	
1100	1500	26	18	11	7	
1500	1900	28	20	13	8	
1900	2500	31	22	15		
2500	3100	33	25	18		
3100	3600	36	27	20		
3600	4000	37	28	21		

6-1 Ball Chain Type Linear Guide

11. Preload Selection

What is preload?

When there is clearance between the components, the rigidity of linear guide is not enough.

It is possible to eliminate the clearance by enlarging the rolling elements to preliminarily apply an internal load to enhance the rigidity.

Table 6.1.4 Preload grade

Preload grade	Slight clearance / No preload	Light preload	Medium to heavy preload
Conditions	1. low impact 2. two rails in parallel 3. low accuracy 4. small friction 5. light load	1. cantilever 2. single rail usage 3. light load 4. high accuracy	1. strong impact 2. strong vibration 3. heavy machining
Applications	1. welding machine 2. chopping machine 3. feeding mechanism 4. tool change mechanism 5. ordinary XY table 6. packing machine	1. NC lathe 2. Electrical discharge machining 3. precision XY table 4. ordinary Z-axis 5. industrial robot 6. PCB punching	1. Machining center 2. NC lathe and miler 3. feeding axis of grinder 4. tool feeding axis

Increase the preload will eliminate the vibration and the inertia impact in a reciprocating movement. However, increase of preload will increase the internal load and increase the assembly difficulty. Therefore, selection of linear guide must bring into account the balance between the impact of vibration and the lifetime decrease by preload.

Table 6.1.5 Radial clearance

Unit: : μm

Type \ Preload	ZF	Z0	Z1	Z2	Z3
CR 15	4 ~ 8	-3 ~ 3	-8 ~ -4	-13 ~ -9	-18 ~ -14
CR 20	4 ~ 8	-3 ~ 3	-8 ~ -4	-14 ~ -9	-19 ~ - 14
CR 25	5 ~ 10	-4 ~ 4	-10 ~ -5	-17 ~ -11	-23 ~ - 18
CR 30	5 ~ 11	-4 ~ 4	-11 ~ -5	-18 ~ - 12	-25 ~ - 19
CR 35	6 ~ 12	-5~5	-12 ~ -6	-20 ~ -13	-27 ~ -20
CR 45	7 ~ 15	-6 ~ 6	-15 ~ -7	-23 ~ - 15	-32 ~ -24
CR 55	8 ~ 19	-7 ~ 7	-19 ~ -8	-29 ~ -20	-38 ~ -30

Table 6.1.6 Preload values

C: Basic dynamic load rating

Grade	Code	Preload
Slight clearance	ZF	0
No preload	Z0	0
Light preload	Z1	0.02C
Medium preload	Z2	0.05C
Heavy preload	Z3	0.07C

※If special preload is needed, please contact us for technical service.

Table 6.1.7 Comparison of interchangeable and non-interchangeable

Precision class	Non-interchangeable type					Interchangeable Type	
	UP	SP	P	H	N	H	N
Preload					ZF		
				Z0	Z0	Z0	Z0
	Z1	Z1	Z1	Z1	Z1	Z1	Z1
	Z2	Z2	Z2	Z2	Z2		
	Z3	Z3	Z3				

Permitted installation tolerance:

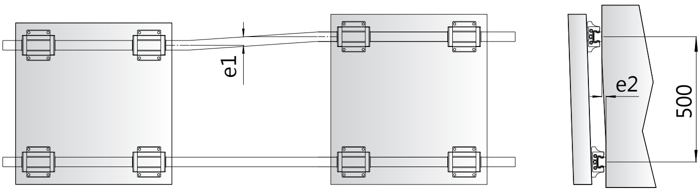


Table 6.1.8 Allowance of installation deviations Unit : μm

Type	Allowance of parallel deviation (e1)					Allowance of level deviation (e2)				
	Z3	Z2	Z1	Z0	ZF	Z3	Z2	Z1	Z0	ZF
CR 15			18	25	35			85	130	190
CR 20		18	20	25	35		50	85	130	190
CR 25	15	20	22	30	42	60	70	85	130	195
CR 30	20	27	30	40	55	80	90	110	170	250
CR 35	22	30	35	50	68	100	120	150	210	290
CR 45	25	35	40	60	85	100	140	170	250	350
CR 55	30	45	50	70	95	125	170	210	300	420

※The defined values of the allowed parallel deviation and level deviation are shown in table 6.1.8. The standard is based on the 500 mm wheelbase.

6-1 Ball Chain Type Linear Guide

Dust Proof of Rails

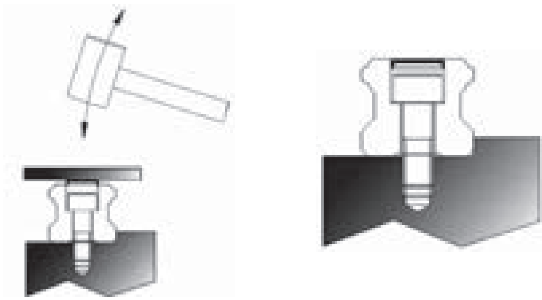


Fig. 6.1.5 Dust proof bore cap

Rail Contamination:

In the machines built with linear guides, chips and foreign objects pile up easily in the rail bores to get inside the carriages. These chips and particles can block the ball circulation and shorten the life of the linear guides.

Bore Cap:

Most chips and foreign objects that fall on the rails can be wiped away by the end seals. Only few accumulate in the bores. The purpose of the rail caps is to block the objects from falling into the bores. These caps can be easily mounted with plastic mallet or plastic panel aligned with bore after rail is secured.

Mounting from Bottom Rails:

These rails are fastened differently from the conventional rails. Since there are no exposed countersunk bores on top, dust and chips simply cannot be stocked.

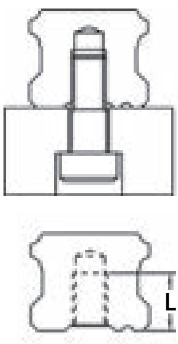
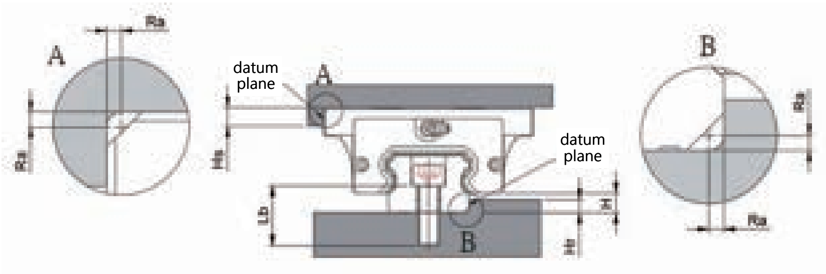


Table 6.1.9 Specification of bolts Unit : mm

Rail Type	Thread Size	Max thread length (L)
CR15	M5x0.8	8
CR20	M6x1.0	10
CR25	M6x1.0	12
CR30	M8x1.25	15
CR35	M8x1.25	17
CR45	M12x1.75	20
CR55	M14x2.0	24

■6-1-3 How to Install Linear Guide

Installation Design Concept



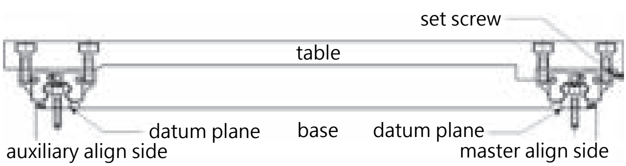
Shoulder height and corner radius of the base

One side of the rail and the carriage is the datum plane for installation and position of linear guide. Datum plane is chamfered both in the rail and in the carriage to avoid interference with the base. It is recommended to design the base shoulder with the dimension in the table below:

Unit : mm

Type	Max. corner radius of align shoulders (Ra)	Height of rail align shoulder (Hr)	Height of carriage align shoulder (Hs)	H
CR 15	0.6	3.1	5	3.3
CR 20	0.9	4.3	6	4.5
CR 25	1.1	5.6	7	5.8
CR 30	1.4	6.8	8	7
CR 35	1.4	7.3	9	7.5
CR 45	1.6	8.7	12	8.9
CR 55	1.6	11.8	17	12.7

Linear guide installation steps



Above picture shows a typical example for rail installation with the features below,

1. There are two datum planes for rail installation on the base.

2. There is set screw in the table to position the table laterally.

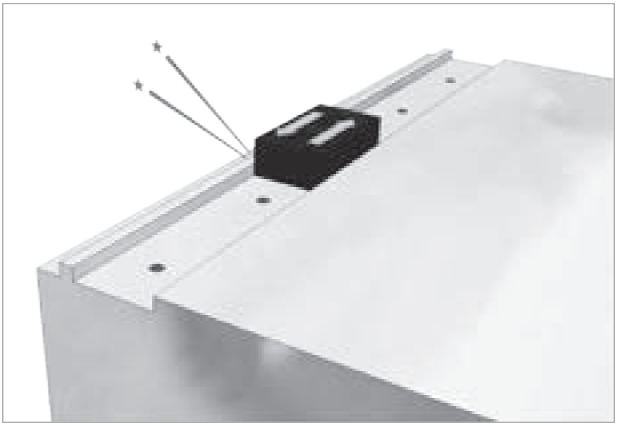
3. The set screw in the table is at the master align side.

