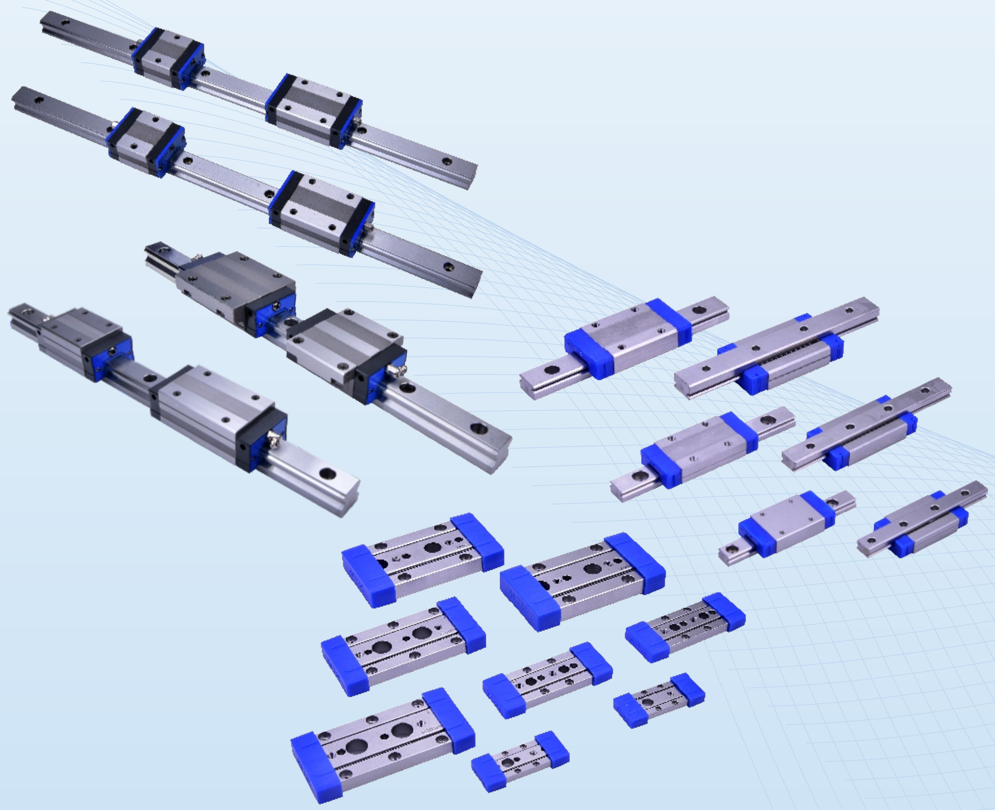
AirTAC INTERNATIONAL GROUP

BIBUS AirTAC

Lineaire Geleidingen (2022A)

- LSH Series Standard Linear Guide
- LSD Series Low Profile Type Linear Guide
- LRM Series Miniature Linear Guide
- LGC Series Crossed Roller Way



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Linear Guide Selection

How to select Linear Guide

Conditions of use	Conditions of use ●Applied equipment ●Installation space ●Rigidity requirements ●Workload ●Frequency of use ●Stroke ●Operating speed and acceleration ●Demand life ●Accuracy requirements ●Use environment
Model selection	Choose proper type and size
Workload calculation	Calculate the load on each block
Equivalent load calculation	Convert loads from all direction into equivalent load for each block
Static safety factor check	Calculate static safety factor based on basic static rated load and maximum equivalent load
Evaluate static safety factor	NO: Change type or size (return to Model selection); YES: continue
Average load calculation	Convert variable loads in movement into average load
Lifespan calculation	Calculate the lifespan based on calculation formula
Compared with demand life	NO: Change the span of rail, numbers of blocks and rails (return to Conditions of use); YES: continue
Rigidity confirmation	●Select preload level ●Determine the fixing method ●Determine the rigidity of the installation site
Accuracy confirmation	●Select accuracy grade ●Accuracy of mounting surface
Lubrication selection	●Lubricant type (grease, lubricating oil, special lubricant) ●Lubrication method (manual or forced lubrication)
Selection completed	

Linear Guide Selection

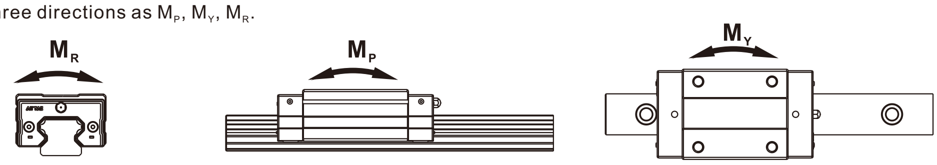
Load Capacity and Rating Life

1.Basic static load rating (C_0)

When a linear guide absorbs a large force or impact in a static or low-speed movement, it will cause permanent deformation either on rollers and groove. When sum of deformation on groove and rollers exceeds a certain limit, it will affect the smoothness of its linear movement.
Basic static load rating is defined as the magnitude of a given stress applied at where the stress is the biggest caused the sum of permanent deformation on groove and roller is 1/10000 of the diameter of the rollers.

2. Allowable static moment(M_0)

When torque is applied on a linear guide, rollers in the both ends of block will endure the major stress force.
Allowable static moment is defined as a given moment applied and raised stress force on linear guide which will cause sum of permanent deformation on groove and roller is 1/10000 of the diameter of the rollers.
Static moment is defined in three directions as M_P, M_Y, M_R.



3.Static safety factor(f_s)

During vibration, impact or sudden start and stop, the inertia force or torque will raise huge loads on linear guide. For this kind of situation, it is necessary to put static safety factor into consideration. Static safety factor is a ratio of the basic statics load rating to the calculated working load as shown in following formula. The reference of static safety factor for different conditions is shown in following table:

Use machinery	Load condition	f_s
General industrial machinery	General load conditions	1.0~1.3
	When there is vibration or shock	2.0~3.0
Machine tool	General load conditions	1.0~1.5
	When there is vibration or shock	2.5~7.0

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

f_s: Static safety factor
C_0: Basic static load rating (N)
M_0: Allowable static moment (N·m)
P: Calculation load (N)
M: Calculation moment (N·m)

4.Basic dynamic load rating(C)

Basic Dynamic Load rating is defined as the maximum allowable load and can be applied on the same specification of linear guides. This will result in a nominal life of 50 KM operation for linear guide.

5.Life calculation

●**Life**

When a linear guide is with bearings loaded during operation, the groove and rollers will constantly endure stress force. Once reaching fatigue, the surface will peel off and damage. The life of a given linear guide is defined as the moving distance of a linear guide in which peeling occurs due to fatigue.

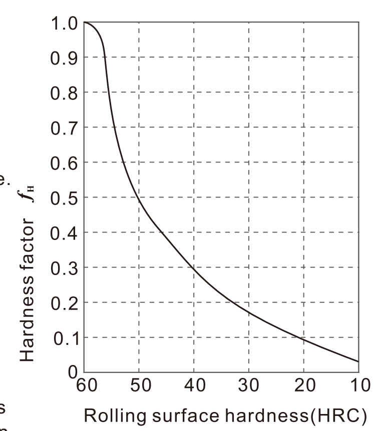
●**Nominal life**

Actual lifespan of linear guide varies enormously. The lifespan of each guide can be different even though they come from the same product batch under the same condition. Therefore, nominal life is usually chosen as bench mark to evaluate lifespan. Nominal life is defined as the moving distance for 90% of linear guides from the same production batch which can perform under the same working condition without peeling.

●**Life factor**

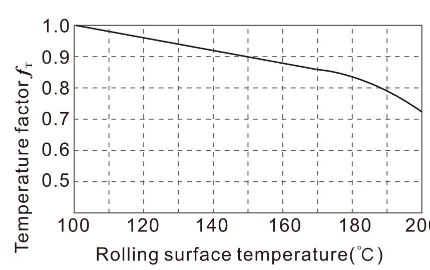
1. Hardness factor(f_H)

Surface hardness of rollers must be HRC 58~62. A softer hardness will reduce load-bearing performance and static load rating. Therefore allowable moment must be multiplied by a hardness factor as correlation shown on the right chart.
Our hardness requirement for linear guide is HRC58~62, therefore f_H = 1.0.



2. Temperature factor(f_T)

High temperature environment will affect lifespan of the linear guide. Therefore, static load rating and allowable moment must be multiplied by a temperature factor f_T as correlation shown on the right graph.
Certain parts of our linear guide are made of plastic and rubber, hence working in temperature higher than 100 is not recommended.



3. Load factor(f_w)

Although loads on a given linear guide can be calculated, it will usually come with vibration or hitting in actual use. This makes actual loads higher than calculated figure. Hence, in heavg vibration or hitting condition, please divide basic dynamic load rating (C) by following empirical load factor.

