ALMOTION

LM Guide

THK General Catalog

A Product Descriptions

THK

Classification Table of the LM Guides

LM Guide

Ball Guide

Caged Ball Type

Standard Type

Model SHS
- Global Standard Size

Model SSR
- Radial

Wide Type

Model SHW
- Low Center of Gravity

Miniature Type

Model SRS
- Lightweight and Compact

Model EPF
- Finite stroke

Cross Type

Model SCR
- 4-way Equal Load

Full-ball Type

Standard Type

Model HSR
- 4-way Equal Load

Model NSR-TBC
- Self-aligning

Model SR
- Radial

Miniature Type

Model RSR
- Ultra Compact

Wide Type

Model HRW
- Wide Rail
- 4-way Equal Load

Optimal for Machine Tools

Model SVR	Model SVS	Model NR-X	Model NRS-X	Model SRG	Model SRW
High Contamination Resistance	High Contamination Resistance	Radial	4-way	Ultra-high Rigidity	Ultra-high Rigidity
Ball cage	Ball cage			Caged roller	Caged roller
Radial	4-way			4-way	Wide Rail

Cross Type

Model CSR
4-way Equal Load

Model MX
Miniature Cross

Special Environment Types

Model HSR-M1
High Temperature
4-way Equal Load

Model SR-M1
High Temperature
Radial

Model HSR-M2
High Corrosion Resistance
4-way Equal Load

Model RSR-M1
High Temperature

Model HSR-M1VV
Medium-to-Low Vacuum

Model SR-MS
Oil-Free

R Guide Type

Model HCR

Straight-Curved Type

Model HMG

Separate Type

Model HR
Heavy Load

Model GSR
Interchangeable, Self-aligning

Model GSR-R
Interchangeable, Self-aligning
With Rack

Model JR Type

Model JR
Structural Member Rail
4-way Equal Load

Roller Guide

With a Caged Roller

Standard Type

Model SRG
Ultra-high Rigidity

Model SRN
Ultra-high Rigidity
Low Center of Gravity

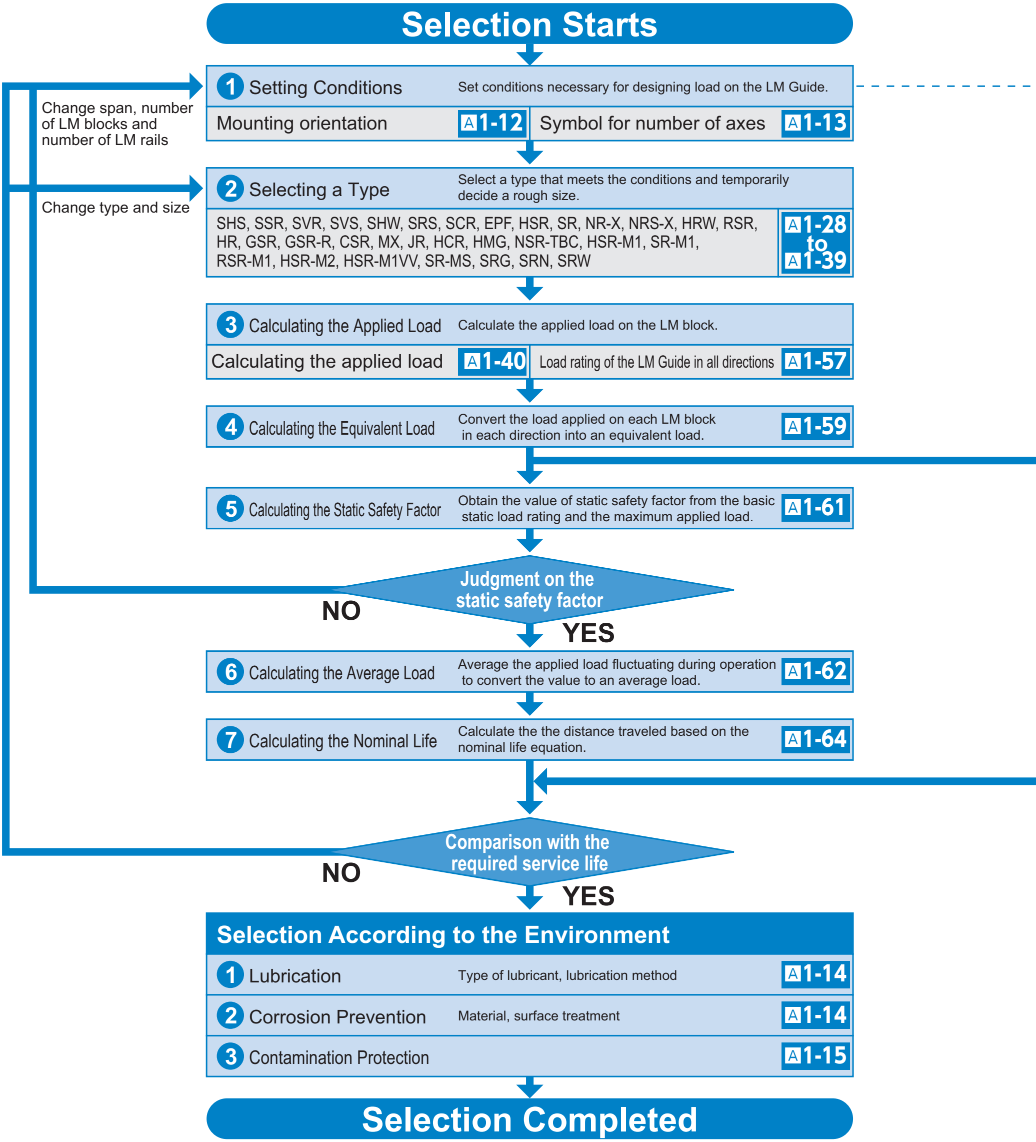
Wide Type

Model SRW
Ultra-high Rigidity

Flowchart for Selecting an LM Guide

[Steps for Selecting an LM Guide]

The following flowchart can be used as reference for selecting an LM Guide.



Selection Starts

① Setting Conditions — Set conditions necessary for designing load on the LM Guide.
- Mounting orientation A1-12
- Symbol for number of axes A1-13

Change span, number of LM blocks and number of LM rails

② Selecting a Type — Select a type that meets the conditions and temporarily decide a rough size.
- SHS, SSR, SVR, SVS, SHW, SRS, SCR, EPF, HSR, SR, NR-X, NRS-X, HRW, RSR, HR, GSR, GSR-R, CSR, MX, JR, HCR, HMG, NSR-TBC, HSR-M1, SR-M1, RSR-M1, HSR-M2, HSR-M1VV, SR-MS, SRG, SRN, SRW — A1-28 to A1-39

Change type and size

③ Calculating the Applied Load — Calculate the applied load on the LM block.
- Calculating the applied load A1-40
- Load rating of the LM Guide in all directions A1-57

④ Calculating the Equivalent Load — Convert the load applied on each LM block in each direction into an equivalent load. A1-59

⑤ Calculating the Static Safety Factor — Obtain the value of static safety factor from the basic static load rating and the maximum applied load. A1-61

Judgment on the static safety factor — NO / YES

⑥ Calculating the Average Load — Average the applied load fluctuating during operation to convert the value to an average load. A1-62

⑦ Calculating the Nominal Life — Calculate the the distance traveled based on the nominal life equation. A1-64

Comparison with the required service life — NO / YES

Selection According to the Environment

① Lubrication — Type of lubricant, lubrication method — A1-14

② Corrosion Prevention — Material, surface treatment — A1-14

③ Contamination Protection — A1-15

Selection Completed

Point of Selection

Flowchart for Selecting an LM Guide

- Space in the guide section
- Dimensions (span, number of LM blocks, number of LM rails, thrust)
- Installation direction (horizontal, vertical, slant mount, wall mount, suspended)
- Magnitude, direction and position of the working load
- Operating frequency (duty cycle)
- Speed (acceleration)
- Stroke length
- Required service life
- Precision of motion
- Environment
- In a special environment (vacuum, clean room, high temperature, environment exposed to contaminated environment, etc.), it is necessary to take into account material, surface treatment, lubrication and contamination protection.

Prediction the Rigidity

1	Selecting a Radial Clearance (Preload)	A1-68
2	Service Life with a Preload Considered	A1-69
3	Rigidity	A1-69
4	Radial Clearance Standard for Each Model	A1-70
5	Designing the Guide System	A1-436

Determining the Accuracy

1	Accuracy Standards	A1-73
2	Guidelines for Accuracy Grades by Machine Type	A1-74
3	Accuracy Standard for Each Model	A1-75~

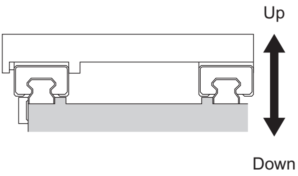
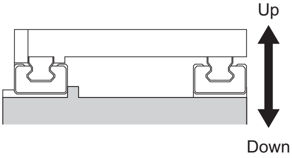
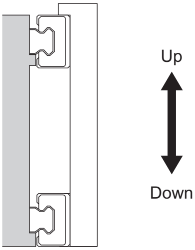
Setting Conditions

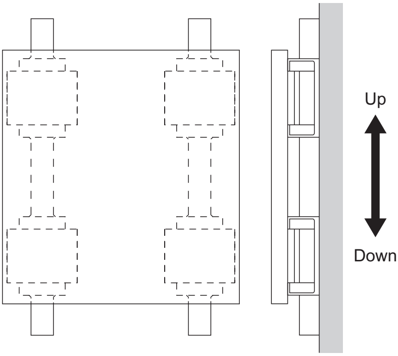
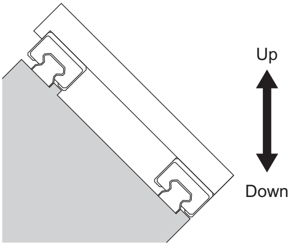
Conditions of the LM Guide

[Mounting Orientation]

The LM Guide can be mounted in the following five orientations.
If the mounting orientation of the LM Guide is other than horizontal use, the lubricant may not reach the raceway completely.
Be sure to let THK know the mounting orientation and the exact position in each LM block where the grease nipple or the piping joint should be attached.
For the lubrication, see A**24-2**.

[Mounting Orientation]

Horizontal (symbol: H)	Inverted (symbol: R)	Wall mount (symbol: K)
		

Vertical (symbol: V)	Slant mount (symbol: T)
	

[Symbol for Number of Axes]

If two or more units of the LM Guide are parallelly used in combination on the same plane, specify the number of the LM rails (symbol for number of axes) used in combination in advance.
(For accuracy standards and radial clearance standards, see **A1-75** and **A1-70**, respectively.)

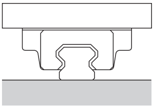
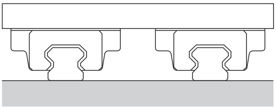
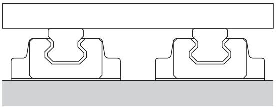
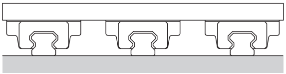
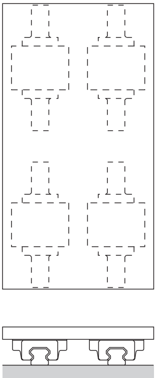
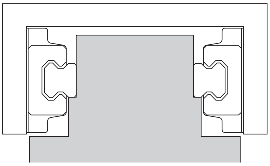
Model number coding

SHS25C2SSCO+1000LP -Ⅱ

Model number (details are given on the corresponding page of the model)

Symbol for number of axes
("II" indicates 2 axes. No symbol for a single axis)

[Symbol for Number of Axes]

Symbol for number of axes: none	Symbol for number of axes: Ⅱ	Symbol for number of axes: Ⅱ
Required number of axes: 1 	**Required number of axes: 2**  Note: When placing an order, specify the number in multiple of 2 axes.	**Required number of axes: 2**  Note: When placing an order, specify the number in multiple of 2 axes.
Symbol for number of axes: Ⅲ	**Symbol for number of axes: Ⅳ**	**Other**
Required number of axes: 3  Note: When placing an order, specify the number in multiple of 3 axes.	**Required number of axes: 4**  Note: When placing an order, specify the number in multiple of 4 axes.	**Required number of axes: 2**  Using 2 axes opposed to each other

[Service environment]

● Lubrication

When using an LM system, it is necessary to provide effective lubrication. Without lubrication, the rolling elements or the raceway may be worn faster and the service life may be shortened.

A lubricant has effects such as the following.

(1) Minimizes friction in moving elements to prevent seizure and reduce wear.

(2) Forms an oil film on the raceway to decrease stress acting on the surface and extend rolling fatigue life.

(3) Covers the metal surface to prevent rust formation.

To fully bring out the LM Guide's functions, it is necessary to provide lubrication according to the conditions.

If the mounting orientation is other than horizontal use, the lubricant may not reach the raceway completely.

Be sure to let THK know the mounting orientation and the exact position in each LM block where the grease nipple or the piping joint should be attached. For the mounting orientations of LM Guides, see A**1-12**. For the lubrication, see A**24-2**.

Even with an LM Guide with seals, the internal lubricant gradually seeps out during operation. Therefore, the system needs to be lubricated at an appropriate interval according to the service conditions.

● Corrosion Prevention

■Determining a Material

Any LM system requires a material that meets the environments. For use in environments where corrosion resistance is required, some LM system models can use martensite stainless steel.

(Martensite stainless steel can be used for LM Guide models SSR, SHW, SRS, HSR, SR, HRW, RSR and HR.)

The HSR series includes HSR-M2, a highly corrosion resistant LM Guide using austenite stainless steel, which has high anti-corrosive effect. For details, see A**1-372**.

■Surface Treatment

The surfaces of the rails and shafts of LM systems can be treated for anti-corrosive or aesthetic purposes.

THK offers THK-AP treatment, which is the optimum surface treatment for LM systems.

There are roughly three types of THK-AP treatment: AP-HC, AP-C and AP-CF. (See B**0-20**.)

● Contamination Protection

When foreign material enters an LM system, it will cause abnormal wear or shorten the service life, and it is necessary to prevent foreign material from entering the system. When entrance of foreign material is predicted, it is important to select an effective sealing device or dust-control device that meets the environment conditions.

THK offers contamination protection accessories for LM Guides by model number, such as end seals made of special synthetic rubber with high wear resistance, and side seals and inner seals for further increasing dust-prevention effect.

In addition, for locations with adverse environment, Laminated Contact Scraper LaCS and dedicated bellows are available by model number. Also, THK offers dedicated caps for LM rail mounting holes, designed to prevent cutting chips from entering the LM rail mounting holes.

When it is required to provide contamination protection for a Ball Screw in an environment exposed to cutting chips and moisture, we recommend using a telescopic cover that protects the whole system or a large bellows.

For the options, see A**1-464**.

[Special environments]

Clean Room

In a clean environment generation of dust from the LM system has to be reduced and anti-rust oil cannot be used. Therefore, it is necessary to increase the corrosion resistance of the LM system. In addition, depending on the level of cleanliness, a dust collector is required.

Dust Generation from the LM System

■Measure to Prevent Dust Generation Resulting from Flying Grease

THK AFE-CA and AFF Grease
Use environmentally clean grease that produces little dust.

■Measure to Reduce Dust Generation Resulting from Metallic Abrasion Dust

Caged Ball LM Guide
Use the Caged Ball LM Guide, which has no friction between balls and generates little metallic abrasion dust, to allow generation of dust to be minimized.

Corrosion Prevention

■Material-based Measure

Stainless Steel LM Guide
This LM Guide uses martensite stainless steel, which has corrosion resistant effect.

Highly Corrosion Resistant LM Guide
It uses austenite stainless steel, which has a high corrosion resistant effect, in its LM rail.

■Measure Through Surface Treatment

THK AP-HC, AP-C and AP-CF Treatment
The LM system is surface treated to increase corrosion resistance.

Caged Ball LM Guide

Supported models
SHS SSR SVR/SVS
SHW SRS SCR EPF

Caged Roller LM Guide

Supported models
SRG SRN SRW

Stainless Steel LM Guide

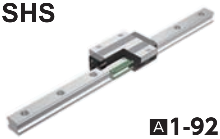
Supported models
SSR SHW SRS HSR SR
HRW HR RSR

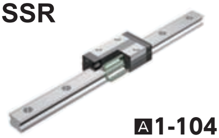
LM Guides for Special Environment

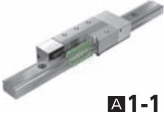
Supported models
High Corrosion Resistance HSR-M2
Oil-Free SR-MS

Surface Treatment

Grease

SHS

A1-92

SSR

A1-104

SVR/SVS

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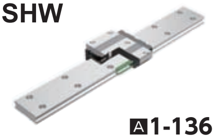
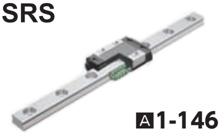
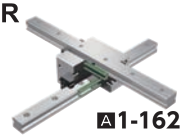
SHW

A1-136

SRS

A1-146

SCR

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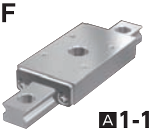
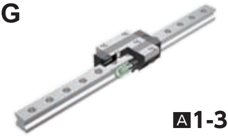
EPF

A1-170

SRG

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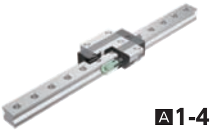
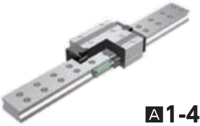
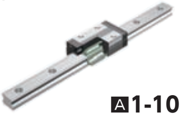
SRN

A1-418

SRW

A1-428

SSR

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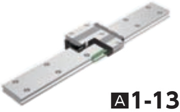
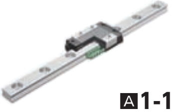
SHW

A1-136

SRS

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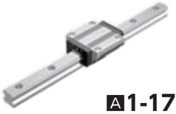
HSR

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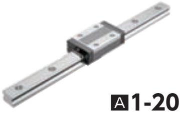
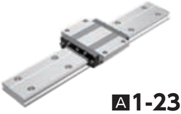
SR

A1-206

HRW

A1-238

HR

A1-258

RSR

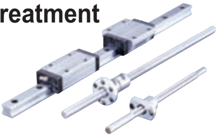
A1-248

HSR-M2

A1-372

SR-MS

A1-386

THK AP-HC Treatment

B0-20

THK AFE-CA Grease

A24-13

THK AFF Grease

A24-15

Vacuum

In a vacuum environment, measures are required to prevent gas from being emitted from a resin and the scattering of grease. Anti-rust oil cannot be used, therefore, it is necessary to select a product with high corrosion resistance.

■Measure to Prevent Emission of Gas from Resin

Stainless Steel LM Guide

The endplate (ball circulation path normally made of resin) of the LM block is made of stainless steel to reduce emission of gas.

■Measure to Prevent Grease from Evaporating

Vacuum Grease

If a general-purpose grease is used in a vacuum environment, oil contained in the grease evaporates and the grease looses lubricity. Therefore, use a vacuum grease that uses fluorine based oil, whose vapor pressure is low, as the base oil.

■Corrosion Prevention

Stainless Steel LM Guide

In a vacuum environment, use a stainless steel LM Guide, which is highly corrosion resistant.

High Temperature LM Guide

If high temperature is predicted due to baking, use a High Temperature LM Guide, which is highly resistant to heat and corrosion.

■Highly Corrosion Resistant LM Guide

This LM Guide uses austenite stainless steel, which has a high anti-corrosion effect, in the LM rail.

Oil-Free

In environments susceptible to liquid lubricants, a lubrication method other than grease or oil is required.

■Dry Lubricant

Dry Lubrication S-Compound Film

Dry Lubrication S-Compound Film is a fully dry lubricant developed for use under atmospheric to high-vacuum environments.
It has superior characteristics in load carrying capacity, wear resistance and sealability to other lubrication systems.

High Temperature LM Guide

Supported models **HSR-M1 SR-M1**
RSR-M1

LM Guides for Special Environment

Supported models For Medium-to-Low Vacuum HSR-M1VV
Oil-Free SR-MS

Highly Corrosion Resistant LM Guide

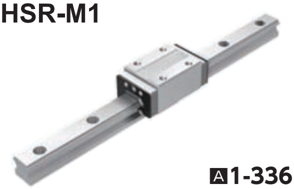
Stainless Steel LM Guide

Supported models **HSR SR HRW HR RSR**

Vacuum Grease

Oil-Free LM Guide

HSR-M1

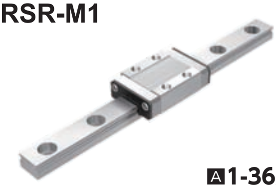


A1-336

SR-M1

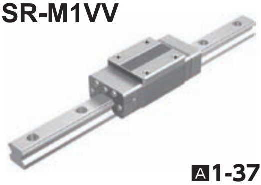
A1-352

RSR-M1



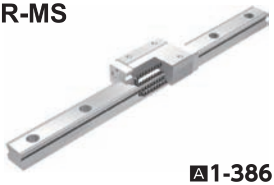
A1-362

HSR-M1VV



A1-378

SR-MS



A1-386

HSR-M2

A1-372

HSR

A1-178

SR

A1-206

HRW

A1-238

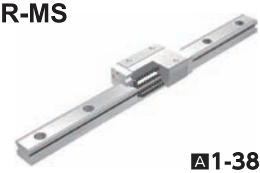
HR

A1-258

RSR

A1-248

SR-MS



A1-386

Corrosion Prevention

As with clean room applications, it is necessary to increase corrosion resistance through material selection and surface treatment.

Material-based Measure

Stainless Steel LM Guide

This LM Guide uses martensite stainless steel, which has an anti-corrosion effect.

Highly Corrosion Resistant LM Guide

It uses austenite stainless steel, which has a high anti-corrosion effect, in its LM rail.

Measure Through Surface Treatment

THK AP-HC, AP-C and AP-CF Treatment

The LM system is surface treated to increase corrosion resistance.

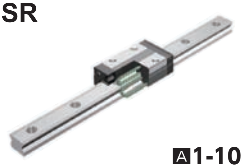
Stainless Steel LM Guide

Supported models
SSR SHW SRS HSR SR
HRW HR RSR

Highly Corrosion Resistant LM Guide

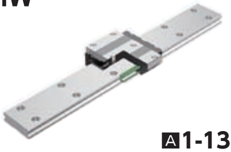
Surface Treatment

SSR



A1-104

SHW

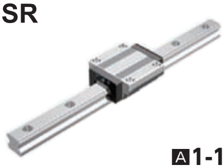


A1-136

SRS

A1-146

HSR

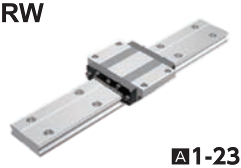


A1-178

SR

A1-206

HRW

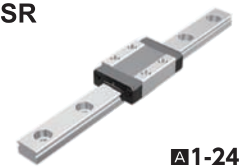


A1-238

HR

A1-258

RSR

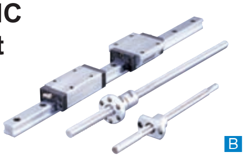


A1-248

HSR-M2

A1-372

THK AP-HC Treatment



B0-20

THK AP-C Treatment

B0-20

THK AP-CF Treatment

B0-20

High Speed

In a high speed environment, it is necessary to apply an optimum lubrication method that reduces heat generation during high speed operation and increases grease retention.

■Measures to Reduce Heat Generation

Caged Ball LM Guide

Use of a ball cage eliminates friction between balls to reduce heat generation. In addition, grease retention is increased, thus to achieve long service life and high speed operation.

THK AFA Grease, AFJ Grease

It reduces heat generation in high speed operation and has superb lubricity.

■Measure to Improve Lubrication

QZ Lubricator

Continuous oil lubrication ensures that the lubrication and maintenance interval can significantly be extended. It also applies the right amount of oil to the raceway, making itself an eco-friendly lubrication system that does not contaminate the surrounding area.

Caged Ball LM Guide

Supported models SHS SSR SVR/SVS
SHW SRS SCR EPF

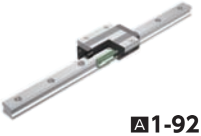
Caged Roller LM Guide

Supported models SRG SRN SRW

QZ Lubricator

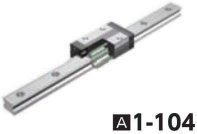
Grease

SHS



A1-92

SSR



A1-104

SVR/SVS

A1-116

SHW

A1-136

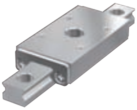
SRS

A1-146

SCR

A1-162

EPF



A1-170

SRG

A1-398

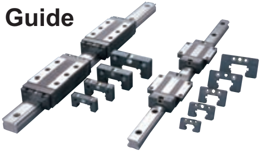
SRN

A1-418

SRW

A1-428

QZ Lubricator for the LM Guide



A1-489

THK AFA Grease

A24-7

THK AFJ Grease

A24-21

High Temperature

In a high temperature environment, dimensional alterations caused by heat is problematic. Use a High Temperature LM Guide, which is heat resistant and has minimal dimensional alterations after being heated. Also, use a high temperature grease.

■Heat Resistance

High Temperature LM Guide

A special heat treatment to maintain dimensional stability minimizes dimensional variations due to heating and cooling.

■Grease

High Temperature Grease

Use a high temperature grease with which the rolling resistance of the LM system is consistent even at high temperature.

High Temperature LM Guide

Supported models HSR-M1 SR-M1 RSR-M1 HSR-M1VV

High Temperature Grease

Low Temperature

In a low temperature environment, use an LM system with a minimal amount of resin components and a grease that minimize fluctuations in rolling resistance, even at low temperature.

■Impact of Low Temperature on Resin Components

Stainless Steel LM Guide

The endplate (ball circulation path normally made of resin) of the LM block is made of stainless steel.

■Corrosion Prevention

Provide surface treatment to the LM system to increase its corrosion resistance.

■Grease

Use THK AFC Grease, with which the rolling resistance of the system little is consistent even at low temperature.

Stainless Steel LM Guide

Supported models SSR SHW SRS HSR SR HRW HR RSR

Surface Treatment

Low Temperature Grease

Micro Motion

Micro strokes cause the oil film to break, resulting in poor lubrication and early wear. In such cases, select a grease with which the oil film strength is high and an oil film can easily be formed.

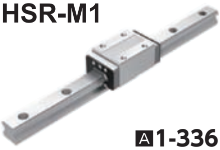
■Grease

THK AFC Grease

AFC Grease is a urea-based grease that excels in oil film strength and wear resistance.

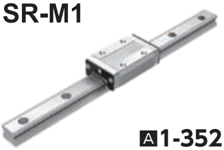
Grease

HSR-M1



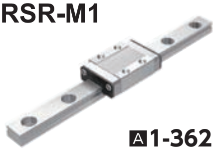
A1-336

SR-M1



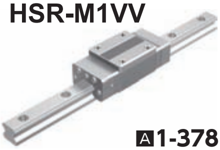
A1-352

RSR-M1



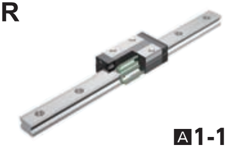
A1-362

HSR-M1VV



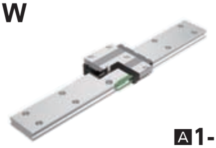
A1-378

SSR



A1-104

SHW



A1-136

SRS

A1-146

HSR

A1-178

SR

A1-206

HRW

A1-238

HR

A1-258

RSR

A1-248

THK AP-CF Treatment

B0-20

THK AFC Grease

A24-11

THK AFC Grease

A24-11

Foreign Matter

If foreign matter enters the LM system, it will cause abnormal wear and shorten the service life. Therefore, it is necessary to prevent such entrance of foreign matter.
Especially in an environment containing small foreign matter or a water-soluble coolant that a telescopic cover or a bellows cannot remove, it is necessary to attach a contamination protection accessory capable of efficiently removing foreign matter.