6-1 Ball Chain Type Linear Guide

Installation Steps

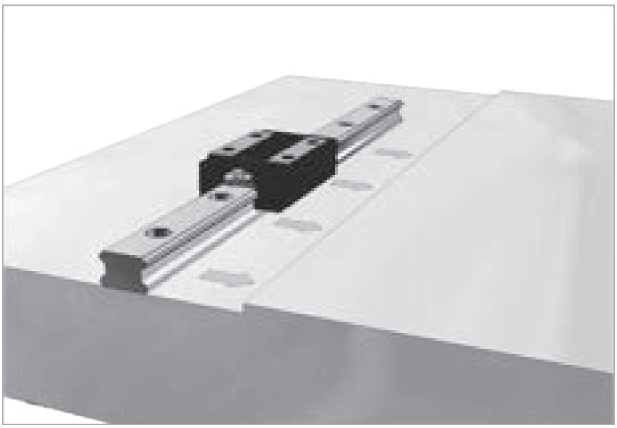
Step 1 All burrs, contaminations and marks must be removed before installation.

Attention: Datum plane is normally covered with antirust oil. Clean the antirust oil with cleaners before installation. Datum plane will get rusty easily without antirust oil, hence, it is recommended to spray some low viscosity lubricant to protect the datum plane from rusting.



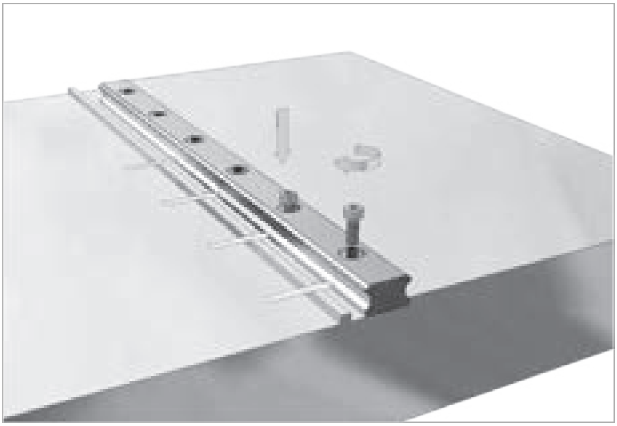
Step 2 Place the master rail gently on the base and make sure it contacts the datum plane nicely with set screws or other fixtures.

Attention: Check the alignment of the screw holes before securing. Fastening the rail with unaligned screw holes will affect the accuracy and quality due to offset or deformation.

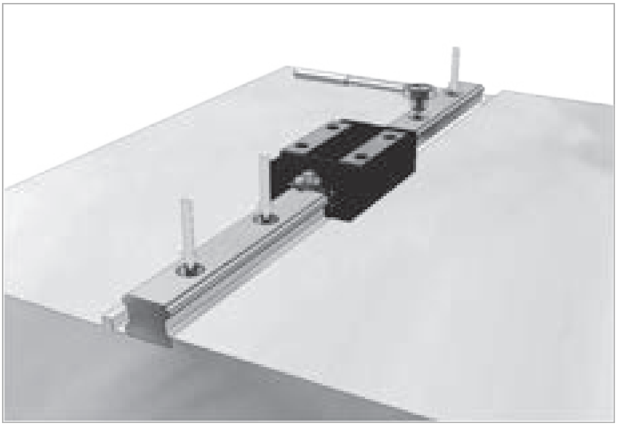


Step 3 Attach the screws to screw holes in the sequence from center to both ends and push the rail gently against the datum plane.

Attention: Fasten the screws in the sequence from center to both ends adequately to make the rail more stable. When the rail is stable in place, enhance the lateral force so that the rail adjoins the datum plane properly.



Step 4 Fasten the screws by a torque wrench with the appropriate torque according to the screw size and base material.



6-1 Ball Chain Type Linear Guide

Recommended rail screw fastening torque

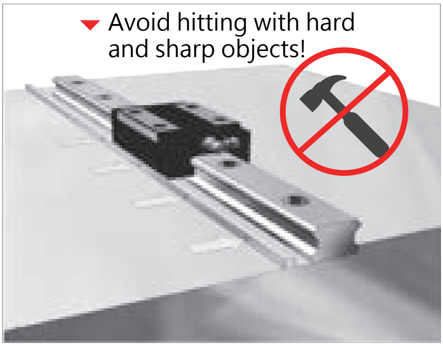
Unit : kgf-cm

Screw size	Fastening torque (kgf-cm)		
	Steel	Cast Iron	Aluminum alloy
M 2	6.3	4.2	3.1
M 2.3	8.4	5.7	4.2
M 2.6	12.6	8.4	6.3
M 3	21	13.6	10.5
M 4	44.1	29.3	22
M 5	94.5	63	47.2
M 6	146.7	98.6	73.5
M 8	325.7	215.3	157.5
M 10	724.2	483.2	356.7
M 12	1264.2	840	630
M 14	1682.1	1125	840
M 16	2100	1403.5	1050

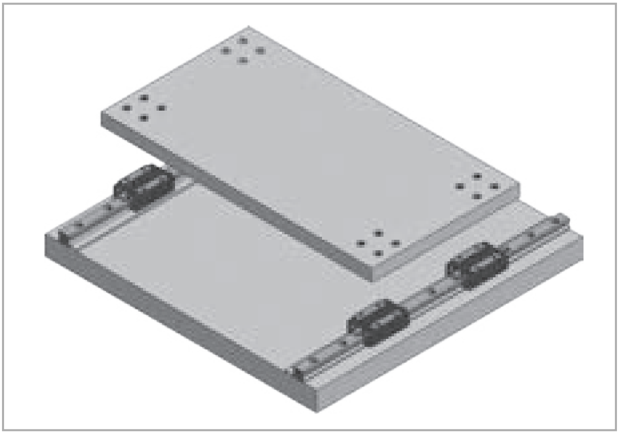
※Please select the appropriate torque according to base material and screw size, and fasten the rail screw gently with the torque wrench.

Step 5 Install the slave rail with the same steps foresaid, then install the carriages onto the rails individually.

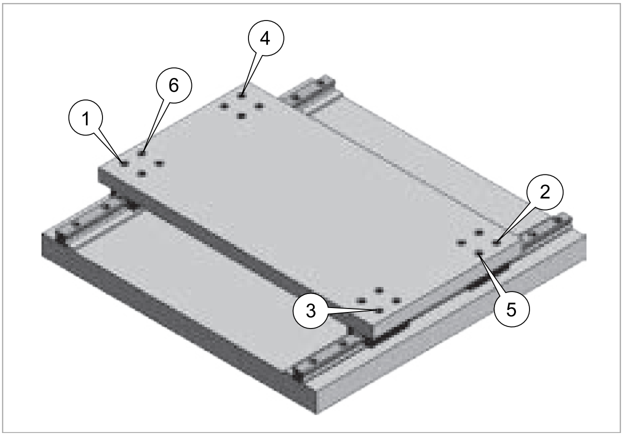
Attention: Space can be very limited and makes it difficult to assembly the accessories after carriage is installed on the rail. Hence, it is recommended to assembly all accessories, such as grease nipple, oil fitting and seals at this stage.



Step 6 Place the table gently on the carriages on both master and slave rails.

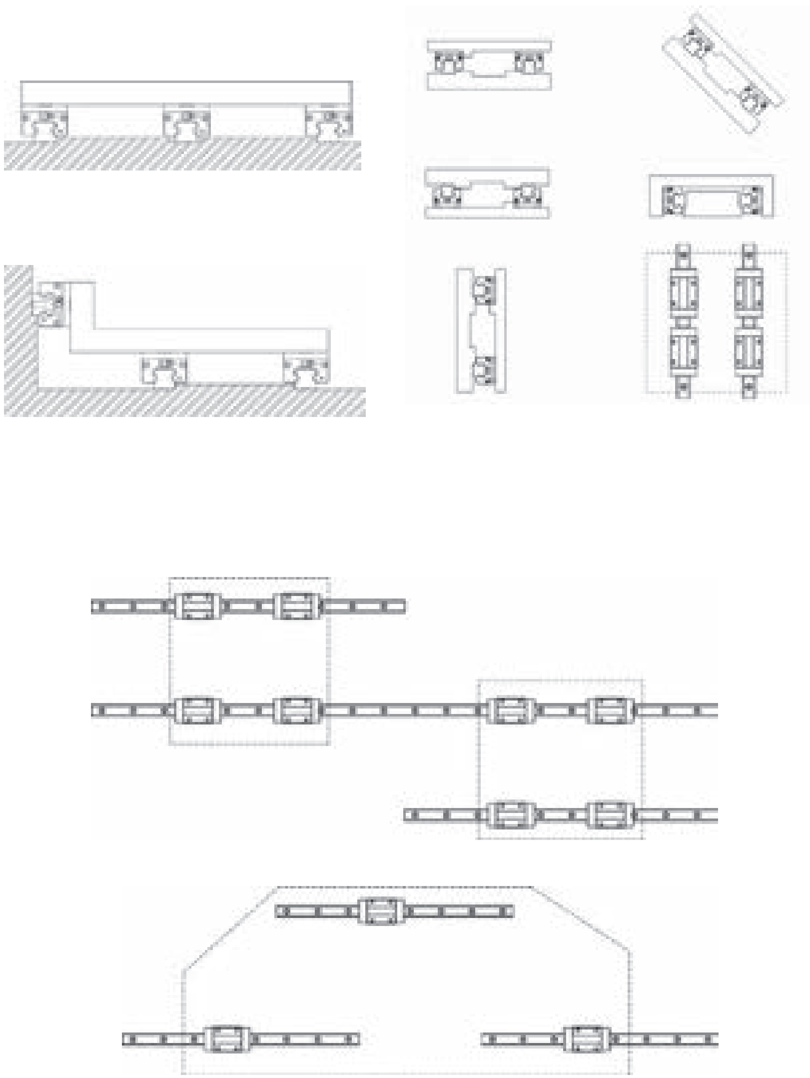


Step 7 Fasten the crosswise set screw to secure the table. Fasten the table screws with the sequence demonstrated in the figure below

