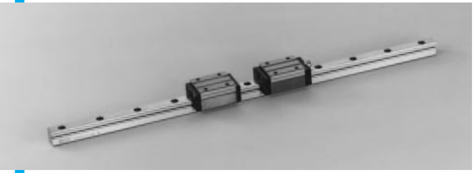
NSK Technical Journal

NSK LINEAR ROLLING GUIDES

Ⅰ Selection Guide to NSK Linear Guides

Ⅱ Technical Description of NSK Linear Guides

Ⅲ Other Linear Rolling Guide Products



Characteristics of NSK Linear Rolling Guides

The following describes comparative characteristics of rolling and slide guide way, which are the most commonly used.

Comparative characteristics of rolling and sliding guide way

Function	Rolling guide	Sliding guide
Friction	• Friction coefficient: 0.01 and lower • Difference between static and dynamic friction is small. • Change by speed is slight.	• Friction is great • Static and dynamic friction vary greatly.
Positioning accuracy	• Lost motion is slight. • Stick-slip is slight. • Easy to sub-micron positioning	• Lost motion is great. • Stick-slip at low speed is great. • Difficult to achieve sub-micron positioning
Life	• Easy to estimate life	• Difficult to estimate life
Static rigidity	• Generally high • No play because of preload • Easy-to estimate rigidity	• Rigidity is great against load from a single direction. • There is mechanical play. • Difficult to estimate rigidity
Speed	• Wide range of use from low to high speed.	• Unsuitable for extremely low and high speed
Maintenance, reliability	• Long life through simple maintenance	• Precision is lost greatly by deteriorated guide surface.

In response to the demand for guide with high-speed, high-precision, high-quality, as well as to the demand for easy maintenance, rolling guides which have above features are becoming prevalent.
Utilizing the technology we sharpened in anti-friction rotating bearings, NSK makes various types of linear guides which are highly accurate and reliable.

Characteristics of the NSK linear rolling guides are:

- **Designs are simple and void of waste. This contributes to high precision and low cost.**

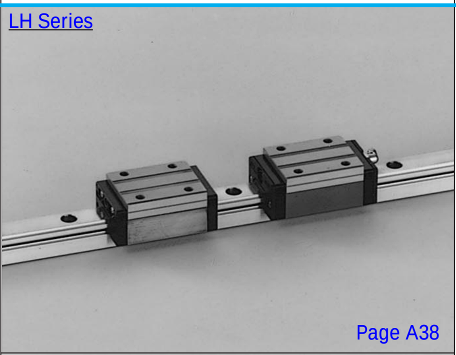
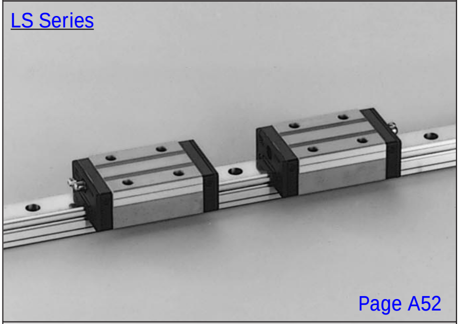
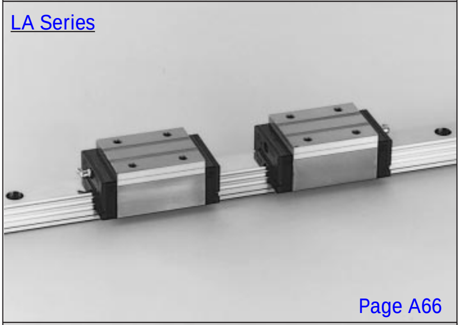
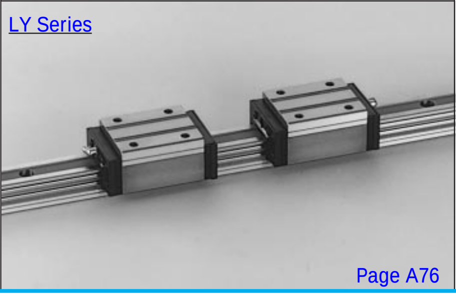
- **Ultra-high purity of materials and superb processing technology assure reliability.**

- **Prompt delivery thanks to interchangeable components and abundant stock.**

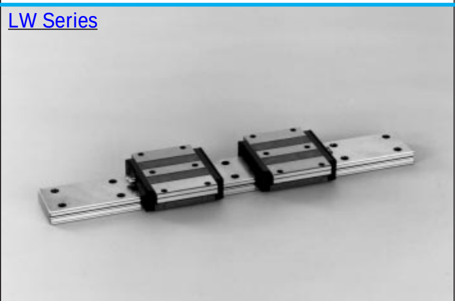
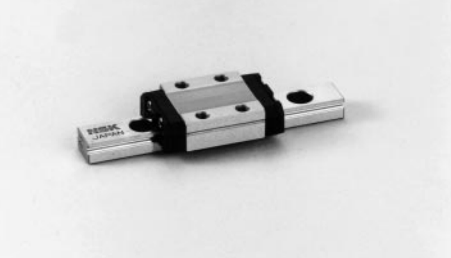
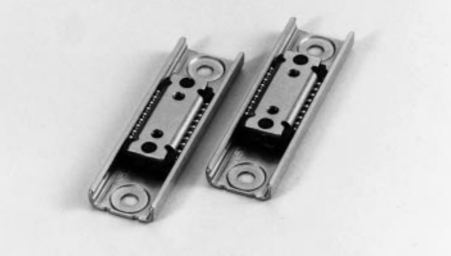
- **The user can select the most suitable guide from a wide choice.**

Types of NSK Linear Rolling Guides

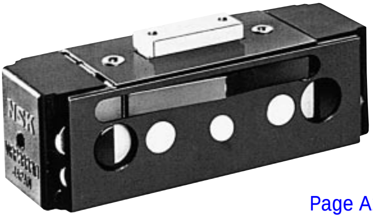
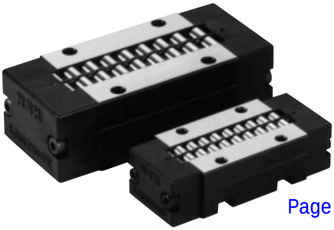
Rigidity; ◎:Superb **O**:Fare O:Low