Working Conditions	Use speed	f_W
Smooth without impact	V≤15m/min	1.0~1.2
Common impact and vibration	15m/min<V≤60m/min	1.2~1.5
Moderate impact and vibration	60m/min<V≤120m/min	1.5~2.0
Strong impact and vibration	V≥120m/min	2.0~3.5

Linear Guide Selection

●**Calculation of nominal life(*L*)**

The nominal life will vary based on applied load. Hardness and working temperature will also have great effects on lifespan of a linear guide. Putting all factors into consideration, nominal life can be calculated by following formula:

$$L=\left(\frac{f_H\times f_T}{f_W}\times\frac{C}{P}\right)^3\times 50Km$$

L : Nominal life (km)
C : Basic dynamic load rating (N)
P : Workload (N)
f_w : Load factor
f_H : Hardness factor
f_T : Temperature factor

●**Calculation of service life time(L_h)**

If stroke length and repeating time are known, service life time (L_h) can be derived based on rated life (L)

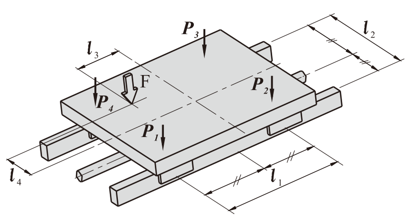
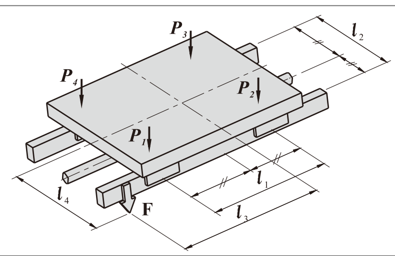
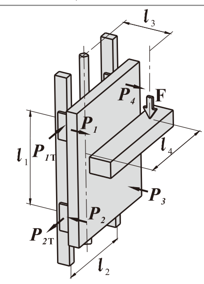
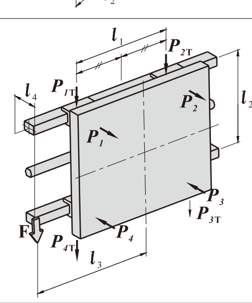
$$L_h=\frac{L\times 10^3}{2\times l_s\times n_1\times 60}$$

L_h : Service life time (hr)
L : Rated life (km)
l_s : Stroke length (m)
n_1 : Rounds per minute (min^{-1})

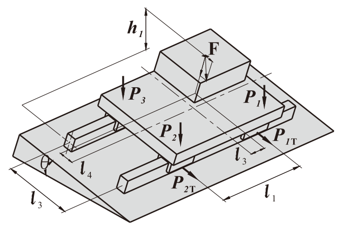
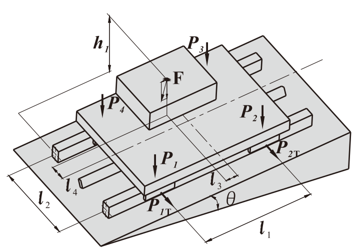
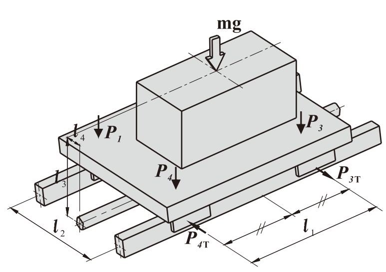
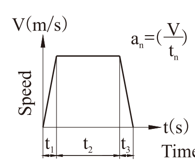
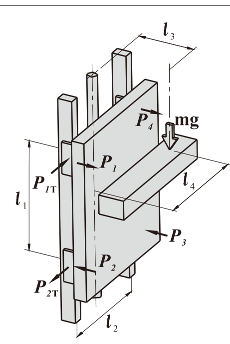
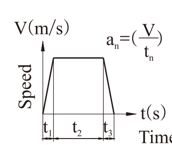
Calculation of working load

Load effect on a linear guide will be affected by its center of mass, position of thrust and inertia force occurring by acceleration when starting or stopping, etcetera. Therefore, most applications of working conditions must be put into consideration in order to acquire accurate nominal life.

Working load calculation

Type	Operation condition	Load on each block
Horizontal use uniform motion Or at rest		$P_1=\frac{F}{4}+\frac{Fl_3}{2l_1}-\frac{Fl_4}{2l_2}$ $P_2=\frac{F}{4}-\frac{Fl_3}{2l_1}-\frac{Fl_4}{2l_2}$ $P_3=\frac{F}{4}-\frac{Fl_3}{2l_1}+\frac{Fl_4}{2l_2}$ $P_4=\frac{F}{4}+\frac{Fl_3}{2l_1}+\frac{Fl_4}{2l_2}$
Horizontal cantilever use uniform motion Or at rest		$P_1=\frac{F}{4}+\frac{Fl_3}{2l_1}+\frac{Fl_4}{2l_2}$ $P_2=\frac{F}{4}-\frac{Fl_3}{2l_1}+\frac{Fl_4}{2l_2}$ $P_3=\frac{F}{4}-\frac{Fl_3}{2l_1}-\frac{Fl_4}{2l_2}$ $P_4=\frac{F}{4}+\frac{Fl_3}{2l_1}-\frac{Fl_4}{2l_2}$
Vertical use uniform motion Or at rest		$P_1=P_2=P_3=P_4=\frac{Fl_3}{2l_1}$ $P_{1T}=P_{2T}=P_{3T}=P_{4T}=\frac{Fl_4}{2l_1}$
Wall-mounted use uniform motion Or at rest		$P_1=P_2=P_3=P_4=\frac{Fl_4}{2l_2}$ $P_{1T}=P_{4T}=\frac{F}{4}+\frac{Fl_3}{2l_1}$ $P_{2T}=P_{3T}=\frac{F}{4}-\frac{Fl_3}{2l_1}$

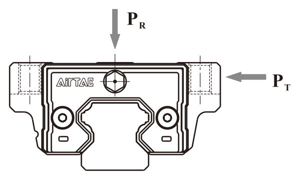
Linear Guide Selection

Type	Operation condition	Load on each block
Lateral Slope		$P_1=\frac{F\cdot cos\theta}{4}+\frac{F\cdot cos\theta\cdot l_3}{2\cdot l_1}-\frac{F\cdot cos\theta\cdot l_4}{2\cdot l_2}+\frac{F\cdot sin\theta\cdot h_1}{2\cdot l_2}$ $P_2=\frac{F\cdot cos\theta}{4}-\frac{F\cdot cos\theta\cdot l_3}{2\cdot l_1}-\frac{F\cdot cos\theta\cdot l_4}{2\cdot l_2}+\frac{F\cdot sin\theta\cdot h_1}{2\cdot l_2}$ $P_3=\frac{F\cdot cos\theta}{4}-\frac{F\cdot cos\theta\cdot l_3}{2\cdot l_1}+\frac{F\cdot cos\theta\cdot l_4}{2\cdot l_2}-\frac{F\cdot sin\theta\cdot h_1}{2\cdot l_2}$ $P_4=\frac{F\cdot cos\theta}{4}+\frac{F\cdot cos\theta\cdot l_3}{2\cdot l_1}+\frac{F\cdot cos\theta\cdot l_4}{2\cdot l_2}-\frac{F\cdot sin\theta\cdot h_1}{2\cdot l_2}$ $P_{1T}=P_{4T}=\frac{F\cdot sin\theta}{4}+\frac{F\cdot sin\theta\cdot l_3}{2\cdot l_1}$ $P_{2T}=P_{3T}=\frac{F\cdot sin\theta}{4}-\frac{F\cdot sin\theta\cdot l_3}{2\cdot l_1}$
Axial Slope		$P_1=\frac{F\cdot cos\theta}{4}+\frac{F\cdot cos\theta\cdot l_3}{2\cdot l_1}-\frac{F\cdot cos\theta\cdot l_4}{2\cdot l_2}+\frac{F\cdot sin\theta\cdot h_1}{2\cdot l_1}$ $P_2=\frac{F\cdot cos\theta}{4}-\frac{F\cdot cos\theta\cdot l_3}{2\cdot l_1}-\frac{F\cdot cos\theta\cdot l_4}{2\cdot l_2}-\frac{F\cdot sin\theta\cdot h_1}{2\cdot l_1}$ $P_3=\frac{F\cdot cos\theta}{4}-\frac{F\cdot cos\theta\cdot l_3}{2\cdot l_1}+\frac{F\cdot cos\theta\cdot l_4}{2\cdot l_2}-\frac{F\cdot sin\theta\cdot h_1}{2\cdot l_1}$ $P_4=\frac{F\cdot cos\theta}{4}+\frac{F\cdot cos\theta\cdot l_3}{2\cdot l_1}+\frac{F\cdot cos\theta\cdot l_4}{2\cdot l_2}+\frac{F\cdot sin\theta\cdot h_1}{2\cdot l_1}$ $P_{1T}=P_{4T}=+\frac{F\cdot sin\theta\cdot l_4}{2\cdot l_1}$ $P_{2T}=P_{3T}=-\frac{F\cdot sin\theta\cdot l_4}{2\cdot l_1}$
Use horizontally with inertial force	  Speed-time graph	When accelerating $P_1=P_4=\frac{mg}{4}-\frac{m\cdot a_1\cdot l_3}{2\cdot l_1}$ $P_2=P_3=\frac{mg}{4}+\frac{m\cdot a_1\cdot l_3}{2\cdot l_1}$ $P_{1T}=P_{2T}=P_{3T}=P_{4T}=\frac{m\cdot a_1\cdot l_4}{2\cdot l_1}$ When decelerating $P_1=P_4=\frac{mg}{4}+\frac{m\cdot a_3\cdot l_3}{2\cdot l_1}$ $P_2=P_3=\frac{mg}{4}-\frac{m\cdot a_3\cdot l_3}{2\cdot l_1}$ $P_{1T}=P_{2T}=P_{3T}=P_{4T}=\frac{m\cdot a_3\cdot l_4}{2\cdot l_1}$ At constant speed $P_1=P_2=P_3=P_4=\frac{mg}{4}$
Use Vertically with inertial force	  Speed-time graph	When accelerating $P_1=P_2=P_3=P_4=\frac{m\cdot(g+a_1)\cdot l_3}{2\cdot l_1}$ $P_{1T}=P_{2T}=P_{3T}=P_{4T}=\frac{m\cdot(g+a_1)\cdot l_4}{2\cdot l_1}$ When decelerating $P_1=P_2=P_3=P_4=\frac{m\cdot(g-a_3)\cdot l_3}{2\cdot l_1}$ $P_{1T}=P_{2T}=P_{3T}=P_{4T}=\frac{m\cdot(g-a_3)\cdot l_4}{2\cdot l_1}$ At constant speed $P_1=P_2=P_3=P_4=\frac{mg\cdot l_3}{2\cdot l_1}$ $P_{1T}=P_{2T}=P_{3T}=P_{4T}=\frac{mg\cdot l_4}{2\cdot l_1}$