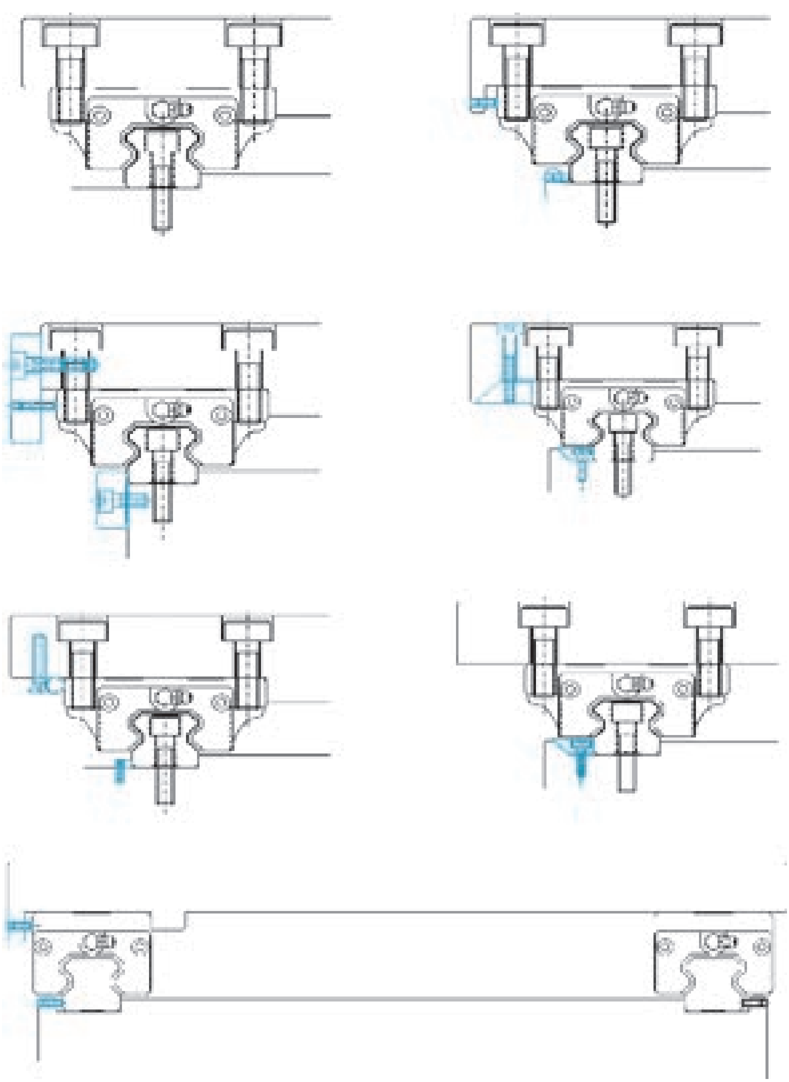


6-1 Ball Chain Type Linear Guide

Common Installation Patterns

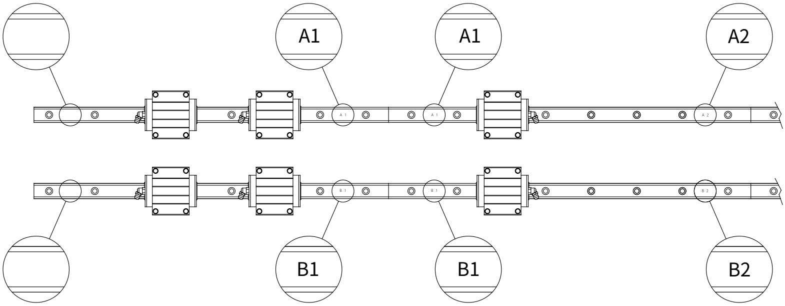


Common Securing Methods



6-1 Ball Chain Type Linear Guide

Use of Jointed Rails

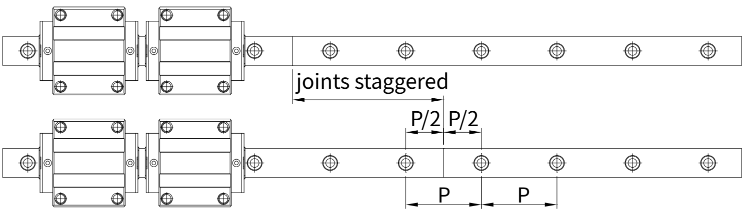


When an over length rail is required, two or more rails can be butt-jointed to the required length. When jointing rails, be sure to match the marked positions correctly as the above figure.

The linear guides will be numbered as the table below:

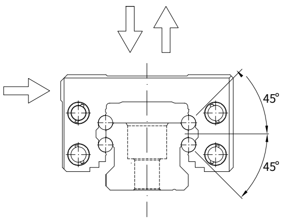
	Jointed rail #1	Jointed rail #2	Jointed rail #3	...	Jointed rail #N
Parallel axis #01	No mark A1	A1 A2	A2 A3	A3 ···	AN No mark
Parallel axis #02	No mark B1	B1 B2	B2 B3	B3 ···	BN No mark
...	⋮	⋮	⋮	⋮	⋮
Parallel axis #26	No mark Z1	Z1 Z2	Z2 Z3	Z3 ···	ZN No mark

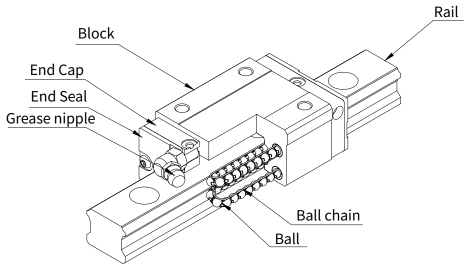
If two jointed rails are used in pair, in order to minimize the deviation, it is recommended to stagger the joint points in these two rails.



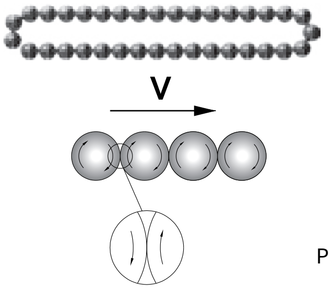
■ 6-1-4 CR Series Ball Chain Linear Guide

Introduction to ball chain

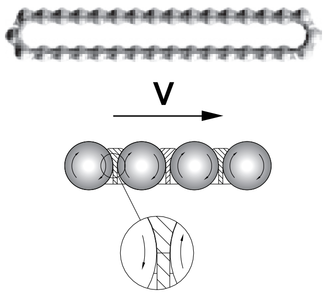




In CR series, the steel balls do not come into direct contact with one another. In contrast, conventional linear guides have steel balls that make point contact at two small spots, which results in significantly higher contact pressure on the linear guide. Because CR series uses a ball chain, an oil film is maintained between balls, and the relative frictional speed is only about half that of conventional linear guides. Considering both frictional speed and contact pressure, the heat generation of CR series is therefore lower than that of conventional linear guides.



$$P = \frac{F}{A}$$



P: Contact pressure of steel balls

F: Interaction force of steel balls

A: Contact area of steel balls

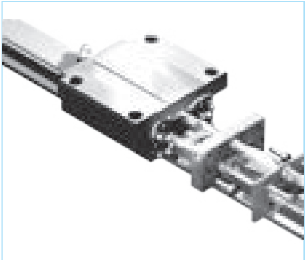
As shown in the upper left figure, Conventional linear guide: The relative speed is double of rotation speed and the pressure is almost infinity owing to the contact area is extremely small.

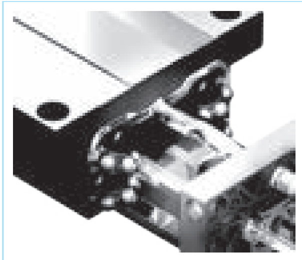
As shown in the upper right figure, CR series linear guide: Ball chain provide better lubrication and absorbed the friction between steel balls that allows the carriage move in high speed.

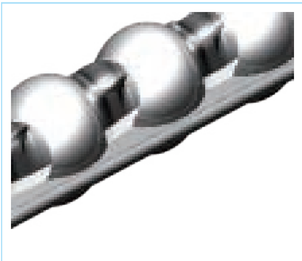
6-1 Ball Chain Type Linear Guide

a. Lubrication by Circulation

The lubricant can be injected via the grease nipples and its effect can be enhanced by the ball chain circulation in CR series.







As shown in the figure, the oil film stays between the steel balls and the ball chain.

This unique chain design of CR series linear guides provides more space to reserve the lubricant. The ball chain brings the lubricant to every circulation surface as it circulates. Even when resting, less lubricant escapes from CR series linear guides than the conventional linear guide.