Product	Appearance	Rolling element, etc.	Rigidity	Major applications
NSK Linear Guide	LH Series  Page A38	Balls Infinite stroke Guided by rail	**O**	• Industrial robots • Materials handling • Electric discharge machines • Woodworking machines • Laser processing machines • Semiconductor manufacturing equipment • Precision measuring equipment • Packaging/packing machines • Food processing machines • Medical equipment • Tool grinders • Flat surface grinders
	LS Series  Page A52		**O**	• Industrial robots • Materials handling • Electric discharge machines • Woodworking machines • Laser processing machines • Semiconductor manufacturing equipment • Precision measuring equipment • Packaging/packing machines • Food processing machines • Medical equipment • Pneumatic components
	LA Series  Page A66		◎	• Machining centers • NC lathes • Heavy cutting machine tools • Grinders • Gear cutting machines • Press • Electric discharge machines
	LY Series  Page A76		◎	• Machining centers • NC lathes • Heavy cutting machine tools • Grinders • Gear cutters

Rigidity; ◎:Superb **O**:Fare O:Low

Product	Appearance	Rolling element, etc.	Rigidity	Major applications
NSK Linear Guide	LW Series  Page A86	Balls Infinite stroke Guided by rail	**O**	• Semiconductor manufacturing equipment • Materials handling • Measuring/Test equipment • Electric discharge machines • Punch press • Industrial robots
	LE Series  Page A92		O	• Semiconductor manufacturing equipment • Liquid crystal display manufacturing equipment • Medical equipment • Optical stage • Microscope XY stage • Transporting optical fiber • Small robots
	LU Series  Page A102		O	• Computer peripheral equipment • Pneumatic equipment
	LL Series  Page A110		O	• Knitting machines • Computer peripheral equipment • Pneumatic equipment • Office equipment

Rigidity; ◎:Superb ⭘:Fare ○:Low

Product	Appearance	Rolling element, etc.	Rigidity	Major applications
Linear rolling bushing	 Page A185	Balls Infinite stroke Round guide shaft	○	• Materials handling • Packaging machines • Medical equipment • Pneumatic equipment • Office equipment • Assembling machines
Crossed roller guide	 Page A196	Roller Limited stroke Rail guide	⭘	• Precision stage • Measuring equipment • Test equipment • Printed circuit board assembly
Roller pack	 Page A202	Roller Infinite stroke Flat surface guide	◎	• Large machine tools • Conveyor system for heavy objects (guide for heavy load)
Linear roller bearing	 Page A209		◎	
Cam-follower/ roller-follower	 Page A214 Page A221		○	• Conveyor systems • Packaging machines • Pallet changers • Office equipment

A-Ⅰ Selection Guide to NSK Linear Guides

A-Ⅰ-1 Structure of NSK Linear Guides

By avoiding structural complexity, and by reducing the number of components, we not only enhanced the precision of linear guides, but also are able to keep costs low. We have added NSK's patented unique structural feature to the original invention (Fig. Ⅰ-1-1). This contributes to higher precision and lower prices.

NSK linear guide is comprised of a rail and ball slide (Fig. Ⅰ-1.2). The balls roll on the grooves on the rail and the ball slide, and scooped up by the end carp attached to the end of the ball slide. Then, the balls go through the opening made in the ball slide, and circulate back to the other end.

A-Ⅰ-2 Characteristics of NSK Linear Guides

The use of a unique offset gothic arch groove (Fig. Ⅰ-1•3) allows the NSK linear guides to satisfy groove designs required for specific purposes.

The precise measurement of the ball groove leads to stable production of highly accurate linear guides and interchangeable linear guides.

(Fig. Ⅰ-1•4).

Such technologies bestow the NSK linear guide with the characteristics outlined below.

(1) Abundant in type for any purpose

* Various series are available, and their ball slide models and size categories are standardized to satisfy any requirement. Our technology, polished by abundant experience in the use of special materials and surface treatments, meets the customer’s most demanding expectations.

(2) High precision and quality

* High precision and quality come from our superb production and measuring technologies, strengthened by extensive experience in antifriction rotary bearings and ball screw production. Our quality assurance extends to the smallest components.

(3) High reliability and durability

* Logical simplicity in shape, along with stable processing, maintain high precision and reliability.
* Super-clean materials and our advanced heat treatment and processing technologies increase product durability.

(4) Component compatibility shortens delivery time

* The adoption of the gothic arch groove, which makes measuring easy, and a new reliable quality control method have made random-matching of the rails and the ball slides possible. This has led to our interchangeable assemblies. Our interchangeable assemblies are stocked as standard products, thereby reducing delivery time.

(5) Patented static load carrying capacity (shock-resistance)

* When a super-high load (shock-load) is imposed, our gothic-arch groove spreads the load to surfaces which usually do not come into contact. This increases shock resistance (Fig. Ⅰ-1•5).

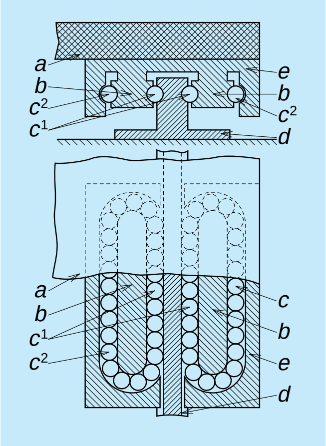


Fig. I-1•1 • **French Patent in 1932.**
• **Inventor : Gretsh (German)**

NSK added its patented technology to the invention in Fig. 1, and improved the linear guide structure and realized low cost design.