Linear Guide Selection

Calculation of equivalent load

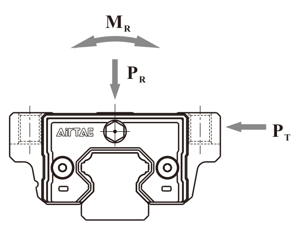
A block can bear force as well as torque from all axial and radial directions. When multiple loads are applied, these loads can be combined as an equivalent axial and radial load for the calculation of nominal life or static safety factor.
Our linear guide can bear loads in four directions, up, down, left, and right. So when using linear slides, it may be subjected to vertical load (P_R) and lateral load (P_T) at the same time. When two or more linear guides are used, the equivalent load (P_E) can be converted according to the following formula.



$$P_E = |P_R| + |P_T|$$

P_E :	Equivalent load	(N)
P_R :	Radial load	(N)
P_T :	Lateral load	(N)

In the case of single linear guide, equivalent load must take torque into account, see following formula.



$$P_E = |P_R| + |P_T| + C_0 \frac{|M|}{M_R}$$

P_E :	Equivalent load	(N)
P_R :	Radial load	(N)
P_T :	Lateral load	(N)
C_0 :	Basic static load rating	(N)
M :	Calculated torque	$(N \cdot m)$
M_R :	Allowable static moment	$(N \cdot m)$

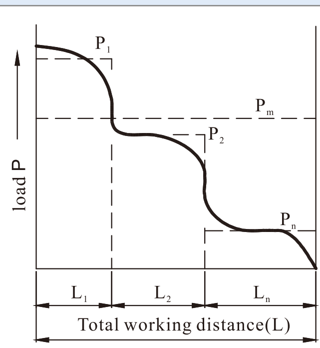
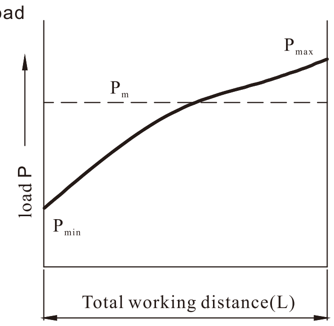
Calculation of average load

The real-time acting load for a block during movement is always variable. One can derive average load for the use of rated life calculation based on different applications. Average load when rollers are steel ball is as follows:

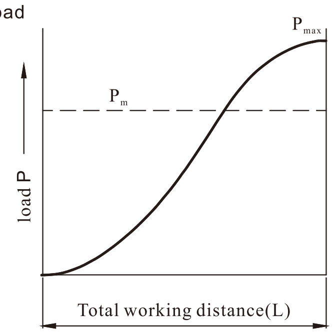
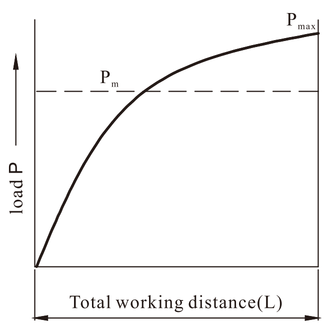
$$P_m = \sqrt[e]{\frac{1}{L} \cdot \sum_{n=1}^{n} (P_n^e \cdot L_n)}$$

P_m:	Average load	(N)
P_n:	Variable load	(N)
L:	Total Working Distance	(mm)
L_n:	Moving distance when load P_n applied	(mm)
e:	Exponent (for steel ball: 3)	

Average load calculation example

Varying load type	Average load calculation
Interval Variable Load 	$P_m = \sqrt[e]{\frac{1}{L} \cdot (P_1^e \cdot L_1 + P_2^e \cdot L_2 + \ldots\ldots + P_n^e \cdot L_n)}$ P_m: Average load (N) P_n: Variable load (N) L: Total Working Distance (mm) L_n: Moving distance when load P_n applied (mm) e: Exponent (for steel ball: 3)
Monotonic variable load 	$P_m \approx \frac{1}{3}(P_{min} + 2 \cdot P_{max})$ P_m: Average load (N) P_{min}: Minimum load (N) P_{max}: Maximum load (N)

Linear Guide Selection

Varying load type	Average load calculation
Sinusoidal variable load 	$P_m \approx 0.65 \cdot P_{max}$ P_m: Average load (*N*) P_{max}: Maximum load (*N*)
	$P_m \approx 0.75 \cdot P_{max}$ P_m: Average load (*N*) P_{max}: Maximum load (*N*)

Calculation example

Conditions of Use

Model：*LSH30HL2X2520S20BP-M6(2 pcs)*

Basic dynamic load rating：$C=45.7\ KN$

Basic static load rating：$C_0=73.1\ KN$

Mass $m_1=700kg$ $m_2=450kg$

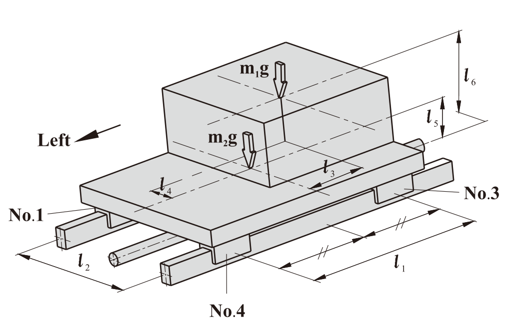
Speed $V=0.75m/s$

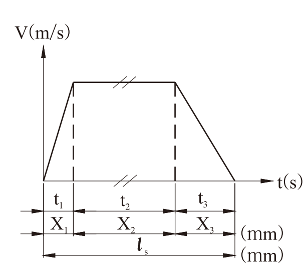
Time $t_1=0.05s$ $t_2=1.9s$ $t_3=0.15s$

Acceleration $a_1=15m/s^2$ $a_3=5m/s^2$

Travel Distance $l_s=1500mm$

Distance l_1=650mm l_2=450mm l_3=135mm l_4=60mm l_5=175mm l_6=400mm





Speed-time graph

Load calculation of each block

At constant speed, the radial load P_n

$$P_1=\frac{m_1g}{4}-\frac{m_1g\cdot l_3}{2l_1}+\frac{m_1g\cdot l_4}{2l_2}+\frac{m_2g}{4}=2562N$$

$$P_2=\frac{m_1g}{4}+\frac{m_1g\cdot l_3}{2l_1}+\frac{m_1g\cdot l_4}{2l_2}+\frac{m_2g}{4}=3987N$$

$$P_3=\frac{m_1g}{4}+\frac{m_1g\cdot l_3}{2l_1}-\frac{m_1g\cdot l_4}{2l_2}+\frac{m_2g}{4}=3073N$$

$$P_4=\frac{m_1g}{4}-\frac{m_1g\cdot l_3}{2l_1}-\frac{m_1g\cdot l_4}{2l_2}+\frac{m_2g}{4}=1648N$$

Acceleration is toward left, the radial load P_nla_1

$$P_1la_1=P_1-\frac{m_1\cdot a_1\cdot l_6}{2l_1}-\frac{m_2\cdot a_1\cdot l_5}{2l_1}=-1577N$$

$$P_2la_1=P_2+\frac{m_1\cdot a_1\cdot l_6}{2l_1}+\frac{m_2\cdot a_1\cdot l_5}{2l_1}=8127N$$

$$P_3la_1=P_3+\frac{m_1\cdot a_1\cdot l_6}{2l_1}+\frac{m_2\cdot a_1\cdot l_5}{2l_1}=7212N$$

$$P_4la_1=P_4-\frac{m_1\cdot a_1\cdot l_6}{2l_1}-\frac{m_2\cdot a_1\cdot l_5}{2l_1}=-2492N$$