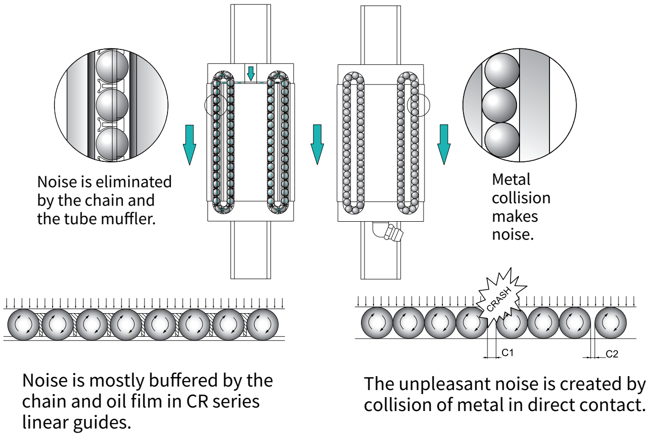
In conventional linear guides, the lubrication oil vanishes easily as they run. Loss of lubrication oil results in wearing, noise and heating. CR series linear guide was design to solve this issue and improves the performance and life effectively.

b. Less Noisy

The conventional linear guides are noisier because:

1. Relative speed at steel ball contact is twice than that of motion speed.

2. The contact area is too small that enlarge the contact pressure as well as the friction.

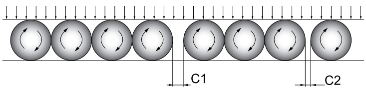


When the steel balls travels in different speeds, circulation will cause chasing in the steel balls. In the conventional linear guides, collisions of steel balls create loud noises. The macromolecular polymer chain of CR series linear guides is designed with rooms to retain lubrication oil. Most collision noises are eliminated by the elasticity of the chain and the oil film buffering.

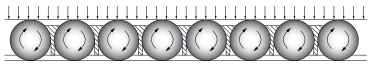
6-1 Ball Chain Type Linear Guide

c. Evenly Load Distributed

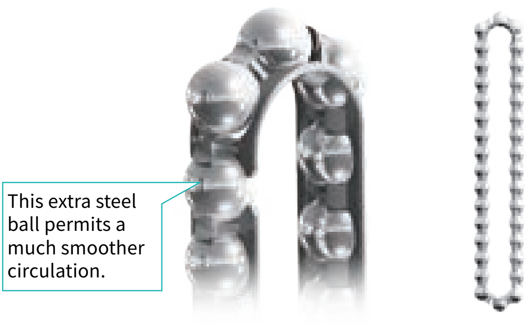
The steel balls in conventional linear guides cannot be evenly distributed to get even clearances between steel balls, so the load on each steel ball is uneven. This uneven load shortens the lifetime of steel balls in a long time. In CR series linear guides, the steel balls fixed by the chain are evenly distributed in the circulation runway and are evenly loaded so the lifetime is more reliable.

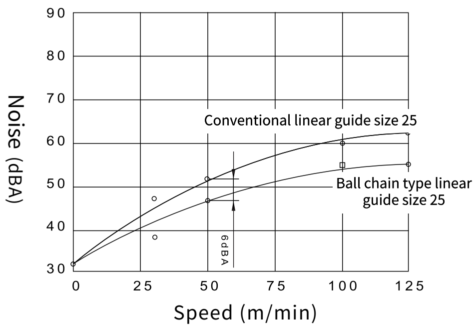


As shown in the figure above: Steel ball are randomly distributed in the conventional linear guides and unevenly loaded.

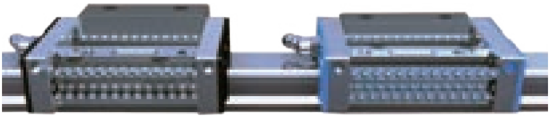


As shown in the figure above: Steel ball are fixed by the chain in CR linear guides. It minimizes the uneven clearance to guarantee a more reliable lifetime.





d. CR series Ball Chain Type vs. Conventional Linear Guides



	Conventional linear guides	CR series Ball chain type linear guides
Maintenance	Oil film not easy to maintain	Oil film easy to maintain
Noise	Noisy	Quiet
Heating	High	Low
Load	Uneven	Even

6-1 Ball Chain Type Linear Guide

■ 6-1-5 Nominal Model Code for Non-interchangeable CR Type

C	R	H	20	F	N	-	2	-		-	1200	-	N	-	Z0	-	II	-	K	+	N3	N3
①	②	③	④	⑤	⑥		⑦		⑧		⑨		⑩		⑫		⑬		⑭		⑭	⑮

①

Nominal Model
C

②

Block Type
R: Standard
X: Special

③

Height of Assembly Type
S: Low-Assembly
H: High-Assembly

④

Dimension
15、20、25、30、35、45、55

⑤

Flange Type
F: With Flange
V: Without Flange

⑥

Length of Block
S: Short
N: Normal
L: Long
E: Extra-Long

⑦

Number of Block per Rail
EX: 2

⑧

Accessory Code
Standard (Please refer to page A164)

⑨

Length of Rail
Unit :mm

⑩

Accuracy Grade
N: Normal
H: High
P: Precision
SP: Super-Precision
UP: Ultra-Precision

⑪

Preload
ZF: Slight Clearance
Z0: No Preload
Z1: Light Preload
Z2: Medium Preload
Z3: Heavy Preload

⑫

Two Sets per Axis
II

⑬

Rail Special Machining
□: Mounting from Top
K: Mounting from Bottom
X: Rail with Special Machining

⑭

Block Surface Treatment
□: Standard
N1: Hard Chrome Plating
N3: Nickel Plating
N4: Raydent (Fluoride chromium)
N5: Chrome Plating

⑮

Rail Surface Treatment
□: Standard
N1: Hard Chrome Plating
N3: Nickel Plating
N4: Raydent (Fluoride chromium)
N5: Chrome Plating

※No Symbol required when plating is not needed.
※The block with ball chain is only suitable for CR series rails.

■ 6-1-6 Nominal Model Code for Interchangeable CR Type

Interchangeable Type of Block

C	R	H	20	F	N	-		-	N	-	Z0	+	N3
①	②	③	④	⑤	⑥		⑦		⑧		⑨		⑩

①

Nominal Model
C

②

Block Type
R: Standard
X: Special

③

Height of Assembly Type
S: Low-Assembly
H: High-Assembly

④

Dimension
15、20、25、30、35、45、55

⑤

Flange Type
F: With Flange
V: Without Flange

⑥

Length of Block
S: Short
N: Normal
L: Long
E: Extra-Long

⑦

Accessory Code
Standard (Please refer to page A164)

⑧

Accuracy Grade
N: Normal
H: High

⑨

Preload
ZF: Slight Clearance
Z0: No Preload
Z1: Light Preload

⑩

Block Surface Treatment
□: Standard
N1: Hard Chrome Plating
N3: Nickel Plating
N4: Raydent (Fluoride chromium)
N5: Chrome Plating

※The block with ball chain is only suitable for CR series rails.

6-1 Ball Chain Type Linear Guide

Interchangeable Type of Rail

C	R	20	-	1200	-	N	-	K	+	N3
①	②	③		④		⑤		⑥		⑦

①

Nominal Model
C

②

Block Type
R: Standard
X: Special

③

Dimension
15、20、25、30、35、45、55

④

Length of Rail
Unit: mm

⑤

Accuracy Grade
N: Normal
H: High

⑥

Rail Special Machining
□: Mounting from Top
K: Mounting from Bottom
X: Rail with Special Machining

⑦

Rail Surface Treatment
□: Standard
N1: Hard Chrome Plating
N3: Nickel Plating
N4: Raydent (Fluoride chromium)
N5: Chrome Plating

※The block with ball chain is only suitable for CR series rails.

Accessory Code

Accessory \ Code	XNB	UNB	DUB	ZNB	SUB	SZB	ZUB	DSB	Add "A" after each code
End Seal	O	O			O		O		
Two End Seals			O	O		O		O	
Top Seal		O		O	O	O			
Bottom Seal	O	O	O	O	O	O	O	O	
Metal Scraper					O	O	O	O	
Self-Lubrication									O

■6-1-7 Dust-proof Accessory

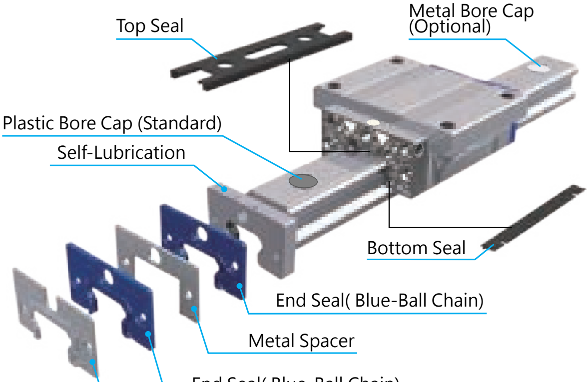
CR Series Dust-proof Design

Incursion of foreign particles is the main reason of shorter rail life because accuracy of linear guide relies very much on the precision of rail, carriage and steel balls. Even the tiniest particle in the circulation runway can cause abnormal vibration and bumping of the linear guide and lead to permanent damage. Therefore, dust-proof is the key to improve the quality of linear guide.

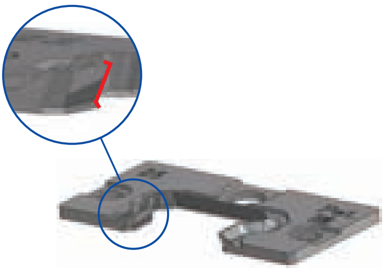
Passages for particle incursion:

1. Bores: Dust accumulates easily at the rail bores and get into the circulation runway due to vibration or machine movements.

2. Gap between carriage and rail: Bigger particles normally incurs from the gap between carriage and rail that is the closest to the runway.