■Metal Scraper

It is used to remove relatively large foreign objects such as cutting chips, spatter and sand or hard foreign matter that adhere to the LM rail.

■Laminated Contact Scraper LaCS

Unlike a metal scraper, it removes foreign matter while it is in contact with the LM rail. Therefore, it demonstrates a high contamination protection effect against small foreign matter, which has been difficult to remove with conventional metal scrapers.

■QZ Lubricator

QZ Lubricator is a lubrication system that feeds the right amount of lubricant by closely contacting its highly oil-impregnated fiber net to the ball raceway.

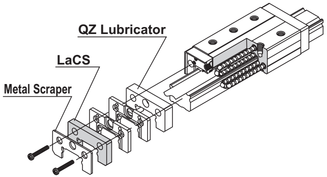
■Metal Cap Dedicated for LM Rail Mounting Holes GC Cap

GC cap is a metallic cap that plugs the LM rail mounting hole (article compliant with the RoHS Directives). It prevents the entrance of foreign material and coolant from the LM rail top face (mounting hole) under harsh environments, and significantly increases the dust control performance of the LM Guide if used with a dust control seal.

■Protector

The protector minimizes the entrance of foreign material even in harsh environments where foreign material such as fine particles and liquids are present.

LM Guide
+Metal scraper
+Contact scraper LaCS
+Cap GC, etc.

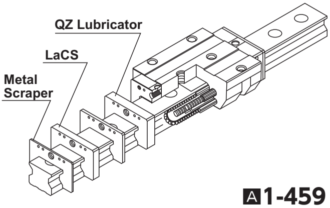


A1-459

Supported models

Caged Ball LM Guide
SHS SSR SVR/SVS SHW SRS
Full Ball LM Guide
HSR NR/NRS-X

Caged Roller LM Guide
+Metal scraper
+Contact scraper LaCS
+Cap GC, etc.



A1-459

Supported models SRG

Caged Ball LM Guide

SHS

A1-92

SSR

A1-104

SHW

A1-136

SRS

A1-146

SVR/SVS

Featuring the protector A1-116

Full ball LM Guide

HSR

A1-178

NR/NRS-X

A1-218

Caged Roller LM Guide

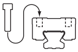
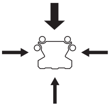
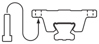
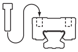
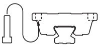
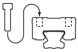
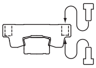
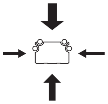
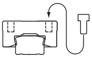
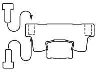
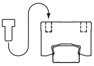
SRG

Featuring the protector A1-398

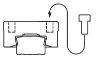
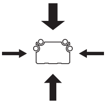
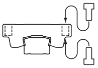
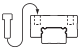
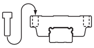
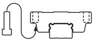
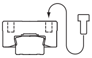
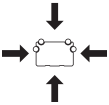
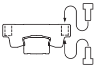
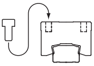
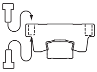
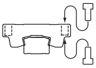
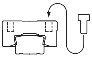
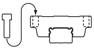
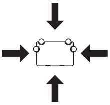
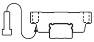
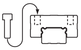
Selecting a Type

Types of LM Guides

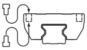
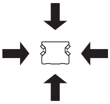
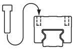
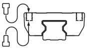
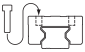
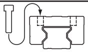
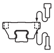
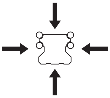
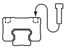
THK offers a wide array of types and dimensions with LM Guides as standard so that you can select the optimal product for any application. With the unit structure of each model, you can easily obtain high running accuracy with no clearance simply by mounting the product on a plane surface with bolts. We have a proven track record and know-how in extensive applications with LM Guides.

Classification		Type		Specification Table	Load capacity diagram	Basic load rating (kN)	
						Basic dynamic load rating	Basic static load rating
Radial type	Caged Ball LM Guide		SSR-XW	▶A1-108		14.7 to 64.6	16.5 to 71.6
			SSR-XV	▶A1-110		9.1 to 21.7	9.7 to 22.5
			SSR-XTB	▶A1-112		14.7 to 31.5	16.5 to 36.4
	Full-Complement Ball LM Guides		SR-W	▶A1-212		13.8 to 411	20.5 to 537
			SR-M1W	▶A1-356		13.8 to 60.4	20.5 to 81.8
			SR-V	▶A1-212		9.1 to 40.9	11.7 to 46.7
			SR-M1V	▶A1-356		9.1 to 40.9	11.7 to 46.7
			SR-TB	▶A1-214		13.8 to 136	20.5 to 179
			SR-M1TB	▶A1-358		13.8 to 60.4	20.5 to 81.8
			SR-SB	▶A1-214		9.1 to 40.9	11.7 to 46.7
			SR-M1SB	▶A1-358		9.1 to 40.9	11.7 to 46.7
	Oil-Free LM Guides for Special Environments		SR-MSV	▶A1-390		—	—
			SR-MSW	▶A1-390		—	—
	Caged Ball LM Guides for Machine Tools high-rigidity model for ultra-heavy loads		SVR-C	▶A1-126		48 to 260	68 to 328
			SVR-LC	▶A1-126		57 to 340	86 to 481
			SVR-R	▶A1-122		48 to 260	68 to 328
			SVR-LR	▶A1-122		57 to 340	86 to 481
			SVR-CH	▶A1-132		90 to 177	115 to 238
			SVR-LCH	▶A1-132		108 to 214	159 to 312
			SVR-RH	▶A1-130		90 to 177	115 to 238
			SVR-LRH	▶A1-130		108 to 214	159 to 312

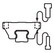
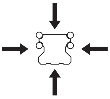
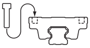
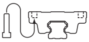
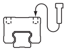
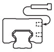
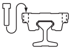
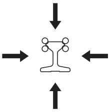
External dimensions (mm)		Features	Major application
Height	Width		
24 to 48	34 to 70	● Long service life, long-term maintenance-free operation ● Low dust generation, low noise, acceptable running sound ● Superbly high speed ● Smooth motion in all mounting orientations ● Thin, compact design, large radial load capacity ● Superb in planar running accuracy ● Superb capability of absorbing mounting error ● Stainless steel type also available as standard	● Surface grinder table ● Tool grinder table ● Electric discharge machine ● Printed circuit board drilling machine ● Chip mounter ● High-speed transfer equipment ● Traveling unit of robots ● Machining center ● NC lathe ● Five axis milling machine ● Conveyance system ● Mold guide of pressing machines ● Inspection equipment ● Testing machine ● Food-related machine ● Medical equipment ● 3D measuring instrument ● Packaging machine ● Injection molding machine ● Woodworking machine ● Ultra precision table ● Semiconductor/liquid crystal manufacturing equipment
24 to 33	34 to 48		
24 to 33	52 to 73		
24 to 135	34 to 250	● Thin, compact design, large radial load capacity ● Superb in planar running accuracy ● Superb capability of absorbing mounting error ● Stainless steel type also available as standard ● Type M1, achieving max service temperature of 150℃, also available	
24 to 48	34 to 70		
24 to 48	34 to 70		
24 to 48	34 to 70		
24 to 68	52 to 140		
24 to 48	52 to 100		
24 to 48	52 to 100		
24 to 48	52 to 100		
24 to 28	34 to 42	● Minimum generation of outgases (water, organic matter) ● Small amount of particles generated ● Can be used at high temperature (up to 150℃)	● Photolithography machine ● Organic EL display manufacturing machine ● Ion implantation equipment
24 to 28	34 to 42		
31 to 75	72 to 170	● Long service life, long-term maintenance-free operation ● Low dust generation, low noise, acceptable running sound ● Superbly high speed ● Smooth motion in all mounting orientations ● Ultra-heavy load capacity optimal for machine tools ● Thin, compact design, large radial load capacity ● High vibration resistance and impact resistance due to improved damping characteristics ● Superb in planar running accuracy	● Machining center ● NC lathe ● Grinding machine ● Five axis milling machine ● Jig borer ● Drilling machine ● NC milling machine ● Horizontal milling machine ● Mold processing machine ● Graphite working machine ● Electric discharge machine ● Wire-cut electric discharge machine
31 to 75	72 to 170		
31 to 75	50 to 126		
31 to 75	50 to 126		
48 to 70	100 to 140	● Long service life, long-term maintenance-free operation ● Low dust generation, low noise, acceptable running sound ● Superbly high speed ● Smooth motion in all mounting orientations ● Ultra-heavy load capacity optimal for machine tools ● Large radial load capacity ● High vibration resistance and impact resistance due to improved damping characteristics ● Superb in planar running accuracy ● Has dimensions almost the same as that of the full-ball type LM Guide model HSR, which is practically a global standard size	
48 to 70	100 to 140		
55 to 80	70 to 100		
55 to 80	70 to 100		

Classification		Type		Specification Table	Load capacity diagram	Basic load rating (kN)	
						Basic dynamic load rating	Basic static load rating
Radial type	Full-Complement Ball LM Guides for Machine Tools high-rigidity model for ultra-heavy loads		NR-RX	▶A1-224		37.1 to 208.7	68.1 to 351.7
			NR-LRX	▶A1-224		45.4 to 268.9	90.8 to 505.5
			NR-CX	▶A1-228		37.1 to 208.7	68.1 to 351.7
			NR-LCX	▶A1-228		45.4 to 268.9	90.8 to 505.5
			NR-R	▶A1-224		271 to 479	610 to 1040
			NR-LR	▶A1-224		355 to 599	800 to 1300
			NR-A	▶A1-232		271 to 479	610 to 1040
			NR-LA	▶A1-232		355 to 599	800 to 1300
			NR-B	▶A1-234		271 to 479	610 to 1040
			NR-LB	▶A1-234		355 to 599	800 to 1300
4-way type	LM Guides for Machine Tools high-rigidity model for ultra-heavy loads		SVS-R	▶A1-124		37 to 199	52 to 251
			SVS-LR	▶A1-124		44 to 261	66 to 368
			SVS-C	▶A1-128		37 to 199	52 to 251
			SVS-LC	▶A1-128		44 to 261	66 to 368
			SVS-RH	▶A1-130		69 to 136	88 to 182
			SVS-LRH	▶A1-130		83 to 164	122 to 239
			SVS-CH	▶A1-132		69 to 136	88 to 182
			SVS-LCH	▶A1-132		83 to 164	122 to 239
	Full-Complement Ball LM Guides for Machine Tools high-rigidity model for ultra-heavy loads		NRS-CX	▶A1-230		28.4 to 159.8	52.2 to 269.4
			NRS-LCX	▶A1-230		34.7 to 206	69.6 to 387.2
			NRS-RX	▶A1-226		28.4 to 159.8	52.2 to 269.4
			NRS-LRX	▶A1-226		34.7 to 206	69.6 to 387.2
4-way equal load type	Full-Complement Ball LM Guides for Machine Tools high-rigidity model for ultra-heavy loads		NRS-A	▶A1-232		212 to 376	431 to 737
			NRS-LA	▶A1-232		278 to 470	566 to 920
			NRS-B	▶A1-234		212 to 376	431 to 737
			NRS-LB	▶A1-234		278 to 470	566 to 920
			NRS-R	▶A1-226		212 to 376	431 to 737
			NRS-LR	▶A1-226		278 to 470	566 to 920

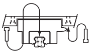
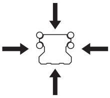
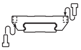
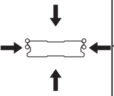
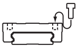
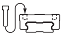
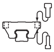
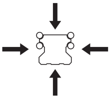
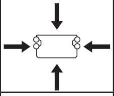
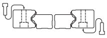
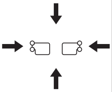
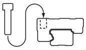
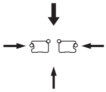
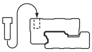
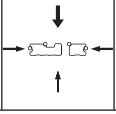
	External dimensions (mm)		Features	Major application
	Height	Width		
	31 to 75	50 to 126	• Low dust generation, low noise, acceptable running sound • Superbly high speed • Smooth motion in all mounting orientations • Ultra-heavy load capacity optimal for machine tools • Thin, compact design, large radial load capacity • High vibration resistance and impact resistance due to improved damping characteristics • Superb in planar running accuracy	• Machining center • NC lathe • Grinding machine • Five axis milling machine • Jig borer • Drilling machine • NC milling machine • Horizontal milling machine • Mold processing machine • Graphite working machine • Electric discharge machine • Wire-cut electric discharge machine
	31 to 75	50 to 126		
	31 to 75	72 to 170		
	31 to 75	72 to 170		
	83 to 105	145 to 200	• Ultra-heavy load capacity optimal for machine tools • High vibration resistance and impact resistance due to improved damping characteristics • Thin, compact design, large radial load capacity • Superb in planar running accuracy	
	83 to 105	145 to 200		
	83 to 105	195 to 260		
	83 to 105	195 to 260		
	83 to 105	195 to 260		
	83 to 105	195 to 260		
	31 to 75	50 to 126	• Long service life, long-term maintenance-free operation • Low dust generation, low noise, acceptable running sound • Superbly high speed • Smooth motion in all mounting orientations • Ultra-heavy load capacity optimal for machine tools • Low profile, compact 4-way type • High vibration resistance and impact resistance due to improved damping characteristics	
	31 to 75	50 to 126		
	31 to 75	72 to 170		
	31 to 75	72 to 170		
	55 to 80	70 to 100	• Long service life, long-term maintenance-free operation • Low dust generation, low noise, acceptable running sound • Superbly high speed • Smooth motion in all mounting orientations • Ultra-heavy load capacity optimal for machine tools • 4-way type • High vibration resistance and impact resistance due to improved damping characteristics • Has dimensions almost the same as that of the full-ball type LM Guide model HSR, which is practically a global standard size	
	55 to 80	70 to 100		
	48 to 70	100 to 140		
	48 to 70	100 to 140		
	31 to 75	72 to 170	• Low dust generation, low noise, acceptable running sound • Superbly high speed • Smooth motion in all mounting orientations • Ultra-heavy load capacity optimal for machine tools • Low profile, compact 4-way type • High vibration resistance and impact resistance due to improved damping characteristics	
	31 to 75	72 to 170		
	31 to 75	50 to 126		
	31 to 75	50 to 126		
	83 to 105	195 to 260	• Ultra-heavy load capacity optimal for machine tools • High vibration resistance and impact resistance due to improved damping characteristics • Low-Profile compact design, 4-way equal load	
	83 to 105	195 to 260		
	83 to 105	195 to 260		
	83 to 105	195 to 260		
	83 to 105	145 to 200		
	83 to 105	145 to 200		

Classification		Type		Specification Table	Load capacity diagram	Basic load rating (kN)	
						Basic dynamic load rating	Basic static load rating
4-way equal load type	Caged Roller LM Guide - super ultra-heavy-load, high rigidity types		SRG-A, C	▶A1-404		11.3 to 131	25.8 to 266
			SRG-LA, LC	▶A1-404		26.7 to 278	63.8 to 599
			SRG-R, V	▶A1-410		11.3 to 131	25.8 to 266
			SRG-LR, LV	▶A1-410		26.7 to 601	63.8 to 1170
			SRN-C	▶A1-422		59.1 to 131	119 to 266
			SRN-LC	▶A1-422		76 to 278	165 to 599
			SRN-R	▶A1-424		59.1 to 131	119 to 266
			SRN-LR	▶A1-424		76 to 278	165 to 599
			SRW-LR	▶A1-432		115 to 601	256 to 1170
	Caged Ball LM Guide - heavy-load, high rigidity types		SHS-C	▶A1-96		14.2 to 205	24.2 to 320
			SHS-LC	▶A1-96		17.2 to 253	31.9 to 408
			SHS-V	▶A1-98		14.2 to 205	24.2 to 320
			SHS-LV	▶A1-98		17.2 to 253	31.9 to 408
			SHS-R	▶A1-100		14.2 to 128	24.2 to 197
			SHS-LR	▶A1-100		36.8 to 161	64.7 to 259

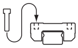
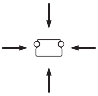
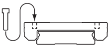
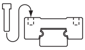
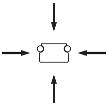
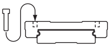
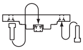
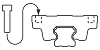
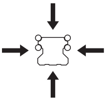
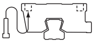
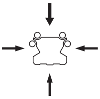
	External dimensions (mm)		Features	Major application
	Height	Width		
	24 to 70	47 to 140	• Long service life, long-term maintenance-free operation • Low noise, acceptable running sound • Superbly high speed • Smooth motion due to prevention of rollers from skewing • Ultra-heavy load capacity optimal for machine tools	• Machining center • NC lathe • Grinding machine • Five axis milling machine • Jig borer • Drilling machine • NC milling machine • Horizontal milling machine • Mold processing machine • Graphite working machine • Electric discharge machine • Wire-cut electric discharge machine
	30 to 120	63 to 250		
	24 to 80	34 to 100		
	30 to 90	44 to 126		
	44 to 63	100 to 140	• Long service life, long-term maintenance-free operation • Low noise, acceptable running sound • Superbly high speed • Smooth motion due to prevention of rollers from skewing • Ultra-heavy load capacity optimal for machine tools • Low center of gravity, ultra-high rigidity	
	44 to 75	100 to 170		
	44 to 63	70 to 100		
	44 to 75	70 to 126		
	70 to 150	135 to 300		
	24 to 90	47 to 170	• Long service life, long-term maintenance-free operation • Low dust generation, low noise, acceptable running sound • Superbly high speed • Smooth motion in all mounting orientations • Heavy load, high rigidity • Has dimensions almost the same as that of the full-ball type LM Guide model HSR, which is practically a global standard size • Superb capability of absorbing mounting error	• Machining center • NC lathe • XYZ axes of heavy cutting machine tools • Grinding head feeding axis of grinding machines • Components requiring a heavy moment and high accuracy • NC milling machine • Horizontal milling machine • Gantry five axis milling machine • Z axis of electric discharge machines • Wire-cut electric discharge machine • Car elevator • Food-related machine • Testing machine • Vehicle doors • Printed circuit board drilling machine • ATC • Construction equipment • Shield machine • Semiconductor/liquid crystal manufacturing equipment
	24 to 90	47 to 170		
	24 to 90	34 to 126		
	24 to 90	34 to 126		
	28 to 80	34 to 100		
	28 to 80	34 to 100		

Classification		Type		Specification Table	Load capacity diagram	Basic load rating (kN)	
						Basic dynamic load rating	Basic static load rating
4-way equal load type	Full-Complement Ball LM Guide - heavy-load, high rigidity types		HSR-C/XC	▶A1-184		10.9 to 195	15.7 to 228
			HSR-LC/XLC	▶A1-184		14.2 to 249	22.9 to 323
			HSR-A	▶A1-190		10.9 to 304	15.7 to 355
			HSR-M1A	▶A1-342		10.9 to 53.9	15.7 to 70.2
			HSR-LA	▶A1-190		23.9 to 367	35.8 to 464
			HSR-M1LA	▶A1-342		23.9 to 65	35.8 to 91.7
			HSR-CA	▶A1-196		19.8 to 304	27.4 to 355
			HSR-HA	▶A1-196		23.9 to 518	35.8 to 728
			HSR-B	▶A1-192		10.9 to 304	15.7 to 355
			HSR-M1B	▶A1-344		10.9 to 53.9	15.7 to 70.2
			HSR-LB	▶A1-192		23.9 to 367	35.8 to 464
			HSR-M1LB	▶A1-344		23.9 to 65	35.8 to 91.7
			HSR-CB	▶A1-198		19.8 to 304	27.4 to 355
			HSR-HB	▶A1-198		23.9 to 518	35.8 to 728
			HSR-R/XR	▶A1-188		1.08 to 304	2.16 to 355
			HSR-M1R	▶A1-346		10.9 to 53.9	15.7 to 70.2
			HSR-LR/XLR	▶A1-188		23.9 to 367	35.8 to 464
			HSR-M1LR	▶A1-346		23.9 to 65	35.8 to 91.7
			HSR-HR	▶A1-200		441 to 518	540 to 728
	LM Guide for Medium-to-Low Vacuum		HSR-M1VV	▶A1-382		10.9	15.7
	Full-ball LM Guide - side mount types		HSR-YR	▶A1-194		10.9 to 195	15.7 to 228
			HSR-M1YR	▶A1-348		10.9 to 53.9	15.7 to 70.2
	Full-Complement LM Guides - special LM rail types		JR-A	▶A1-310		27.6 to 121	36.4 to 146
			JR-B	▶A1-310		27.6 to 121	36.4 to 146
			JR-R	▶A1-310		27.6 to 121	36.4 to 146

External dimensions (mm)		Features	Major application
Height	Width		
24 to 90	47 to 170	● Heavy load, high rigidity ● Practically a global standard size ● Superb capability of absorbing mounting error ● Stainless steel type also available as standard ● Type M1, achieving max service temperature of 150℃, also available ● Type M2, with high corrosion resistance, also available (Basic dynamic load rating: 2.33 to 5.57 kN) (Basic static load rating: 2.03 to 5.16 kN)	● Machining center ● NC lathe ● XYZ axes of heavy cutting machine tools ● Grinding head feeding axis of grinding machines ● Components requiring a heavy moment and high accuracy ● NC milling machine ● Horizontal milling machine ● Gantry five axis milling machine ● Z axis of electric discharge machines ● Wire-cut electric discharge machine ● Car elevator ● Food-related machine ● Testing machine ● Vehicle doors ● Printed circuit board drilling machine ● ATC ● Construction equipment ● Shield machine ● Semiconductor/liquid crystal manufacturing equipment
24 to 90	47 to 170		
24 to 110	47 to 215		
24 to 48	47 to 100		
30 to 110	63 to 215		
30 to 48	63 to 100		
30 to 110	63 to 215		
30 to 145	63 to 350		
24 to 110	47 to 215		
24 to 48	47 to 100		
30 to 110	63 to 215		
30 to 48	63 to 100		
30 to 110	63 to 215		
30 to 145	63 to 350		
11 to 110	16 to 156		
28 to 55	34 to 70		
30 to 110	44 to 156		
30 to 55	44 to 70		
120 to 145	250 to 266		
28	34	● Can be used in various environments at atmospheric pressure to vacuum (10^{-3} [Pa]) ● Allows baking temperature of 200℃* at a maximum * If the baking temperature exceeds 100℃, multiply the basic load rating with the temperature coefficient.	● Medical equipment ● Semiconductor/liquid crystal manufacturing equipment
28 to 90	33.5 to 124.5	● Easy mounting and reduced mounting height when using 2 units opposed to each other since the side faces of the LM block have mounting holes ● Heavy load, high rigidity ● Superb capability of absorbing mounting error ● Stainless steel type also available as standard ● Type M1, achieving max service temperature of 150℃, also available	● Cross rails of gantry machine tools ● Z axis of woodworking machines ● Z axis of measuring instruments ● Components opposed to each other
28 to 55	33.5 to 69.5		
61 to 114	70 to 140	● Since the central part of the LM rail is thinly structured, the LM Guide is capable of absorbing an error and achieving smooth motion if the parallelism between the two axes is poor ● Since the LM rail has a highly rigid sectional shape, it can be used as a structural member	● Automated warehouse ● Garage ● Gantry robot ● FMS traveling rail ● Lift ● Conveyance system ● Welding machine ● Lifter ● Crane ● Forklift ● Coating machine ● Shield machine ● Stage setting
61 to 114	70 to 140		
65 to 124	48 to 100		

Classification		Type		Specification Table	Load capacity diagram	Basic load rating (kN)	
						Basic dynamic load rating	Basic static load rating
4-way equal load type	Caged Ball Cross LM Guide		SCR	▶A1-166		36.8 to 253	64.7 to 408
	Full-Complement LM Guide orthogonal type		CSR	▶A1-296		10.9 to 100	15.7 to 135
	Caged Ball LM Guide - wide, low center of gravity types		SHW-CA	▶A1-140		4.31 to 70.2	5.66 to 91.4
			SHW-CR, HR	▶A1-142		4.31 to 70.2	5.66 to 91.4
	Full-Complement Ball LM Guide - wide, low center of gravity types		HRW-CA	▶A1-242		5.53 to 80.3	9.1 to 109
			HRW-CR, LRM	▶A1-244		3.29 to 62.4	7.16 to 86.3
	Full-ball Straight - Curved Guide		HMG	▶A1-326		2.56 to 66.2	Straight section 4.23 to 66.7 Curved section 0.44 to 36.2
	Caged Ball LM Guides Finite stroke		EPF	▶A1-174		0.90 to 3.71	1.60 to 5.88
	Full-Complement Ball LM Guide - separate types		HR, HR-T	▶A1-264		2.82 to 226	3.48 to 232
Interchangeable designs			GSR-T	▶A1-276		8.42 to 37	9.77 to 39.1
			GSR-V	▶A1-276		6.51 to 15.5	6.77 to 15.2
	Full-Complement Ball LM Guides - LM rail-rack intergrated type		GSR-R	▶A1-284		15.5 to 37	15.2 to 39.1

External dimensions (mm)		Features	Major application
Height	Width		
70 to 180	88 to 226	• A compact XY structure is allowed due to an XY orthogonal, single-piece LM block • Since a saddle-less structure is allowed, the machine can be lightweighted and compactly designed • Long service life, long-term maintenance-free operation • Low dust generation, low noise, acceptable running sound • Superbly high speed	• Low center of gravity, precision XY table • NC lathe • Optical measuring instrument • Automatic lathe • Inspection equipment • Cartesian coordinate robot • Bonding machine • Wire-cut electric discharge machine • Hollow table • Printed circuit board assembler • Machine tool table • Electric discharge machine • XY axes of horizontal machining center
47 to 118	38.8 to 129.8	• A compact XY structure is allowed due to an XY orthogonal, single-piece LM block • Since a saddle-less structure is allowed, the machine can be lightweighted and compactly designed	
12 to 50	40 to 162	• Long service life, long-term maintenance-free operation • Low dust generation, low noise, acceptable running sound • Superbly high speed • Smooth motion in all mounting orientations • Wide, low center of gravity, space saving structure • Stainless steel type also available as standard	• Z axis of IC printed circuit board drilling machine • Z axis of small electric discharge machine • Loader • Machining center • NC lathe • Robot • Wire-cut electric discharge machine • APC • Semiconductor/liquid crystal manufacturing equipment • Measuring instrument • Wafer transfer equipment • Construction equipment • Railroad vehicle
12 to 50	30 to 130		
17 to 60	60 to 200	• 4-way equal load, thin and highly rigid • Wide, low center of gravity, space saving structure • Stainless steel type also available as standard	
12 to 50	30 to 130		
24 to 90	47 to 170	• Freedom of design • Cost reduction through simplified structure	• Large swivel base • Pendulum vehicle for railroad • Pantagraph • Control unit • Optical measuring machine • Tool grinder • X-Ray machine • CT scanner • Medical equipment • Stage setting • Car elevator • Amusement machine • Turntable • Tool changer
8 to 16	17 to 32	• Caged ball effect using a cage • Smooth movement with minimal rolling variation • 4-groove construction in a compact body	• Semiconductor manufacturing equipment • Medical equipment • Inspection equipment • Industrial machinery
8.5 to 60	18 to 125	• Low-Profile high rigidity, space saving structure • Interchangeable with Cross-Roller Guide • Preload can be adjusted • Stainless steel type also available as standard	• XYZ axes of electric discharge machine • Precision table • XZ axes of NC lathe • Assembly robot • Conveyance system • Machining center • Wire-cut electric discharge machine • Tool changer • Woodworking machine
20 to 38	32 to 68	• LM block and LM rail are both interchangeable • Preload can be adjusted • Capable of absorbing vertical level error and horizontal tolerance for parallelism	• Industrial robot • Various conveyance systems • Automated warehouse • Palette changer • ATC • Door closing device • Guide using an aluminum mold base • Welding machine • Coating machine • Car washing machine
20 to 30	32 to 50		
30 to 38	59.91 to 80.18	• LM rail-rack integrated design eliminates assembly and adjustment work • LM rail-rack integrated design enables a space-saving structure to be achieved • Capable of supporting long strokes	