Lateral load Pt_nla_1

$$Pt_1la_1=-\frac{m_1\cdot a_1\cdot l_4}{2l_1}=-485N$$

$$Pt_2la_1=\frac{m_1\cdot a_1\cdot l_4}{2l_1}=485N$$

$$Pt_3la_1=\frac{m_1\cdot a_1\cdot l_4}{2l_1}=485N$$

$$Pt_4la_1=-\frac{m_1\cdot a_1\cdot l_4}{2l_1}=-485N$$

Linear Guide Selection

Conditions of Use

Model：*LSH30HL2X2520S20BP-M6(2 pcs)*

Basic dynamic load rating：$C=45.7\ KN$

Basic static load rating：$C_0=73.1\ KN$

Mass $m_1=700kg$ $m_2=450kg$

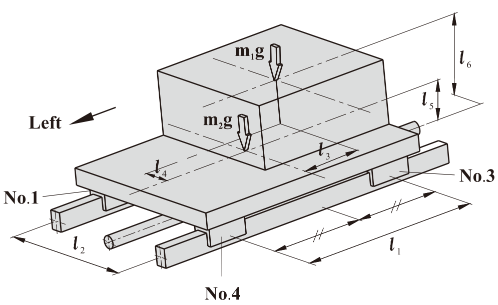
Speed $V=0.75m/s$

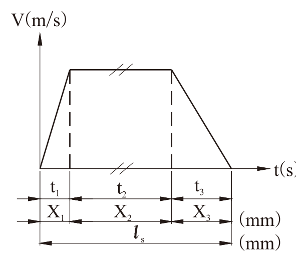
Time $t_1=0.05s$ $t_2=1.9s$ $t_3=0.15s$

Acceleration $a_1=15m/s^2$ $a_3=5m/s^2$

Travel Distance $l_s=1500mm$

Distance l_1=650mm l_2=450mm l_3=135mm l_4=60mm l_5=175mm l_6=400mm





Speed-time graph

Load calculation of each block

Deceleration is toward left, the radial load $P_n la_3$

$$P_1la_3=P_1+\frac{m_1\cdot a_3\cdot l_6}{2l_1}+\frac{m_2\cdot a_3\cdot l_5}{2l_1}=3942N$$

$$P_2la_3=P_2-\frac{m_1\cdot a_3\cdot l_6}{2l_1}-\frac{m_2\cdot a_3\cdot l_5}{2l_1}=2607N$$

$$P_3la_3=P_3-\frac{m_1\cdot a_3\cdot l_6}{2l_1}-\frac{m_2\cdot a_3\cdot l_5}{2l_1}=1693N$$

$$P_4la_3=P_4+\frac{m_1\cdot a_3\cdot l_6}{2l_1}+\frac{m_2\cdot a_3\cdot l_5}{2l_1}=3028N$$

Lateral load $Pt_n la_3$

$$Pt_1la_3=\frac{m_1\cdot a_3\cdot l_4}{2l_1}=162N$$

$$Pt_2la_3=-\frac{m_1\cdot a_3\cdot l_4}{2l_1}=-162N$$

$$Pt_3la_3=-\frac{m_1\cdot a_3\cdot l_4}{2l_1}=-162N$$

$$Pt_4la_3=\frac{m_1\cdot a_3\cdot l_4}{2l_1}=162N$$

Acceleration is toward right, the radial load $P_n ra_1$

$$P_1ra_1=P_1+\frac{m_1\cdot a_1\cdot l_6}{2l_1}+\frac{m_2\cdot a_1\cdot l_5}{2l_1}=6702N$$

$$P_2ra_1=P_2-\frac{m_1\cdot a_1\cdot l_6}{2l_1}-\frac{m_2\cdot a_1\cdot l_5}{2l_1}=-152N$$

$$P_3ra_1=P_3-\frac{m_1\cdot a_1\cdot l_6}{2l_1}-\frac{m_2\cdot a_1\cdot l_5}{2l_1}=-1067N$$

$$P_4ra_1=P_4+\frac{m_1\cdot a_1\cdot l_6}{2l_1}+\frac{m_2\cdot a_1\cdot l_5}{2l_1}=5787N$$

Lateral load $Pt_n ra_1$

$$Pt_1ra_1=\frac{m_1\cdot a_1\cdot l_4}{2l_1}=485N$$

$$Pt_2ra_1=-\frac{m_1\cdot a_1\cdot l_4}{2l_1}=-485N$$

$$Pt_3ra_1=-\frac{m_1\cdot a_1\cdot l_4}{2l_1}=-485N$$

$$Pt_4ra_1=\frac{m_1\cdot a_1\cdot l_4}{2l_1}=485N$$

Deceleration is toward right, the radial load $P_n ra_3$

$$P_1ra_3=P_1-\frac{m_1\cdot a_3\cdot l_6}{2l_1}-\frac{m_2\cdot a_3\cdot l_5}{2l_1}=1183N$$

$$P_2ra_3=P_2+\frac{m_1\cdot a_3\cdot l_6}{2l_1}+\frac{m_2\cdot a_3\cdot l_5}{2l_1}=5367N$$

$$P_3ra_3=P_3+\frac{m_1\cdot a_3\cdot l_6}{2l_1}+\frac{m_2\cdot a_3\cdot l_5}{2l_1}=4452N$$

$$P_4ra_3=P_4-\frac{m_1\cdot a_3\cdot l_6}{2l_1}-\frac{m_2\cdot a_3\cdot l_5}{2l_1}=268N$$

Lateral load $Pt_n ra_3$

$$Pt_1ra_3=-\frac{m_1\cdot a_3\cdot l_4}{2l_1}=-162N$$

$$Pt_2ra_3=\frac{m_1\cdot a_3\cdot l_4}{2l_1}=162N$$

$$Pt_3ra_3=\frac{m_1\cdot a_3\cdot l_4}{2l_1}=162N$$

$$Pt_4ra_3=-\frac{m_1\cdot a_3\cdot l_4}{2l_1}=-162N$$

Equivalent load calculation

At constant speed

$P_{E1}=P_1=2562N$

$P_{E2}=P_2=3987N$

$P_{E3}=P_3=3073N$

$P_{E4}=P_4=1648N$

When acceleration is toward left

$P_{E1}la_1=|P_1la_1|+|Pt_1la_1|=2062N$

$P_{E2}la_1=|P_2la_1|+|Pt_2la_1|=8611N$

$P_{E3}la_1=|P_3la_1|+|Pt_3la_1|=7697N$

$P_{E4}la_1=|P_4la_1|+|Pt_4la_1|=2976N$

Linear Guide Selection

Conditions of Use	Equivalent load calculation

Conditions of Use

Model：*LSH30HL2X2520S20BP-M6(2 pcs)*

Basic dynamic load rating：$C=45.7\ KN$

Basic static load rating：$C_0=73.1\ KN$

Mass $m_1=700kg$ $m_2=450kg$

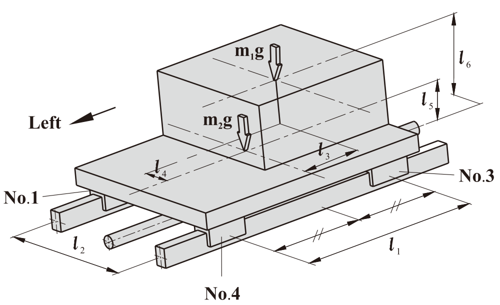
Speed $V=0.75m/s$

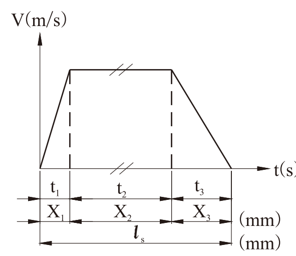
Time $t_1=0.05s$ $t_2=1.9s$ $t_3=0.15s$

Acceleration $a_1=15m/s^2$ $a_3=5m/s^2$

Travel Distance $l_s=1500mm$

Distance l_1=650mm l_2=450mm l_3=135mm l_4=60mm l_5=175mm l_6=400mm





Speed-time graph

Equivalent load calculation

When deceleration is toward left

$P_{E1}la_3=|P_1la_3|+|Pt_1la_3|=4104N$

$P_{E2}la_3=|P_2la_3|+|Pt_2la_3|=2769N$

$P_{E3}la_3=|P_3la_3|+|Pt_3la_3|=1854N$

$P_{E4}la_3=|P_4la_3|+|Pt_4la_3|=3189N$

When acceleration is toward right

$P_{E1}ra_1=|P_1ra_1|+|Pt_1ra_1|=7186N$

$P_{E2}ra_1=|P_2ra_1|+|Pt_2ra_1|=637N$

$P_{E3}ra_1=|P_3ra_1|+|Pt_3ra_1|=1551N$

$P_{E4}ra_1=|P_4ra_1|+|Pt_4ra_1|=6272N$

When deceleration is toward right

$P_{E1}ra_3=|P_1ra_3|+|Pt_1ra_3|=1344N$

$P_{E2}ra_3=|P_2ra_3|+|Pt_2ra_3|=5529N$

$P_{E3}ra_3=|P_3ra_3|+|Pt_3ra_3|=4614N$

$P_{E4}ra_3=|P_4ra_3|+|Pt_4ra_3|=430N$

Calculation of static safety factor

We now know that the maximum equivalent load occurs on No.2 slider. Therefore, one can calculate static safety factor based on it in following formula

$$f_s=\frac{C_0}{P_{E2}la_1}=\frac{73.1\times10^3}{8611}=8.49$$

Calculation of the average load of each slider P_{mn}

$$P_{m1}=\sqrt[3]{\frac{(P_{E1}la_1^3X_1+P_{E1}^3X_2+P_{E1}la_3^3X_3+P_{E1}ra_1^3X_1+P_{E1}^3X_2+P_{E1}ra_3^3X_3)}{2l_s}}$$