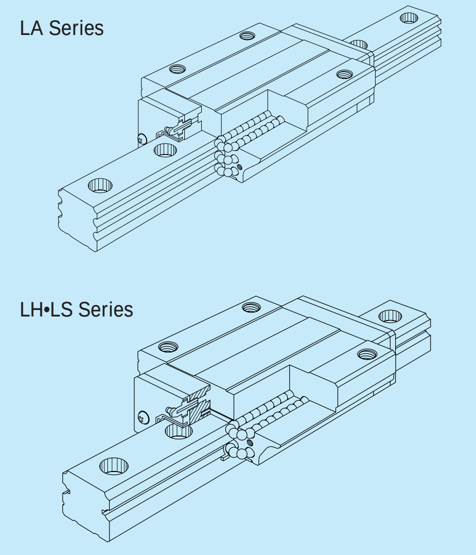


Fig. I-1•2 **Structure of NSK linear guides**

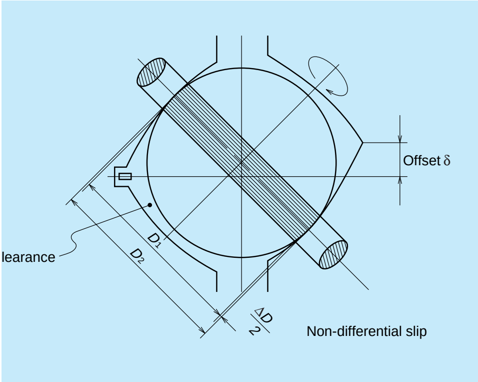


Fig. I-1•3 **Offset gothic-arch groove**

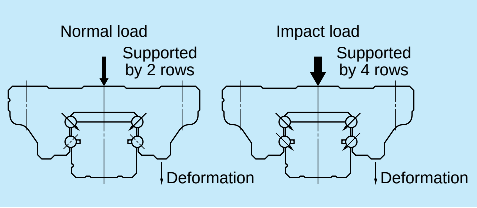


Fig. I-1•5 **Shock-resistance**

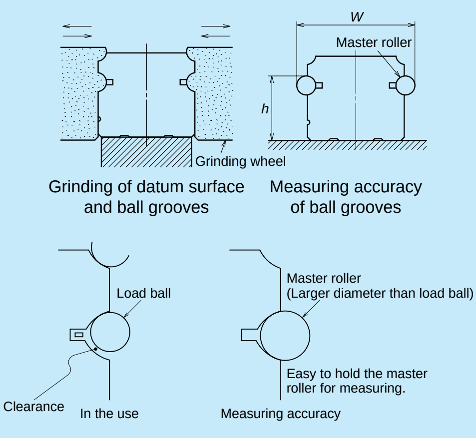


Fig. I-1•4 **Processing and measuring a groove**

Measuring grooves is easy, and you can obtain highly accurate results for all types of NSK series. This is why you can purchase rail and ball slide separately (interchangeability).

A-Ⅰ-2.1 Types and Characteristics of NSK Linear Guides

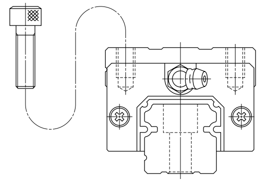
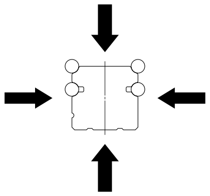
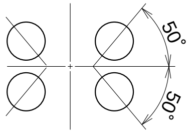
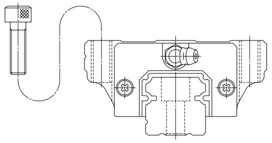
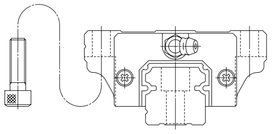
We have abundant types of linear guide for any purpose to accommodate the most special needs of the users.

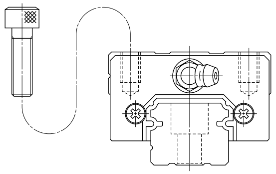
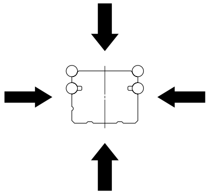
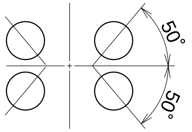
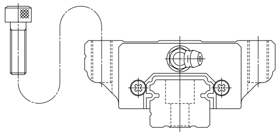
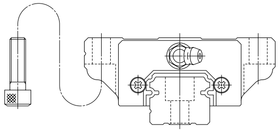
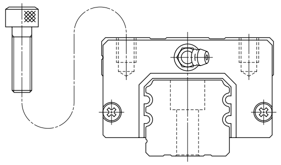
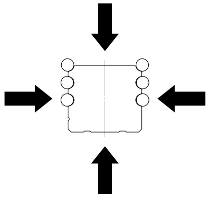
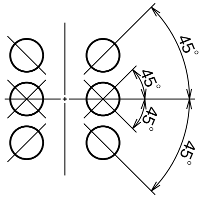
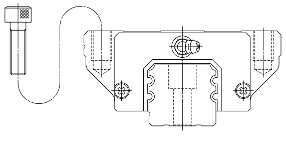
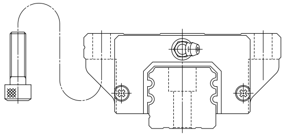
(1) Types of series and classification by feature

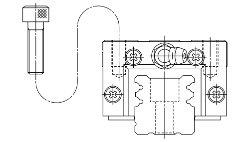
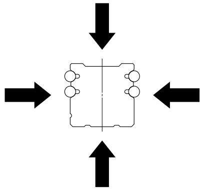
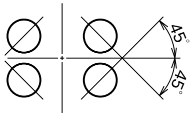
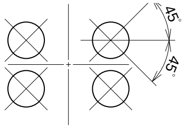
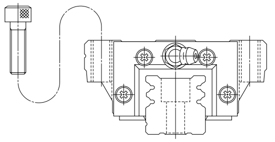
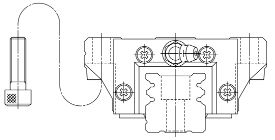
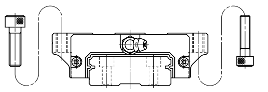
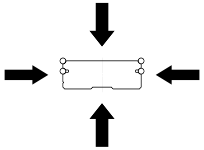
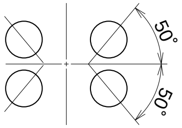
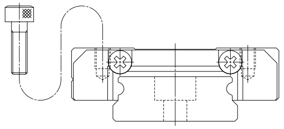
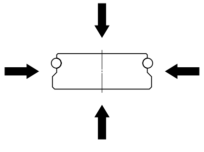
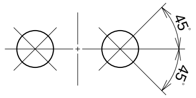
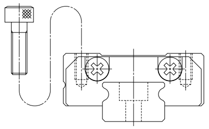
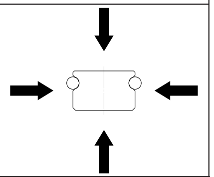
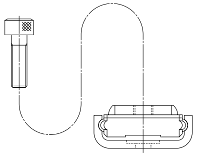
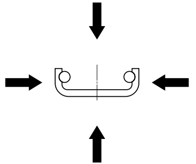
- There are two types of NSK linear guide:
  1. Rigidity and load carrying capacity against the vertical direction are greater than the rigidity and load carrying capacity against the load from the lateral direction (high vertical load carrying capacity type);
  2. Load is equally distributed to four directions (four-directional iso-load carrying capacity type)

- There are three types of NSK linear guide by the length of the ball slide
  1. Standard length ball slide with high-load carrying capacity;
  2. Long ball slide with super-high load carrying capacity;
  3. Short ball slide for mid-level load carrying capacity.
- Four-row ball grooves linear guide has two types:
  1. Self-aligning capability- which absorbs certain amount of installation error;
  2. High moment carrying type with great moment rigidity.
- Two-row ball grooves linear guide has mid-level moment rigidity.
- Interchangeable assemblies: Thanks to the ease in measuring gothic-arch groove, you can separately purchase rail and ball slide in some series.
- Stainless steel is also available as standard material for some series.