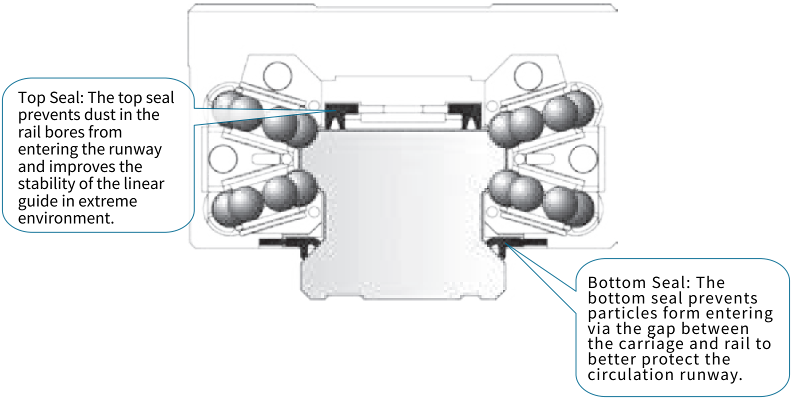
End Seal



Strength

1. Lighter friction
2. Good dust-proof performance
3. Smooth running

6-1 Ball Chain Type Linear Guide



Top Seal

Top seal aims at dust accumulated in the rail bores. It stops the dust from entering the circulation runway with the lips to separate the rail bores.

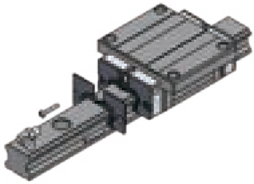
Bottom Seal

Bottom seal aims at the gap between carriage and rail. It closes the gap with the wiper to prevent dust getting into the circulation runway from aside and underneath.

Nylon applied and fit closely with the rail surface, which blocks the dust effectively.

Metal Scraper

It is applicable for metal cutting machines or flame cutting machines to scrape bigger chips or welding spatters. It protects the end seal from being damaged by sharp chips or burning spatters so that the end seal will keep its dust-proof function.



6-1 Ball Chain Type Linear Guide

Dust-proof Systems

Standard System

The double-lip end seal ensures that the dust and particles will be kept of the carriage by the inner lip to secure performance even if the outer lip is worn out. It is recommended for the environment with much powder and chips.

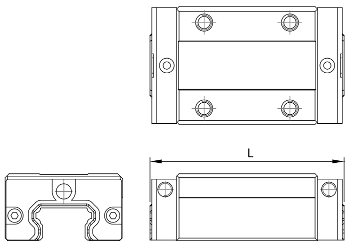


Table 6.1.10 Length of CR series Block with Accessory Unit: mm

End Seal+Bottom Seal (XNB) / End Seal+Top Seal+Bottom Seal (UNB)							
Length of Block \ Size	CR15	CR20	CR25	CR30	CR35	CR45	CR55
S	40.6	49.1	54	64.2	75.5		
N	58.6	70.1	79.2	94.8	111.5	129	155
L	66.1	82.9	93.9	105	123.5	145	193
E		98.1	108.6	130.5	153.5	174	210

Two End Seals+Bottom Seal (DUB) / Two End Seals+Top Seal+Bottom Seal (ZNB)							
Length of Block \ Size	CR15	CR20	CR25	CR30	CR35	CR45	CR55
S	46.6	56.1	61	72.2	84.5		
N	64.6	77.1	86.2	102.8	120.5	139	165
L	72.1	89.9	100.9	113	132.5	155	203
E		105.1	115.6	138.5	162.5	184	220

End Seal+Top Seal+Bottom Seal+Metal Scraper (SUB) / End Seal+Bottom Seal+Metal Scraper (ZUB)							
Length of Block \ Size	CR15	CR20	CR25	CR30	CR35	CR45	CR55
S	42.4	51.5	56.9	66.8	78.1		
N	60.4	72.5	82.1	97.4	114.1	132	157.6
L	67.9	85.3	96.8	107.6	126.1	148	195.6
E		100.5	111.5	133.1	156.1	177	212.6

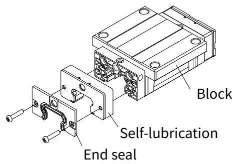
Two End Seals+Top Seal+Bottom Seal+Metal Scraper (SZB) / Two End Seals+Bottom Seal+Metal Scraper (DSB)							
Length of Block \ Size	CR15	CR20	CR25	CR30	CR35	CR45	CR55
S	48.4	58.5	63.9	74.8	87.1		
N	66.4	79.5	89.1	105.4	123.1	142	167.6
L	73.9	92.3	103.8	115.6	135.1	158	205.6
E		107.5	118.5	141.1	165.1	187	222.6

■ 6-1-8 Self-Lubrication System

(1) Introduction

Self-Lubrication system laminates lubricant on the runway surface. It creates oil film throughout the rolling route to ensure the rollers are properly lubricated. Unlike the previous lubrication loop that just delivers the lubricant to the rollers, the self-lubrication system together with the pumping system ensures the lubrication reliability.

◎ Pay attention that if the viscosity of the lubrication oil is not within 100 to 400 cSt, the lubrication effect may be not as expected.
◎ Lubrication volume can be appropriately adjusted when self-lubrication system is integrated.
◎ Grease nipples are not attached when self-lubrication system is integrated. Please contact our sales staff if grease nipples are required.

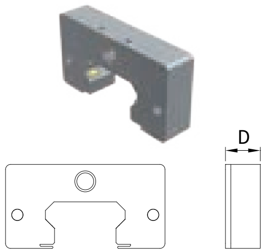


(2) Specifications

Table 6.1.11 Specifications and size of self-lubrication

Size	D(mm)	V(cm^3)
15	10.3	2.0
20	10.3	2.5
25	10.3	3.0
30	10.3	5.5
35	10.5	8.5
45	13.0	15.0
55	13.0	22.5

D: Thickness of the single self-lubricating component
V: Oil storage capacity



(3) Long-lasting lubrication

It has been experimented that there would be residual oil after 1,500km of travel if recommended viscosity oil was applied. Excess oil in the runway will be recycled by the capillary fiber in the component.

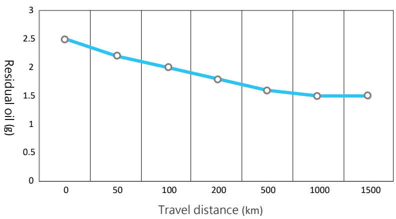


Table 6.1.12 Durability of self-lubrication

Travel distance (km)	0	50	100	200	500	1000	1500
Residual oil(g)	2.5	2.2	2.0	1.8	1.6	1.5	1.5

※Carriage CR15 integrated with self-lubricating component would still maintain the lubrication performance after 1,500km of travel. If operated in ideal conditions, it would last over 3,000km.

(4) System Compositions

All self-lubrication system consists of

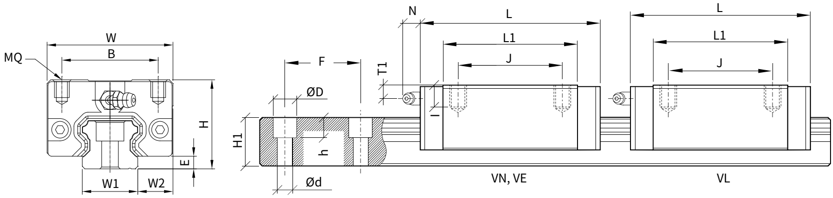
4 kinds of components in table 6.1.13.

Table 6.1.13 Compositions

Compositions	Quantity
Self-lubrication system	4
Cover	1
Housing	1
Felt	2

6-1 Ball Chain Type Linear Guide

CRH-V Series Specifications



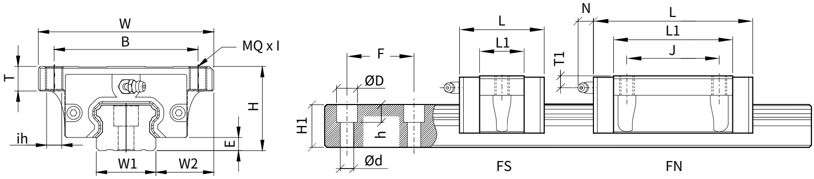
Model No.	Assembly (mm)				Block Dimension (mm)								
	H	W	W2	E	L	B	J	MQ	l	L1	Oil H	T1	N
CRH15VN	28	34	9.5	3.3	58.6	26	26	M4	6.0	40.2	M4X0.7	9.5	(5.7)
CRH20VN	30	44	12.0	4.5	70.1	32	36	M5	6.5	48.5	M6X1	7.1	(12.3)
CRH20VL	30	44	12.0	4.5	82.9	32	36	M5	6.5	61.3	M6X1	7.1	(12.3)
CRH20VE	30	44	12.0	4.5	98.1	32	50	M5	6.5	76.5	M6X1	7.1	(12.3)
CRH25VN	40	48	12.5	5.8	79.2	35	35	M6	9.0	57.5	M6X1	14.2	(12.2)
CRH25VL	40	48	12.5	5.8	93.9	35	35	M6	9.0	72.2	M6X1	14.2	(12.2)
CRH25VE	40	48	12.5	5.8	108.6	35	50	M6	9.0	86.9	M6X1	14.2	(12.2)
CRH30VN	45	60	16.0	7.0	94.8	40	40	M8	12.0	67.8	M6X1	13.0	(11.7)
CRH30VL	45	60	16.0	7.0	105.0	40	40	M8	12.0	78.0	M6X1	13.0	(11.7)
CRH30VE	45	60	16.0	7.0	130.5	40	60	M8	12.0	103.5	M6X1	13.0	(11.7)
CRH35VN	55	70	18.0	7.5	111.5	50	50	M8	12.0	80.5	M6X1	18.5	(11.5)
CRH35VL	55	70	18.0	7.5	123.5	50	50	M8	12.0	92.5	M6X1	18.5	(11.5)
CRH35VE	55	70	18.0	7.5	153.5	50	72	M8	12.0	122.5	M6X1	18.5	(11.5)
CRH45VN	70	86	20.5	8.9	129.0	60	60	M10	18.0	94.0	M8X1.25	24.4	(10.8)
CRH45VL	70	86	20.5	8.9	145.0	60	60	M10	18.0	110.0	M8X1.25	24.4	(10.8)
CRH45VE	70	86	20.5	8.9	174.0	60	80	M10	18.0	139.0	M8X1.25	24.4	(10.8)
CRH55VN	80	100	23.5	12.7	155.0	75	75	M12	22.0	116.0	M8X1.25	24.0	(10.8)
CRH55VL	80	100	23.5	12.7	193.0	75	75	M12	22.0	154.0	M8X1.25	24.0	(10.8)
CRH55VE	80	100	23.5	12.7	210.0	75	95	M12	22.0	171.0	M8X1.25	24.0	(10.8)

※This is the standard XNB dust-proof specification. For other optional accessories, please refer to page A164.