$=2701N$

$$P_{m2}=\sqrt[3]{\frac{(P_{E2}la_1^3X_1+P_{E2}^3X_2+P_{E2}la_3^3X_3+P_{E2}ra_1^3X_1+P_{E2}^3X_2+P_{E2}ra_3^3X_3)}{2l_s}}$$

$=4077N$

$$P_{m3}=\sqrt[3]{\frac{(P_{E3}la_1^3X_1+P_{E3}^3X_2+P_{E3}la_3^3X_3+P_{E3}ra_1^3X_1+P_{E3}^3X_2+P_{E3}ra_3^3X_3)}{2l_s}}$$

$=3188N$

$$P_{m4}=\sqrt[3]{\frac{(P_{E4}la_1^3X_1+P_{E4}^3X_2+P_{E4}la_3^3X_3+P_{E4}ra_1^3X_1+P_{E4}^3X_2+P_{E4}ra_3^3X_3)}{2l_s}}$$

$=1873N$

Calculation of rated life L_n

Assuming f_w=1.5 and according to rated life formula, the rated life can be calculated as follows:

$$L_1=\left(\frac{C}{f_wP_{m1}}\right)^3\times50=71758Km \qquad L_3=\left(\frac{C}{f_wP_{m3}}\right)^3\times50=43641Km$$

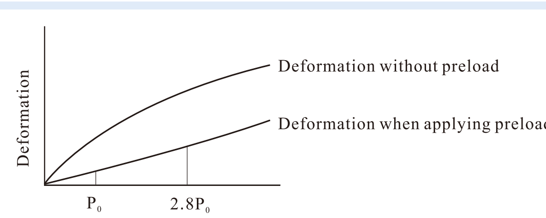
$$L_2=\left(\frac{C}{f_wP_{m2}}\right)^3\times50=20865Km \qquad L_4=\left(\frac{C}{f_wP_{m4}}\right)^3\times50=215195Km$$

Calculation conclusion

Choose the minimum from four sliders to represent rated life, which is 20865 Km on No.2 slider

Preload and rigidity

Preload spec can be applied to enhance rigidity. As the graph shows on the right, the effectiveness of preload can maintain until external load reaches 2.8 times of preload strength. In other words, rigidity increases 2.8 times. Preload is applied by choosing bigger diameter of rollers to increase interference between rollers and groove and raise initial loads. Therefore when calculating rated life, preload should be put into consideration.



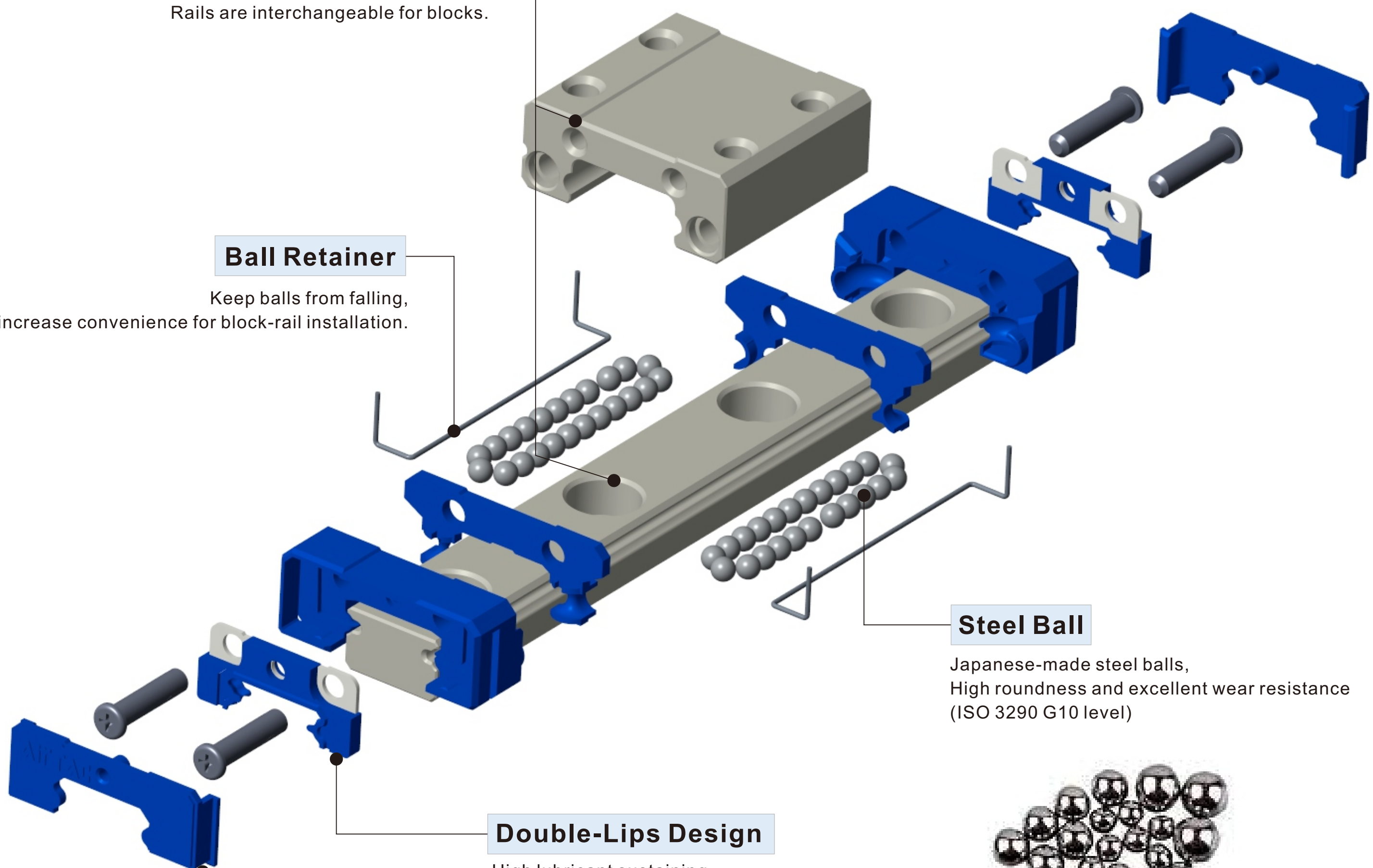
Product Introduction

Rail

Stainless steel. High rigidity.
Rails are interchangeable for blocks.

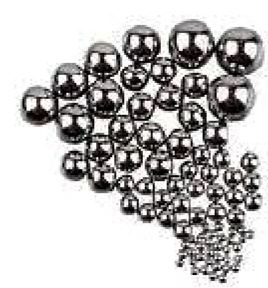
Ball Retainer

Keep balls from falling,
increase convenience for block-rail installation.



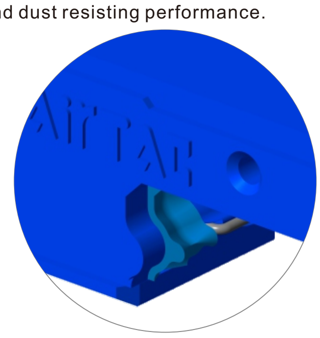
Steel Ball

Japanese-made steel balls,
High roundness and excellent wear resistance
(ISO 3290 G10 level)



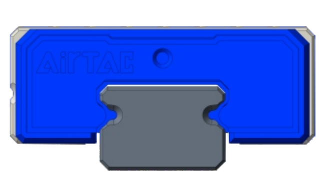
Double-Lips Design

High lubricant sustaining
and dust resisting performance.

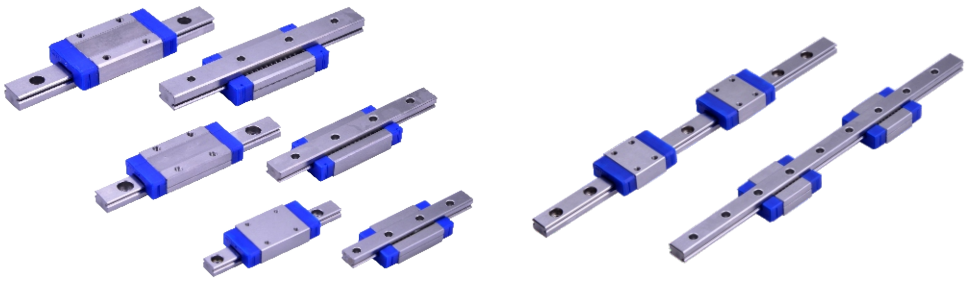


Protection Cover

Protect the product from large dust particles.