Table I-2.1 Classification of NSK linear guides

Category		Series	Ball slide model	Shape/installation method	Load direction/capacity	Ball groove structure	Characteristics	Applications	Page
High vertical load carrying capacity type	Self-aligning type	LH	AN BN				● High load capacity type. ● The contact angle between the ball and ball raceway is set at 50 degrees. The load carrying capacity against the vertical directions, which is prevalent in most operations, increases by this design. ● The DF contact structure greatly absorbs the error in the perpendicular direction to rail at the time of installation. ● Balls make contacts at two points thanks to the offset gothic-arch groove. This keeps friction to a minimum. ● Structural resistance against shock load. ● Gothic-arch groove renders measuring of ball grooves accurate and easy. ● Standardized interchangeable assemblies allows separate purchase of rails and ball slides. ● Stainless steel type is also available for small sizes (- #30).	• Cartesian type robots • Robots that remove plastic molds from injection machine • Material hardling • Food processing machines • Packaging/packing machines • Printing machines • Woodworking machines • Paper machines • Measuring equipment • Inspecting equipment • Semiconductor manufacturing equipment • Liquid crystal display manufacturing equipment • Medical equipment • Electric discharge machines • Laser processing machines • Press • Tool grinders • Flat surface grinders • NC lathes • Machining centers • ATC	A38
			EL GL						
			FL HL						

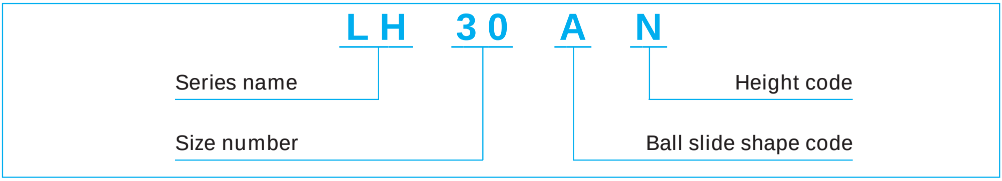
Category		Series	Ball slide model	Shape/installation method	Load direction/capacity	Ball groove structure	Characteristics	Applications	Page
High vertical load carrying capacity type	Self-aligning type	LS	AL CL				• Compact, low in height • The contact angle between the ball and the raceway is set at 50 degrees. The load carrying capacity against vertical directions, which is prevalent in most operations, increases by this design. • The DF contact structure greatly absorbs the error in the perpendicular direction of rail at time of installation. • Thanks to the offset gothic arch groove, balls make contacts at two points. This keeps friction small. • Great resistance against shock load. • Gothic arch groove renders measuring groove accurate and easy. • Standardized interchangeablility allows separate purchase of rails and ball slide. • Some are standardized stainless steel type. • Low-noise type	• Cartesian type robots • Robots that remove plastic molds from injection machine • Material handling • Food processing machines • Packaging/packing machines • Printing machines • Woodworking machines • Paper machines • Measuring equipment • Inspection equipment • Semiconductor manufacturing equipment • Liquid crystal display manufacturing equipment • Medical equipment • Electric discharge machines • Laser processing machines • Press	A52
			EL JL						
			FL KL						
Four-directional iso-load carrying type	Super-rigid type	LA	AN BN AL BL				• The contact angle between the ball and the raceway is set at 45 degrees. This makes load carrying capacity and rigidity equal in vertical and lateral directions. • Six-row ball grooves support load from vertical and lateral directions, enhancing rigidity and increasing load carrying capacity. • Appropriate friction • Best for machine tools.	• Machining centers • NC lathes • Heavy cutting machine tools • Gear cutters • Electric discharge machines • Press • Grinders	A66
			EL GL						
			FL HL						

Category		Series	Ball slide model	Shape/installation method	Load direction/capacity	Ball groove structur	Characteristics	Applications	Page
Four-directional iso-load carrying type	High rigidity type	LY	AN BN AL BL			 At time of light preload  At time of high preload	● The contact angle between the ball and the raceway is set at 45 degrees. Therefore, load carrying capacity and rigidity are equal in vertical and lateral directions. ● Balls contact at four points during high preload. The four-row ball groove supports the load from vertical and lateral directions. This makes the linear guide highly rigid. ● Rigidity against moment load is great due to the DB contact (at time of light preload) or the four-point contact (at time of high preload) ● Sliding resistance slightly increases, absorbing vibration to the rail longitudinal direction due to the four-point contact at time of high preload. ● Ideal for heavy cutting machine tools. ● Strong against shock load ● Low-noise type	• Machining centers • NC lathes • Heavy cutting machine tools • Gear cutters	A76
			EL GL						
			FL HL						
High vertical load carrying capacity type	High moment capacity type	LW	EL				● The contact angle between the ball and the raceway is set at 50 degrees. The load carrying capacity against vertical directions, which is prevalent in most operations, increases with this design ● The rail is wide. This contributes to a high rolling moment carrying capacity and to great moment rigidity when only single linear guide is in use ● Balls contact at two points in the offset gothic arch groove, keeping friction small. ● High resistance against shock load ● Standardized interchangeable assemblies allows separate purchase of rails and ball slides.	• Semiconductor manufacturing equipment • Liquid crystal display manufacturing equipment • Conveyor systems • Inspection equipment • Punch press	A86
Miniature	High moment capacity type	LE	AL TL BL UL CL SL AR TR				● Extremely thin, and wide in shape. This is ideal in use of only single linear guide. ● Available in standardized stainless steel ● Standardized series with ball retainer. ● Standardizedinterchangeablity allows separate purchase of rails and ball slide.	• Semiconductor manufacturing equipment • Liquid crystal display manufacturing equipment • Medical equipment • Optical stage • Microscope XY stage • Conveying optical fiber • Small robots • Computer peripheral equipment • Pneumatic equipment	A92
Miniature		LU	AL TL BL UL AR TR				● Super-small size ● Stainless steel is standard as the material. ● Series with a ball retainer is standardized. ● Interchangeability is standardized, allowing separate purchase of rails and ball slide.		A102
Lightweight miniature		LL	PL				● Light-weight and compact ● Stainless steel as standard material is available.	• Knitting machines • Hard disk carriage damper	A110

A-I-2.2 Model Number and Shape Code of Ball Slide

- "Model number" refers to a combination of the series name, size number, and code of shape and height of ball slide.