Rail Dimension (mm)						Load Rating (kgf)		Static Permissible Moment (kg•mm)			Weight	
W1	H1	F	d	D	h	C	C0	Mx	My	Mz	Block (kg)	Rail (kg/m)
15	13.0	60	4.5	7.5	5.5	1173	2000	13878	11939	11939	0.19	1.28
20	16.3	60	6.0	9.5	8.5	1806	3112	29082	22449	22449	0.31	2.15
20	16.3	60	6.0	9.5	8.5	2347	4031	37653	36837	36837	0.36	2.15
20	16.3	60	6.0	9.5	8.5	2786	4990	46531	56837	56837	0.47	2.15
23	19.2	60	7.0	11.0	9.0	2531	4194	44898	35918	35918	0.45	2.88
23	19.2	60	7.0	11.0	9.0	3255	5388	57755	57959	57959	0.66	2.88
23	19.2	60	7.0	11.0	9.0	3673	6459	69286	83571	83571	0.80	2.88
28	22.8	80	9.0	14.0	12.0	3745	5571	72041	56224	56224	0.91	4.45
28	22.8	80	9.0	14.0	12.0	4847	7214	93367	83776	83776	1.04	4.45
28	22.8	80	9.0	14.0	12.0	5398	8847	114490	136327	136327	1.36	4.45
34	26.0	80	9.0	14.0	12.0	5337	8276	130816	99184	99184	1.50	6.25
34	26.0	80	9.0	14.0	12.0	6673	10347	163469	142449	142449	1.80	6.25
34	26.0	80	9.0	14.0	12.0	7337	12786	202143	233265	233265	2.34	6.25
45	31.1	105	14.0	20.0	17.0	7306	11112	234694	155510	155510	2.28	9.60
45	31.1	105	14.0	20.0	17.0	8684	13214	279184	216531	216531	2.67	9.60
45	31.1	105	14.0	20.0	17.0	10041	16663	351939	344796	344796	3.35	9.60
53	38.0	120	16.0	23.0	20.0	8796	13612	337041	235102	235102	3.42	13.80
53	38.0	120	16.0	23.0	20.0	11867	18255	451837	418469	418469	4.57	13.80
53	38.0	120	16.0	23.0	20.0	16092	25878	640714	658980	658980	5.08	13.80

6-1 Ball Chain Type Linear Guide

CRH-F Series Specifications



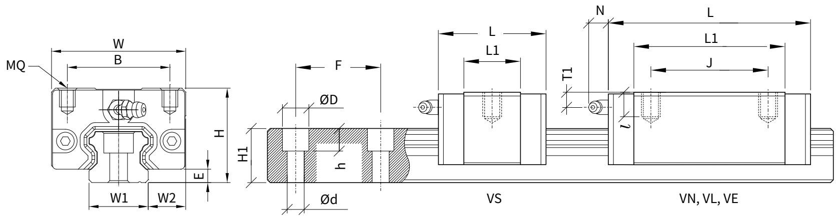
Model No.	Assembly (mm)				Block Dimension (mm)										
	H	W	W2	E	L	B	J	MQ	l	ih	T	L1	Oil H	T1	N
CRH15FN	24	47	16.0	3.3	58.6	38	30	M5	7.0	4.4	7.5	40.2	M4X0.7	5.5	(5.7)
CRH15FL	24	47	16.0	3.3	66.1	38	30	M5	7.0	4.4	7.5	47.7	M4X0.7	5.5	(5.7)
CRH20FN	30	63	21.5	4.5	70.1	53	40	M6	8.5	5.4	9.0	48.5	M6X1	7.1	(12.3)
CRH20FL	30	63	21.5	4.5	82.9	53	40	M6	8.5	5.4	9.0	61.3	M6X1	7.1	(12.3)
CRH20FE	30	63	21.5	4.5	98.1	53	40	M6	8.5	5.4	9.0	76.5	M6X1	7.1	(12.3)
CRH25FN	36	70	23.5	5.8	79.2	57	45	M8	9.6	6.8	10.1	57.5	M6X1	10.2	(12.2)
CRH25FL	36	70	23.5	5.8	93.9	57	45	M8	9.6	6.8	10.1	72.2	M6X1	10.2	(12.2)
CRH25FE	36	70	23.5	5.8	108.6	57	45	M8	9.6	6.8	10.1	86.9	M6X1	10.2	(12.2)
CRH30FS	42	90	31.0	7.0	64.2	72		M10	11.5	8.6	12.0	37.2	M6X1	10.0	(11.7)
CRH30FN	42	90	31.0	7.0	94.8	72	52	M10	11.5	8.6	12.0	67.8	M6X1	10.0	(11.7)
CRH30FL	42	90	31.0	7.0	105.0	72	52	M10	11.5	8.6	12.0	78.0	M6X1	10.0	(11.7)
CRH30FE	42	90	31.0	7.0	130.5	72	52	M10	11.5	8.6	12.0	103.5	M6X1	10.0	(11.7)
CRH35FS	48	100	33.0	7.5	75.5	82		M10	13.5	8.6	14.0	44.5	M6X1	11.5	(11.5)
CRH35FN	48	100	33.0	7.5	111.5	82	62	M10	13.5	8.6	14.0	80.5	M6X1	11.5	(11.5)
CRH35FL	48	100	33.0	7.5	123.5	82	62	M10	13.5	8.6	14.0	92.5	M6X1	11.5	(11.5)
CRH35FE	48	100	33.0	7.5	153.5	82	62	M10	13.5	8.6	14.0	122.5	M6X1	11.5	(11.5)
CRH45FL	60	120	37.5	8.9	145.0	100	80	M12	15.5	10.6	16.0	110.0	M8X1.25	14.4	(10.8)
CRH45FE	60	120	37.5	8.9	174.0	100	80	M12	15.5	10.6	16.0	139.0	M8X1.25	14.4	(10.8)
CRH55FN	70	140	43.5	12.7	155.0	116	95	M14	18.5	12.6	19.0	116.0	M8X1.25	14.0	(10.8)
CRH55FL	70	140	43.5	12.7	193.0	116	95	M14	18.5	12.6	19.0	154.0	M8X1.25	14.0	(10.8)
CRH55FE	70	140	43.5	12.7	210.0	116	95	M14	18.5	12.6	19.0	171.0	M8X1.25	14.0	(10.8)

※This is the standard XNB dust-proof specification. For other optional accessories, please refer to page A164.

Rail Dimension (mm)						Load Rating (kgf)		Static Permissible Moment (kg•mm)			Weight	
W1	H1	F	d	D	h	C	C0	Mx	My	Mz	Block (kg)	Rail (kg/m)
15	13	60	4.5	7.5	5.5	1173	2000	13878	11939	11939	0.21	1.28
15	13	60	4.5	7.5	5.5	1418	2418	16735	17245	17245	0.23	1.28
20	16	60	6.0	9.5	8.5	1806	3112	29082	22449	22449	0.40	2.15
20	16	60	6.0	9.5	8.5	2347	4031	37653	36837	36837	0.46	2.15
20	16	60	6.0	9.5	8.5	2786	4990	46531	56837	56837	0.61	2.15
23	19	60	7.0	11.0	9.0	2531	4194	44898	35918	35918	0.57	2.88
23	19	60	7.0	11.0	9.0	3255	5388	57755	57959	57959	0.72	2.88
23	19	60	7.0	11.0	9.0	3673	6459	69286	83571	83571	0.89	2.88
28	23	80	9.0	14.0	12.0	1857	2755	35714	15306	15306	0.80	4.45
28	23	80	9.0	14.0	12.0	3745	5571	72041	56224	56224	1.10	4.45
28	23	80	9.0	14.0	12.0	4847	7214	93367	83776	83776	1.34	4.45
28	23	80	9.0	14.0	12.0	5398	8847	114490	136327	136327	1.66	4.45
34	26	80	9.0	14.0	12.0	2673	4153	65612	27449	27449	1.00	6.25
34	26	80	9.0	14.0	12.0	5337	8276	130816	99184	99184	1.50	6.25
34	26	80	9.0	14.0	12.0	6673	10347	163469	142449	142449	1.90	6.25
34	26	80	9.0	14.0	12.0	7337	12786	202143	233265	233265	2.54	6.25
45	31	105	14.0	20.0	17.0	8684	13214	279184	216531	216531	2.68	9.60
45	31	105	14.0	20.0	17.0	10041	16663	351939	344796	344796	3.42	9.60
53	38	120	16.0	23.0	20.0	8796	13612	337041	235102	235102	3.44	13.80
53	38	120	16.0	23.0	20.0	11867	18255	451837	418469	418469	4.63	13.80
53	38	120	16.0	23.0	20.0	16092	25878	640714	658980	658980	5.16	13.80