Classification		Type		Specification Table	Load capacity diagram	Basic load rating (kN)	
						Basic dynamic load rating	Basic static load rating
Miniature types	Caged Ball LM Guides		SRS-S	▶A1-152		1.09 to 4.5	0.964 to 3.39
			SRS-M			0.439 to 16.5	0.468 to 20.2
			SRS-N			0.515 to 9.71	0.586 to 8.55
			SRS-WS	▶A1-156		1.38 to 6.64	1.35 to 5.94
			SRS-WM			0.584 to 9.12	0.703 to 8.55
			SRS-WN			0.746 to 12.4	0.996 to 12.1
	Full-Complement Ball LM Guides		RSR-M	▶A1-254		0.18 to 8.82	0.27 to 12.7
			RSR-M1V	▶A1-366		1.47 to 8.82	2.25 to 12.7
			RSR-N	▶A1-254		0.3 to 14.2	0.44 to 20.6
			RSR-M1N	▶A1-366		2.6 to 14.2	3.96 to 20.6
	Full-Complement Ball LM Guide - wide types		RSR-WM/WV	▶A1-254		0.25 to 6.66	0.47 to 9.8
			RSR-M1WV	▶A1-368		2.45 to 6.66	3.92 to 9.8
			RSR-WN	▶A1-254		0.39 to 9.91	0.75 to 14.9
			RSR-M1WN	▶A1-368		3.52 to 9.91	5.37 to 14.9
	Full Complement Ball LM Guide - orthogonal type		MX	▶A1-302		0.59 to 2.04	1.1 to 3.21
Circular arc types	Full-Complement Ball LM Guides		HCR	▶A1-318		4.7 to 141	8.53 to 215
Self-aligning types	Full-Complement Ball LM Guides		NSR-TBC	▶A1-332		9.41 to 90.8	18.6 to 152

External dimensions (mm)		Features	Major application
Height	Width		
8 to 16	17 to 32	• Long service life, long-term maintenance-free operation • Low dust generation, low noise, acceptable running sound • Superbly high speed • Smooth motion in all mounting orientations • Stainless steel type also available as standard • Lightweight and compact	• IC/LSI manufacturing machine • Hard disc drive • Slide unit of OA equipment • Wafer transfer equipment • Printed circuit board assembly table • Medical equipment • Electronic components of electron microscope • Optical stage • Stepper • Plotting machine • Feed mechanism of IC bonding machine • Inspection equipment
6 to 25	17 to 48		
6 to 16	12 to 32		
9 to 16	25 to 60		
6.5 to 16	17 to 60		
4 to 25	8 to 46	• Stainless steel type also available as standard • Long type with increased load capacity also offered as standard • Type M1, achieving max service temperature of 150℃, also available	• IC/LSI manufacturing machine • Hard disc drive • Slide unit of OA equipment • Wafer transfer equipment • Printed circuit board assembly table • Medical equipment • Electronic components of electron microscope • Optical stage • Stepper • Plotting machine • Feed mechanism of IC bonding machine • Inspection equipment
10 to 25	20 to 46		
4 to 25	8 to 46		
10 to 25	20 to 46		
4.5 to 16	12 to 60	• Stainless steel type also available as standard • Long type with increased load capacity also offered as standard • Type M1, achieving max service temperature of 150℃, also available	
12 to 16	30 to 60		
4.5 to 16	12 to 60		
12 to 16	30 to 60		
10 to 14.5	15.2 to 30.2	• A compact XY structure is allowed due to an XY orthogonal, single-piece LM block • Stainless steel type also available as standard	• IC/LSI manufacturing machine • Inspection equipment • Slide unit of OA equipment • Wafer transfer equipment • Feed mechanism of IC bonding machine • Printed circuit board assembly table • Medical equipment • Electronic components of electron microscope • Optical stage
18 to 90	39 to 170	• Circular motion guide in a 4-way equal load design • Highly accurate circular motion without play • Allows an efficient design with the LM block placed in the loading point • Large circular motion easily achieved	• Large swivel base • Pendulum vehicle for railroad • Pantagraph • Control unit • Optical measuring machine • Tool grinder • X-Ray machine • CT scanner • Medical equipment • Stage setting • Car elevator • Amusement machine • Turntable • Tool changer
40 to 105	70 to 175	• Can be used in rough mount due to self-aligning on the fit surface of the case • Preload can be adjusted • Can be mounted on a black steel sheet	• XY axes of ordinary industrial machinery • Various conveyance systems • Automated warehouse • Palette changer • Automatic coating machine • Various welding machines

Calculating the Applied Load

The LM Guide is capable of receiving loads and moments in all directions that are generated due to the mounting orientation, alignment, gravity center position of a traveling object, thrust position and cutting resistance.

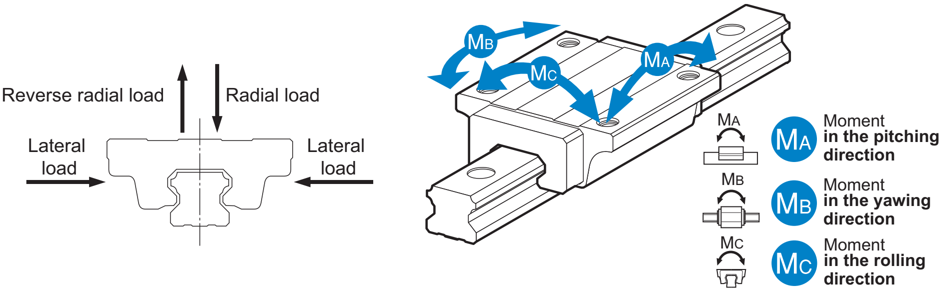


Fig.1 Directions of the Loads Applied on the LM Guide

Calculating an Applied Load

[Single-Axis Use]

● Moment Equivalence

When the installation space for the LM Guide is limited, you may have to use only one LM block, or double LM blocks closely contacting with each other. In such a setting, the load distribution is not uniform and, as a result, an excessive load is applied in localized areas (i.e., both ends) as shown in Fig.2. Continued use under such conditions may result in flaking in those areas, consequently shortening the service life. In such a case, calculate the actual load by multiplying the moment value by any one of the equivalent-moment factors specified in Table1 to Table6.

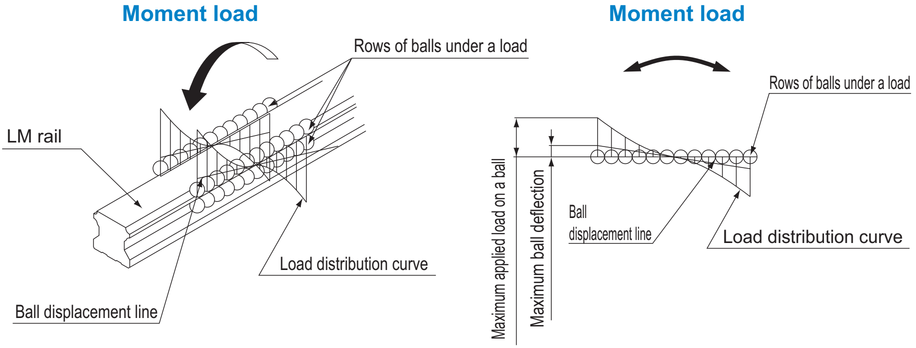


Fig.2 Ball Load when a Moment is Applied

An equivalent-load equation applicable when a moment acts on an LM Guide is shown below.

$$P = K \cdot M$$

P : Equivalent load per LM Guide (N)
K : Equivalent moment factor
M : Applied moment (N-mm)

● Equivalent Factor

Since the rated load is equivalent to the permissible moment, the equivalent factor to be multiplied when equalizing the M_A, M_B and M_C moments to the applied load per block is obtained by dividing the rated loads in the corresponding directions.
With those models other than 4-way equal load types, however, the load ratings in the 4 directions differ from each other. Therefore, the equivalent factor values for the M_A and M_C moments also differ depending on whether the direction is radial or reverse radial.

■Equivalent Factors for the M_A Moment

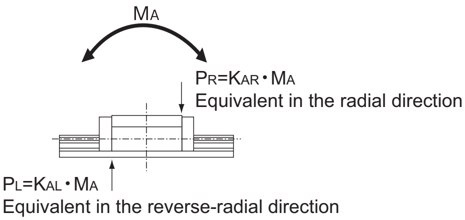


Fig.3 Equivalent Factors for the M_A Moment

Equivalent factors for the M_A Moment

- Equivalent factor in the radial direction $K_{AR}=\frac{C_0}{M_A}$
- Equivalent factor in the reverse radial direction $K_{AL}=\frac{C_{0L}}{M_A}$

$$\frac{C_0}{K_{AR}\cdot M_A}=\frac{C_{0L}}{K_{AL}\cdot M_A}=1$$

■Equivalent Factors for the M_B Moment

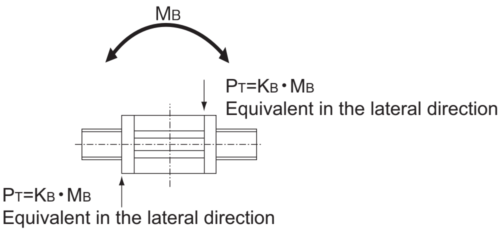


Fig.4 Equivalent Factors for the M_B Moment

Equivalent factors for the M_B Moment

- Equivalent factor in the lateral directions $K_B=\frac{C_{0T}}{M_B}$

$$\frac{C_{0T}}{K_B\cdot M_B}=1$$

■Equivalent Factors for the M_C Moment

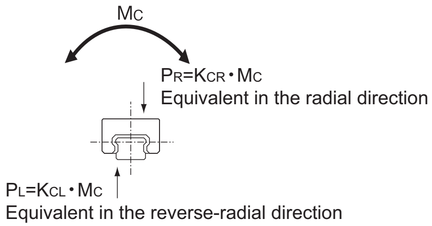


Fig.5 Equivalent Factors for the M_C Moment

Equivalent factors for the M_C Moment

- Equivalent factor in the radial direction $K_{CR}=\frac{C_0}{M_C}$
- Equivalent factor in the reverse radial direction $K_{CL}=\frac{C_{0L}}{M_C}$

$$\frac{C_0}{K_{CR}\cdot M_C}=\frac{C_{0L}}{K_{CL}\cdot M_C}=1$$

C_0 : Basic static load rating (radial direction) (N)
C_{0L} : Basic static load rating (reverse radial direction) (N)
C_{0T} : Basic static load rating (lateral direction) (N)
P_R : Calculated load (radial direction) (N)
P_L : Calculated load (reverse radial direction) (N)
P_T : Calculated load (lateral direction) (N)

Table1 Equivalent Factors (Models SHS, SSR, SVR, SVS, SHW and SRS)

Model No.		Equivalent factor							
		K_{AR1}	K_{AL1}	K_{AR2}	K_{AL2}	K_{B1}	K_{B2}	K_{CR}	K_{CL}
SHS	15	1.38×10^{-1}		2.69×10^{-2}		1.38×10^{-1}	2.69×10^{-2}	1.50×10^{-1}	
	15L	1.07×10^{-1}		2.22×10^{-2}		1.07×10^{-1}	2.22×10^{-2}	1.50×10^{-1}	
	20	1.15×10^{-1}		2.18×10^{-2}		1.15×10^{-1}	2.18×10^{-2}	1.06×10^{-1}	
	20L	8.85×10^{-2}		1.79×10^{-2}		8.85×10^{-2}	1.79×10^{-2}	1.06×10^{-1}	
	25	9.25×10^{-2}		1.90×10^{-2}		9.25×10^{-2}	1.90×10^{-2}	9.29×10^{-2}	
	25L	7.62×10^{-2}		1.62×10^{-2}		7.62×10^{-2}	1.62×10^{-2}	9.29×10^{-2}	
	30	8.47×10^{-2}		1.63×10^{-2}		8.47×10^{-2}	1.63×10^{-2}	7.69×10^{-2}	
	30L	6.52×10^{-2}		1.34×10^{-2}		6.52×10^{-2}	1.34×10^{-2}	7.69×10^{-2}	
	35	6.95×10^{-2}		1.43×10^{-2}		6.95×10^{-2}	1.43×10^{-2}	6.29×10^{-2}	
	35L	5.43×10^{-2}		1.16×10^{-2}		5.43×10^{-2}	1.16×10^{-2}	6.29×10^{-2}	
	45	6.13×10^{-2}		1.24×10^{-2}		6.13×10^{-2}	1.24×10^{-2}	4.69×10^{-2}	
	45L	4.79×10^{-2}		1.02×10^{-2}		4.79×10^{-2}	1.02×10^{-2}	4.69×10^{-2}	
	55	4.97×10^{-2}		1.02×10^{-2}		4.97×10^{-2}	1.02×10^{-2}	4.02×10^{-2}	
	55L	3.88×10^{-2}		8.30×10^{-3}		3.88×10^{-2}	8.30×10^{-3}	4.02×10^{-2}	
	65	3.87×10^{-2}		7.91×10^{-3}		3.87×10^{-2}	7.91×10^{-3}	3.40×10^{-2}	
	65L	3.06×10^{-2}		6.51×10^{-3}		3.06×10^{-2}	6.51×10^{-3}	3.40×10^{-2}	
SSR	15XW (TB)	2.08×10^{-1}	1.04×10^{-1}	3.75×10^{-2}	1.87×10^{-2}	1.46×10^{-1}	2.59×10^{-2}	1.71×10^{-1}	8.57×10^{-2}
	15XV	3.19×10^{-1}	1.60×10^{-1}	5.03×10^{-2}	2.51×10^{-2}	2.20×10^{-1}	3.41×10^{-2}	1.71×10^{-1}	8.57×10^{-2}
	20XW (TB)	1.69×10^{-1}	8.46×10^{-2}	3.23×10^{-2}	1.62×10^{-2}	1.19×10^{-1}	2.25×10^{-2}	1.29×10^{-1}	6.44×10^{-2}
	20XV	2.75×10^{-1}	1.37×10^{-1}	4.28×10^{-2}	2.14×10^{-2}	1.89×10^{-1}	2.89×10^{-2}	1.29×10^{-1}	6.44×10^{-2}
	25XW (TB)	1.41×10^{-1}	7.05×10^{-2}	2.56×10^{-2}	1.28×10^{-2}	9.86×10^{-2}	1.77×10^{-2}	1.10×10^{-1}	5.51×10^{-2}
	25XV	2.15×10^{-1}	1.08×10^{-1}	3.40×10^{-2}	1.70×10^{-2}	1.48×10^{-1}	2.31×10^{-2}	1.10×10^{-1}	5.51×10^{-2}
	30XW	1.18×10^{-1}	5.91×10^{-2}	2.19×10^{-2}	1.10×10^{-2}	8.26×10^{-2}	1.52×10^{-2}	9.22×10^{-2}	4.61×10^{-2}
	35XW	1.01×10^{-1}	5.03×10^{-2}	1.92×10^{-2}	9.60×10^{-3}	7.04×10^{-2}	1.33×10^{-2}	7.64×10^{-2}	3.82×10^{-2}
SVR	25	1.13×10^{-1}	7.28×10^{-2}	2.25×10^{-2}	1.45×10^{-2}	7.14×10^{-2}	1.43×10^{-2}	9.59×10^{-2}	6.17×10^{-2}
	25L	9.14×10^{-2}	5.88×10^{-2}	1.85×10^{-2}	1.19×10^{-2}	5.80×10^{-2}	1.17×10^{-2}	9.59×10^{-2}	6.17×10^{-2}
	30	1.01×10^{-1}	6.50×10^{-2}	1.89×10^{-2}	1.21×10^{-2}	6.36×10^{-2}	1.19×10^{-2}	8.45×10^{-2}	5.43×10^{-2}
	30L	7.56×10^{-2}	4.86×10^{-2}	1.57×10^{-2}	1.01×10^{-2}	4.79×10^{-2}	1.00×10^{-2}	8.45×10^{-2}	5.43×10^{-2}
	35	9.19×10^{-2}	5.91×10^{-2}	1.68×10^{-2}	1.08×10^{-2}	5.77×10^{-2}	1.06×10^{-2}	7.08×10^{-2}	4.55×10^{-2}
	35L	6.80×10^{-2}	4.37×10^{-2}	1.39×10^{-2}	8.97×10^{-3}	4.31×10^{-2}	8.86×10^{-3}	7.08×10^{-2}	4.55×10^{-2}
	45	6.73×10^{-2}	4.33×10^{-2}	1.35×10^{-2}	8.71×10^{-3}	4.25×10^{-2}	8.59×10^{-3}	5.32×10^{-2}	3.42×10^{-2}
	45L	5.40×10^{-2}	3.47×10^{-2}	1.10×10^{-2}	7.09×10^{-3}	3.41×10^{-2}	6.97×10^{-3}	5.30×10^{-2}	3.41×10^{-2}
	55	5.89×10^{-2}	3.79×10^{-2}	1.14×10^{-2}	7.35×10^{-3}	3.72×10^{-2}	7.24×10^{-3}	4.63×10^{-2}	2.98×10^{-2}
	55L	4.55×10^{-2}	2.92×10^{-2}	9.45×10^{-3}	6.08×10^{-3}	2.89×10^{-2}	6.02×10^{-3}	4.63×10^{-2}	2.98×10^{-2}
	65	4.85×10^{-2}	3.12×10^{-2}	1.01×10^{-2}	6.48×10^{-3}	3.06×10^{-2}	6.40×10^{-3}	3.91×10^{-2}	2.51×10^{-2}
	65L	3.58×10^{-2}	2.30×10^{-2}	7.73×10^{-3}	4.97×10^{-3}	2.28×10^{-2}	4.93×10^{-3}	3.91×10^{-2}	2.51×10^{-2}

Model No.		Equivalent factor							
		K_{AR1}	K_{AL1}	K_{AR2}	K_{AL2}	K_{B1}	K_{B2}	K_{CR}	K_{CL}
SVS	25	1.09×10^{-1}	9.14×10^{-2}	2.17×10^{-2}	1.82×10^{-2}	1.00×10^{-1}	2.00×10^{-2}	9.95×10^{-2}	8.35×10^{-2}
	25L	8.82×10^{-2}	7.40×10^{-2}	1.78×10^{-2}	1.50×10^{-2}	8.13×10^{-2}	1.64×10^{-2}	9.95×10^{-2}	8.35×10^{-2}
	30	9.71×10^{-2}	8.15×10^{-2}	1.82×10^{-2}	1.52×10^{-2}	8.95×10^{-2}	1.67×10^{-2}	8.78×10^{-2}	7.37×10^{-2}
	30L	7.29×10^{-2}	6.11×10^{-2}	1.51×10^{-2}	1.27×10^{-2}	6.72×10^{-2}	1.39×10^{-2}	8.78×10^{-2}	7.37×10^{-2}
	35	8.84×10^{-2}	7.42×10^{-2}	1.61×10^{-2}	1.35×10^{-2}	8.14×10^{-2}	1.48×10^{-2}	7.36×10^{-2}	6.17×10^{-2}
	35L	6.56×10^{-2}	5.50×10^{-2}	1.34×10^{-2}	1.13×10^{-2}	6.04×10^{-2}	1.24×10^{-2}	7.36×10^{-2}	6.17×10^{-2}
	45	6.48×10^{-2}	5.44×10^{-2}	1.30×10^{-2}	1.09×10^{-2}	5.98×10^{-2}	1.20×10^{-2}	5.45×10^{-2}	4.57×10^{-2}
	45L	5.22×10^{-2}	4.38×10^{-2}	1.07×10^{-2}	8.94×10^{-3}	4.81×10^{-2}	9.81×10^{-3}	5.44×10^{-2}	4.56×10^{-2}
	55	5.67×10^{-2}	4.76×10^{-2}	1.10×10^{-2}	9.24×10^{-3}	5.23×10^{-2}	1.01×10^{-2}	4.78×10^{-2}	4.01×10^{-2}
	55L	4.39×10^{-2}	3.68×10^{-2}	9.12×10^{-3}	7.65×10^{-3}	4.05×10^{-2}	8.40×10^{-3}	4.78×10^{-2}	4.01×10^{-2}
	65	4.67×10^{-2}	3.92×10^{-2}	9.72×10^{-3}	8.15×10^{-3}	4.30×10^{-2}	8.95×10^{-3}	4.04×10^{-2}	3.39×10^{-2}
	65L	3.46×10^{-2}	2.90×10^{-2}	7.46×10^{-3}	6.26×10^{-3}	3.19×10^{-2}	6.88×10^{-3}	4.04×10^{-2}	3.39×10^{-2}
SHW	12	2.48×10^{-1}		4.69×10^{-2}		2.48×10^{-1}	4.69×10^{-2}	1.40×10^{-1}	
	12HR	1.70×10^{-1}		3.52×10^{-2}		1.70×10^{-1}	3.52×10^{-2}	1.40×10^{-1}	
	14	1.92×10^{-1}		3.80×10^{-2}		1.92×10^{-1}	3.80×10^{-2}	9.93×10^{-2}	
	17	1.72×10^{-1}		3.41×10^{-2}		1.72×10^{-1}	3.41×10^{-2}	6.21×10^{-2}	
	21	1.59×10^{-1}		2.95×10^{-2}		1.59×10^{-1}	2.95×10^{-2}	5.57×10^{-2}	
	27	1.21×10^{-1}		2.39×10^{-2}		1.21×10^{-1}	2.39×10^{-2}	4.99×10^{-2}	
	35	8.15×10^{-2}		1.64×10^{-2}		8.15×10^{-2}	1.64×10^{-2}	3.02×10^{-2}	
	50	6.22×10^{-2}		1.24×10^{-2}		6.22×10^{-2}	1.24×10^{-2}	2.30×10^{-2}	
SRS	5M	6.33×10^{-1}		9.20×10^{-2}		6.45×10^{-1}	9.30×10^{-2}	3.85×10^{-1}	
	5GM	6.71×10^{-1}		9.15×10^{-2}		6.66×10^{-1}	9.08×10^{-2}	3.85×10^{-1}	
	5N	5.23×10^{-1}		7.87×10^{-2}		5.32×10^{-1}	7.99×10^{-2}	3.86×10^{-1}	
	5GN	5.25×10^{-1}		7.97×10^{-2}		5.33×10^{-1}	8.12×10^{-2}	3.84×10^{-1}	
	5WM	4.48×10^{-1}		7.30×10^{-2}		4.56×10^{-1}	7.40×10^{-2}	1.96×10^{-1}	
	5WGM	4.58×10^{-1}		7.39×10^{-2}		4.54×10^{-1}	7.34×10^{-2}	1.96×10^{-1}	
	5WN	3.31×10^{-1}		5.93×10^{-2}		3.36×10^{-1}	6.02×10^{-2}	1.96×10^{-1}	
	5WGN	3.31×10^{-1}		5.97×10^{-2}		3.35×10^{-1}	6.05×10^{-2}	1.96×10^{-1}	
	7S	6.03×10^{-1}		7.65×10^{-2}		6.27×10^{-1}	7.91×10^{-2}	2.58×10^{-1}	
	7GS	5.92×10^{-1}		7.89×10^{-2}		6.14×10^{-1}	8.17×10^{-2}	2.58×10^{-1}	
	7M	4.19×10^{-1}		6.76×10^{-2}		4.18×10^{-1}	6.94×10^{-2}	2.58×10^{-1}	
	7GM	4.27×10^{-1}		6.04×10^{-2}		4.43×10^{-1}	6.23×10^{-2}	2.34×10^{-1}	
	7N	2.97×10^{-1}		5.35×10^{-2}		3.07×10^{-1}	5.50×10^{-2}	2.58×10^{-1}	
	7GN	3.11×10^{-1}		5.35×10^{-2}		3.20×10^{-1}	5.51×10^{-2}	2.58×10^{-1}	
	7WS	4.67×10^{-1}		6.89×10^{-2}		4.84×10^{-1}	7.08×10^{-2}	1.36×10^{-1}	
	7WGS	5.23×10^{-1}		6.75×10^{-2}		5.43×10^{-1}	6.95×10^{-2}	1.36×10^{-1}	
	7WM	3.01×10^{-1}		5.32×10^{-2}		3.00×10^{-1}	5.46×10^{-2}	1.36×10^{-1}	
	7WGM	2.83×10^{-1}		4.87×10^{-2}		2.93×10^{-1}	5.02×10^{-2}	1.24×10^{-1}	
	7WN	2.19×10^{-1}		4.16×10^{-2}		2.24×10^{-1}	4.28×10^{-2}	1.36×10^{-1}	
	7WGN	2.20×10^{-1}		4.17×10^{-2}		2.27×10^{-1}	4.31×10^{-2}	1.36×10^{-1}	

K_{AR1} : Equivalent factor in the M_A radial direction when one LM block is used
K_{AL1} : Equivalent factor in the M_A reverse radial direction when one LM block is used
K_{AR2} : Equivalent factor in the M_A radial direction when two LM blocks are used in close contact with each other
K_{AL2} : Equivalent factor in the M_A reverse radial direction when two LM blocks are used in close contact with each other
K_{B1} : M_B Equivalent factor when one LM block is used
K_{B2} : M_B Equivalent factor when two LM blocks are used in close contact with each other
K_{CR} : Equivalent factor in the M_C radial direction
K_{CL} : Equivalent factor in the M_C reverse radial direction

Table2 Equivalent Factors (Models SRS, SCR, EPF and HSR)