Example of a model number:



Note: Height code R of LE and LU series refers to low type eith ball retainer.

- The combination of ball shape shape and height are shown in table I-2•2

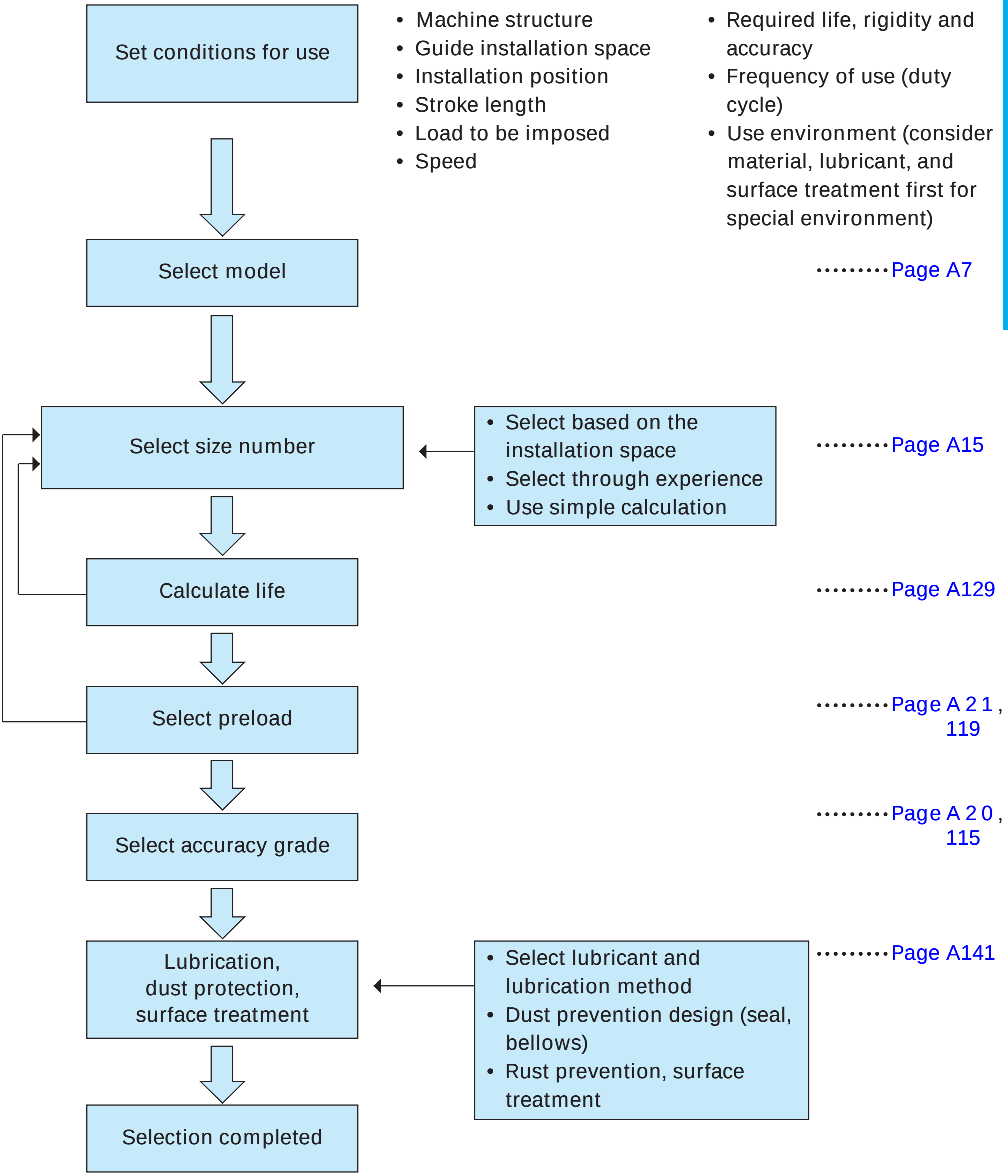
Table I-2•2 Shape and height of Ball slide

Series	Height	Ball slide length	Square type	Flanged type	
			Mounting tap	Mounting tap	Mounting bolt hole
LH	High	Standard	LH-AN		
		Long	LH-BN		
	Low	Standard		LH-EL	LH-FL
		Long		LH-GL	LH-HL
LS	Low	Standard	LS-AL	LS-EL	LS-FL
		Short	LS-CL	LS-JL	LS-KL
LA	High	Standard	LA-AN		
		Long	LA-BN		
	Low	Standard	LA-AL	LA-EL	LA-FL
		Long	LA-BL	LA-GL	LA-HL
LY	High	Standard	LY-AN		
		Long	LY-BN		
	Low	Standard	LY-AL	LY-EL	LY-FL
		Long	LY-BL	LY-GL	LY-HL
LW	Low	Standard		LW-EL	
LE	Low	Standard	LE-AL, TL, AR, TR		
		Long	LE-BL, UL		
		Short	LE-CL, SL		
LU	Low	Standard	LU-AL, TL, AR, TR		
		Long	LU-BL, UL		
LL	Low	Standard	LL-PL		

A-Ⅰ-3 Procedures for Selecting Linear Guide

A-Ⅰ-3.1 Flow Chart for Selection

The flow chart below indicates general steps for selection.



A-Ⅰ-3.2 Selection of Linear Guide Size

To select a linear guide of satisfactory durability; it is a standard practice to calculate its expected life. Prior to calculating the linear guide's life expectancy, select an appropriate size of the linear guide.

Below is an easy selection method. After selecting the size by this method, check the life by using the "**A-Ⅱ-3.2: Calculation of Life Expectancy.**"

(1) Select the size based on the space to be used

Select a linear guide which matches the space in which it is used. Select directly from the "**A-Ⅰ-5: Model Number and Dimension Table.**"

(2) Select the size based on the ball screw size

Always select a linear guide which matches the size of the screw shaft diameter, or the size closest to it, e.g., when the ball screw shaft diameter is 32 the select linear guide type should be LH30, or LH35.

(3) Select the size based on the estimated load on one ball slider

Most linear guides are table-shaped and have two rails and four ball slides for an axis.