6-1 Ball Chain Type Linear Guide

CRS-V Series Specifications



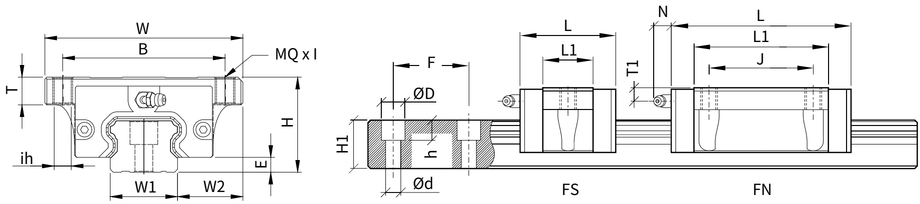
Model No.	Assembly (mm)				Block Dimension (mm)								
	H	W	W2	E	L	B	J	MQ	l	L1	Oil H	T1	N
CRS15VS	24	34	9.5	3.3	40.6	26		M4	4.8	22.2	M4X0.7	5.5	(5.7)
CRS15VN	24	34	9.5	3.3	58.6	26	26	M4	4.8	40.2	M4X0.7	5.5	(5.7)
CRS15VL	24	34	9.5	3.3	66.1	26	26	M4	4.8	47.7	M4X0.7	5.5	(5.7)
CRS20VS	28	42	11.0	4.5	49.1	32		M5	5.5	27.5	M6X1.0	5.1	(12.3)
CRS20VN	28	42	11.0	4.5	70.1	32	32	M5	5.5	48.5	M6X1.0	5.1	(12.3)
CRS25VS	33	48	12.5	5.8	54.0	35		M6	6.8	32.3	M6X1.0	7.2	(12.2)
CRS25VN	33	48	12.5	5.8	79.2	35	35	M6	6.8	57.5	M6X1.0	7.2	(12.2)
CRS30VS	42	60	16.0	7.0	64.2	40		M8	10.0	37.2	M6X1.0	10.0	(11.7)
CRS30VN	42	60	16.0	7.0	94.8	40	40	M8	10.0	67.8	M6X1.0	10.0	(11.7)
CRS30VL	42	60	16.0	7.0	105.0	40	40	M8	10.0	78.0	M6X1.0	10.0	(11.7)
CRS30VE	42	60	16.0	7.0	130.5	40	60	M8	10.0	103.5	M6X1.0	10.0	(11.7)
CRS35VS	48	70	18.0	7.5	75.5	50		M8	10.0	44.5	M6X1.0	11.5	(11.5)
CRS35VN	48	70	18.0	7.5	111.5	50	50	M8	10.0	80.5	M6X1.0	11.5	(11.5)
CRS35VL	48	70	18.0	7.5	123.5	50	50	M8	10.0	92.5	M6X1.0	11.5	(11.5)
CRS35VE	48	70	18.0	7.5	153.5	50	72	M8	10.0	122.5	M6X1.0	11.5	(11.5)
CRS45VN	60	86	20.5	8.9	129.0	60	60	M10	15.5	94.0	M8X1.25	14.4	(10.8)
CRS45VL	60	86	20.5	8.9	145.0	60	60	M10	15.5	110.0	M8X1.25	14.4	(10.8)
CRS45VE	60	86	20.5	8.9	174.0	60	80	M10	15.5	139.0	M8X1.25	14.4	(10.8)
CRS55VN	70	100	23.5	12.7	155.0	75	75	M12	18.0	116.0	M8X1.25	14.0	(10.8)
CRS55VL	70	100	23.5	12.7	193.0	75	75	M12	18.0	154.0	M8X1.25	14.0	(10.8)
CRS55VE	70	100	23.5	12.7	210.0	75	95	M12	18.0	171.0	M8X1.25	14.0	(10.8)

※This is the standard XNB dust-proof specification. For other optional accessories, please refer to page A164.

Rail Dimension (mm)						Load Rating (kgf)		Static Permissible Moment (kg•mm)			Weight	
W1	H1	F	d	D	h	C	C0	Mx	My	Mz	Block (kg)	Rail (kg/m)
15	13.0	60	4.5	7.5	5.5	582	1000	6939	3265	3265	0.10	1.28
15	13.0	60	4.5	7.5	5.5	1173	2000	13878	11939	11939	0.17	1.28
15	13.0	60	4.5	7.5	5.5	1418	2418	16735	17245	17245	0.18	1.28
20	16.3	60	6.0	9.5	8.5	929	1602	14898	6531	6531	0.17	2.15
20	16.3	60	6.0	9.5	8.5	1806	3112	29082	22449	22449	0.26	2.15
23	19.2	60	7.0	11.0	9.0	1296	2143	22959	10306	10306	0.21	2.88
23	19.2	60	7.0	11.0	9.0	2531	4194	44898	35918	35918	0.38	2.88
28	22.8	80	9.0	14.0	12.0	1857	2755	35714	15306	15306	0.50	4.45
28	22.8	80	9.0	14.0	12.0	3745	5571	72041	56224	56224	0.80	4.45
28	22.8	80	9.0	14.0	12.0	4847	7214	93367	83776	83776	0.94	4.45
28	22.8	80	9.0	14.0	12.0	5398	8847	114490	136327	136327	1.16	4.45
34	26.0	80	9.0	14.0	12.0	2673	4153	65612	27449	27449	0.80	6.25
34	26.0	80	9.0	14.0	12.0	5337	8276	130816	99184	99184	1.20	6.25
34	26.0	80	9.0	14.0	12.0	6673	10347	163469	142449	142449	1.40	6.25
34	26.0	80	9.0	14.0	12.0	7337	12786	202143	233265	233265	1.84	6.25
45	31.1	105	14.0	20.0	17.0	7306	11112	234694	155510	155510	1.64	9.60
45	31.1	105	14.0	20.0	17.0	8684	13214	279184	216531	216531	1.93	9.60
45	31.1	105	14.0	20.0	17.0	10041	16663	351939	344796	344796	2.42	9.60
53	38.0	120	16.0	23.0	20.0	8796	13612	337041	235102	235102	2.67	13.80
53	38.0	120	16.0	23.0	20.0	11867	18255	451837	418469	418469	3.57	13.80
53	38.0	120	16.0	23.0	20.0	16092	25878	640714	658980	658980	3.97	13.80

6-1 Ball Chain Type Linear Guide

CRS-F Series Specifications



Model No.	Assembly (mm)				Block Dimension (mm)										
	H	W	W2	E	L	B	J	MQ	I	ih	T	L1	Oil H	T1	N
CRS15FS	24	52	18.5	3.3	40.6	41		M5	7	4.4	7.5	22.2	M4X0.7	5.5	(5.7)
CRS15FN	24	52	18.5	3.3	58.6	41	26	M5	7	4.4	7.5	40.2	M4X0.7	5.5	(5.7)
CRS20FS	28	59	19.5	4.5	49.1	49		M6	6.5	5.4	7.0	27.5	M6X1	5.1	(12.3)
CRS20FN	28	59	19.5	4.5	70.1	49	32	M6	6.5	5.4	7.0	48.5	M6X1	5.1	(12.3)
CRS25FS	33	73	25.0	5.8	54.0	60		M8	6.6	6.8	7.1	32.3	M6X1	7.2	(12.3)
CRS25FN	33	73	25.0	5.8	79.2	60	35	M8	6.6	6.8	7.1	57.5	M6X1	7.2	(12.3)

※ This is the standard XNB dust-proof specification. For other optional accessories, please refer to page A164.

Rail Dimension (mm)						Load Rating (kgf)		Static Permissible Moment (kg•mm)			Weight	
W1	**H1**	**F**	**d**	**D**	**h**	**C**	**C0**	**Mx**	**My**	**Mz**	**Block (kg)**	**Rail (kg/m)**
15	13.0	60	4.5	7.5	5.5	582	1000.0	6939	3265	3265	0.12	1.28
15	13.0	60	4.5	7.5	5.5	1173	2000.0	13878	11939	11939	0.19	1.28
20	16.3	60	6.0	9.5	8.5	929	1602.0	22959	10306	10306	0.18	2.15
20	16.3	60	6.0	9.5	8.5	1806	3112.2	29082	22449	22449	0.31	2.15
23	19.2	60	7.0	11.0	9.0	1296	2142.9	22959	10306	10306	0.33	2.88
23	19.2	60	7.0	11.0	9.0	2531	4193.9	44898	35918	35918	0.50	2.88

6-1 Ball Chain Type Linear Guide

■ 6-1-9 Grease Nipples

Table 6.1.14 Standard Grease Nipples

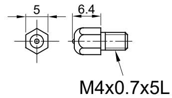
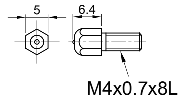
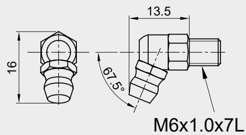
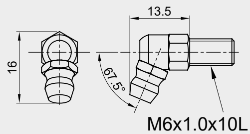
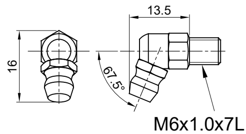
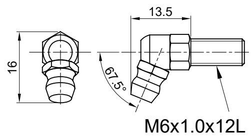
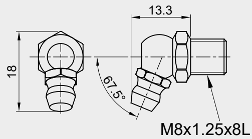
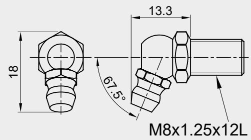
Model	Accessory Code	Grease Nipple Code	Size
CR15	XNB, UNB, SUB, ZUB	ND-01	
	DUB, ZNB, SZB, DSB	ND-02	
CR20, CR25	XNB, UNB, SUB, ZUB	ND-03	
	DUB, ZNB, SZB, DSB	ND-04	
CR30, CR35	XNB, UNB, SUB, ZUB	ND-03	
	DUB, ZNB, SZB, DSB	ND-05	