LRM Series



Order Information(Combined)

LRM 7 N 1 X40 S5 A H T

① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨

① Model Code	LRM : Miniature Linear Guide
Rail Width	5:5mm 7:7mm 9:9mm 12:12mm 15:15mm
Block type	N: Standard L: Long
Number of Block	1: One 2: Two [Note: Amount of block on a single set of linear guide]
Rail Length	40: 40mm......... [Refer to rail spec. table for detail]
Position of first mounting hole	S□ : Distance from end of rail to the center of first mounting hole. (It is recommended to be greater than minimum edge) [Refer to rail spec table for details]
Preload	A: Standard clearance B: Light Preload C: Medium Preload
Accuracy	H : High P : Precision
⑨ Rail type	Blank : Top-Mount T : Bottom-Mount

Butt-jointed Order Information

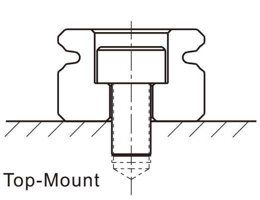
LRM 7 N 1 X 705 T 705 A H T

① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

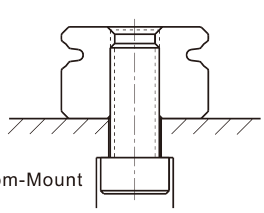
① Model Code	LRM : Miniature Linear Guide
Rail Width	5:5mm 7:7mm 9:9mm 12:12mm 15:15mm
Block type	N: Standard L: Long
Number of Block	1: One 2: Two [Note: Amount of block on a single set of linear guide]
Length of first Rail	705: 705mm ....[Defined by customer]
Butt-jointed mark	T: Rail Butt-jointed mark(Butt-jointed end margin:1/2P) [P is the standard hole distance]
Length of tail Rail	705: 705mm ....[Defined by customer]
Preload	A: Standard clearance B: Light Preload C: Medium Preload
Accuracy	H : High P : Precision
Rail type	Blank : Top-Mount T : Bottom-Mount

Butt-jointed end margin:1/2P
Position of the first and last hole is defined by customer.

[Note 1] Allow only two rails for standard joint. Customization is needed for more than two rails.
[Note 2] Customization is needed if the first/last mounting hole position is out of range in 'Rail Specification Table'.



Blank : Top-Mount



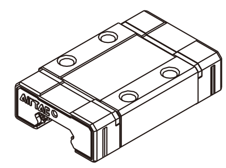
T : Bottom-Mount

1. Block Order Information

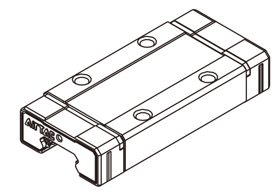
LRM 7 BK - N - H - D

① ② ③ ④ ⑤ ⑥

① Model Code	LRM : Miniature Linear Guide
② Rail Width	7 : 7mm 9 : 9mm 12 : 12mm 15 : 15mm
③ Block Code	BK: Block
④ BlockType	N: Standard L: Long
⑤ Accuracy	H : High
⑥ Group Code	B C D E [Note]



N: Standard



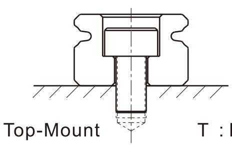
L: Long

Notes: When selecting rails and bearings, the different pairing codes can change the units preload, details see “preload pairing chart”.

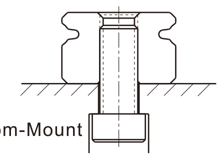
2. Uncut Rail Order Information

LRM 7 RL X 985 - H - E - T

① ② ③ ④ ⑤ ⑥ ⑦

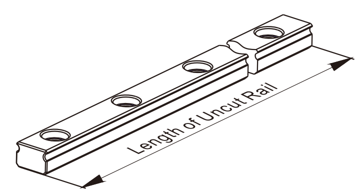


Blank : Top-Mount



T : Bottom-Mount

① Model Code	LRM: Miniature Linear Guide			
② Rail Width	7:7mm	9:9mm	12:12mm	15:15mm
③ Rail Code	RL: Rail			
④ Rail Length	985:985mm	995:995mm	995:995mm	990:990mm
⑤ Accuracy	H : High			
⑥ Group Code	E [Note]			
⑦ Rail Type	Blank : Top-Mount		T : Bottom-Mount	

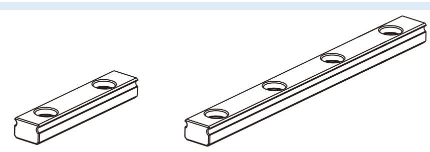


Note: When selecting rails and bearings, the different pairing codes can change the units preload, details see “preload pairing chart”.

3. Rail Order Information

LRM 7 RLX40 -S5 - H - E - T

① ② ③ ④ ⑤ ⑥ ⑦ ⑧



① Model Code	LRM: Miniature Linear Guide
② Rail Width	7 : 7mm 9 : 9mm 12 : 12mm 15 : 15mm
③ Rail Code	RL: Rail
④ Rail Length	40: 40mm......... [Refer to rail spec. table for detail]
⑤ Position of first mounting hole	S□ : Distance from end of rail to the center of first mounting hole. (It is recommended to be greater than minimum edge) [Refer to rail spec table for details]
⑥ Accuracy	H : High
⑦ Group Code	E [Note]
⑧ Rail Type	Blank : Top-Mount T : Bottom-Mount

Note: When selecting rails and bearings, the different pairing codes can change the units preload, details see “preload pairing chart”.

4. Rail/Block preload pairing chart

When customer orders rail/block, please choose the pairing code of rail/block in accordance with the needed preload of linear guide(combined).
Details please refer to the “preload pairing chart”.

Preload grade		Rail pairing code
		E
Block pairing code	B	-
	C	Medium preload
	D	Light preload
	E	Standard clearance

Preload grade		Rail pairing code
		E
Block pairing code	B	Medium preload
	C	Light preload
	D	-
	E	Standard clearance

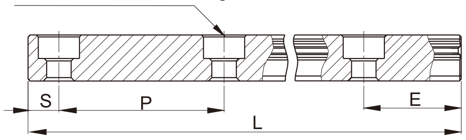
Miniature Linear Guide

LRM Series

Rail Specification

The edge pitch of first mounting hole (S) and last mounting hole (E) should not be greater than 1/2P. Overlong edge may induce unstable installation and affect the accuracy.

n: Numbers of mounting holes



L=(n-1)×P+S+E

L: Total length of rail(mm)

n: Numbers of mounting holes on rail

P: Distance between bolt holes(mm)

S: Edge of first mounting hole(mm)

E: Edge of last mounting hole(mm)

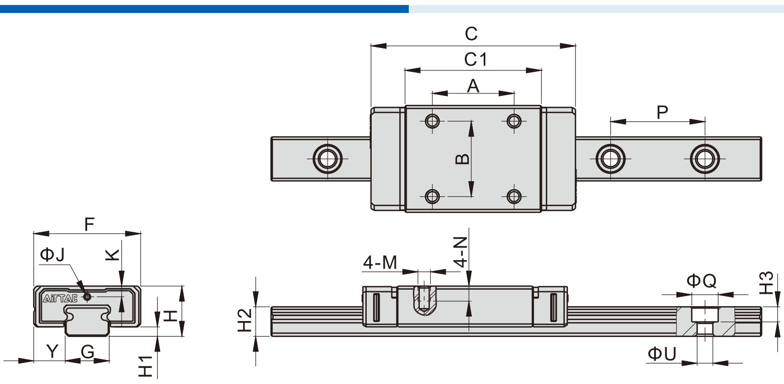
Model	Standard rail length(L) (mm)	Maximum length (L max)(mm)
LRM5	40 55 70 85 100 115 130 145	490
LRM7	40 55 70 85 100 115 130 145 160 175 190 205 220 235 250	985
LRM9	55 75 95 115 135 155 175 195 215 235 255 275 295 315 335 355 375 395	995
LRM12	70 95 120 145 170 195 220 245 270 295 320 345 370 395 420 445 470 495	995
LRM15	70 110 150 190 230 270 310 350 390 430 470 510	990

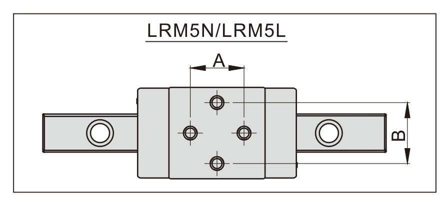
Model	Pitch(P)	Standard Edge pitch	Min. Edge Pitch (S/E min)	Max. Edge Pitch (S/E max)
LRM5	15	5	3	10
LRM7	15	5	3	10
LRM9	20		4	15
LRM12	25	10	4	20
LRM15	40	15	4	35

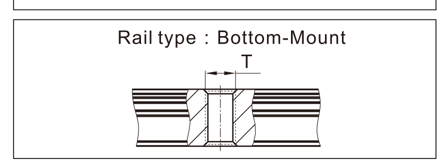
Note: ●Joint rail must be chosen if length of rail exceeds the maximum.