Model No.		Equivalent factor							
		K_{AR1}	K_{AL1}	K_{AR2}	K_{AL2}	K_{B1}	K_{B2}	K_{CR}	K_{CL}
SRS	9XS	4.86×10^{-1}		6.89×10^{-2}		5.04×10^{-1}	7.11×10^{-2}	2.17×10^{-1}	
	9XGS	5.37×10^{-1}		6.77×10^{-2}		5.57×10^{-1}	7.00×10^{-2}	2.17×10^{-1}	
	9XM	2.95×10^{-1}		5.27×10^{-2}		3.06×10^{-1}	5.43×10^{-2}	2.17×10^{-1}	
	9XGM	3.10×10^{-1}		5.28×10^{-2}		3.19×10^{-1}	5.44×10^{-2}	2.17×10^{-1}	
	9XN	2.13×10^{-1}		4.12×10^{-2}		2.19×10^{-1}	4.23×10^{-2}	2.17×10^{-1}	
	9XGN	2.18×10^{-1}		4.14×10^{-2}		2.24×10^{-1}	4.27×10^{-2}	2.17×10^{-1}	
	9WS	4.10×10^{-1}		5.73×10^{-2}		4.25×10^{-1}	5.63×10^{-2}	1.06×10^{-1}	
	9WGS	4.16×10^{-1}		5.80×10^{-2}		4.30×10^{-1}	5.98×10^{-2}	1.06×10^{-1}	
	9WM	2.37×10^{-1}		4.25×10^{-2}		2.44×10^{-1}	4.37×10^{-2}	1.06×10^{-1}	
	9WGM	2.41×10^{-1}		4.80×10^{-2}		2.41×10^{-1}	4.13×10^{-2}	1.06×10^{-1}	
	9WN	1.74×10^{-1}		3.35×10^{-2}		1.78×10^{-1}	3.44×10^{-2}	1.06×10^{-1}	
	9WGN	1.75×10^{-1}		3.38×10^{-2}		1.73×10^{-1}	3.32×10^{-2}	1.06×10^{-1}	
	12S	4.55×10^{-1}		5.60×10^{-2}		4.55×10^{-1}	5.60×10^{-2}	1.52×10^{-1}	
	12GS	5.04×10^{-1}		5.51×10^{-2}		5.04×10^{-1}	5.51×10^{-2}	1.52×10^{-1}	
	12M	2.94×10^{-1}		4.50×10^{-2}		2.94×10^{-1}	4.50×10^{-2}	1.53×10^{-1}	
	12GM	2.93×10^{-1}		4.49×10^{-2}		2.93×10^{-1}	4.49×10^{-2}	1.53×10^{-1}	
	12N	1.86×10^{-1}		3.51×10^{-2}		1.86×10^{-1}	3.51×10^{-2}	1.53×10^{-1}	
	12GN	1.96×10^{-1}		3.50×10^{-2}		1.96×10^{-1}	3.50×10^{-2}	1.53×10^{-1}	
	12WS	3.22×10^{-1}		5.00×10^{-2}		3.22×10^{-1}	5.00×10^{-2}	7.97×10^{-2}	
	12WGS	3.32×10^{-1}		5.07×10^{-2}		3.32×10^{-1}	5.07×10^{-2}	7.97×10^{-2}	
	12WM	2.00×10^{-1}		3.69×10^{-2}		2.00×10^{-1}	3.69×10^{-2}	7.97×10^{-2}	
	12WGM	2.07×10^{-1}		3.64×10^{-2}		2.07×10^{-1}	3.64×10^{-2}	7.96×10^{-2}	
	12WN	1.44×10^{-1}		2.83×10^{-2}		1.44×10^{-1}	2.83×10^{-2}	7.97×10^{-2}	
	12WGN	1.46×10^{-1}		2.85×10^{-2}		1.46×10^{-1}	2.85×10^{-2}	7.95×10^{-2}	
	15S	3.56×10^{-1}		4.38×10^{-2}		3.56×10^{-1}	4.38×10^{-2}	1.41×10^{-1}	
	15GS	3.37×10^{-1}		4.57×10^{-2}		3.37×10^{-1}	4.57×10^{-2}	1.41×10^{-1}	
	15M	2.17×10^{-1}		3.69×10^{-2}		2.17×10^{-1}	3.69×10^{-2}	1.41×10^{-1}	
	15GM	2.31×10^{-1}		3.61×10^{-2}		2.31×10^{-1}	3.61×10^{-2}	1.41×10^{-1}	
	15N	1.43×10^{-1}		2.73×10^{-2}		1.43×10^{-1}	2.73×10^{-2}	1.41×10^{-1}	
	15GN	1.45×10^{-1}		2.75×10^{-2}		1.45×10^{-1}	2.75×10^{-2}	1.41×10^{-1}	
	15WS	2.34×10^{-1}		3.76×10^{-2}		2.34×10^{-1}	3.76×10^{-2}	4.83×10^{-2}	
	15WGS	2.34×10^{-1}		3.81×10^{-2}		2.34×10^{-1}	3.81×10^{-2}	4.84×10^{-2}	
	15WM	1.67×10^{-1}		2.94×10^{-2}		1.67×10^{-1}	2.94×10^{-2}	4.83×10^{-2}	
	15WGM	1.63×10^{-1}		2.93×10^{-2}		1.63×10^{-1}	2.93×10^{-2}	4.83×10^{-2}	
	15WN	1.13×10^{-1}		2.27×10^{-2}		1.13×10^{-1}	2.27×10^{-2}	4.83×10^{-2}	
	15WGN	1.15×10^{-1}		2.28×10^{-2}		1.15×10^{-1}	2.28×10^{-2}	4.83×10^{-2}	
	20M	1.80×10^{-1}		3.30×10^{-2}		1.86×10^{-1}	3.41×10^{-2}	9.34×10^{-2}	
	20GM	2.10×10^{-1}		3.88×10^{-2}		2.10×10^{-1}	3.87×10^{-2}	1.03×10^{-1}	
	25M	1.14×10^{-1}		2.17×10^{-2}		1.14×10^{-1}	2.17×10^{-2}	8.13×10^{-2}	
	25GM	1.23×10^{-1}		2.32×10^{-2}		1.23×10^{-1}	2.32×10^{-2}	8.75×10^{-2}	

Model No.		Equivalent factor							
		K_{AR1}	K_{AL1}	K_{AR2}	K_{AL2}	K_{B1}	K_{B2}	K_{CR}	K_{CL}
SCR	15S	1.38×10^{-1}		2.69×10^{-2}		1.38×10^{-1}		1.50×10^{-1}	
	20S	1.15×10^{-1}		2.18×10^{-2}		1.15×10^{-1}		1.06×10^{-1}	
	20	8.85×10^{-2}		1.79×10^{-2}		8.85×10^{-2}		1.06×10^{-1}	
	25	9.25×10^{-2}		1.90×10^{-2}		9.25×10^{-2}	1.90×10^{-2}	9.29×10^{-2}	
	30	8.47×10^{-2}		1.63×10^{-2}		8.47×10^{-2}	1.63×10^{-2}	7.69×10^{-2}	
	35	6.95×10^{-2}		1.43×10^{-2}		6.95×10^{-2}	1.43×10^{-2}	6.29×10^{-2}	
	45	6.13×10^{-2}		1.24×10^{-2}		6.13×10^{-2}	1.24×10^{-2}	4.69×10^{-2}	
	65	3.87×10^{-2}		7.91×10^{-3}		3.87×10^{-2}	7.91×10^{-3}	3.40×10^{-2}	
EPF	7M	3.55×10^{-1}		—		3.55×10^{-1}		2.86×10^{-1}	
	9M	3.10×10^{-1}		—		3.10×10^{-1}		2.22×10^{-1}	
	12M	2.68×10^{-1}		—		2.68×10^{-1}		1.67×10^{-1}	
	15M	2.00×10^{-1}		—		2.00×10^{-1}		1.34×10^{-1}	
HSR	8	4.39×10^{-1}		6.75×10^{-2}		4.39×10^{-1}	6.75×10^{-2}	2.97×10^{-1}	
	10	3.09×10^{-1}		5.33×10^{-2}		3.09×10^{-1}	5.33×10^{-2}	2.35×10^{-1}	
	12	2.08×10^{-1}		3.74×10^{-2}		2.08×10^{-1}	3.74×10^{-2}	1.91×10^{-1}	
	15	1.66×10^{-1}		2.98×10^{-2}		1.66×10^{-1}	2.98×10^{-2}	1.57×10^{-1}	
	15L	1.18×10^{-1}		2.33×10^{-2}		1.18×10^{-1}	2.33×10^{-2}	1.57×10^{-1}	
	20	1.26×10^{-1}		2.28×10^{-2}		1.26×10^{-1}	2.28×10^{-2}	1.17×10^{-1}	
	20L	9.88×10^{-2}		1.92×10^{-2}		9.88×10^{-2}	1.92×10^{-2}	1.17×10^{-1}	
	25	1.12×10^{-1}		2.02×10^{-2}		1.12×10^{-1}	2.02×10^{-2}	9.96×10^{-2}	
	25L	8.23×10^{-2}		1.70×10^{-2}		8.23×10^{-2}	1.70×10^{-2}	9.96×10^{-2}	
	30	8.97×10^{-2}		1.73×10^{-2}		8.97×10^{-2}	1.73×10^{-2}	8.24×10^{-2}	
	30L	7.05×10^{-2}		1.44×10^{-2}		7.05×10^{-2}	1.44×10^{-2}	8.24×10^{-2}	
	35	7.85×10^{-2}		1.56×10^{-2}		7.85×10^{-2}	1.56×10^{-2}	6.69×10^{-2}	
	35L	6.17×10^{-2}		1.29×10^{-2}		6.17×10^{-2}	1.29×10^{-2}	6.69×10^{-2}	
	45	6.73×10^{-2}		1.21×10^{-2}		6.73×10^{-2}	1.21×10^{-2}	5.20×10^{-2}	
	45L	5.22×10^{-2}		1.01×10^{-2}		5.22×10^{-2}	1.01×10^{-2}	5.20×10^{-2}	
	55	5.61×10^{-2}		1.03×10^{-2}		5.61×10^{-2}	1.03×10^{-2}	4.26×10^{-2}	
	55L	4.35×10^{-2}		8.56×10^{-3}		4.35×10^{-2}	8.56×10^{-3}	4.26×10^{-2}	
	65	4.49×10^{-2}		9.13×10^{-3}		4.49×10^{-2}	9.13×10^{-3}	3.68×10^{-2}	
	65L	3.29×10^{-2}		7.08×10^{-3}		3.29×10^{-2}	7.08×10^{-3}	3.68×10^{-2}	
	85	3.49×10^{-2}		6.94×10^{-3}		3.49×10^{-2}	6.94×10^{-3}	2.78×10^{-2}	
	85L	2.74×10^{-2}		5.72×10^{-3}		2.74×10^{-2}	5.72×10^{-3}	2.78×10^{-2}	
	100	2.61×10^{-2}		5.16×10^{-3}		2.61×10^{-2}	5.16×10^{-3}	2.24×10^{-2}	
	120	2.37×10^{-2}		4.72×10^{-3}		2.37×10^{-2}	4.72×10^{-3}	1.96×10^{-2}	
	150	2.17×10^{-2}		4.35×10^{-3}		2.17×10^{-2}	4.35×10^{-3}	1.61×10^{-2}	
	15M2A	1.65×10^{-1}		2.89×10^{-2}		1.65×10^{-1}	2.89×10^{-2}	1.86×10^{-1}	
	20M2A	1.23×10^{-1}		2.23×10^{-2}		1.23×10^{-1}	2.23×10^{-2}	1.34×10^{-1}	
	25M2A	1.10×10^{-1}		1.98×10^{-2}		1.10×10^{-1}	1.98×10^{-2}	1.14×10^{-1}	

K_{AR1} : Equivalent factor in the M_A radial direction when one LM block is used

K_{AL1} : Equivalent factor in the M_A reverse radial direction when one LM block is used

K_{AR2} : Equivalent factor in the M_A radial direction when two LM blocks are used in close contact with each other

K_{AL2} : Equivalent factor in the M_A reverse radial direction when two LM blocks are used in close contact with each other

K_{B1} : M_B Equivalent factor when one LM block is used

K_{B2} : M_B Equivalent factor when two LM blocks are used in close contact with each other

K_{CR} : Equivalent factor in the M_C radial direction

K_{CL} : Equivalent factor in the M_C reverse radial direction

Table3 Equivalent Factors (Models SR, NR-X and NR)

Model No.		Equivalent factor							
		K_{AR1}	K_{AL1}	K_{AR2}	K_{AL2}	K_{B1}	K_{B2}	K_{CR}	K_{CL}
SR	15W (TB)	2.08×10^{-1}	1.04×10^{-1}	3.72×10^{-2}	1.86×10^{-2}	1.46×10^{-1}	2.57×10^{-2}	1.69×10^{-1}	8.43×10^{-2}
	15V (SB)	3.40×10^{-1}	1.70×10^{-1}	5.00×10^{-2}	2.50×10^{-2}	2.34×10^{-1}	3.37×10^{-2}	1.69×10^{-1}	8.43×10^{-2}
	20W (TB)	1.71×10^{-1}	8.56×10^{-2}	3.23×10^{-2}	1.61×10^{-2}	1.20×10^{-1}	2.24×10^{-2}	1.28×10^{-1}	6.40×10^{-2}
	20V (SB)	2.69×10^{-1}	1.34×10^{-1}	4.34×10^{-2}	2.17×10^{-2}	1.86×10^{-1}	2.95×10^{-2}	1.28×10^{-1}	6.39×10^{-2}
	25W (TB)	1.37×10^{-1}	6.85×10^{-2}	2.57×10^{-2}	1.29×10^{-2}	9.61×10^{-2}	1.78×10^{-2}	1.09×10^{-1}	5.47×10^{-2}
	25V (SB)	2.15×10^{-1}	1.08×10^{-1}	3.47×10^{-2}	1.73×10^{-2}	1.49×10^{-1}	2.36×10^{-2}	1.10×10^{-1}	5.48×10^{-2}
	30W (TB)	1.14×10^{-1}	5.71×10^{-2}	2.21×10^{-2}	1.10×10^{-2}	8.01×10^{-2}	1.54×10^{-2}	9.16×10^{-2}	4.58×10^{-2}
	30V (SB)	1.98×10^{-1}	9.92×10^{-2}	2.98×10^{-2}	1.49×10^{-2}	1.37×10^{-1}	2.01×10^{-2}	9.16×10^{-2}	4.58×10^{-2}
	35W (TB)	1.04×10^{-1}	5.21×10^{-2}	1.91×10^{-2}	9.57×10^{-3}	7.30×10^{-2}	1.32×10^{-2}	7.59×10^{-2}	3.80×10^{-2}
	35V (SB)	1.70×10^{-1}	8.50×10^{-2}	2.61×10^{-2}	1.31×10^{-2}	1.17×10^{-1}	1.77×10^{-2}	7.59×10^{-2}	3.80×10^{-2}
	45W (TB)	9.11×10^{-2}	4.56×10^{-2}	1.69×10^{-2}	8.44×10^{-3}	6.38×10^{-2}	1.17×10^{-2}	5.67×10^{-2}	2.83×10^{-2}
	55W (TB)	6.85×10^{-2}	3.42×10^{-2}	1.37×10^{-2}	6.86×10^{-3}	4.80×10^{-2}	9.57×10^{-3}	5.38×10^{-2}	2.69×10^{-2}
	15MSV	4.00×10^{-1}	2.48×10^{-1}	5.89×10^{-2}	3.65×10^{-2}	3.51×10^{-1}	4.98×10^{-2}	2.76×10^{-1}	1.71×10^{-1}
	15MSW	2.43×10^{-1}	1.50×10^{-1}	4.38×10^{-2}	2.72×10^{-2}	2.17×10^{-1}	3.84×10^{-2}	2.74×10^{-1}	1.70×10^{-1}
	20MSV	3.19×10^{-1}	1.97×10^{-1}	5.09×10^{-2}	3.16×10^{-2}	2.77×10^{-1}	4.36×10^{-2}	2.10×10^{-1}	1.30×10^{-1}
	20MSW	1.99×10^{-1}	1.24×10^{-1}	3.77×10^{-2}	2.34×10^{-2}	1.78×10^{-1}	3.33×10^{-2}	2.09×10^{-1}	1.30×10^{-1}
NR-X	25	11.90×10^{-2}	7.64×10^{-2}	2.24×10^{-2}	14.3×10^{-3}	7.47×10^{-2}	1.41×10^{-2}	9.69×10^{-2}	6.2×10^{-2}
	25L	9.18×10^{-2}	5.87×10^{-2}	1.85×10^{-2}	11.8×10^{-3}	5.78×10^{-2}	1.17×10^{-2}	9.69×10^{-2}	6.2×10^{-2}
	30	9.95×10^{-2}	6.37×10^{-2}	1.90×10^{-2}	12.1×10^{-3}	6.23×10^{-2}	1.19×10^{-2}	8.55×10^{-2}	5.47×10^{-2}
	30L	7.65×10^{-2}	4.89×10^{-2}	1.57×10^{-2}	10.0×10^{-3}	4.82×10^{-2}	0.99×10^{-2}	8.55×10^{-2}	5.47×10^{-2}
	35	9.08×10^{-2}	5.81×10^{-2}	1.69×10^{-2}	10.8×10^{-3}	5.67×10^{-2}	1.06×10^{-2}	7.17×10^{-2}	4.59×10^{-2}
	35L	6.88×10^{-2}	4.40×10^{-2}	1.40×10^{-2}	8.9×10^{-3}	4.32×10^{-2}	0.88×10^{-2}	7.17×10^{-2}	4.59×10^{-2}
	45	7.02×10^{-2}	4.50×10^{-2}	1.35×10^{-2}	8.6×10^{-3}	4.37×10^{-2}	0.84×10^{-2}	5.31×10^{-2}	3.4×10^{-2}
	45L	5.25×10^{-2}	3.36×10^{-2}	1.11×10^{-2}	7.1×10^{-3}	3.31×10^{-2}	0.70×10^{-2}	5.32×10^{-2}	3.41×10^{-2}
	55	5.92×10^{-2}	3.79×10^{-2}	1.15×10^{-2}	7.3×10^{-3}	3.72×10^{-2}	0.72×10^{-2}	4.66×10^{-2}	2.98×10^{-2}
	55L	4.66×10^{-2}	2.98×10^{-2}	0.94×10^{-2}	6.0×10^{-3}	2.92×10^{-2}	0.59×10^{-2}	4.65×10^{-2}	2.98×10^{-2}
	65	5.12×10^{-2}	3.28×10^{-2}	1.00×10^{-2}	6.4×10^{-3}	3.21×10^{-2}	0.63×10^{-2}	3.93×10^{-2}	2.52×10^{-2}
	65L	3.66×10^{-2}	2.34×10^{-2}	0.77×10^{-2}	4.9×10^{-3}	2.31×10^{-2}	0.49×10^{-2}	3.93×10^{-2}	2.52×10^{-2}
NR	75	4.21×10^{-2}	2.99×10^{-2}	8.31×10^{-3}	5.90×10^{-3}	3.08×10^{-2}	6.13×10^{-3}	3.16×10^{-2}	2.24×10^{-2}
	75L	3.14×10^{-2}	2.23×10^{-2}	6.74×10^{-3}	4.78×10^{-3}	2.33×10^{-2}	5.04×10^{-3}	3.16×10^{-2}	2.24×10^{-2}
	85	3.70×10^{-2}	2.62×10^{-2}	7.31×10^{-3}	5.19×10^{-3}	2.71×10^{-2}	5.40×10^{-3}	2.80×10^{-2}	1.99×10^{-2}
	85L	2.80×10^{-2}	1.99×10^{-2}	6.07×10^{-3}	4.31×10^{-3}	2.08×10^{-2}	4.55×10^{-3}	2.80×10^{-2}	1.99×10^{-2}
	100	3.05×10^{-2}	2.17×10^{-2}	6.20×10^{-3}	4.41×10^{-3}	2.26×10^{-2}	4.63×10^{-3}	2.38×10^{-2}	1.69×10^{-2}
	100L	2.74×10^{-2}	1.95×10^{-2}	5.46×10^{-3}	3.87×10^{-3}	2.00×10^{-2}	4.00×10^{-3}	2.38×10^{-2}	1.69×10^{-2}

K_{AR1} : Equivalent factor in the M_A radial direction when one LM block is used

K_{AL1} : Equivalent factor in the M_A reverse radial direction when one LM block is used

K_{AR2} : Equivalent factor in the M_A radial direction when two LM blocks are used in close contact with each other

K_{AL2} : Equivalent factor in the M_A reverse radial direction when two LM blocks are used in close contact with each other

K_{B1} : M_B Equivalent factor when one LM block is used

K_{B2} : M_B Equivalent factor when two LM blocks are used in close contact with each other

K_{CR} : Equivalent factor in the M_C radial direction

K_{CL} : Equivalent factor in the M_C reverse radial direction

Table4 Equivalent Factors (Models NRS-X, NRS, HRW and RSR)

Model No.		Equivalent factor							
		K_{AR1}	K_{AL1}	K_{AR2}	K_{AL2}	K_{B1}	K_{B2}	K_{CR}	K_{CL}
NRS-X	25	11.50×10^{-2}	9.66×10^{-2}	2.16×10^{-2}	18.1×10^{-3}	10.57×10^{-2}	1.98×10^{-2}	9.51×10^{-2}	7.99×10^{-2}
	25L	8.85×10^{-2}	7.44×10^{-2}	1.79×10^{-2}	15.0×10^{-3}	8.14×10^{-2}	1.64×10^{-2}	9.51×10^{-2}	7.99×10^{-2}
	30	9.58×10^{-2}	8.05×10^{-2}	1.83×10^{-2}	15.3×10^{-3}	8.81×10^{-2}	1.68×10^{-2}	8.40×10^{-2}	7.05×10^{-2}
	30L	7.38×10^{-2}	6.20×10^{-2}	1.51×10^{-2}	12.7×10^{-3}	6.79×10^{-2}	1.39×10^{-2}	8.40×10^{-2}	7.05×10^{-2}
	35	8.73×10^{-2}	7.33×10^{-2}	1.62×10^{-2}	13.6×10^{-3}	8.03×10^{-2}	1.49×10^{-2}	7.04×10^{-2}	5.91×10^{-2}
	35L	6.63×10^{-2}	5.57×10^{-2}	1.35×10^{-2}	11.3×10^{-3}	6.10×10^{-2}	1.24×10^{-2}	7.04×10^{-2}	5.91×10^{-2}
	45	6.78×10^{-2}	5.69×10^{-2}	1.30×10^{-2}	10.9×10^{-3}	6.23×10^{-2}	1.19×10^{-2}	5.22×10^{-2}	4.39×10^{-2}
	45L	5.07×10^{-2}	4.26×10^{-2}	1.07×10^{-2}	9.0×10^{-3}	4.66×10^{-2}	0.99×10^{-2}	5.22×10^{-2}	4.39×10^{-2}
	55	5.71×10^{-2}	4.79×10^{-2}	1.10×10^{-2}	9.3×10^{-3}	5.25×10^{-2}	1.01×10^{-2}	4.58×10^{-2}	3.84×10^{-2}
	55L	4.50×10^{-2}	3.78×10^{-2}	0.91×10^{-2}	7.7×10^{-3}	4.14×10^{-2}	0.84×10^{-2}	4.57×10^{-2}	3.84×10^{-2}
	65	4.93×10^{-2}	4.14×10^{-2}	0.97×10^{-2}	8.1×10^{-3}	4.53×10^{-2}	0.89×10^{-2}	3.86×10^{-2}	3.25×10^{-2}
	65L	3.54×10^{-2}	2.97×10^{-2}	0.75×10^{-2}	6.3×10^{-3}	3.25×10^{-2}	0.69×10^{-2}	3.86×10^{-2}	3.25×10^{-2}
NRS	75	4.05×10^{-2}		8.01×10^{-3}		4.05×10^{-2}	8.01×10^{-3}	3.20×10^{-2}	
	75L	3.03×10^{-2}		6.50×10^{-3}		3.03×10^{-2}	6.50×10^{-3}	3.20×10^{-2}	
	85	3.56×10^{-2}		7.05×10^{-3}		3.56×10^{-2}	7.05×10^{-3}	2.83×10^{-2}	
	85L	2.70×10^{-2}		5.87×10^{-3}		2.70×10^{-2}	5.87×10^{-3}	2.83×10^{-2}	
	100	2.93×10^{-2}		5.97×10^{-3}		2.93×10^{-2}	5.97×10^{-3}	2.41×10^{-2}	
	100L	2.65×10^{-2}		5.27×10^{-3}		2.65×10^{-2}	5.27×10^{-3}	2.41×10^{-2}	
HRW	12	2.72×10^{-1}	1.93×10^{-1}	5.16×10^{-2}	3.65×10^{-2}	5.47×10^{-1}	1.04×10^{-1}	1.40×10^{-1}	9.92×10^{-2}
	14	2.28×10^{-1}	1.61×10^{-1}	4.16×10^{-2}	2.94×10^{-2}	4.54×10^{-1}	8.28×10^{-2}	1.01×10^{-1}	7.18×10^{-2}
	17	1.96×10^{-1}		3.34×10^{-2}		1.96×10^{-1}	3.34×10^{-2}	6.30×10^{-2}	
	21	1.65×10^{-1}		2.90×10^{-2}		1.65×10^{-1}	2.90×10^{-2}	5.89×10^{-2}	
	27	1.30×10^{-1}		2.34×10^{-2}		1.30×10^{-1}	2.34×10^{-2}	5.11×10^{-2}	
	35	8.69×10^{-2}		1.60×10^{-2}		8.69×10^{-2}	1.60×10^{-2}	3.06×10^{-2}	
	50	6.52×10^{-2}		1.22×10^{-2}		6.52×10^{-2}	1.22×10^{-2}	2.35×10^{-2}	
	60	5.80×10^{-2}		1.08×10^{-2}		5.80×10^{-2}	1.08×10^{-2}	1.77×10^{-2}	
RSR	2N	6.81×10^{-1}		1.28×10^{-1}		6.81×10^{-1}	1.28×10^{-1}	8.69×10^{-1}	
	2WN	5.10×10^{-1}		9.32×10^{-2}		5.10×10^{-1}	9.32×10^{-2}	4.54×10^{-1}	
	3M	9.20×10^{-1}		1.27×10^{-1}		9.20×10^{-1}	1.27×10^{-1}	6.06×10^{-1}	
	3N	6.06×10^{-1}		1.01×10^{-1}		6.06×10^{-1}	1.01×10^{-1}	6.06×10^{-1}	
	3W	7.03×10^{-1}		1.06×10^{-1}		7.03×10^{-1}	1.06×10^{-1}	3.17×10^{-1}	
	3WN	4.76×10^{-1}		8.27×10^{-2}		4.76×10^{-1}	8.27×10^{-2}	3.17×10^{-1}	
	9M1K	3.06×10^{-1}		5.19×10^{-2}		3.06×10^{-1}	5.19×10^{-2}	2.15×10^{-1}	
	9M1N	2.15×10^{-1}		4.08×10^{-2}		2.15×10^{-1}	4.08×10^{-2}	2.15×10^{-1}	
	12M1V	3.52×10^{-1}	2.46×10^{-1}	5.37×10^{-2}	3.76×10^{-2}	2.81×10^{-1}	4.21×10^{-2}	2.09×10^{-1}	1.46×10^{-1}
	12M1N	2.30×10^{-1}	1.61×10^{-1}	4.08×10^{-2}	2.85×10^{-2}	1.85×10^{-1}	3.25×10^{-2}	2.09×10^{-1}	1.46×10^{-1}
	14WV	2.10×10^{-1}	1.47×10^{-1}	3.89×10^{-2}	2.73×10^{-2}	1.69×10^{-1}	3.10×10^{-2}	8.22×10^{-2}	5.75×10^{-2}
	15M1V	2.77×10^{-1}	1.94×10^{-1}	4.38×10^{-2}	3.07×10^{-2}	2.21×10^{-1}	3.45×10^{-2}	1.69×10^{-1}	1.18×10^{-1}
	15M1N	1.70×10^{-1}	1.19×10^{-1}	3.24×10^{-2}	2.27×10^{-2}	1.37×10^{-1}	2.59×10^{-2}	1.69×10^{-1}	1.18×10^{-1}
	15M1WV	1.95×10^{-1}	1.36×10^{-1}	3.52×10^{-2}	2.46×10^{-2}	1.56×10^{-1}	2.80×10^{-2}	5.83×10^{-2}	4.08×10^{-2}
	15M1WN	1.34×10^{-1}	9.41×10^{-2}	2.68×10^{-2}	1.88×10^{-2}	1.09×10^{-1}	2.16×10^{-2}	5.82×10^{-2}	4.08×10^{-2}
	20M1V	1.68×10^{-1}	1.18×10^{-1}	2.92×10^{-2}	2.04×10^{-2}	1.35×10^{-1}	2.32×10^{-2}	1.30×10^{-1}	9.13×10^{-2}
	20M1N	1.20×10^{-1}	8.39×10^{-2}	2.30×10^{-2}	1.61×10^{-2}	9.68×10^{-2}	1.84×10^{-2}	1.30×10^{-1}	9.13×10^{-2}