Assuming the linear guide is this type, calculate a rough load per ball slide using the formula below:

$$P = \sum \frac{F}{4} + \sum \frac{K_p \cdot F}{2} \qquad \cdots\cdots\cdots\cdots\cdots\cdots \textbf{(3.1)}$$

P **: Load per ball slide**

K_p **: Load position coefficient**

F **: Load**

Load position coefficient K_p should be found for each load by the proportion of the distance between ball slide span and load point, and the distance between rail span and load point.

(A) When load is vertical

(Fig. Ⅰ-3•1)

$$K_p = \left|\frac{X_0}{L_b}\right| + \left|\frac{Y_0}{L_r}\right|$$

(B) When the load is in the axial direction

(Fig. Ⅰ-3•2)

$$K_p = \left|\frac{Z_1}{L_b}\right| + \left|\frac{Y_1}{L_b}\right|$$

(C) When the load is lateral to the rail

(Fig. Ⅰ-3•3)

$$K_p = \left|\frac{X_0}{L_b}\right| + \left|\frac{Z_0}{L_r}\right|$$

The load position is normally the coordinate position. Disregard + or - symbols, and use absolute values.

Upon obtaining the load value P per ball slide by using the above position coefficient K_p in (3.1), select the matching size (model number) from Fig. Ⅰ-3•4. Because the above calculation formula is a simple one, the load obtained by the above formula may be larger than the actual case if the value of K_p is over 1, or in the case three patterns (A), (B), and (C) are combined. In such case, the size to be selected (model number) should be larger; however, the life will be longer.