● When deciding edge pitch, it should be within the range of above table. There would be risk of broken hole if pitch is out of range.

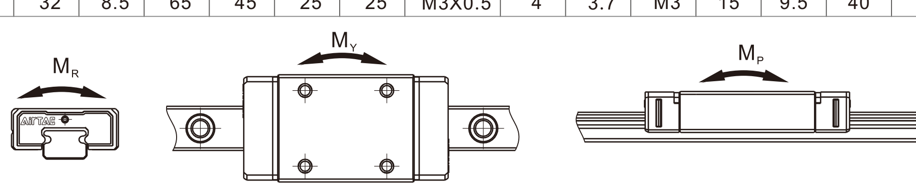
Specifications and Dimensions







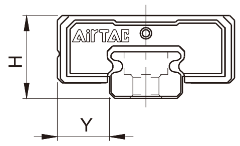
Model\Item	External Dimension (mm)					Block Dimension (mm)							Rail Dimension (mm)						
	H	H1	F	Y	C	C1	A	B	M	N	K	ΦJ	G	H2	P	ΦQ	ΦU	H3	T
LRM5N	6	1.5	12	3.5	18.2	10	7	8	M2X0.4	1.5	1.3	0.7	5	3.5	15	3.5	2.2	1.1	M3X0.5
LRM5L	6	1.5	12	3.5	21.2	13	7	8	M2X0.4	1.5	1.3	0.7	5	3.5	15	3.5	2.2	1.1	M3X0.5
LRM7N	8	1.5	17	5	24.3	13.5	8	12	M2X0.4	2.3	1.7	0.7	7	4.7	15	4.2	2.4	2.4	M3X0.5
LRM7L	8	1.5	17	5	32.5	21.7	13	12	M2X0.4	2.3	1.7	0.7	7	4.7	15	4.2	2.4	2.4	M3X0.5
LRM9N	10	2	20	5.5	31	18.9	10	15	M3X0.5	2.8	2.2	1	9	5.6	20	6	3.5	3.4	M4X0.7
LRM9L	10	2	20	5.5	42.1	30	16	15	M3X0.5	2.8	2.2	1	9	5.6	20	6	3.5	3.4	M4X0.7
LRM12N	13	3	27	7.5	37.6	21.7	15	20	M3X0.5	4	3	1.5	12	7.5	25	6	3.5	4.4	M4X0.7
LRM12L	13	3	27	7.5	48.4	32.5	20	20	M3X0.5	4	3	1.5	12	7.5	25	6	3.5	4.4	M4X0.7
LRM15N	16	3.5	32	8.5	48	28	20	25	M3X0.5	4	3.7	M3	15	9.5	40	6	3.5	4.4	M4X0.7
LRM15L	16	3.5	32	8.5	65	45	25	25	M3X0.5	4	3.7	M3	15	9.5	40	6	3.5	4.4	M4X0.7



Model\Item	Mounting Screw	Dynamic Load Rating(kN)	Static Load Rating(kN)	Static Rated Moment (N.m)			Weight	
		C_{100B}	C_0	M_R	M_P	M_Y	Block(kg)	Rail(kg/m)
LRM5N	M2	0.33	0.55	1.68	0.99	0.99	0.0035	0.114
LRM5L	M2	0.48	0.9	2.4	2.08	2.08	0.004	0.114
LRM7N	M2	1.02	1.53	5.42	3.17	3.17	0.009	0.22
LRM7L	M2	1.43	2.45	9.27	7.96	7.96	0.014	0.22
LRM9N	M3	1.97	2.6	11.84	8.19	8.19	0.018	0.315
LRM9L	M3	2.61	4.11	19.73	18.94	18.94	0.027	0.315
LRM12N	M3	3.04	3.86	23.63	12.57	12.57	0.037	0.602
LRM12L	M3	3.96	5.9	40.96	32.57	32.57	0.053	0.602
LRM15N	M3	4.27	5.7	45.05	23.05	23.05	0.054	0.981
LRM15L	M3	6.53	9.53	70.08	63.69	63.69	0.088	0.981

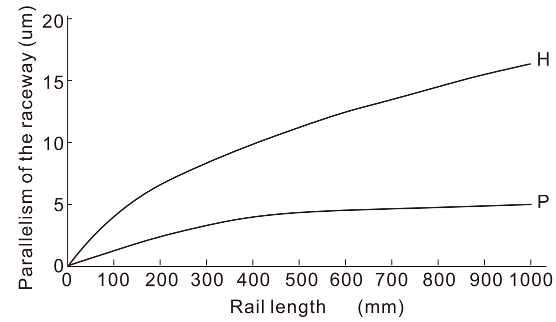
Accuracy

LRM miniature linear guide comes with 2 accuracy levels.



Accuracy Standards (mm)		
Accuracy	H: High	P:Precision
Tolerance of height H	±0.02	±0.01
Variation of height ΔH	0.015	0.007
Tolerance of width Y	±0.025	±0.015
Variation of width ΔY	0.02	0.01

Parallelism of motion relative to benchmark surface.



Preload Level

LRM Miniature Linear Guide has three preload categories: A ,B and C.
Choosing suitable preload level will enhance rigidity, precision and torsion resistant performace of the linear guide.

Preload Level	Code	Radial interference (μm)					Application
		5	7	9	12	15	
Standard clearance	A	−1~+2	−2~+2	−2~+2	−2~+3	−2~+3	Smooth operation
Light Preload	B	−3~−1	−4~−2	−5~−2	−6~−2	−7~−2	High Precision
Medium Preload	C	−6~−2	−7~−3	−8~−4	−9~−5	−10~−6	High rigidity

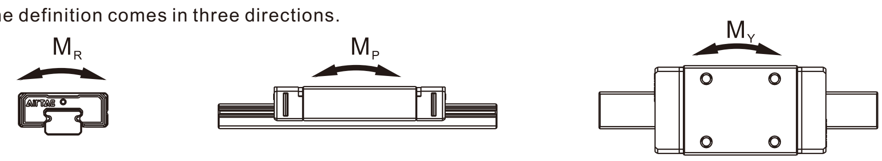
Load Capacity and Rating Life

1. Basic static load rating(C_0)

It is defined as the static load when the total permanent deformation of the steel ball and the surface of the groove is exactly one ten-thousandth of the diameter of the steel ball under the state of the load direction and size unchanged.

2. Static Permissible Moment(M_0)

When the steel ball subjected to the maximum stress in the slider reaches a static rated load condition, this loading moment is called the "Static permissible moment". The definition comes in three directions.



3. Static Safety Factor(f_s)

Impact, vibration and inertial loading during start and stop moment lead to unexpected load on the linear guide way.
Therefore, when calculating the static load, safety factors must be considered.

Load Condition	f_s
Normal Load	1.0~2.0
Load with Impacts or Vibrations	2.0~3.0

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

f_s : Static safety factor
C_0 : Basic static load rating (N)
M_0 : Static permissible moment (N.m)
P : Calculated working load (N)
M : Calculated applying moment (N.m)

4. Load Factor(f_w)

The loads acting on a linear guide way include the weight of block, the inertia load at the times of start and stop, and the moment loads caused by overhanging.
Therefore, the load on a linear guide way should be divided by the empirical factor.

Loading condition	Service speed	f_w
No impacts & vibration	V≤15m/min	1~1.2
Small impacts	15m/min<V≤60m/min	1.2~1.5
Normal load	60m/min<V≤120m/min	1.5~2.0
With impacts & vibration	V>120m/min	2.0~3.5

5. Dynamic Load Rating(C_{100B})

C_{100B} (According to ISO 14728-1) As the direction and magnitude remains the same, C_{100B} is the maximum workload for the product to maintain its nominal life at 100km of operation.

6. Calculation of Nominal Life(L)

Recognizing that nominal life of a linear guide is affected by the actual working loads, the general calculation of the nominal life excluding the environmental factors is carried out as follow:

$$L=\left(\frac{C_{100B}}{f_w x P}\right)^3 x10^5$$

L = Nominal Life (m)
C_{100B} = Dynamic Load Rating (N)
f_w: Load Factor
P = Equivalent load (N)

Taking LRM9N for example, its C_{100B} is 1.97kN. Therefore, when the product bears a 1.5kN equivalent load P、 f_w=1, its theoretical rated life can be calculated as follows:

$$L=\left(\frac{C_{100B}}{f_w x P}\right)^3 x10^5=\left(\frac{1.97}{1x1.5}\right)^3 x10^5=226529\ m = 226.5\ km$$

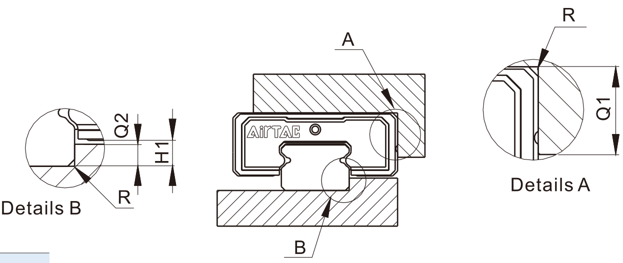
Installation Illustration

1. Height and Chamfer of Reference Edge

In order to ensure accurate installation of LRM Linear Guide, the contact space should not exceed the given figures in following table.