K_{AR1} : Equivalent factor in the M_A radial direction when one LM block is used

K_{AL1} : Equivalent factor in the M_A reverse radial direction when one LM block is used

K_{AR2} : Equivalent factor in the M_A radial direction when two LM blocks are used in close contact with each other

K_{AL2} : Equivalent factor in the M_A reverse radial direction when two LM blocks are used in close contact with each other

K_{B1} : M_B Equivalent factor when one LM block is used

K_{B2} : M_B Equivalent factor when two LM blocks are used in close contact with each other

K_{CR} : Equivalent factor in the M_C radial direction

K_{CL} : Equivalent factor in the M_C reverse radial direction

Table5 Equivalent Factors (Models HR, GSR, CSR, MX and JR)

Model No.		Equivalent factor							
		K_{AR1}	K_{AL1}	K_{AR2}	K_{AL2}	K_{B1}	K_{B2}	K_{CR}	K_{CL}
HR	918	2.65×10^{-1}		3.58×10^{-2}		2.65×10^{-1}	3.58×10^{-2}	—	—
	1123	2.08×10^{-1}		3.17×10^{-2}		2.08×10^{-1}	3.17×10^{-2}	—	—
	1530	1.56×10^{-1}		2.39×10^{-2}		1.56×10^{-1}	2.39×10^{-2}	—	—
	2042	1.11×10^{-1}		1.80×10^{-2}		1.11×10^{-1}	1.80×10^{-2}	—	—
	2042T	8.64×10^{-2}		1.53×10^{-2}		8.64×10^{-2}	1.53×10^{-2}	—	—
	2555	7.79×10^{-2}		1.38×10^{-2}		7.79×10^{-2}	1.38×10^{-2}	—	—
	2555T	6.13×10^{-2}		1.17×10^{-2}		6.13×10^{-2}	1.17×10^{-2}	—	—
	3065	6.92×10^{-2}		1.15×10^{-2}		6.92×10^{-2}	1.15×10^{-2}	—	—
	3065T	5.45×10^{-2}		9.92×10^{-3}		5.45×10^{-2}	9.92×10^{-3}	—	—
	3575	6.23×10^{-2}		1.08×10^{-2}		6.23×10^{-2}	1.08×10^{-2}	—	—
	3575T	4.90×10^{-2}		9.42×10^{-3}		4.90×10^{-2}	9.42×10^{-3}	—	—
	4085	5.19×10^{-2}		9.53×10^{-3}		5.19×10^{-2}	9.53×10^{-3}	—	—
	4085T	4.09×10^{-2}		7.97×10^{-3}		4.09×10^{-2}	7.97×10^{-3}	—	—
	50105	4.15×10^{-2}		7.40×10^{-3}		4.15×10^{-2}	7.40×10^{-3}	—	—
	50105T	3.27×10^{-2}		6.26×10^{-3}		3.27×10^{-2}	6.26×10^{-3}	—	—
	60125	2.88×10^{-2}		5.18×10^{-3}		2.88×10^{-2}	5.18×10^{-3}	—	—
GSR	15T	1.61×10^{-1}	1.44×10^{-1}	2.88×10^{-2}	2.59×10^{-2}	1.68×10^{-1}	3.01×10^{-2}	—	—
	15V	2.21×10^{-1}	1.99×10^{-1}	3.54×10^{-2}	3.18×10^{-2}	2.30×10^{-1}	3.68×10^{-2}	—	—
	20T	1.28×10^{-1}	1.16×10^{-1}	2.34×10^{-2}	2.10×10^{-2}	1.34×10^{-1}	2.44×10^{-2}	—	—
	20V	1.77×10^{-1}	1.59×10^{-1}	2.87×10^{-2}	2.58×10^{-2}	1.84×10^{-1}	2.99×10^{-2}	—	—
	25T	1.07×10^{-1}	9.63×10^{-2}	1.97×10^{-2}	1.77×10^{-2}	1.12×10^{-1}	2.06×10^{-2}	—	—
	25V	1.47×10^{-1}	1.33×10^{-1}	2.42×10^{-2}	2.18×10^{-2}	1.53×10^{-1}	2.52×10^{-2}	—	—
	30T	9.17×10^{-2}	8.26×10^{-2}	1.68×10^{-2}	1.51×10^{-2}	9.59×10^{-2}	1.76×10^{-2}	—	—
	35T	8.03×10^{-2}	7.22×10^{-2}	1.48×10^{-2}	1.33×10^{-2}	8.39×10^{-2}	1.55×10^{-2}	—	—
CSR	15	1.66×10^{-1}		—		1.66×10^{-1}	—	1.57×10^{-1}	
	20S	1.26×10^{-1}		—		1.26×10^{-1}	—	1.17×10^{-1}	
	20	9.88×10^{-2}		—		9.88×10^{-2}	—	1.17×10^{-1}	
	25S	1.12×10^{-1}		—		1.12×10^{-1}	—	9.96×10^{-2}	
	25	8.23×10^{-2}		—		8.23×10^{-2}	—	9.96×10^{-2}	
	30S	8.97×10^{-2}		—		8.97×10^{-2}	—	8.24×10^{-2}	
	30	7.05×10^{-2}		—		7.05×10^{-2}	—	8.24×10^{-2}	
	35	6.17×10^{-2}		—		6.17×10^{-2}	—	6.69×10^{-2}	
	45	5.22×10^{-2}		—		5.22×10^{-2}	—	5.20×10^{-2}	
MX	5	4.27×10^{-1}		7.01×10^{-2}		4.27×10^{-1}	7.01×10^{-2}	3.85×10^{-1}	
	7W	2.18×10^{-1}		4.13×10^{-2}		2.18×10^{-1}	4.13×10^{-2}	1.40×10^{-1}	
JR	25	1.12×10^{-1}		2.02×10^{-2}		1.12×10^{-1}	2.02×10^{-2}	9.96×10^{-2}	
	35	7.85×10^{-2}		1.56×10^{-2}		7.85×10^{-2}	1.56×10^{-2}	6.69×10^{-2}	
	45	6.73×10^{-2}		1.21×10^{-2}		6.73×10^{-2}	1.21×10^{-2}	5.20×10^{-2}	
	55	5.61×10^{-2}		1.03×10^{-2}		5.61×10^{-2}	1.03×10^{-2}	4.26×10^{-2}	

K_{AR1} : Equivalent factor in the M_A radial direction when one LM block is used
K_{AL1} : Equivalent factor in the M_A reverse radial direction when one LM block is used
K_{AR2} : Equivalent factor in the M_A radial direction when two LM blocks are used in close contact with each other
K_{AL2} : Equivalent factor in the M_A reverse radial direction when two LM blocks are used in close contact with each other

K_{B1} : M_B Equivalent factor when one LM block is used
K_{B2} : M_B Equivalent factor when two LM blocks are used in close contact with each other
K_{CR} : Equivalent factor in the M_C radial direction
K_{CL} : Equivalent factor in the M_C reverse radial direction

Table6 Equivalent Factors (Model NSR, SRG, SRN and SRW)

<table>
<tr><th colspan="2" rowspan="2">Model No.</th><th colspan="8">Equivalent factor</th></tr>
<tr><th>K_{AR1}</th><th>K_{AL1}</th><th>K_{AR2}</th><th>K_{AL2}</th><th>K_{B1}</th><th>K_{B2}</th><th>K_{CR}</th><th>K_{CL}</th></tr>
<tr><td rowspan="6">NSR</td><td>20TBC</td><td colspan="2">2.29×10^{-1}</td><td colspan="2">2.68×10^{-2}</td><td>2.29×10^{-1}</td><td>2.68×10^{-2}</td><td>—</td><td>—</td></tr>
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<tr><td>30TBC</td><td colspan="2">1.85×10^{-1}</td><td colspan="2">1.93×10^{-2}</td><td>1.85×10^{-1}</td><td>1.93×10^{-2}</td><td>—</td><td>—</td></tr>
<tr><td>40TBC</td><td colspan="2">1.39×10^{-1}</td><td colspan="2">1.60×10^{-2}</td><td>1.39×10^{-1}</td><td>1.60×10^{-2}</td><td>—</td><td>—</td></tr>
<tr><td>50TBC</td><td colspan="2">1.24×10^{-1}</td><td colspan="2">1.42×10^{-2}</td><td>1.24×10^{-1}</td><td>1.42×10^{-2}</td><td>—</td><td>—</td></tr>
<tr><td>70TBC</td><td colspan="2">9.99×10^{-2}</td><td colspan="2">1.15×10^{-2}</td><td>9.99×10^{-2}</td><td>1.15×10^{-2}</td><td>—</td><td>—</td></tr>
<tr><td rowspan="21">SRG</td><td>15</td><td colspan="2">1.23×10^{-1}</td><td colspan="2">2.07×10^{-2}</td><td>1.23×10^{-1}</td><td>2.07×10^{-2}</td><td colspan="2">1.04×10^{-1}</td></tr>
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<tr><td>20L</td><td colspan="2">7.21×10^{-2}</td><td colspan="2">1.42×10^{-2}</td><td>7.21×10^{-2}</td><td>1.42×10^{-2}</td><td colspan="2">8.00×10^{-2}</td></tr>
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<tr><td>25L</td><td colspan="2">6.99×10^{-2}</td><td colspan="2">1.31×10^{-2}</td><td>6.99×10^{-2}</td><td>1.31×10^{-2}</td><td colspan="2">7.23×10^{-2}</td></tr>
<tr><td>30</td><td colspan="2">8.06×10^{-2}</td><td colspan="2">1.33×10^{-2}</td><td>8.06×10^{-2}</td><td>1.33×10^{-2}</td><td colspan="2">5.61×10^{-2}</td></tr>
<tr><td>30L</td><td colspan="2">6.12×10^{-2}</td><td colspan="2">1.11×10^{-2}</td><td>6.12×10^{-2}</td><td>1.11×10^{-2}</td><td colspan="2">5.61×10^{-2}</td></tr>
<tr><td>35</td><td colspan="2">7.14×10^{-2}</td><td colspan="2">1.18×10^{-2}</td><td>7.14×10^{-2}</td><td>1.18×10^{-2}</td><td colspan="2">4.98×10^{-2}</td></tr>
<tr><td>35L</td><td colspan="2">5.26×10^{-2}</td><td colspan="2">9.67×10^{-3}</td><td>5.26×10^{-2}</td><td>9.67×10^{-3}</td><td colspan="2">4.98×10^{-2}</td></tr>
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<tr><td>45</td><td colspan="2">5.49×10^{-2}</td><td colspan="2">9.58×10^{-3}</td><td>5.49×10^{-2}</td><td>9.58×10^{-3}</td><td colspan="2">3.85×10^{-2}</td></tr>
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<tr><td>45SL</td><td colspan="2">3.28×10^{-2}</td><td colspan="2">6.56×10^{-3}</td><td>3.28×10^{-2}</td><td>6.56×10^{-3}</td><td colspan="2">3.85×10^{-2}</td></tr>
<tr><td>55</td><td colspan="2">4.56×10^{-2}</td><td colspan="2">8.04×10^{-3}</td><td>4.56×10^{-2}</td><td>8.04×10^{-3}</td><td colspan="2">3.25×10^{-2}</td></tr>
<tr><td>55L</td><td colspan="2">3.37×10^{-2}</td><td colspan="2">6.42×10^{-3}</td><td>3.37×10^{-2}</td><td>6.42×10^{-3}</td><td colspan="2">3.25×10^{-2}</td></tr>
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<tr><td>65</td><td colspan="2">3.54×10^{-2}</td><td colspan="2">6.06×10^{-3}</td><td>3.54×10^{-2}</td><td>6.06×10^{-3}</td><td colspan="2">2.70×10^{-2}</td></tr>
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<tr><td>65SL</td><td colspan="2">1.97×10^{-2}</td><td colspan="2">4.01×10^{-3}</td><td>1.97×10^{-2}</td><td>4.01×10^{-3}</td><td colspan="2">2.70×10^{-2}</td></tr>
<tr><td>85LC</td><td colspan="2">2.19×10^{-2}</td><td colspan="2">4.15×10^{-3}</td><td>2.19×10^{-2}</td><td>4.15×10^{-3}</td><td colspan="2">1.91×10^{-2}</td></tr>
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<tr><td rowspan="7">SRN</td><td>35</td><td colspan="2">7.14×10^{-2}</td><td colspan="2">1.18×10^{-2}</td><td>7.14×10^{-2}</td><td>1.18×10^{-2}</td><td colspan="2">4.98×10^{-2}</td></tr>
<tr><td>35L</td><td colspan="2">5.26×10^{-2}</td><td colspan="2">9.67×10^{-3}</td><td>5.26×10^{-2}</td><td>9.67×10^{-3}</td><td colspan="2">4.98×10^{-2}</td></tr>
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<tr><td>55L</td><td colspan="2">3.37×10^{-2}</td><td colspan="2">6.42×10^{-3}</td><td>3.37×10^{-2}</td><td>6.42×10^{-3}</td><td colspan="2">3.25×10^{-2}</td></tr>
<tr><td>65L</td><td colspan="2">2.63×10^{-2}</td><td colspan="2">4.97×10^{-3}</td><td>2.63×10^{-2}</td><td>4.97×10^{-3}</td><td colspan="2">2.70×10^{-2}</td></tr>
<tr><td rowspan="5">SRW</td><td>70</td><td colspan="2">4.18×10^{-2}</td><td colspan="2">7.93×10^{-3}</td><td>4.18×10^{-2}</td><td>7.93×10^{-3}</td><td colspan="2">2.52×10^{-2}</td></tr>
<tr><td>85</td><td colspan="2">3.37×10^{-2}</td><td colspan="2">6.42×10^{-3}</td><td>3.37×10^{-2}</td><td>6.42×10^{-3}</td><td colspan="2">2.09×10^{-2}</td></tr>
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</table>

K_{AR1} : Equivalent factor in the M_A radial direction when one LM block is used

K_{AL1} : Equivalent factor in the M_A reverse radial direction when one LM block is used

K_{AR2} : Equivalent factor in the M_A radial direction when two LM blocks are used in close contact with each other

K_{AL2} : Equivalent factor in the M_A reverse radial direction when two LM blocks are used in close contact with each other

K_{B1} : M_B Equivalent factor when one LM block is used

K_{B2} : M_B Equivalent factor when two LM blocks are used in close contact with each other

K_{CR} : Equivalent factor in the M_C radial direction

K_{CL} : Equivalent factor in the M_C reverse radial direction

[Double-axis Use]

● Setting Conditions

Set the conditions needed to calculate the LM system's applied load and service life in hours.
The conditions consist of the following items.

(1) Mass: m (kg)
(2) Direction of the working load
(3) Position of the working point (e.g., center of gravity): ℓ_2, ℓ_3, h_1(mm)
(4) Thrust position: ℓ_4, h_2(mm)
(5) LM system arrangement: ℓ_0, ℓ_1(mm)
(No. of units and axes)
(6) Velocity diagram
Speed: V (mm/s)
Time constant: t_n (s)
Acceleration: α_n(mm/s^2)

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

(7) Duty cycle
Number of reciprocations per minute: N_1(min^{-1})
(8) Stroke length: ℓ_s(mm)
(9) Average speed: V_m(m/s)
(10) Required service life in hours: L_h(h)

Gravitational acceleration g=9.8 (m/s^2)

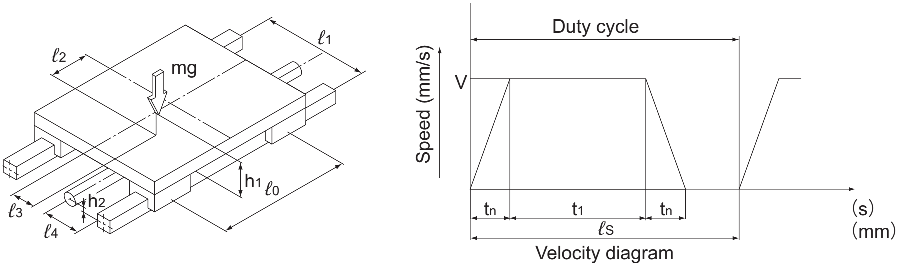


Fig.6 Condition

Applied Load Equation

The load applied to the LM Guide varies with the external force, such as the position of the gravity center of an object, thrust position, inertia generated from acceleration/deceleration during start or stop, and cutting force.

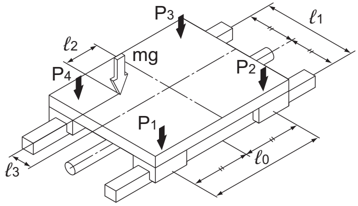
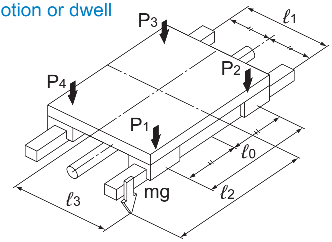
In selecting an LM Guide, it is necessary to obtain the value of the applied load while taking into account these conditions.

Calculate the load applied to the LM Guide in each of the examples 1 to 10 shown below.

m : Mass (kg)
ℓ_n : Distance (mm)
F_n : External force (N)
P_n : Applied load (radial/reverse radial direction) (N)
P_{nT} : Applied load (lateral directions) (N)
g : Gravitational acceleration (m/s^2)
($g = 9.8 m/s^2$)
V : Speed (m/s)
t_n : Time constant (s)
α_n : Acceleration (m/s^2)

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

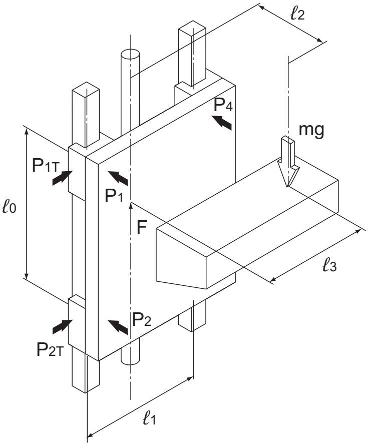
[Example]

	Condition	Applied Load Equation
1	Horizontal mount (with the block traveling) Uniform motion or dwell  	$P_1 = \frac{mg}{4} + \frac{mg \cdot \ell_2}{2 \cdot \ell_0} - \frac{mg \cdot \ell_3}{2 \cdot \ell_1}$ $P_2 = \frac{mg}{4} - \frac{mg \cdot \ell_2}{2 \cdot \ell_0} - \frac{mg \cdot \ell_3}{2 \cdot \ell_1}$ $P_3 = \frac{mg}{4} - \frac{mg \cdot \ell_2}{2 \cdot \ell_0} + \frac{mg \cdot \ell_3}{2 \cdot \ell_1}$ $P_4 = \frac{mg}{4} + \frac{mg \cdot \ell_2}{2 \cdot \ell_0} + \frac{mg \cdot \ell_3}{2 \cdot \ell_1}$
2	Horizontal mount, overhung (with the block traveling) Uniform motion or dwell  	$P_1 = \frac{mg}{4} + \frac{mg \cdot \ell_2}{2 \cdot \ell_0} + \frac{mg \cdot \ell_3}{2 \cdot \ell_1}$ $P_2 = \frac{mg}{4} - \frac{mg \cdot \ell_2}{2 \cdot \ell_0} + \frac{mg \cdot \ell_3}{2 \cdot \ell_1}$ $P_3 = \frac{mg}{4} - \frac{mg \cdot \ell_2}{2 \cdot \ell_0} - \frac{mg \cdot \ell_3}{2 \cdot \ell_1}$ $P_4 = \frac{mg}{4} + \frac{mg \cdot \ell_2}{2 \cdot \ell_0} - \frac{mg \cdot \ell_3}{2 \cdot \ell_1}$

Note) Load is positive in the direction of the arrow.

<table>
<tr><th></th><th>Condition</th><th>Applied Load Equation</th></tr>
<tr><td>3</td><td>

Vertical mount
Uniform motion or dwell



E.g.: Vertical axis of industrial robot, automatic coating machine, lifter

</td><td>

$P_1 = P_4 = -\dfrac{mg \cdot \ell_2}{2 \cdot \ell_0}$

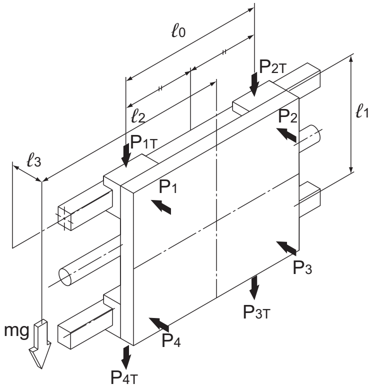
$P_2 = P_3 = \dfrac{mg \cdot \ell_2}{2 \cdot \ell_0}$

$P_{1T} = P_{4T} = \dfrac{mg \cdot \ell_3}{2 \cdot \ell_0}$

$P_{2T} = P_{3T} = -\dfrac{mg \cdot \ell_3}{2 \cdot \ell_0}$

</td></tr>
<tr><td>4</td><td>

Wall mount
Uniform motion or dwell



E.g.: Travel axis of cross-rail loader

</td><td>

$P_1 = P_2 = -\dfrac{mg \cdot \ell_3}{2 \cdot \ell_1}$

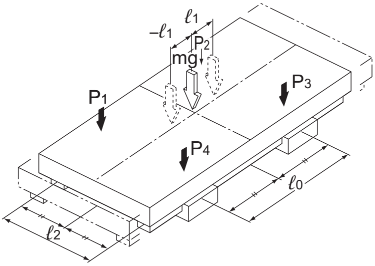
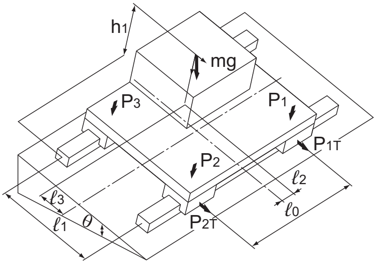
$P_3 = P_4 = \dfrac{mg \cdot \ell_3}{2 \cdot \ell_1}$

$P_{1T} = P_{4T} = \dfrac{mg}{4} + \dfrac{mg \cdot \ell_2}{2 \cdot \ell_0}$

$P_{2T} = P_{3T} = \dfrac{mg}{4} - \dfrac{mg \cdot \ell_2}{2 \cdot \ell_0}$

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

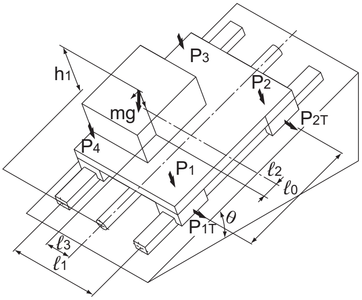
Note) Load is positive in the direction of the arrow.

	Condition	Applied Load Equation
5	**With the LM rails movable Horizontal mount**  E.g.: XY table sliding fork	$P_1 \text{ to } P_4 \text{ (max)} = \frac{mg}{4} + \frac{mg \cdot \ell_1}{2 \cdot \ell_0}$ $P_1 \text{ to } P_4 \text{ (min)} = \frac{mg}{4} - \frac{mg \cdot \ell_1}{2 \cdot \ell_0}$
6	**Laterally tilt mount**  E.g.: NC lathe Carriage	$P_1 = + \frac{mg \cdot \cos\theta}{4} + \frac{mg \cdot \cos\theta \cdot \ell_2}{2 \cdot \ell_0} - \frac{mg \cdot \cos\theta \cdot \ell_3}{2 \cdot \ell_1} + \frac{mg \cdot \sin\theta \cdot h_1}{2 \cdot \ell_1}$ $P_{1T} = \frac{mg \cdot \sin\theta}{4} + \frac{mg \cdot \sin\theta \cdot \ell_2}{2 \cdot \ell_0}$ $P_2 = + \frac{mg \cdot \cos\theta}{4} - \frac{mg \cdot \cos\theta \cdot \ell_2}{2 \cdot \ell_0} - \frac{mg \cdot \cos\theta \cdot \ell_3}{2 \cdot \ell_1} + \frac{mg \cdot \sin\theta \cdot h_1}{2 \cdot \ell_1}$ $P_{2T} = \frac{mg \cdot \sin\theta}{4} - \frac{mg \cdot \sin\theta \cdot \ell_2}{2 \cdot \ell_0}$ $P_3 = + \frac{mg \cdot \cos\theta}{4} - \frac{mg \cdot \cos\theta \cdot \ell_2}{2 \cdot \ell_0} + \frac{mg \cdot \cos\theta \cdot \ell_3}{2 \cdot \ell_1} - \frac{mg \cdot \sin\theta \cdot h_1}{2 \cdot \ell_1}$ $P_{3T} = \frac{mg \cdot \sin\theta}{4} - \frac{mg \cdot \sin\theta \cdot \ell_2}{2 \cdot \ell_0}$ $P_4 = + \frac{mg \cdot \cos\theta}{4} + \frac{mg \cdot \cos\theta \cdot \ell_2}{2 \cdot \ell_0} + \frac{mg \cdot \cos\theta \cdot \ell_3}{2 \cdot \ell_1} - \frac{mg \cdot \sin\theta \cdot h_1}{2 \cdot \ell_1}$ $P_{4T} = \frac{mg \cdot \sin\theta}{4} + \frac{mg \cdot \sin\theta \cdot \ell_2}{2 \cdot \ell_0}$

Note) Load is positive in the direction of the arrow.