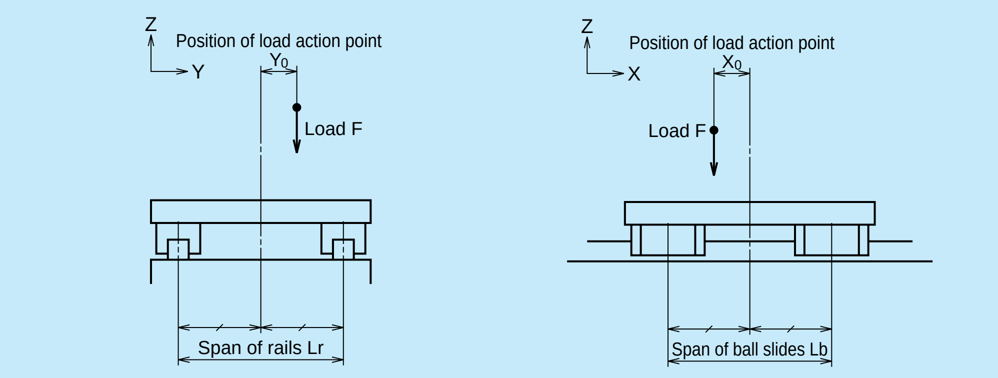


Fig. Ⅰ-3•1 Load from vertical direction

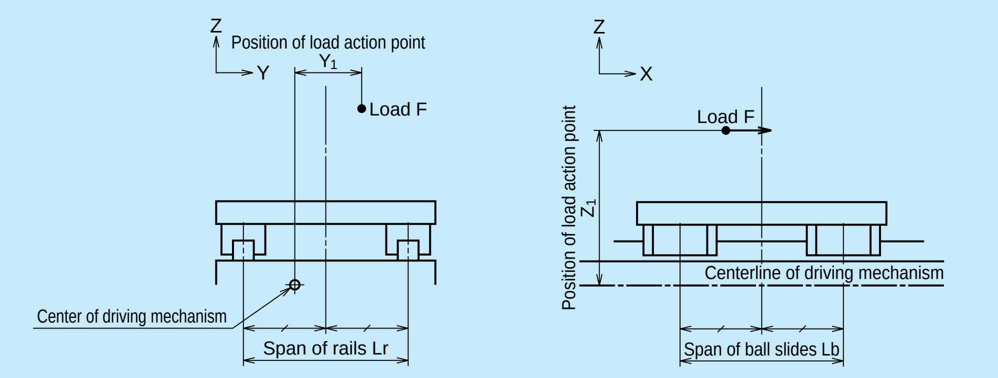


Fig. Ⅰ-3•2 Load to the axis direction

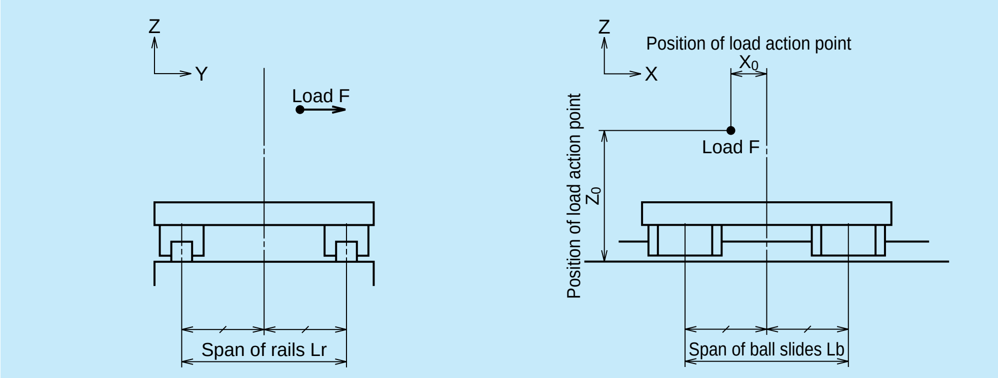


Fig. Ⅰ-3•3 Load from the lateral direction of rail

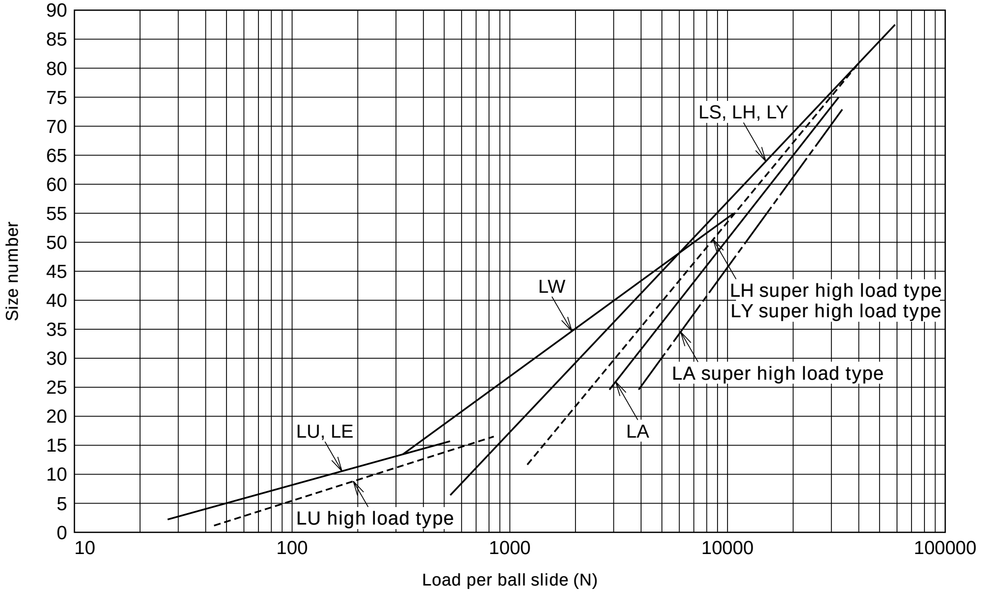


Fig.I-3•4 Selection based on the load

(4) Selection based on the moment load per ball slide

- In cases shown in Fig.I-3•5 to •6, •7, it is necessary to consider the moment load applied to the ball slide.
- Moment directions that have to be taken into account are only those shown by the arrow in the Figures.
- When the load is applied from more than one direction, select the value of the direction which applies to the largest moment load.
- Select the size (model number) based on the moment load per ball slide referring to either Fig.I-3•8 or Fig.I-3•9.
- Consult NSK when: moment load and vertical load are applied at the same time; or moment load and horizontal load are applied at the same time.

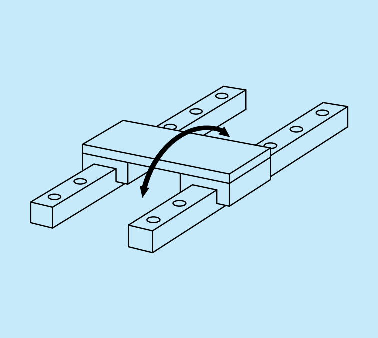


Fig.I-3•5 Pitching direction

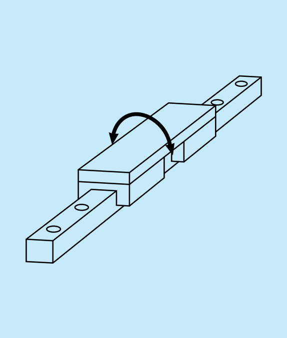


Fig.I-3•6 Rolling direction

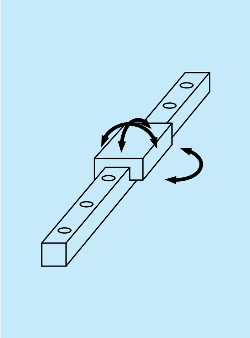


Fig.I-3•7 Pitching, rolling and yawing directions

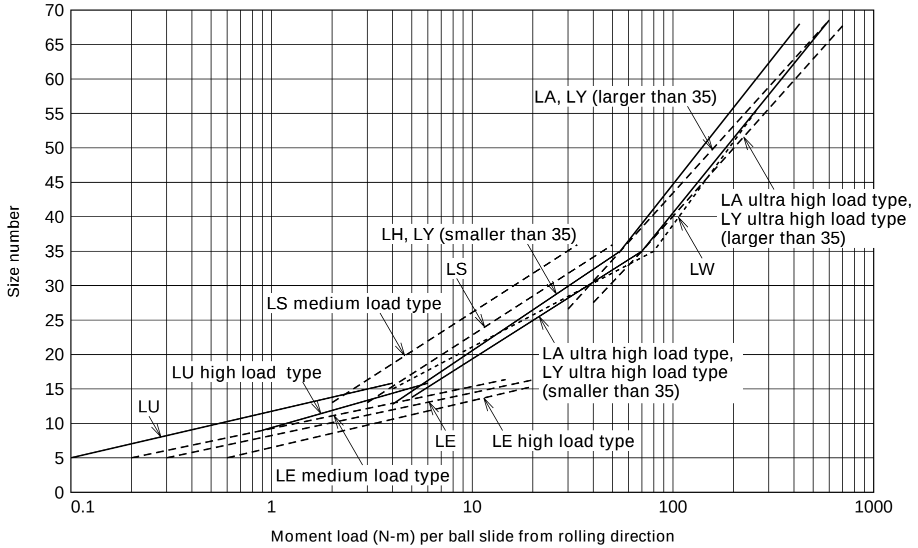


Fig.Ⅰ-3•8 Selection based on the moment load, rolling direction

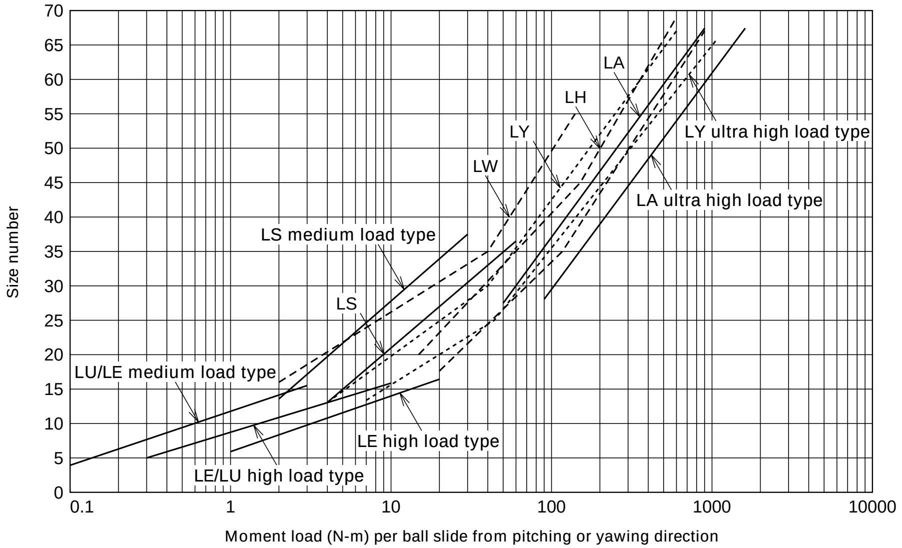


Fig.Ⅰ-3•9 Selection based on the moment load, pitching or yawing direction

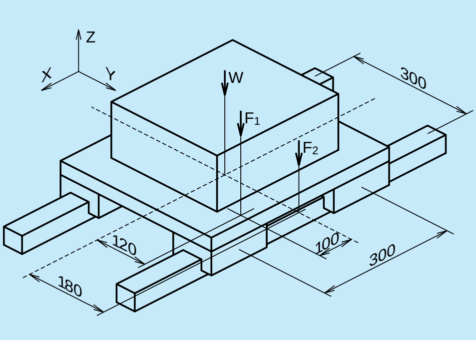
- Loads applied to the types recommended in Fig.Ⅰ-3•4, Ⅰ-3•8, and Ⅰ-3•9 are equivalent to 10% of the basic dynamic load rating of the linear guide. This contributes to select a size numfer with a longer life.