Unit：mm

Model	Q1	Q2	H1	R(Max)
LRM5	1.4	1.2	1.5	0.2
LRM7	5.5	1.2	1.5	0.2
LRM9	7	1.7	2	0.3
LRM12	9	2.7	3	0.4
LRM15	10	3.2	3.5	0.5

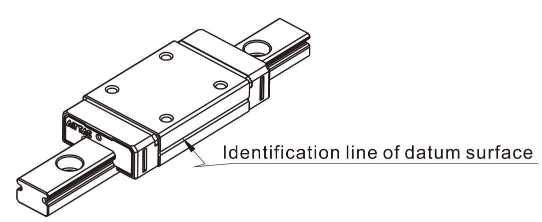


2.Screw Tighten Torque

Model	Screw size	Iron	Casting	Aluminum alloy
LRM5	M2	58.8	39.2	29.4
LRM7				
LRM9	M3	196	127	98
LRM12				
LRM15				

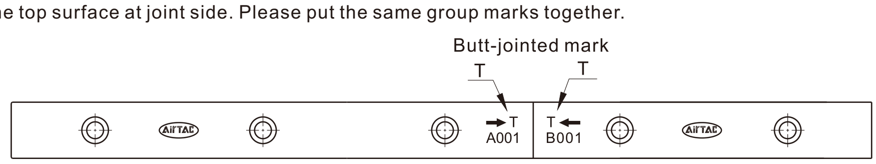
3. Datum plane

- Datum plane for installation must be ground or finely milled to ensure accuracy.
- Both sides of rail can be used as the datum plane.
- For multi-blocks on a rail, identification line on blocks should be put on the same side to ensure moving accuracy.

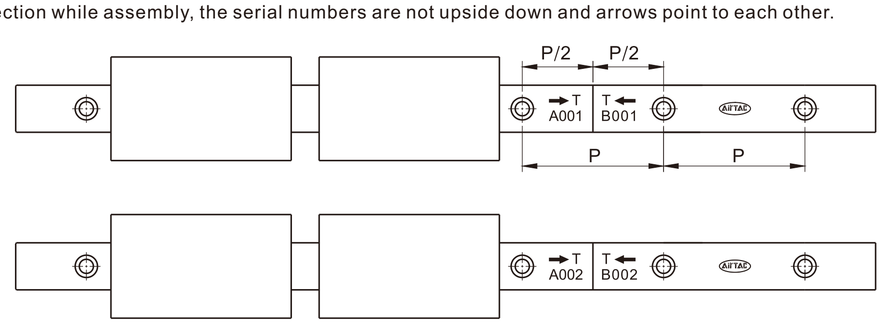


Rail Butt-jointed

- When jointing rails, it must follow group marks on rail to ensure the accuracy of linear guide. These marks are located on the top surface at joint side. Please put the same group marks together.



- Be aware serial number of group mark when assemble. A001 and B001 are in a group, so as to A002 and B002 and so on.
- Be aware the installation direction while assembly, the serial numbers are not upside down and arrows point to each other.



Lubrication Method

When a linear guide is well lubricated, it can reduce wear and increase lifespan significantly. Lubrication has the following benefits:

- Reduces friction of the rollers and rail to minimize wear.
- The grease film between contact surface can decrease the fatigue failure.
- Prevent rust.

1. Lubrication method

LRM series linear guide is well lubricated with 'Synergy Grease PS NO.2' in factory.
Customers are recommended to use identical or the same grade of lubricant.
Please refer to the right table for the amount of oil:
In order to be well lubricated, the blocks need to be moved back and forth after lubricating.
Lubrication can be done either by manual or automatic device.

2. Lubrication frequency

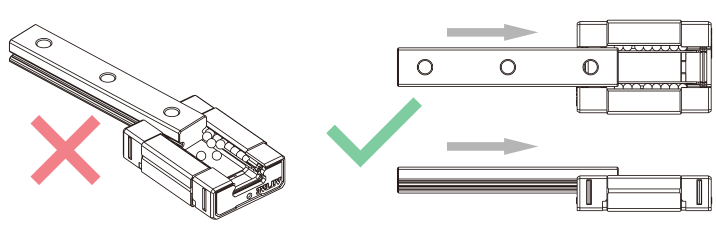
Although the linear guides are well lubricated at the factory and retains grease well, frequent lubrication is still necessary to avoid undesirable wear.
Recommended lubrication period is every 100km of movement or every 3~6 months.
(Refer to table on the right for suggested amount).

Model		
LRM5N	0.02	
LRM5L		
LRM7N		
LRM7L		
LRM9N		
LRM9L		
LRM12N		
LRM12L		
LRM15N		
LRM15L		

Precautions on use

1. Block disassembly

LRM is equipped with ball retainers to prevent steel balls from falling out when block separates from rail. However, if obliquely insert rail into blocks or quickly assemble and disassemble, there is risk for steel balls of falling out. Please carefully assemble the linear guide or use plastic rails to assist.



2.Caution

- Parts may slide out if linear guide is put unevenly. Please be careful.
- Hitting or dropping a linear guide could have huge effects on accuracy and lifespan even though appearance may remain intact. Please be careful.
- Do not separate linear guide as external objects may enter blocks and cause accuracy problem.

3. Lubrication

- Linear guide have been treated with anti-rust oil during production. Before use, wipe the rail and treat it with lubrication.
- Do not mix lubricating oil (grease) with different properties.
- While lubricating, the block needs to be moved back and forth. After lubrication, there should be a grease film on rail.

4.Use

- The operating environment temperature should not exceed 80 , and the maximum temperature should not exceed 100 .
- Do not separate blocks from rail whenever it is not necessary. If you need to separate them, please use plastic rails to prevent steel balls from falling out.

5. Storage

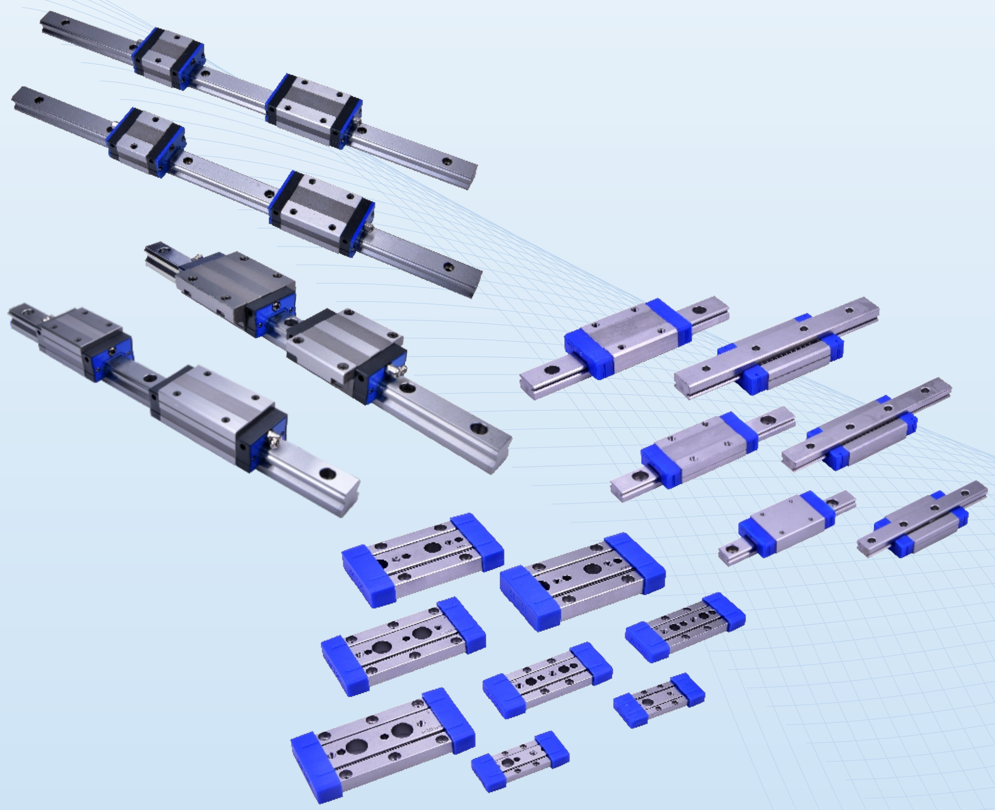
- When storing blocks, rails or set, please be sure that anti-rust oil is well applied and product is well sealed as well as placed horizontally.
  Avoid humidity and high temperatures environment.

AirTAC INTERNATIONAL GROUP

BIBUS AirTAC

Lineaire Geleidingen (2022A)

- LSH Series Standard Linear Guide
- LSD Series Low Profile Type Linear Guide
- LRM Series Miniature Linear Guide
- LGC Series Crossed Roller Way



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