<table>
<tr><th></th><th>Condition</th><th>Applied Load Equation</th></tr>
<tr><td>7</td><td>

Longitudinally tilt mount



E.g.: NC lathe
Tool rest

</td><td>

$$P_1 = +\frac{mg\cdot\cos\theta}{4} + \frac{mg\cdot\cos\theta\cdot\ell_2}{2\cdot\ell_0} - \frac{mg\cdot\cos\theta\cdot\ell_3}{2\cdot\ell_1} + \frac{mg\cdot\sin\theta\cdot h_1}{2\cdot\ell_0}$$

$$P_{1T} = +\frac{mg\cdot\sin\theta\cdot\ell_3}{2\cdot\ell_0}$$

$$P_2 = +\frac{mg\cdot\cos\theta}{4} - \frac{mg\cdot\cos\theta\cdot\ell_2}{2\cdot\ell_0} - \frac{mg\cdot\cos\theta\cdot\ell_3}{2\cdot\ell_1} - \frac{mg\cdot\sin\theta\cdot h_1}{2\cdot\ell_0}$$

$$P_{2T} = -\frac{mg\cdot\sin\theta\cdot\ell_3}{2\cdot\ell_0}$$

$$P_3 = +\frac{mg\cdot\cos\theta}{4} - \frac{mg\cdot\cos\theta\cdot\ell_2}{2\cdot\ell_0} + \frac{mg\cdot\cos\theta\cdot\ell_3}{2\cdot\ell_1} - \frac{mg\cdot\sin\theta\cdot h_1}{2\cdot\ell_0}$$

$$P_{3T} = -\frac{mg\cdot\sin\theta\cdot\ell_3}{2\cdot\ell_0}$$

$$P_4 = +\frac{mg\cdot\cos\theta}{4} + \frac{mg\cdot\cos\theta\cdot\ell_2}{2\cdot\ell_0} + \frac{mg\cdot\cos\theta\cdot\ell_3}{2\cdot\ell_1} + \frac{mg\cdot\sin\theta\cdot h_1}{2\cdot\ell_0}$$

$$P_{4T} = +\frac{mg\cdot\sin\theta\cdot\ell_3}{2\cdot\ell_0}$$

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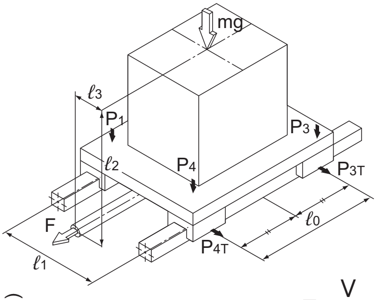
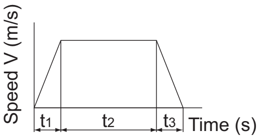
<tr><td>8</td><td>

Horizontal mount with inertia



$$\alpha_n = \frac{V}{t_n}$$



Velocity diagram

E.g.: Conveyance truck

</td><td>

During acceleration

$$P_1 = P_4 = \frac{mg}{4} - \frac{m\cdot\alpha_1\cdot\ell_2}{2\cdot\ell_0}$$

$$P_2 = P_3 = \frac{mg}{4} + \frac{m\cdot\alpha_1\cdot\ell_2}{2\cdot\ell_0}$$

$$P_{1T} = P_{4T} = \frac{m\cdot\alpha_1\cdot\ell_3}{2\cdot\ell_0}$$

$$P_{2T} = P_{3T} = -\frac{m\cdot\alpha_1\cdot\ell_3}{2\cdot\ell_0}$$

During uniform motion

$$P_1 \text{ to } P_4 = \frac{mg}{4}$$

During deceleration

$$P_1 = P_4 = \frac{mg}{4} + \frac{m\cdot\alpha_3\cdot\ell_2}{2\cdot\ell_0}$$

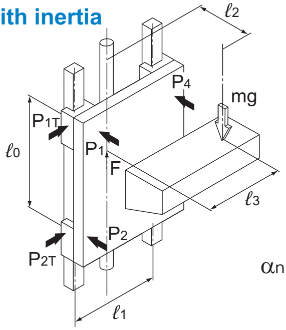
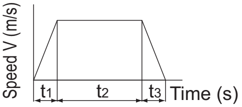
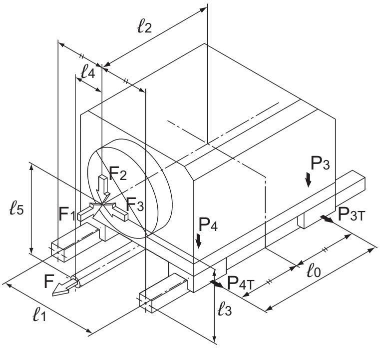
$$P_2 = P_3 = \frac{mg}{4} - \frac{m\cdot\alpha_3\cdot\ell_2}{2\cdot\ell_0}$$

$$P_{1T} = P_{4T} = -\frac{m\cdot\alpha_3\cdot\ell_3}{2\cdot\ell_0}$$

$$P_{2T} = P_{3T} = \frac{m\cdot\alpha_3\cdot\ell_3}{2\cdot\ell_0}$$

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

Note) Load is positive in the direction of the arrow.

	Condition	Applied Load Equation
9	**Vertical mount with inertia**  $\alpha_n = \frac{V}{t_n}$  Velocity diagram E.g.: Conveyance lift	During acceleration $P_1 = P_4 = -\frac{m(g+\alpha_1)\ell_2}{2\cdot\ell_0}$ $P_2 = P_3 = \frac{m(g+\alpha_1)\ell_2}{2\cdot\ell_0}$ $P_{1T} = P_{4T} = \frac{m(g+\alpha_1)\ell_3}{2\cdot\ell_0}$ $P_{2T} = P_{3T} = -\frac{m(g+\alpha_1)\ell_3}{2\cdot\ell_0}$ During uniform motion $P_1 = P_4 = -\frac{mg\cdot\ell_2}{2\cdot\ell_0}$ $P_2 = P_3 = \frac{mg\cdot\ell_2}{2\cdot\ell_0}$ $P_{1T} = P_{4T} = \frac{mg\cdot\ell_3}{2\cdot\ell_0}$ $P_{2T} = P_{3T} = -\frac{mg\cdot\ell_3}{2\cdot\ell_0}$ During deceleration $P_1 = P_4 = -\frac{m(g-\alpha_3)\ell_2}{2\cdot\ell_0}$ $P_2 = P_3 = \frac{m(g-\alpha_3)\ell_2}{2\cdot\ell_0}$ $P_{1T} = P_{4T} = \frac{m(g-\alpha_3)\ell_3}{2\cdot\ell_0}$ $P_{2T} = P_{3T} = -\frac{m(g-\alpha_3)\ell_3}{2\cdot\ell_0}$
10	**Horizontal mount with external force**  E.g.: Drill unit, Milling machine, Lathe, Machining center and other cutting machine	Under force F1 $P_1 = P_4 = -\frac{F_1\cdot\ell_5}{2\cdot\ell_0}$ $P_2 = P_3 = \frac{F_1\cdot\ell_5}{2\cdot\ell_0}$ $P_{1T} = P_{4T} = \frac{F_1\cdot\ell_4}{2\cdot\ell_0}$ $P_{2T} = P_{3T} = -\frac{F_1\cdot\ell_4}{2\cdot\ell_0}$ Under force F2 $P_1 = P_4 = \frac{F_2}{4} + \frac{F_2\cdot\ell_2}{2\cdot\ell_0}$ $P_2 = P_3 = \frac{F_2}{4} - \frac{F_2\cdot\ell_2}{2\cdot\ell_0}$ Under force F3 $P_1 = P_2 = \frac{F_3\cdot\ell_3}{2\cdot\ell_1}$ $P_3 = P_4 = -\frac{F_3\cdot\ell_3}{2\cdot\ell_1}$ $P_{1T} = P_{4T} = -\frac{F_3}{4} - \frac{F_3\cdot\ell_2}{2\cdot\ell_0}$ $P_{2T} = P_{3T} = -\frac{F_3}{4} + \frac{F_3\cdot\ell_2}{2\cdot\ell_0}$

Note) Load is positive in the direction of the arrow.

Calculating the Equivalent Load

Rated Load of an LM Guide in Each Direction

The LM Guide is categorized into roughly two types: the 4-way equal load type, which has the same rated load in the radial, reverse radial and lateral directions, and the radial type, which has a large rated load in the radial direction. With the radial type LM Guide, the rated load in the radial direction is different from that in the reverse radial and lateral directions. The basic load rating in the radial direction is indicated in the specification table. The values in the reverse-radial and lateral directions are obtained from Table7 on **A1-58**.

[Rated Loads in All Directions]

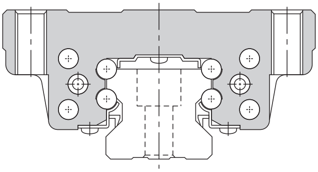
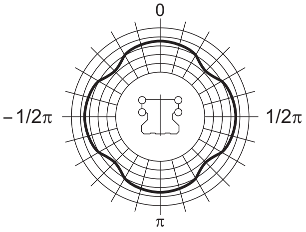
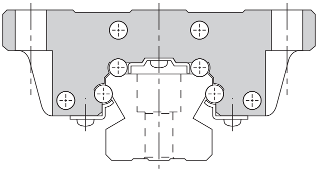
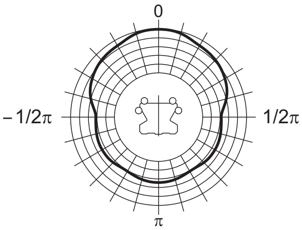
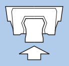
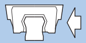
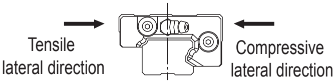
Type	Load Distribution Curve
4-way Equal Load Type 	
Radial Type 	

Table7 Rated Loads in All Directions

Classification	Model No.		Reverse radial direction 		Lateral directions 	
	Type	Size	Dynamic load rating C_L	Static load rating C_{0L}	Dynamic load rating C_T	Static load rating C_{0T}
4-way Equal Load	SHS		C	C_0	C	C_0
	SHW		C	C_0	C	C_0
	SRS	12,15,25	C	C_0	C	C_0
	SCR		C	C_0	C	C_0
	EPF		C	C_0	C	C_0
	HSR		C	C_0	C	C_0
	NRS	75,85,100	C	C_0	C	C_0
	HRW	17,21,27,35,50,60	C	C_0	C	C_0
	RSR	2,3	C	C_0	C	C_0
	CSR		C	C_0	C	C_0
	MX		C	C_0	C	C_0
	JR		C	C_0	C	C_0
	HCR		C	C_0	C	C_0
	HMG		C	C_0	C	C_0
	HSR-M1		C	C_0	C	C_0
	RSR-M1	9	C	C_0	C	C_0
	HSR-M2		C	C_0	C	C_0
	HSR-M1VV		C	C_0	C	C_0
	SRG		C	C_0	C	C_0
	SRN		C	C_0	C	C_0
	SRW		C	C_0	C	C_0
Radial	SSR		0.50C	$0.50C_0$	0.53C	$0.43C_0$
	SVR		0.64C	$0.64C_0$	0.47C	$0.38C_0$
	SR	15,20,25,30,35,45,55,70	0.62C	$0.50C_0$	0.56C	$0.43C_0$
	SR	85,100,120,150	0.78C	$0.71C_0$	0.48C	$0.35C_0$
	NR-X		0.64C	$0.64C_0$	0.47C	$0.38C_0$
	NR	75,85,100	0.78C	$0.71C_0$	0.48C	$0.45C_0$
	HRW	12,14	0.78C	$0.71C_0$	0.48C	$0.35C_0$
	NSR		0.62C	$0.50C_0$	0.56C	$0.43C_0$
	SR-M1		0.62C	$0.50C_0$	0.56C	$0.43C_0$
	SR-MS		—	$0.50F_0$	—	$0.43F_0$
Other	SVS		0.84C	$0.84C_0$	0.92C	$0.85C_0$
	NRS-X		0.84C	$0.84C_0$	0.92C	$0.85C_0$
	SRS	5,7,9,20	C	C_0	1.19C	$1.19C_0$
	RSR	14	0.78C	$0.70C_0$	0.78C	$0.71C_0$
	HR		C	C_0	C	C_0
	GSR		0.93C	$0.90C_0$	(T) 0.84C* (C) 0.93C*	(T) $0.78C_0$* (C) $0.90C_0$*
	GSR-R		0.93C	$0.90C_0$	(T) 0.84C* (C) 0.93C*	(T) $0.78C_0$* (C) $0.90C_0$*
	RSR-M1	12,15,20	0.78C	$0.70C_0$	0.78C	$0.71C_0$

*(T): Tensile lateral direction; (C): Compressive lateral direction

Note) C and C_0 in the table each represent the basic load rating indicated in the specification table of the respective model. F_0 represents the permissible load.
For types with no size indication in the table, the same factor is applied to all sizes.
Models HR, GSR and GSR-R cannot be used in single-axis applications.



[Equivalent Load P_E]

The LM Guide can bear loads and moments in all directions, including a radial load (PR), reverse radial load (PL) and lateral loads (PT), simultaneously.

When two or more loads (e.g., radial load and lateral load) are simultaneously applied to the LM Guide, the service life and the static safety factor are calculated using equivalent load values obtained by converting all the loads into radial load or reverse radial load.

[Equivalent Load Equation]

When the LM block of the LM Guide receives loads simultaneously in the radial and lateral directions, or the reverse radial and lateral directions, the equivalent load is obtained from the equation below.

$$P_E = X \cdot P_{R(L)} + Y \cdot P_T$$

P_E : Equivalent load (N)
·Radial direction
·Reverse radial direction
P_L : Reverse radial load (N)
P_T : Lateral load (N)
X,Y : Equivalent factor (see Table8)

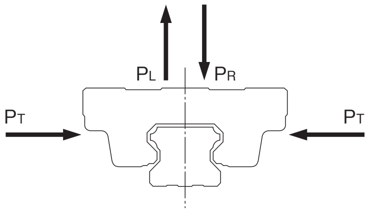
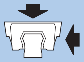
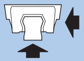


Fig.7 Equivalent of Load of the LM Guide

Table8 Equivalent factor in each direction

Classification	Model No.		If radial and lateral loads are applied simultaneously 		If reverse-radial and lateral loads are applied simultaneously 	
			Equivalent in radial direction 		Equivalent in reverse radial direction 	
	Type	Size	X	Y	X	Y
4-way Equal Load	SHS		1.000	1.000	1.000	1.000
	SHW		1.000	1.000	1.000	1.000
	SRS	12,15,25	1.000	1.000	1.000	1.000
	SCR		1.000	1.000	1.000	1.000
	EPF		1.000	1.000	1.000	1.000
	HSR		1.000	1.000	1.000	1.000
	NRS	75,85,100	1.000	1.000	1.000	1.000
	HRW	17,21,27,35,50,60	1.000	1.000	1.000	1.000
	RSR	2,3	1.000	1.000	1.000	1.000
	CSR		1.000	1.000	1.000	1.000
	MX		1.000	1.000	1.000	1.000
	JR		1.000	1.000	1.000	1.000
	HCR		1.000	1.000	1.000	1.000
	HMG		1.000	1.000	1.000	1.000
	HSR-M1		1.000	1.000	1.000	1.000
	RSR-M1	9	1.000	1.000	1.000	1.000
	HSR-M2		1.000	1.000	1.000	1.000
	HSR-M1VV		1.000	1.000	1.000	1.000
	SRG		1.000	1.000	1.000	1.000
	SRN		1.000	1.000	1.000	1.000
	SRW		1.000	1.000	1.000	1.000
Radial	SSR		—	—	1.000	1.155
	SVR		—	—	1.000	1.678
	SR	15,20,25,30,35,45,55,70	—	—	1.000	1.155
	SR	85,100,120,150	—	—	1.000	2.000
	NR-X		—	—	1.000	1.678
	NR	75,85,100	—	—	1.000	2.000
	HRW	12,14	—	—	1.000	2.000
	NSR		—	—	1.000	1.155
	SR-M1		—	—	1.000	1.155
	SR-MS		—	—	1.000	1.155
Other	SVS		1.000	0.935	1.000	1.020
	NRS-X		1.000	0.935	1.000	1.020
	SRS	5,7,9,20	1.000	0.839	1.000	0.839
	RSR	14	1.000	0.830	1.000	0.990
	HR		1.000	0.500	1.000	0.500
	GSR		1.000	1.280	1.000	1.000
	GSR-R		1.000	1.280	1.000	1.280
	RSR-M1	12,15,20	1.000	0.830	1.000	0.990

Note) If the radial type LM Guide receives radial and lateral loads simultaneously, study the safety static factor and the rated load in the radial-load and lateral-load directions.
For types with no size indication in the table, the same factor is applied to all sizes.
Models HR, GSR and GSR-R cannot be used in single-axis applications.

Calculating the Static Safety Factor

To calculate a load applied to the LM Guide, the average load required for calculating the service life and the maximum load needed for calculating the static safety factor must be obtained first. In a system subject to frequent starts and stops, placed under cutting forces or under a large moment caused by an overhang load, an excessively large load may apply to the LM Guide. When selecting a model number, make sure that the desired model is capable of receiving the required maximum load (whether stationary or in motion). Table9 shows reference values for the static safety factor.

Table9 Reference Values for the Static Safety Factor (f_S)

Machine using the LM Guide	Load conditions	Lower limit of f_S
General industrial machinery	Without vibration or impact	1.0 to 3.5
	With vibration or impact	2.0 to 5.0
Machine tool	Without vibration or impact	1.0 to 4.0
	With vibration or impact	2.5 to 7.0

When the radial load is large	$\frac{f_H \cdot f_T \cdot f_C \cdot C_0}{P_R} \geqq f_S$
When the reverse radial load is large	$\frac{f_H \cdot f_T \cdot f_C \cdot C_{0L}}{P_L} \geqq f_S$
When the lateral loads are large	$\frac{f_H \cdot f_T \cdot f_C \cdot C_{0T}}{P_T} \geqq f_S$

f_S : Static safety factor
C_0 : Basic static load rating (radial direction) (N)
C_{0L} : Basic static load rating (reverse-radial direction) (N)
C_{0T} : Basic static load rating (lateral direction) (N)
P_R : Calculated load (radial direction) (N)
P_L : Calculated load (reverse-radial direction) (N)
P_T : Calculated load (lateral direction) (N)
f_H : Hardness factor (see Fig.8 on **A1-66**)
f_T : Temperature factor (see Fig.9 on **A1-66**)
f_C : Contact factor (see Table10 on **A1-66**)

Calculating the Average Load

In cases where the load applied to each LM block fluctuates under different conditions, such as an industrial robot holding a work with its arm as it advances and receding with its arm empty, and a machine tool handling various workpieces, it is necessary to calculate the service life of the LM Block while taking into account such fluctuating loading conditions.
The average load (P_m) is the load under which the service life of the LM Guide is equivalent to that under varying loads applied to the LM blocks.

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

P_m : Average Load (N)
P_n : Varying load (N)
L : Total travel distance (mm)
L_n : Distance traveled under load P_n (mm)
i : Constant determined by rolling element

Note) The above equation or the equation (1) below applies when the rolling elements are balls.

(1) When the load fluctuates stepwise

LM Guide Using Balls (i=3)

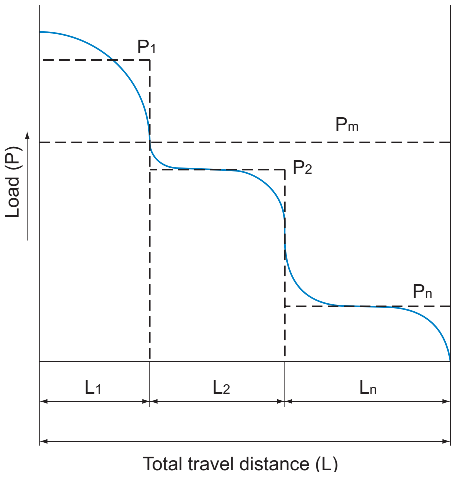
$$P_m = \sqrt[3]{\frac{1}{L}(P_1{}^{3}\cdot L_1 + P_2{}^{3}\cdot L_2 \cdots\cdots + P_n{}^{3}\cdot L_n)} \quad \cdots\cdots\cdots\cdots (1)$$

P_m : Average load (N)
P_n : Varying load (N)
L : Total travel distance (mm)
L_n : Distance traveled under P_n (mm)

LM Guide Using Rollers ($i = \frac{10}{3}$)

$$P_m = \sqrt[\frac{10}{3}]{\frac{1}{L}(P_1{}^{\frac{10}{3}}\cdot L_1 + P_2{}^{\frac{10}{3}}\cdot L_2 \cdots\cdots + P_n{}^{\frac{10}{3}}\cdot L_n)} \quad \cdots\cdots\cdots\cdots (2)$$

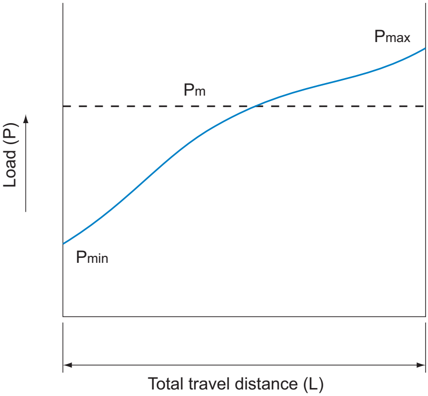
P_m : Average Load (N)
P_n : Varying load (N)
L : Total travel distance (mm)
L_n : Distance traveled under P_n (mm)



(2) When the load fluctuates monotonically

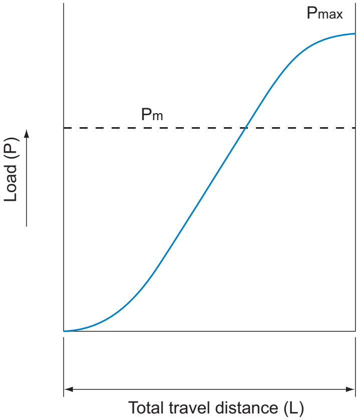
$$P_m \fallingdotseq \frac{1}{3}\left(P_{min} + 2 \cdot P_{max}\right) \cdots\cdots\cdots\cdots(3)$$

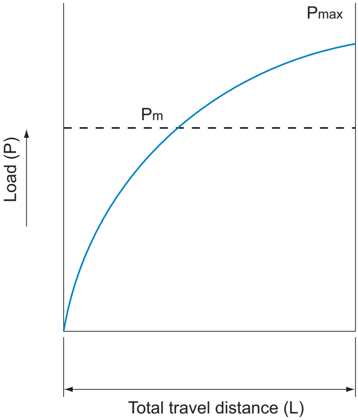
P_{min} : Minimum load (N)
P_{max} : Maximum load (N)



(3) When the load fluctuates sinusoidally

(a) $P_m \fallingdotseq 0.65P_{max} \cdots\cdots\cdots\cdots(4)$ (b) $P_m \fallingdotseq 0.75P_{max} \cdots\cdots\cdots\cdots(5)$





Calculating the Nominal Life

The service life of an LM Guide is subject to variations even under the same operational conditions. Therefore, it is necessary to use the nominal life defined below as a reference value for obtaining the service life of the LM Guide. The nominal life means the total travel distance that 90% of a group of units of the same LM Guide model can achieve without flaking (scale-like pieces on the metal surface) after individually running under the same conditions.

Calculating the Nominal Life

The nominal life (L_{10}) is to be calculated by using the basic dynamic load rating (C) and the calculated load acting on the LM Guide (P_C) according to the following formulas, which are to be based on a nominal life of 50 km in case of an LM Guide with balls, or 100 km in case of an LM Guide with rollers.

- LM Guide with balls (Using a basic dynamic load rating that will result in a nominal life of 50 km)

$$L_{10} = \left(\frac{C}{P_C}\right)^3 \times 50 \quad \cdots\cdots\cdots\cdots\cdots(1)$$

L_{10}	: Nominal life	(km)
C	: Basic dynamic load rating	(N)
P_C	: Calculated load	(N)

- LM Guide with rollers (Using a basic dynamic load rating that will result in a nominal life of 100 km)

$$L_{10} = \left(\frac{C}{P_C}\right)^{\frac{10}{3}} \times 100 \quad \cdots\cdots\cdots\cdots(2)$$

*These nominal life formulas may not apply if the length of the stroke is less than or equal to twice the length of the LM block.

When comparing the nominal life (L_{10}), you must take into account whether the basic dynamic load rating was defined based on 50 km or 100 km. Convert the basic dynamic load rating based on ISO 14728-1 as necessary.

ISO-regulated basic dynamic load rating conversion formulas:

- LM Guide with balls

$$C_{100} = \frac{C_{50}}{1.26}$$

- LM Guide with rollers

$$C_{100} = \frac{C_{50}}{1.23}$$

C_{50}	: Basic dynamic load rating such that the nominal life will be 50 km
C_{100}	: Basic dynamic load rating such that the nominal life will be 100 km

Calculating the Nominal Life Accounting for Usage Conditions

During use, an LM Guide may be subjected to vibrations and shocks as well as fluctuating loads, which are difficult to detect. In addition, the surface hardness of the raceways, the operating temperature, and having LM blocks arranged directly behind one another will have a decisive impact on the service life. Taking these factors into account, the modified nominal life (L_{10m}) can be calculated according to the following formulas (3) and (4).

- Modified factor α

$$\alpha = \frac{f_H \cdot f_T \cdot f_C}{f_W}$$

α : Modified factor

f_H : Hardness factor (see Fig.8 on A1-66)

f_T : Temperature factor (see Fig.9 on A1-66)

f_C : Contact factor (see Table10 on A1-66)

f_W : Load factor (see Table11 on A1-67)

- Modified nominal life L_{10m}
  - LM Guide with balls

$$L_{10m} = \left(\alpha \times \frac{C}{P_C}\right)^3 \times 50 \quad \cdots\cdots\cdots\cdots\cdots (3)$$

  - LM Guide with rollers

$$L_{10m} = \left(\alpha \times \frac{C}{P_C}\right)^{\frac{10}{3}} \times 100 \quad \cdots\cdots\cdots\cdots (4)$$

L_{10m} : Modified nominal life (km)

C : Basic dynamic load rating (N)

P_C : Calculated load (N)

Once the nominal life (L_{10}) has been obtained, the service life time can be obtained using the following equation if the stroke length and the number reciprocations are constant.

$$L_h = \frac{L_{10} \times 10^6}{2 \times \ell_S \times n_1 \times 60}$$

L_h : Service life time (h)

ℓ_s : Stroke length (mm)

n_1 : Number of reciprocations per minute (min^{-1})

[f_H: Hardness Factor]

To ensure the achievement of the optimum load capacity of the LM Guide, the raceway hardness must be between 58 and 64 HRC.

If the hardness is lower than this range, the basic dynamic load rating and the basic static load rating decrease. Therefore, it is necessary to multiply each rating by the respective hardness factor (f_H).

Since the LM Guide has sufficient hardness, the f_H value for the LM Guide is normally 1.0 unless otherwise specified.

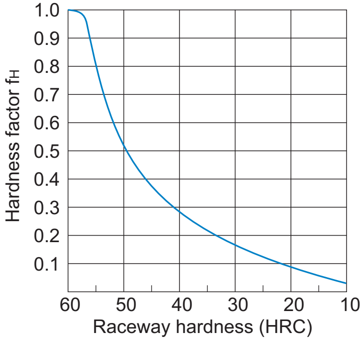


Fig.8 Hardness Factor (f_H)

[f_T:Temperature Factor]

If the temperature of the environment surrounding the operating LM Guide exceeds 100℃, take into account the adverse effect of the high temperature and multiply the basic load ratings by the temperature factor indicated in Fig.9.