Table 6.1.14 Standard Grease Nipples

Model	Accessory Code	Grease Nipple Code	Size
CR45, CR55	XNB, UNB, SUB, ZUB	ND-06	
	DUB, ZNB, SZB, DSB	ND-07	

6-1 Ball Chain Type Linear Guide

Table 6.1.15 Special Grease Nipples

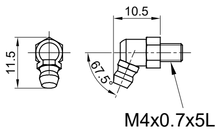
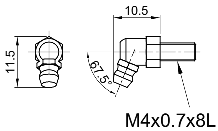
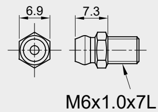
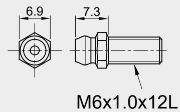
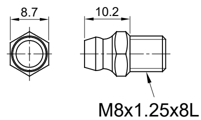
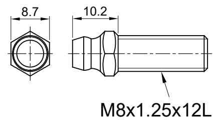
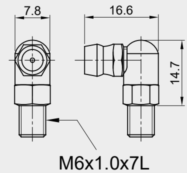
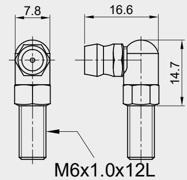
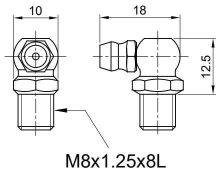
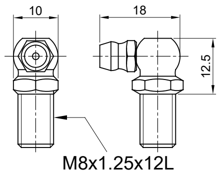
Model	Accessory Code	Grease Nipple Code	Size
CR15	XNB, UNB, SUB, ZUB	ND-08	
CR15	DUB, ZNB, SZB, DSB	ND-09	
CR20, CR25, CR30, CR35	XNB, UNB, SUB, ZUB	ND-10	
CR20, CR25, CR30, CR35	DUB, ZNB, SZB, DSB	ND-11	
CR45, CR55	XNB, UNB, SUB, ZUB	ND-12	
CR45, CR55	DUB, ZNB, SZB, DSB	ND-13	

Table 6.1.15 Special Grease Nipples

Model	Accessory Code	Grease Nipple Code	Size
CR20, CR25, CR30, CR35	XNB, UNB, SUB, ZUB	ND-14	
	DUB, ZNB, SZB, DSB	ND-15	
CR45, CR55	XNB, UNB, SUB, ZUB	ND-16	
	DUB, ZNB, SZB, DSB	ND-17	

6-1 Ball Chain Type Linear Guide

Table 6.1.16 Special Lubrication Coupler

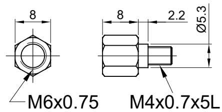
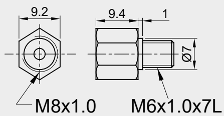
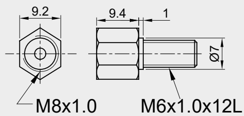
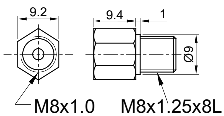
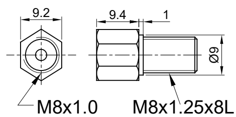
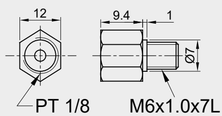
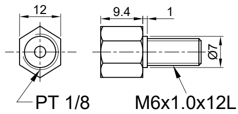
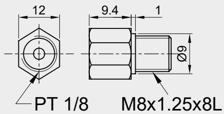
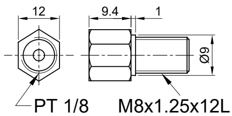
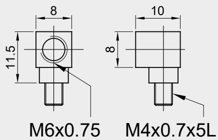
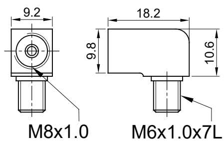
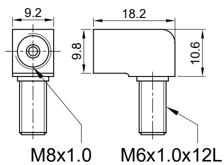
Model	Accessory Code	Grease Nipple Code	Size
CR15	XNB, UNB, SUB, ZUB	ND-18	
CR20, CR25, CR30, CR35	XNB, UNB, SUB, ZUB	ND-19	
	DUB, ZNB, SZB, DSB	ND-20	
CR45, CR55	XNB, UNB, SUB, ZUB	ND-21	
	DUB, ZNB, SZB, DSB	ND-22	
CR20, CR25, CR30, CR35	XNB, UNB, SUB, ZUB	ND-23	

Table 6.1.16 Special Lubrication Coupler

Model	Accessory Code	Grease Nipple Code	Size
CR25, CR30, CR35	DUB, ZNB, SZB, DSB	ND-24	
CR45, CR55	XNB, UNB, SUB, ZUB	ND-25	
CR45, CR55	DUB, ZNB, SZB, DSB	ND-26	
CR15	XNB, UNB, SUB, ZUB	ND-27	
CR20, CR25, CR30, CR35	XNB, UNB, SUB, ZUB	ND-28	
	DUB, ZNB, SZB, DSB	ND-29	

6-1 Ball Chain Type Linear Guide

Table 6.1.16 Special Lubrication Coupler

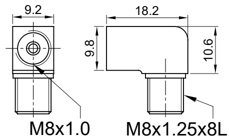
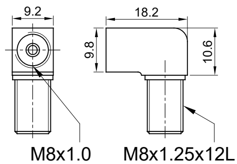
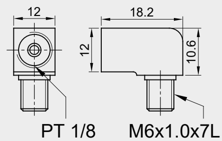
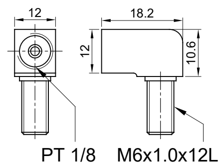
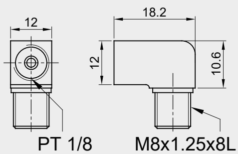
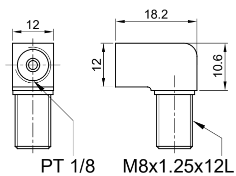
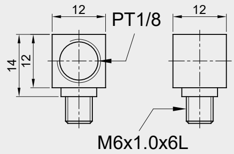
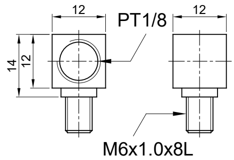
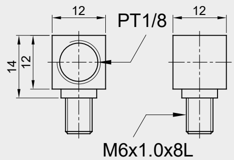
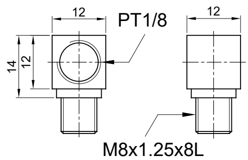
Model	Accessory Code	Grease Nipple Code	Size
CR45, CR55	XNB, UNB, SUB, ZUB	ND-30	
	DUB, ZNB, SZB, DSB	ND-31	
CR20, CR25, CR30, CR35	XNB, UNB, SUB, ZUB	ND-32	
CR25, CR30, CR35	DUB, ZNB, SZB, DSB	ND-33	
CR45, CR55	XNB, UNB, SUB, ZUB	ND-34	
CR45, CR55	DUB, ZNB, SZB, DSB	ND-35	

Table 6.1.16 Special Lubrication Coupler

Model	Accessory Code	Grease Nipple Code	Size
CR20, CR25	XNB, UNB, SUB, ZUB	ND-36	
CR20	DUB, ZNB, SZB, DSB	ND-37	
CR30, CR35	XNB, UNB, SUB, ZUB	ND-37	
CR45, CR55	XNB, UNB, SUB, ZUB	ND-38	

6-1 Ball Chain Type Linear Guide

Lubrication tool

With different size greaser spouts, grease gun is capable to fill lubrication to all types and sizes of linear guides.

Special accessories are available for smaller linear guides. Please select appropriate accessories according to the type and space.

Lubrication accessories

The adaptor tube, with different accessories attached, may be applicable for refill in various ways.

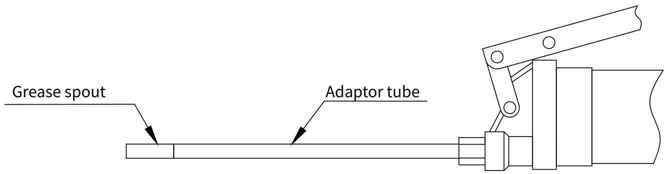


Table 6.1.17 Applicable lubrication accessories for each linear guide type

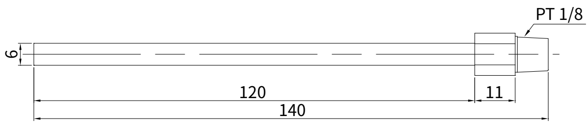
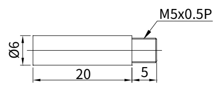
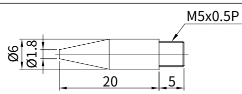
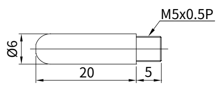
Type	Dimensions
E Type (PT1/8-M5)	

Table 6.1.18 Grease spout

Type	Dimensions	Linear Guide Type
N Type		CR15
P Type		CR15
R Type		CR15

※Lubrication accessory kit includes adaptor tube and grease spouts, but not the grease gun.