In addition, the selected LM Guide must also be of a high temperature type.

Note) LM guides not designed to withstand high temperatures should be used at 80°C or less.Please contact THK if application requirements exceed 80°C.

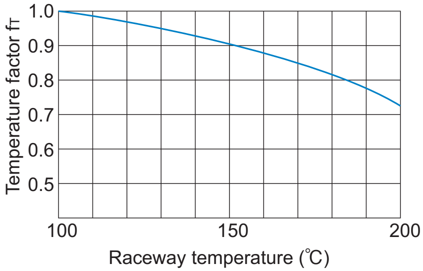


Fig.9 Temperature Factor (f_T)

[f_C: Contact Factor]

When multiple LM blocks are used in close contact with each other, it is difficult to achieve uniform load distribution due to moment loads and mounting-surface accuracy. When using multiple blocks in close contact with each other, multiply the basic load rating (C or C_0) by the corresponding contact factor indicated in Table10.

Note) If uneven load distribution is expected in a large machine, take into account the respective contact factor indicated in Table10.

Table10 Contact Factor (f_C)

Number of blocks used in close contact	Contact factor f_C
2	0.81
3	0.72
4	0.66
5	0.61
6 or more	0.6
Normal use	1

[f_W: Load Factor]

In general, reciprocating machines tend to involve vibrations or impact during operation. It is extremely difficult to accurately determine vibrations generated during high-speed operation and impact during frequent start and stop. 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 Table11, which contains empirically obtained data.

Table11 Load Factor (f_W)

Vibrations/ impact	Speed (V)	f_W
Faint	Very low V≦0.25m/s	1 to 1.2
Weak	low 0.25<V≦1m/s	1.2 to 1.5
Medium	Medium 1<V≦2m/s	1.5 to 2
Strong	High V>2m/s	2 to 3.5

Predicting the Rigidity

Selecting a Radial Clearance (Preload)

Since the radial clearance of an LM Guide greatly affects the running accuracy, load carrying capacity and rigidity of the LM Guide, it is important to select an appropriate clearance according to the application. In general, selecting a negative clearance (i.e., a preload* is applied) while taking into account possible vibrations and impact generated from reciprocating motion favorably affects the service life and the accuracy.

For specific radial clearances, contact THK. We will help you select the optimal clearance according to the conditions.

The clearances of all LM Guide models (except model HR, GSR and GSR-R, which are separate types) are adjusted as specified before shipment, and therefore they do not need further preload adjustment.

*Preload is an internal load applied to the rolling elements (balls, rollers, etc.) of an LM block in advance in order to increase its rigidity.

Table12 Types of Radial Clearance

	Normal Clearance	Clearance C1 (Light Preload)	Clearance C0 (Medium Preload)
Condition	● The loading direction is fixed, impact and vibrations are minimal and 2 rails are installed in parallel. ● Very high precision is not required, and the sliding resistance must be as low as possible.	● An overhang load or moment load is applied. ● LM Guide is used in a single-rail configuration. ● Light load and high accuracy are required.	● High rigidity is required and vibrations and impact are applied. ● Heavy-cutting machine tool
Examples of applications	• Beam-welding machine • Book-binding machin • Automatic packaging machine • XY axes of general industrial machinery • Automatic sash-manufacturing machine • Welding machine • Flame cutting machine • Tool changer • Various kinds of material feeder	• Grinding machine table feed axis • Automatic coating machine • Industrial robot • various kinds of material high speed feeder • NC drilling machine • Vertical axis of general industrial machinery • Printed circuit board drilling machine • Electric discharge machine • Measuring instrument • Precision XY table	• Machining center • NC lathe • Grinding stone feed axis of grinding machine • Milling machine • Vertical/horizontal boring machine • Tool rest guide • Vertical axis of machine tool

Service Life with a Preload Considered

When using an LM Guide under a medium preload (clearance C0), it is necessary to calculate the service life while taking into account the magnitude of the preload.
To identify the appropriate preload for any selected LM Guide model, contact THK.

Rigidity

When a load is applied to an LM Guide, the bearings and LM block will elastically deform within the allowable load range. The ratio of displacement to applied load is referred to as "rigidity." The radial internal clearance (preload) for the LM Guide can be specified in order to reduce displacement.
By using balls larger than the width of the race, they will naturally deform elastically as they roll, allowing the load to be maintained for longer while limiting displacement in the LM Guide.
The effect of the preload can be up to 2.8 times greater than the size of the preload itself. If that level is exceeded, the preload is released and the effect of the preload is lost.
When a preloaded LM Guide takes an external load, the displacement will be linear. The level of displacement will be approximately half that of an LM Guide with no preload.
The preload, in addition to reducing displacement, helps prevent premature failure due to vibration and impact/shock.

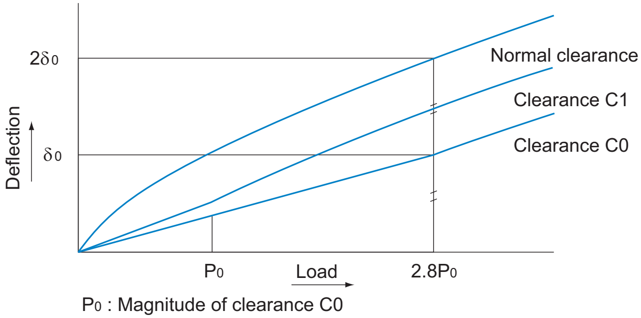
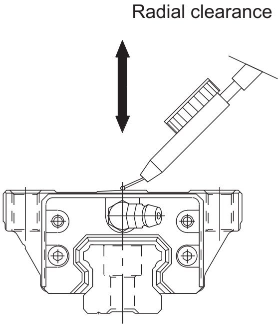


Fig.10 Rigidity Data

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

K	: Rigidity value	(N/μm)
δ	: Deflection	(μm)
P	: Calculated load	(N)

Radial Clearance Standard for Each Model



[Radial clearances for models SHS and SCR]

Unit: μm

Indication symbol	Normal	Light preload	Medium preload
Model No.	No Symbol	C1	C0
15	–5 to 0	–12 to –5	—
20	–6 to 0	–12 to –6	–18 to –12
25	–8 to 0	–14 to –8	–20 to –14
30	–9 to 0	–17 to –9	–27 to –17
35	–11 to 0	–19 to –11	–29 to –19
45	–12 to 0	–22 to –12	–32 to –22
55	–15 to 0	–28 to –16	–38 to –28
65	–18 to 0	–34 to –22	–45 to –34

[Radial clearance for model SSR]

Unit: μm

Indication symbol	Normal	Light preload
Model No.	No Symbol	C1
15	–4 to +2	–10 to –4
20	–5 to +2	–12 to –5
25	–6 to +3	–15 to –6
30	–7 to +4	–18 to –7
35	–8 to +4	–20 to –8

[Radial clearance for models SVR/SVS, NR/NRS-X and NR/NRS]

Unit: μm

Indication symbol	Normal	Light preload	Medium preload
Model No.	No Symbol	C1	C0
25	–3 to +2	–6 to –3	–9 to –6
30	–4 to +2	–8 to –4	–12 to –8
35	–4 to +2	–8 to –4	–12 to –8
45	–5 to +3	–10 to –5	–15 to –10
55	–6 to +3	–11 to –6	–16 to –11
65	–8 to +3	–14 to –8	–20 to –14
75	–10 to +4	–17 to –10	–24 to –17
85	–13 to +4	–20 to –13	–27 to –20
100	–14 to +4	–24 to –14	–34 to –24

[Radial clearance for model SHW]

Unit: μm

Indication symbol	Normal	Light preload	Medium preload
Model No.	No Symbol	C1	C0
12	–1.5 to 0	–4 to –1	—
14	–2 to 0	–5 to –1	—
17	–3 to 0	–7 to –3	—
21	–4 to +2	–8 to –4	—
27	–5 to +2	–11 to –5	—
35	–8 to +4	–18 to –8	–28 to –18
50	–10 to +5	–24 to –10	–38 to –24

[Radial clearance for model SRS]

Unit: μm

Indication symbol	Normal	Light preload
Model No.	No Symbol	C1
5	0 to +1.5	–1 to 0
7	–2 to +2	–3 to 0
9	–2 to +2	–4 to 0
12	–3 to +3	–6 to 0
15	–5 to +5	–10 to 0
20	–5 to +5	–10 to 0
25	–7 to +7	–14 to 0

[Radial clearance for models HSR, CSR, HSR-M1 and HSR-M1VV]

Unit: μm

Indication symbol	Normal	Light preload	Medium preload
Model No.	No Symbol	C1	C0
8	–1 to +1	–4 to –1	—
10	–2 to +2	–5 to –1	—
12	–3 to +3	–6 to –2	—
15	–4 to +2	–12 to –4	—
20	–5 to +2	–14 to –5	–23 to –14
25	–6 to +3	–16 to –6	–26 to –16
30	–7 to +4	–19 to –7	–31 to –19
35	–8 to +4	–22 to –8	–35 to –22
45	–10 to +5	–25 to –10	–40 to –25
55	–12 to +5	–29 to –12	–46 to –29
65	–14 to +7	–32 to –14	–50 to –32
85	–16 to +8	–36 to –16	–56 to –36
100	–19 to +9	–42 to –19	–65 to –42
120	–21 to +10	–47 to –21	–73 to –47
150	–23 to +11	–51 to –23	–79 to –51

[Radial clearances for models SR and SR-M1]

Unit: μm

Indication symbol	Normal	Light preload	Medium preload
Model No.	No Symbol	C1	C0
15	–4 to +2	–10 to –4	—
20	–5 to +2	–12 to –5	–17 to –12
25	–6 to +3	–15 to –6	–21 to –15
30	–7 to +4	–18 to –7	–26 to –18
35	–8 to +4	–20 to –8	–31 to –20
45	–10 to +5	–24 to –10	–36 to –24
55	–12 to +5	–28 to –12	–45 to –28
70	–14 to +7	–32 to –14	–50 to –32
85	–20 to +9	–46 to –20	–70 to –46
100	–22 to +10	–52 to –22	–78 to –52
120	–25 to +12	–57 to –25	–87 to –57
150	–29 to +14	–69 to –29	–104 to –69

[Radial clearance for model HRW]

Unit: μm

Indication symbol	Normal	Light preload	Medium preload
Model No.	No Symbol	C1	C0
12	–1.5 to +1.5	–4 to –1	—
14	–2 to +2	–5 to –1	—
17	–3 to +2	–7 to –3	—
21	–4 to +2	–8 to –4	—
27	–5 to +2	–11 to –5	—
35	–8 to +4	–18 to –8	–28 to –18
50	–10 to +5	–24 to –10	–38 to –24
60	–12 to +5	–27 to –12	–42 to –27

[Radial clearance for models RSR, RSR-W and RSR-M1]

Unit: μm

Indication symbol	Normal	Light preload
Model No.	No Symbol	C1
2	0 to +4	—
3	0 to +1	–0.5 to 0
9	–2 to +2	–4 to 0
12	–3 to +3	–6 to 0
14	–5 to +5	–10 to 0
15	–5 to +5	–10 to 0
20	–7 to +7	–14 to 0

[Radial clearance for model MX]

Unit: μm

Indication symbol	Normal	Light preload
Model No.	No Symbol	C1
5	0 to +1.5	–1 to 0
7	–2 to +2	–3 to 0

[Radial clearance for model JR]

Unit: µm

Indication symbol	Normal
Model No.	No Symbol
25	0 to +30
35	0 to +30
45	0 to +50
55	0 to +50

[Radial clearances for models HCR and HMG]

Unit: µm

Indication symbol	Normal	Light preload
Model No.	No Symbol	C1
12	–3 to +3	–6 to –2
15	–4 to +2	–12 to –4
25	–6 to +3	–16 to –6
35	–8 to +4	–22 to –8
45	–10 to +5	–25 to –10
65	–14 to +7	–32 to –14

[Radial clearance for model NSR-TBC]

Unit: µm

Indication symbol	Normal	Light preload	Medium preload
Model No.	No Symbol	C1	C0
20	–5 to +5	–15 to –5	–25 to –15
25	–5 to +5	–15 to –5	–25 to –15
30	–5 to +5	–15 to –5	–25 to –15
40	–8 to +8	–22 to –8	–36 to –22
50	–8 to +8	–22 to –8	–36 to –22
70	–10 to +10	–26 to –10	–42 to –26

[Radial clearance for model HSR-M2]

Unit: µm

Indication symbol	Normal	Light preload
Model No.	No Symbol	C1
15	–4 to +2	–12 to –4
20	–5 to +2	–14 to –5
25	–6 to +3	–16 to –6

[Radial clearances for models SRG and SRN]

Unit: µm

Indication symbol	Normal	Light preload	Medium preload
Model No.	No Symbol	C1	C0
15	–0.5 to 0	–1 to –0.5	–2 to –1
20	–0.8 to 0	–2 to –0.8	–3 to –2
25	–2 to –1	–3 to –2	–4 to –3
30	–2 to –1	–3 to –2	–4 to –3
35	–2 to –1	–3 to –2	–5 to –3
45	–2 to –1	–3 to –2	–5 to –3
55	–2 to –1	–4 to –2	–6 to –4
65	–3 to –1	–5 to –3	–8 to –5
85	–3 to –1	–7 to –3	–12 to –7
100	–3 to –1	–8 to –3	–13 to –8

[Radial clearance for model SRW]

Unit: µm

Indication symbol	Normal	Light preload	Medium preload
Model No.	No Symbol	C1	C0
70	–2 to –1	–3 to –2	–5 to –3
85	–2 to –1	–4 to –2	–6 to –4
100	–3 to –1	–5 to –3	–8 to –5
130	–3 to –1	–7 to –3	–12 to –7
150	–3 to –1	–8 to –3	–13 to –8

[Radial clearance for model EPF]

Unit: µm

Indication symbol	Normal
Model No.	No Symbol
7M	0 or less
9M	
12M	
15M	

[Radial Clearance for the Oil-Free LM Guide Model SR-MS]

Unit: µm

Indication symbol	Clearance CS
Model No.	
15	–2 to +1
20	–2 to +1

Determining the Accuracy

Accuracy Standards

Accuracy of the LM Guide is specified in terms of running parallelism, dimensional tolerance for height and width, and height and width difference between a pair when 2 or more LM blocks are used on one rail or when 2 or more rails are mounted on the same plane.
For details, see “Accuracy Standard for Each Model” on **A1-75** to **A1-85**.

[Running of Parallelism]

It refers to the tolerance for parallelism between the LM block and the LM rail reference surface when the LM block travels the whole length of the LM rail with the LM rail secured on the reference reference surface using bolts.

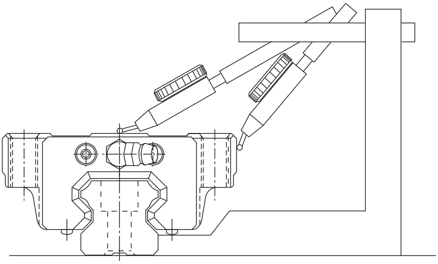


Fig.11 Running of Parallelism

[Difference in Height M]

Indicates a difference between the minimum and maximum values of height (M) of each of the LM blocks used on the same plane in combination.

[Difference in Width W_2]

Indicates a difference between the minimum and maximum values of the width (W_2) between each of the LM blocks, mounted on one LM rail in combination, and the LM rail.

Note 1) When two or more rails are used on the same plane in parallel, only the width (W_2) variation and dimensional tolerance of the master rail apply. Master LM rails will have a serial number ending with “KB” printed on them. However, this is not the case for standard grade products.

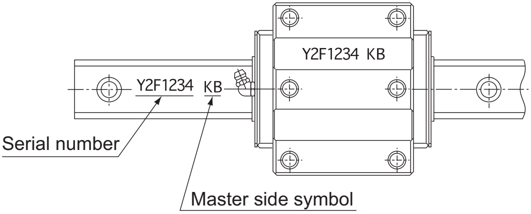


Fig.12 Master LM Rail (E.g. Model HSR-A)

Note 2) Accuracy measurements each represent the average value of the central point or the central area of the LM block.
Note 3) If it is mounted on a less rigid base such as an aluminum base, the curve of the rail will affect the accuracy of the machine. Therefore, it is necessary to define straightness of the rail in advance.

Guidelines for Accuracy Grades by Machine Type

Table13 shows guidelines for selecting an accuracy grade of the LM Guide according to the machine type.

Table13 Guideline for Accuracy Grades by Machine Type

Type of machine		Accuracy grades				
		Normal	H	P	SP	UP
Machine tool	Machining center			●	●	
	Lathe			●	●	
	Milling machine			●	●	
	Boring machine			●	●	
	Jig borer				●	●
	Grinding machine				●	●
	Electric discharge machine			●	●	●
	Punching press		●	●		
	Laser beam machine		●	●	●	
	Woodworking machine	●	●	●		
	NC drilling machine		●	●		
	Tapping center		●	●		
	Palette changer	●				
	ATC	●				
	Wire cutting machine			●	●	
	Dressing machine				●	●
Industrial robot	Cartesian coordinate	●	●	●		
	Cylindrical coordinate	●	●			
Semiconductor manufacturing equipment	Wire bonding machine			●	●	
	Prober				●	●
	Electronic component inserter		●	●		
	Printed circuit board drilling machine		●	●	●	
Other equipment	Injection molding machine	●	●			
	3D measuring instrument				●	●
	Office equipment	●	●			
	Conveyance system	●	●			
	XY table		●	●	●	
	Coating machine	●	●			
	Welding machine	●	●			
	Medical equipment	●	●			
	Digitizer		●	●	●	
	Inspection equipment			●	●	●

Normal : Normal grade
H : High accuracy grade
P : Precision grade
SP : Super precision grade
UP : Ultra precision grade

Accuracy Standard for Each Model

- Accuracies of models SHS, SSR, SVR/SVS, SHW, HSR, SR, NR/NRS-X, NR/NRS, HRW, NSR-TBC, HSR-M1, HSR-M1VV, SR-M1, HSR-M2, SRG and SRN are categorized into Normal grade (no symbol), High accuracy grade (H), Precision grade (P), Super precision grade (SP) and Ultra precision grade (UP) by model numbers, as indicated in Table15 on **A1-76**.

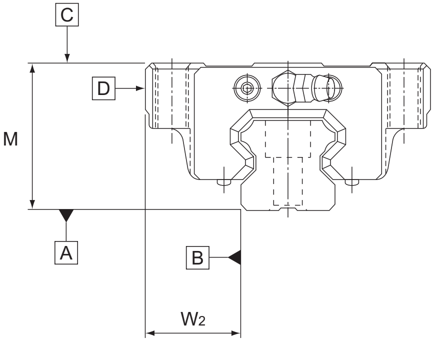


Fig.13

Table14 LM Rail Length and Running Parallelism by Accuracy Standard

Unit: μm

LM rail length (mm)		Running Parallelism Values				
Above	Or less	Normal grade	High-accuracy grade	Precision grade	Super precision grade	Ultra precision grade
—	50	5	3	2	1.5	1
50	80	5	3	2	1.5	1
80	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	11	7	5	3	2
630	800	12	8.5	6	3.5	2
800	1000	13	9	6.5	4	2.5
1000	1250	15	11	7.5	4.5	3
1250	1600	16	12	8	5	4
1600	2000	18	13	8.5	5.5	4.5
2000	2500	20	14	9.5	6	5
2500	3090	21	16	11	6.5	5.5

Table15 Accuracy Standards for Models SHS, SSR, SVR/SVS, SHW, HSR, SR, NR/NRS-X, NR/NRS, HRW, NSR-TBC, HSR-M1, HSR-M1VV, SR-M1, HSR-M2, SRG, and SRN.

Unit: mm

Model No.	Accuracy standards	Normal grade	High-accuracy grade	Precision grade	Super precision grade	Ultra precision grade
	Item	No Symbol	H	P	SP	UP
8 10 12 14	Dimensional tolerance in height M	±0.07	±0.03	±0.015	±0.007	—
	Difference in height M	0.015	0.007	0.005	0.003	—
	Dimensional tolerance in width W_2	±0.04	±0.02	±0.01	±0.007	—
	Difference in width W_2	0.02	0.01	0.006	0.004	—
	Running parallelism of surface C against surface A	ΔC (as shown in Table14 A**1-75**)				
	Running parallelism of surface D against surface B	ΔD (as shown in Table14 A**1-75**)				
15 17 20 21	Dimensional tolerance in height M	±0.07	±0.03	0 −0.03	0 −0.015	0 −0.008
	Difference in height M	0.02	0.01	0.006	0.004	0.003
	Dimensional tolerance in width W_2	±0.06	±0.03	0 −0.02	0 −0.015	0 −0.008
	Difference in width W_2	0.02	0.01	0.006	0.004	0.003
	Running parallelism of surface C against surface A	ΔC (as shown in Table14 A**1-75**)				
	Running parallelism of surface D against surface B	ΔD (as shown in Table14 A**1-75**)				
25 27 30 35	Dimensional tolerance in height M	±0.08	±0.04	0 −0.04	0 −0.02	0 −0.01
	Difference in height M	0.02	0.015	0.007	0.005	0.003
	Dimensional tolerance in width W_2	±0.07	±0.03	0 −0.03	0 −0.015	0 −0.01
	Difference in width W_2	0.025	0.015	0.007	0.005	0.003
	Running parallelism of surface C against surface A	ΔC (as shown in Table14 A**1-75**)				
	Running parallelism of surface D against surface B	ΔD (as shown in Table14 A**1-75**)				
40 45 50 55 60	Dimensional tolerance in height M	±0.08	±0.04	0 −0.05	0 −0.03	0 −0.015
	Difference in height M	0.025	0.015	0.007	0.005	0.003
	Dimensional tolerance in width W_2	±0.07	±0.04	0 −0.04	0 −0.025	0 −0.015
	Difference in width W_2	0.03	0.015	0.007	0.005	0.003
	Running parallelism of surface C against surface A	ΔC (as shown in Table14 A**1-75**)				
	Running parallelism of surface D against surface B	ΔD (as shown in Table14 A**1-75**)				
65 70 75 85 100 120 150	Dimensional tolerance in height M	±0.08	±0.04	0 −0.05	0 −0.04	0 −0.03
	Difference in height M	0.03	0.02	0.01	0.007	0.005
	Dimensional tolerance in width W_2	±0.08	±0.04	0 −0.05	0 −0.04	0 −0.03
	Difference in width W_2	0.03	0.02	0.01	0.007	0.005
	Running parallelism of surface C against surface A	ΔC (as shown in Table14 A**1-75**)				
	Running parallelism of surface D against surface B	ΔD (as shown in Table14 A**1-75**)				

Note1) Models SRG35 to 65 are available in high accuracy grade and above. Other models are only available in precision grade or above. (Normal grade is not available.)

Note2) Model SRN is available in precision grade or above. (Normal and H grade are not available.)

- Accuracies of model HMG are defined by model number as indicated in Table16.

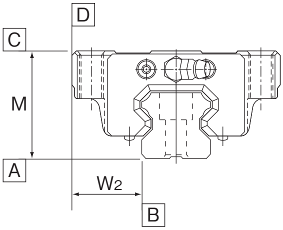


Fig.14

Table16 Model HMG Accuracy Standard

Unit: mm

Model No.	Accuracy Standards Item	Normal grade No symbol
15	Dimensional tolerance in height M	±0.1
	Difference in height M	0.02
	Dimensional tolerance in width W_2	±0.1
	Difference in width W_2	0.02
	Running parallelism of surface C against surface A	ΔC (as shown in Table17)
	Running parallelism of surface D against surface B	ΔD (as shown in Table17)
25 35	Dimensional tolerance in height M	±0.1
	Difference in height M	0.02
	Dimensional tolerance in width W_2	±0.1
	Difference in width W_2	0.03
	Running parallelism of surface C against surface A	ΔC (as shown in Table17)
	Running parallelism of surface D against surface B	ΔD (as shown in Table17)
45 65	Dimensional tolerance in height M	±0.1
	Difference in height M	0.03
	Dimensional tolerance in width W_2	±0.1
	Difference in width W_2	0.03
	Running parallelism of surface C against surface A	ΔC (as shown in Table17)
	Running parallelism of surface D against surface B	ΔD (as shown in Table17)

Table17 LM Rail Length and Running Parallelism by Accuracy Standard

Unit: µm

LM rail length (mm)		Running Parallelism Values
Above	Or less	Normal grade
—	125	30
125	200	37
200	250	40
250	315	44
315	400	49
400	500	53
500	630	58
630	800	64
800	1000	70
1000	1250	77
1250	1600	84
1600	2000	92

- Accuracies of model HCR are categorized into normal and high accuracy grades by model number as indicated in Table18.

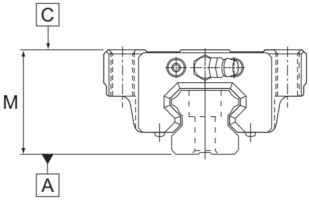


Fig.15

Table18 Accuracy Standard for Model HCR

Unit: mm

Model No.	Accuracy standards	Normal grade	High-accuracy grade
	Item	No Symbol	H
12 15 25 35	Dimensional tolerance in height M	±0.2	±0.2
	Difference in height M	0.05	0.03
	Running parallelism of surface C against surface A	ΔC (as shown in Table19)	
45 65	Dimensional tolerance in height M	±0.2	±0.2
	Difference in height M	0.06	0.04
	Running parallelism of surface C against surface A	ΔC (as shown in Table19)	

Table19 LM Rail Length and Running Parallelism by Accuracy Standard

Unit: µm

LM rail length (mm)		Running Parallelism Values	
Above	Or less	Normal grade	High-accuracy grade
—	125	30	15
125	200	37	18
200	250	40	20
250	315	44	22
315	400	49	24
400	500	53	26
500	630	58	29
630	800	64	32
800	1000	70	35
1000	1250	77	38
1250	1600	84	42
1600	2000	92	46

- Accuracies of model JR are defined by model number as indicated in Table20.

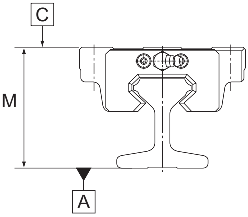


Fig.16

Table20 Accuracy Standard for Model JR

Unit: mm

Model No.	Accuracy standards	Normal grade
	Item	No Symbol
25 35	Difference in height M	0.05
	Running parallelism of surface C against surface A	ΔC (as shown in Table21)
45 55	Difference in height M	0.06
	Running parallelism of surface C against surface A	ΔC (as shown in Table21)

Table21 LM Rail Length and Running Parallelism by Accuracy Standard

Unit: µm

LM rail length (mm)		Running Parallelism Values
Above	Or less	Normal grade
—	50	5
50	80	5
80	125	5
125	200	6
200	250	8
250	315	9
315	400	11
400	500	13
500	630	15
630	800	17
800	1000	19
1000	1250	21
1250	1600	23
1600	2000	26
2000	2500	28
2500	3150	30
3150	4000	33

- Accuracies of models SCR and CSR are categorized into precision, super precision and ultra precision grades by model number as indicated in Table22.

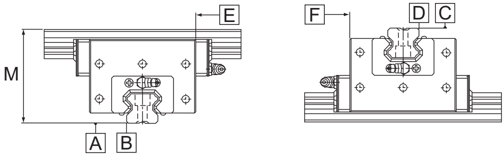


Fig.17

Table22 Accuracy Standard for Models SCR and CSR

Unit: mm

Model No.	Accuracy standards	Precision grade	Super precision grade	Ultra precision grade
	Item	P	SP	UP
15 20	Difference in height M	0.01	0.007	0.005
	Perpendicularity of surface D against surface B	0.005	0.004	0.003
	Running parallelism of surface E against surface B	ΔC (as shown in Table23)		
	Running parallelism of surface F against surface D	ΔD (as shown in Table23)		
25	Difference in height M	0.01	0.007	0.005
	Perpendicularity of surface D against surface B	0.008	0.006	0.004
	Running parallelism of surface E against surface B	ΔC (as shown in Table23)		
	Running parallelism of surface F against surface D	ΔD (as shown in Table23)		
30 35	Difference in height M	0.01	0.007	0.005
	Perpendicularity of surface D against surface B	0.01	0.007	0.005
	Running parallelism of surface E against surface B	ΔC (as shown in Table23)		
	Running parallelism of surface F against surface D	ΔD (as shown in Table23)		
45	Difference in height M	0.012	0.008	0.006
	Perpendicularity of surface D against surface B	0.012	0.008	0.006
	Running parallelism of surface E against surface B	ΔC (as shown in Table23)		
	Running parallelism of surface F against surface D	ΔD (as shown in Table23)		
65	Difference in height M	0.018	0.012	0.009
	Perpendicularity of surface D against surface B	0.018	0.012	0.009
	Running parallelism of surface E against surface B	ΔC (as shown in Table23)		
	Running parallelism of surface F against surface D	ΔD (as shown in Table23)		

Table23 LM Rail Length and Running Parallelism by Accuracy Standard

Unit: µm

LM rail length (mm)		Running Parallelism Values		
Above	Or less	Precision grade	Super precision grade	Ultra precision grade
—	50	2	1.5	1
50	80	2	1.5	1
80	125	2	1.5	1
125	200	2	1.5	1
200	250	2.5	1.5	1
250	315	3	1.5	1
315	400	3.5	2	1.5
400	500	4.5	2.5	1.5
500	630	5	3	2
630	800	6	3.5	2
800	1000	6.5	4	2.5
1000	1250	7.5	4.5	3
1250	1600	8	5	4
1600	2000	8.5	5.5	4.5
2000	2500	9.5	6	5
2500	3090	11	6.5	5.5

- Accuracies of model HR are categorized into normal, high accuracy, precision, super precision and ultra precision grades as indicated in Table24.

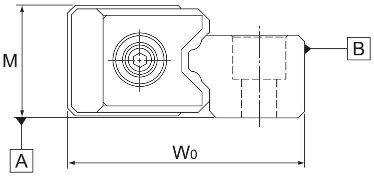


Fig.18

Table24 Accuracy Standard for Model HR

Unit: mm

Accuracy standards	Normal grade	High-accuracy grade	Precision grade	Super precision grade	Ultra precision grade
Item	No Symbol	H	P	SP	UP
Dimensional tolerance in height M	±0.1	±0.05	±0.025	±0.015	±0.01
Difference in height M Note 1)	0.03	0.02	0.01	0.005	0.003
Dimensional tolerance for total width W_0	±0.1		±0.05		
Difference in total width W_0 Note 2)	0.03	0.015	0.01	0.005	0.003
Parallelism of the raceway against surfaces A and B	ΔC (as shown in Table25)				

Note 1) Difference in height M applies to a set of LM Guides used on the same plane.
Note 2) Difference in total width W_0 applies to LM blocks used in combination on one LM rail.
Note 3) In a set of LM Guides, dimensional tolerance and difference in total width W_0 for precision and higher grades apply only to the master rail. The Master LM Guide will have a serial number ending with “KB” printed on it.

Table25 LM Rail Length and Running Parallelism by Accuracy Standard

Unit: µm

LM rail length (mm)		Running Parallelism Values				
Above	Or less	Normal grade	High-accuracy grade	Precision grade	Super precision grade	Ultra precision grade
—	50	5	3	2	1.5	1
50	80	5	3	2	1.5	1
80	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	11	7	5	3	2
630	800	12	8.5	6	3.5	2
800	1000	13	9	6.5	4	2.5
1000	1250	15	11	7.5	4.5	3
1250	1600	16	12	8	5	4
1600	2000	18	13	8.5	5.5	4.5
2000	2500	20	14	9.5	6	5
2500	3000	21	16	11	6.5	5.5

- Accuracies of model GSR are categorized into normal, high accuracy and precision grades by model number as indicated in Table26.

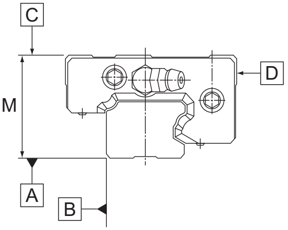


Fig.19

Table26 Accuracy Standard for Model GSR

Unit: mm

Model No.	Accuracy standards	Normal grade	High-accuracy grade	Precision grade
	Item	No Symbol	H	P
15 20	Dimensional tolerance in height M	±0.02		
	Running parallelism of surface C against surface A	ΔC (as shown in Table27)		
	Running parallelism of surface D against surface B	ΔD (as shown in Table27)		
25 30 35	Dimensional tolerance in height M	±0.03		
	Running parallelism of surface C against surface A	ΔC (as shown in Table27)		
	Running parallelism of surface D against surface B	ΔD (as shown in Table27)		

Table27 LM Rail Length and Running Parallelism by Accuracy Standard

Unit: μm

LM rail length (mm)		Running Parallelism Values		
Above	Or less	Normal grade	High-accuracy grade	Precision grade
—	50	5	3	2
50	80	5	3	2
80	125	5	3	2
125	200	5	3.5	2
200	250	6	4	2.5
250	315	7	4.5	3
315	400	8	5	3.5
400	500	9	6	4.5
500	630	11	7	5
630	800	12	8.5	6
800	1000	13	9	6.5
1000	1250	15	11	7.5
1250	1600	16	12	8
1600	2000	18	13	8.5
2000	2500	20	14	9.5
2500	3000	21	16	11

- Accuracies of model GSR-R are categorized into normal and high accuracy grades by model number as indicated in Table28.

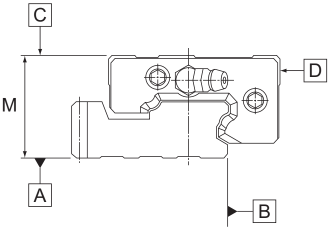


Fig.20

Table28 Accuracy Standard for GSR-R

Unit: mm

Model No.	Accuracy standards	Normal grade	High-accuracy grade
	Item	No Symbol	H
25 30 35	Dimensional tolerance in height M	±0.03	
	Running parallelism of surface C against surface A	ΔC (as shown in Table29)	
	Running parallelism of surface D against surface B	ΔD (as shown in Table29)	

Table29 LM Rail Length and Running Parallelism by Accuracy Standard

Unit: μm

LM rail length (mm)		Running Parallelism Values	
Above	Or less	Normal grade	High-accuracy grade
—	50	5	3
50	80	5	3
80	125	5	3
125	200	5	3.5
200	250	6	4
250	315	7	4.5
315	400	8	5
400	500	9	6
500	630	11	7
630	800	12	8.5
800	1000	13	9
1000	1250	15	11
1250	1600	16	12
1600	2000	18	13

- Accuracies of models SRS, RSR, RSR-M1and RSR-W are categorized into normal, high accuracy and precision grades by model number as indicated in Table30.

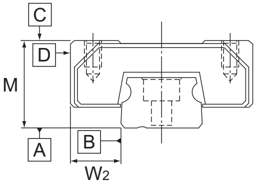


Fig.21

Table30 Accuracy Standards for Models SRS, RSR, RSR-M1 and RSR-W

Unit: mm

Model No.	Accuracy standards	Normal grade	High-accuracy grade	Precision grade
	Item	No Symbol	H	P
3 5	Dimensional tolerance in height M	±0.03	—	±0.015
	Difference in height M	0.015	—	0.005
	Dimensional tolerance in width W_2	±0.03	—	±0.015
	Difference in width W_2	0.015	—	0.005
	Running parallelism of surface C against surface A	ΔC (as shown in Table31)		
	Running parallelism of surface D against surface B	ΔD (as shown in Table31)		
7 9 12 14 15 20 25	Dimensional tolerance in height M	±0.04	±0.02	±0.01
	Difference in height M	0.03	0.015	0.007
	Dimensional tolerance in width W_2	±0.04	±0.025	±0.015
	Difference in width W_2	0.03	0.02	0.01
	Running parallelism of surface C against surface A	ΔC (as shown in Table32)		
	Running parallelism of surface D against surface B	ΔD (as shown in Table32)		

Table31 LM Rail Length and Running Parallelism for Models SRS5, RSR3 and RSR5 by Accuracy Standard

Unit: µm

LM rail length (mm)		Running Parallelism Values	
Above	Or less	Normal grade	Precision grade
—	25	2.5	1.5
25	50	3.5	2
50	100	5.5	3
100	150	7	4
150	200	8.4	5

Table32 LM Rail Length and Running Parallelism for Models SRS7 to 25 and RSR7 to 25 by Accuracy Standard

Unit: µm

LM rail length (mm)		Running Parallelism Values		
Above	Or less	Normal grade	High-accuracy grade	Precision grade
—	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	280	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	520	21	12	4
520	550	22	12	4
550	640	22	13	4
640	670	23	13	4
670	700	23	13	5
700	820	23	14	5
820	850	24	14	5
850	970	24	15	5
970	1030	25	16	5
1030	1150	25	16	6
1150	1330	26	17	6
1330	1420	27	18	6
1420	1510	27	18	7
1510	1830	28	19	7
1830	2000	28	19	8

- Accuracies of model MX are categorized into normal and precision grades by model number as indicated in Table33.

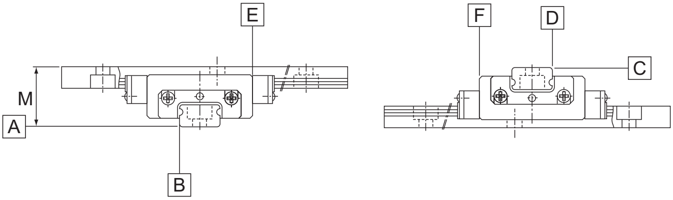


Fig.22

Table33 Accuracy Standard for Model MX

Unit: mm

Model No.	Accuracy standards	Normal grade	Precision grade
	Item	No Symbol	P
5	Difference in height M	0.015	0.005
	Perpendicularity of surface D against surface B	0.003	0.002
	Running parallelism of surface E against surface B	ΔC (as shown in Table34)	
	Running parallelism of surface F against surface D	ΔD (as shown in Table34)	
7	Difference in height M	0.03	0.007
	Perpendicularity of surface D against surface B	0.01	0.005
	Running parallelism of surface E against surface B	ΔC (as shown in Table35)	
	Running parallelism of surface F against surface D	ΔD (as shown in Table35)	

Table34 LM Rail Length and Running Parallelism for Model MX5 by Accuracy Standard

Unit: μm

LM rail length (mm)		Running Parallelism Values	
Above	Or less	Normal grade	Precision grade
—	25	2.5	1.5
25	50	3.5	2
50	100	5.5	3
100	150	7	4
150	200	8.4	5

Table35 LM Rail Length and Running Parallelism for Model MX7 by Accuracy Standard

Unit: μm

LM rail length (mm)		Running Parallelism Values	
Above	Or less	Normal grade	Precision grade
—	40	8	1
40	70	10	1
70	100	11	2
100	130	12	2
130	160	13	2
160	190	14	2
190	220	15	3
220	250	16	3
250	280	17	3
280	310	17	3
310	340	18	3
340	370	18	3
370	400	19	3

- Accuracies of model SRW are categorized into precision, super precision and ultra precision grades by model number as indicated in Table36.

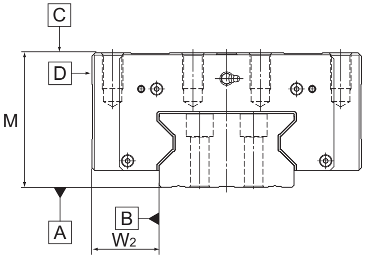


Fig.23

Table36 Accuracy Standard for Model SRW

Unit: mm

Model No.	Accuracy standards	Precision grade	Super precision grade	Ultra precision grade
	Item	P	SP	UP
70 85	Dimensional tolerance in height M	0 –0.05	0 –0.03	0 –0.015
	Difference in height M	0.007	0.005	0.003
	Dimensional tolerance in width W_2	0 –0.04	0 –0.025	0 –0.015
	Difference in width W_2	0.007	0.005	0.003
	Running parallelism of surface C against surface A	ΔC (as shown in Table37)		
	Running parallelism of surface D against surface B	ΔD (as shown in Table37)		
100	Dimensional tolerance in height M	0 –0.05	0 –0.04	0 –0.03
	Difference in height M	0.01	0.007	0.005
	Dimensional tolerance in width W_2	0 –0.05	0 –0.04	0 –0.03
	Difference in width W_2	0.01	0.007	0.005
	Running parallelism of surface C against surface A	ΔC (as shown in Table37)		
	Running parallelism of surface D against surface B	ΔD (as shown in Table37)		
130 150	Dimensional tolerance in height M	0 –0.05	0 –0.04	0 –0.03
	Difference in height M	0.01	0.007	0.005
	Dimensional tolerance in width W_2	0 –0.05	0 –0.04	0 –0.03
	Difference in width W_2	0.01	0.007	0.005
	Running parallelism of surface C against surface A	ΔC (as shown in Table37)		
	Running parallelism of surface D against surface B	ΔD (as shown in Table37)		

Table37 LM Rail Length and Running Parallelism by Accuracy Standard

Unit: μm

LM rail length (mm)		Running Parallelism Values		
Above	Or less	Precision grade	Super precision grade	Ultra precision grade
—	50	2	1.5	1
50	80	2	1.5	1
80	125	2	1.5	1
125	200	2	1.5	1
200	250	2.5	1.5	1
250	315	3	1.5	1
315	400	3.5	2	1.5
400	500	4.5	2.5	1.5
500	630	5	3	2
630	800	6	3.5	2
800	1000	6.5	4	2.5
1000	1250	7.5	4.5	3
1250	1600	8	5	4
1600	2000	8.5	5.5	4.5
2000	2500	9.5	6	5
2500	3090	11	6.5	5.5

- Accuracies of model EPF are categorized into normal, high accuracy and precision grades by model number as indicated in Table38.

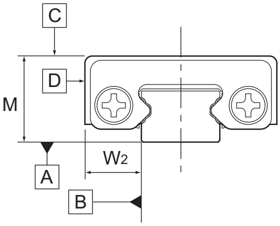


Fig.24

Table38 Accuracy Standard for Model EPF

Unit: mm

Model No.	Accuracy Standards	Normal grade	High-accuracy grade	Precision grade
	Item	No Symbol	H	P
7M 9M 12M 15M	Dimensional tolerance in height M	±0.04	±0.02	±0.01
	Difference in height M	0.03	0.015	0.007
	Dimensional tolerance in width W_2	±0.04	±0.025	±0.015
	Running parallelism of surface C against surface A^Note)	0.008	0.004	0.001
	Running parallelism of surface D against surface B^Note)	0.008	0.004	0.001

Note) If the stroke is more than 40 mm, contact THK.

- Accuracies of model SR-MS are categorized into precision, super precision and ultra precision grades by model number as indicated in Table39.

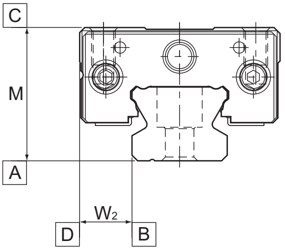


Fig.25

Table39 Accuracy Standard for Model SR-MS

Unit: mm

Model No.	Accuracy Standards	Precision grade	Super precision grade	Ultra precision grade
	Item	P	SP	UP
15 20	Dimensional tolerance in height M	0 −0.03	0 −0.015	0 −0.008
	Difference in Height M	0.006	0.004	0.003
	Dimensional tolerance in width W_2	0 −0.02	0 −0.015	0 −0.008
	Difference in Width W_2	0.006	0.004	0.003
	Running parallelism of surface C against surface A	ΔC (as shown in Table40)		
	Running parallelism of surface D against surface B	ΔD (as shown in Table40)		

Table40 LM Rail Length and Running Parallelism by Accuracy Standard

Unit: μm

LM rail length (mm)		Running Parallelism Values		
Above	Or less	Precision grade	Super precision grade	Ultra precision grade
		P	SP	UP
—	50	2	1.5	1
50	80	2	1.5	1
80	125	2	1.5	1
125	200	2	1.5	1
200	250	2.5	1.5	1
250	315	3	1.5	1
315	400	3.5	2	1.5

LM Guide

Features and Dimensions of Each Model

Structure and Features of the Caged Ball LM Guide

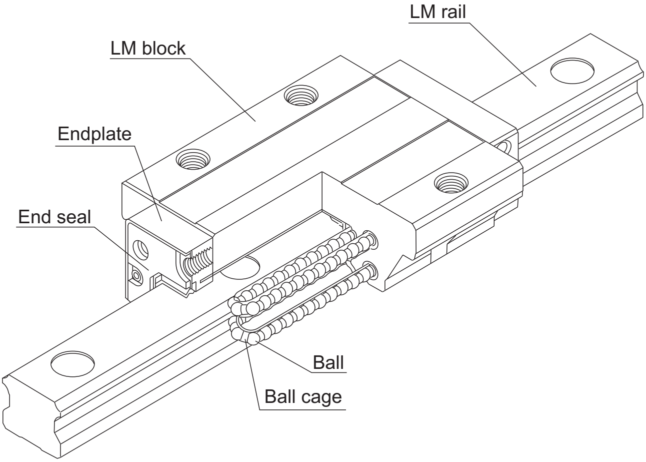


Fig.1 Structural Drawing of the Caged Ball LM Guide Model SHS

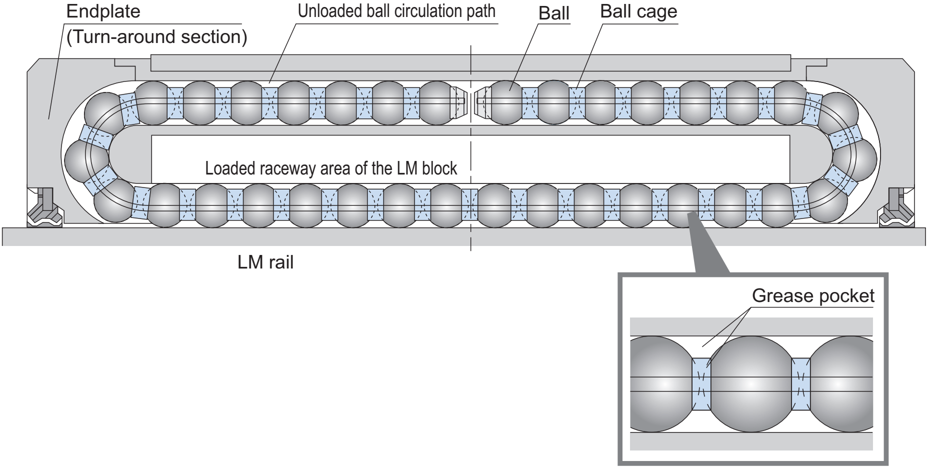


Fig.2 Circulation Structure inside the LM Block of the Caged Ball LM Guide

With the Caged Ball LM Guide, the use of a ball cage allows lines of evenly spaced balls to circulate, thus to eliminate friction between the balls.
In addition, grease held in a space between the ball circulation path and the ball cage (grease pocket) is applied on the contact surface between each ball and the ball cage as the ball rotates, forming an oil film on the ball surface. As a result, an oil film is not easily broken.

Advantages of the Ball Cage Technology

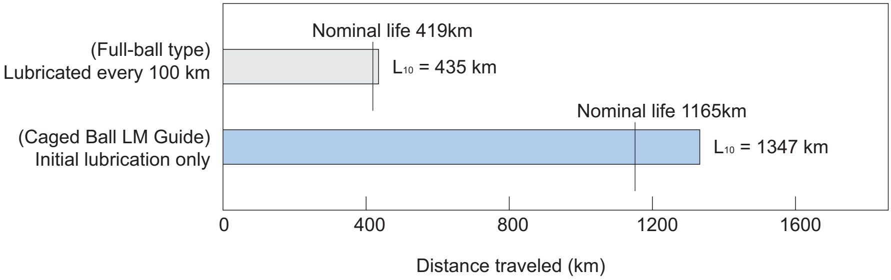
(1) The absence of friction between balls, together with increased grease retention, achieves long service life and long-term maintenance-free (lubrication-free) operation.
(2) The absence of ball-to-ball collision achieves low noise and acceptable running sound.
(3) The absence of friction between balls achieves low heat generation and high speed operation.
(4) The circulation of lines of evenly spaced balls ensures smooth ball rotation.
(5) The absence of friction between balls allows high grease retention and low dust generation.

[Long Service Life and Long-term Maintenance-free Operation]

● Data on Long Service Life and Long-term Maintenance-free Operation

Use of a ball cage eliminates friction between balls and increases grease retention, thus to achieve long service life and long-term maintenance-free operation.

[Condition]
Speed : 60m/min
Stroke : 350mm
Acceleration: 9.8m/s^2
Orientation : horizontal
Load : Caged Ball LM Guide : 11.1kN
Full-ball type : 9.8kN

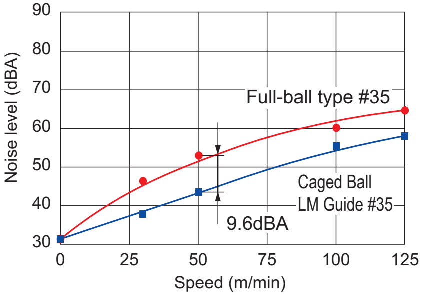


Caged Ball LM Guide and Full-Ball Type Durability Testing Data

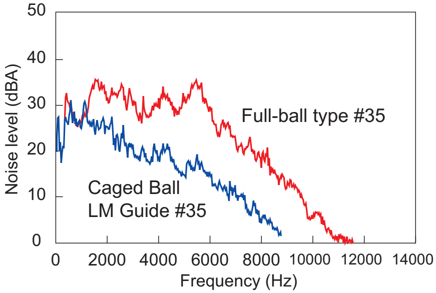
[Low Noise, Acceptable Running Sound]

● Noise Level Data

Since the ball circulation path inside the LM block is made of resin, metallic noise between balls and the LM block is eliminated. In addition, use of a ball cage eliminates metallic noise of ball-to-ball collision, allowing a low noise level to be maintained even at high speed.



Comparison of Noise Levels between
Caged Ball LM Guide #35 and
Full-Ball Type #35



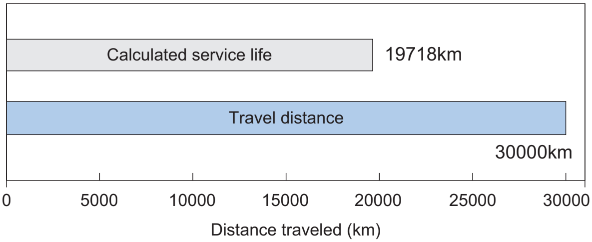
Comparison of Noise Levels between
Caged Ball LM Guide #35 and Full-Ball Type #35
(at speed of 50 m/min)

[High Speed]

● High-speed Durability Test Data

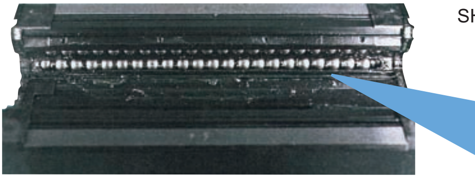
Since use of a ball cage eliminates friction between balls, only a low level of heat is generated and superbly high speed is achieved.

[Condition]
Model No. : Caged Ball LM Guide Model SHS65LVSS
Speed : 200m/min
Stroke : 2500mm
Lubrication : initial lubrication only
Applied load: 34.5kN
Acceleration: 1.5G



SHS65LVSS High-speed Durability Test Data

Grease remains, and no anomaly is observed in the balls and grease.

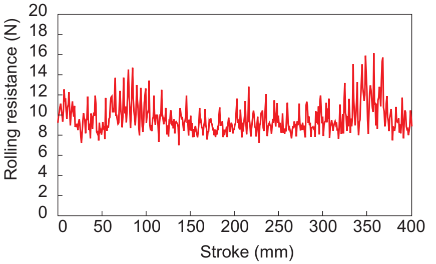


Detail view of the ball cage

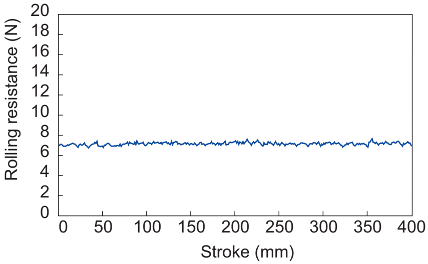
[Smooth Motion]

● Rolling Resistance Data

Use of a ball cage allows the balls to be uniformly aligned and prevents a line of balls from meandering as they enter the LM block. This enables smooth and stable motion to be achieved, minimizes fluctuations in rolling resistance, and ensures high accuracy, in any mounting orientation.



Rolling Resistance Fluctuation Data with Full-Ball Type #25
(Feeding speed: 10 mm/s)



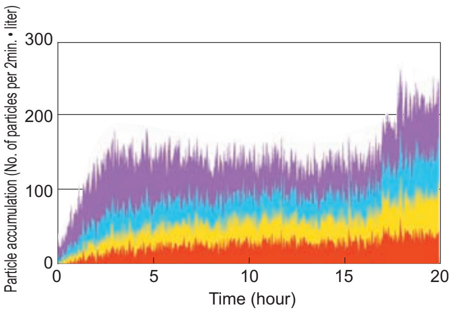
Rolling Resistance Fluctuation Data with Caged Ball LM Guide #25
(Feeding speed: 10 mm/s)

[Low dust generation]

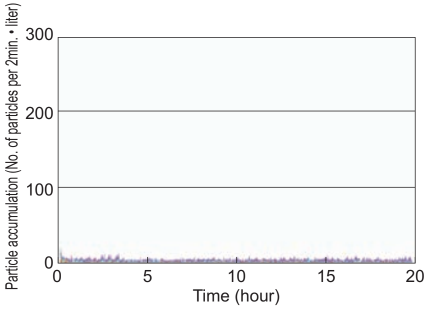
● Low Dust Generation Data

In addition to friction between balls, metallic contact has also been eliminated by using resin for the through holes. Furthermore, the Caged Ball LM Guide has a high level of grease retention and minimizes fly loss of grease, thus to achieve superbly low dust generation.

Particle diameter (μm)
🟪 0.3-0.5
🟦 0.5-1.0
🟨 1.0-2.0
🟥 2.0-5.0
⬛ 5.0-



Full-Ball Type Dust Generation Data



Caged Ball LM Guide Model SSR20
Dust Generation Data