A-Ⅰ-3.3 Example of Linear Guide Selection (Model number)

The selection below used "**A-Ⅰ-3.2 (3) Selection based on load per ball slide.**"

In this example, let us select a linear guide for a single axis table as illustrated below.

Use LH-AN type in LH Series which is selected based on "**A-Ⅰ-2.1 Types and Characteristics of NSK Linear Guides**"



Weight and coordinates of Table *W* :

500N, (0, 0, —)

Weight and coordinates of Weight F_1:

2500N, (100,120, —)

Weight and coordinates of Weight F_2:

1000N, (0,180, —)

Since the above is all vertical load, we do not consider Z axis coordinates.

Therefore, the formula "**(A) When vertical load is applied**" is.:

$$K_{p0}=\left|\frac{X_0}{L_b}\right|+\left|\frac{Y_0}{L_r}\right|=\frac{0}{300}+\frac{0}{300}=0$$

(1) Also $K_{p1}=\frac{100}{300}+\frac{120}{300}=0.73$

$$K_{p2}=\frac{0}{300}+\frac{180}{300}=0.6$$

obtain the load per ball slide *P* using formula (5.1.) as follows.

$$P=\sum\frac{F}{4}+\sum\frac{K_p\cdot F}{2}$$

$$=\frac{W+F_1+F_2}{4}+\frac{K_{p0}\cdot W+K_{p1}\cdot F_1+K_{p2}\cdot F_2}{2}$$

$$=\frac{500+2500+1000}{4}$$

$$+\frac{0\times500+0.73\times2500+0.6\times1000}{2}$$

$$=2212.5\ (N)$$

The appropriate size is around 30 for LH, LS, and LY types according to Fig. Ⅰ-3.4. Confirm the size (Model number) in "**A-Ⅰ-5 Model Number and Dimension Table.**" The correct linear guide size is **LH30AN**.

Calculate the life expectancy using "**A-Ⅱ-3.2 Calculation of Life Expectancy.**" In this case, the expected life is 47560 km.

A-Ⅰ-3.4 Accuracy and Preload

(1) Accuracy grades and types of preload

① **Accuracy grades**

- The accuracy grade which matches the characteristic of each series is set for NSK linear guides.
- Table Ⅰ-3•1 shows accuracy grade set for each series.
- See Page A115 for accuracy specifications of each series.
- Refer to "**(2) Application examples of accuracy grades and preload**" which shows cases of appropriate accuracy grade and preload type for specific purpose.

Table Ⅰ-3•1 Accuracy grades and applicable series

	Preloaded assembly (non-interchangeable)					Interchangeable assembly
	Ultra precision	Super precision	High precision	Precision	Normal grade	Normal grade
Series	P3	P4	P5	P6	PN	PC
LH	O	O	O	O	O	O
LS	O	O	O	O	O	O
LA	O	O	O	O		
LY	O	O	O	O		
LW			O	O	O	O
LE			O	O	O	O
LU		O	O	O	O	O
LL					O	

② Preload

- Several types of preload that match the characteristic of each series are set for NSK linear guides.
- Types of preload for each series are shown in Table Ⅰ-3•2.
- Radial clearance, preload, and rigidity of each series are shown in Page A119.
- "**(2) Application examples of accuracy grade and preload**" show cases of appropriate preload and accuracy grades for specific purposes.

Table Ⅰ-3.2 Classification of preload

	Preloaded assembly (non-interchangeable)					Interchangeable assembly	
	Heavy preload	Medium preload	Light preload	Slight preload	Fine clearance	Slight preload	Fine clearance
Series	Z4	Z3	Z2	Z1	Z0	ZZ	ZT(Z0)
LH		O		O	O	O	O
LS		O		O	O	O	O
LA	O	O					
LY	O	O	O	O	O		
LW		(O)		O	O		O
LE				O	O		O
LU				O	O		O
LL					O		

Note: • Z3 preload types for LW Series are LW35, 50 only.
• "Z" is omitted from the specification number (See A-Ⅰ-4.1).

③ Combinations of accuracy grade and preload

- Combinations of accuracy grade and preload are shown in Table Ⅰ-3•3.

Table Ⅰ-3•3 Combinations of accuracy grade and preload type

	Accuracy grade	Preload
Preloaded assembly	P3~P6	Z4~Z0
	PN	Z1, Z0
Interchangeable assembly	PC	ZZ, ZT

(2) Application examples of accuracy grade and preload

Table Ⅰ-3.4 shows examples of accuracy grade and preload" of NSK linear guides for specific purposes. Refer to this table when selecting accuracy grade and preload type for your application.

Tabl Ⅰ-3•4 Examples of accuracy grade and preload for specific purpose

Type of machine	Application	Accuracy grade					Preload				
		Ultra precision P3	Super precision P4	High precision P5	Precision P6	Normal grade PN, PC	Heavy preload Z4	Medium preload Z3	Light preload Z2	Slight preload Z1, ZZ	Fine clearance Z0, ZT
Machine tools	• Machining centers		O	O	O		O	O			
	• Grinders	O	O	O			O	O	O		
	• Lathes		O	O	O		O	O			
	• Milling machines		O	O	O		O	O			
	• Drilling machines			O	O		O	O			
	• Boring machines		O	O	O		O	O			
	• Gear cutters		O	O	O		O	O	O		
	• Diesinking machine		O	O	O			O	O	O	
	• Laser processing machine		O	O	O			O	O	O	
	• Electric discharge machine	O	O	O			O	O			
Industrial machines and equipment	• Punch press			O	O			O	O	O	
	• Press machine				O	O				O	O
	• Welding machine				O	O		O	O	O	O
	• Painting machine				O	O				O	O
	• Textile machine				O	O				O	O
	• Coil winder				O	O		O	O	O	
	• Woodworking machine			O	O	O		O	O	O	O
	• Glass processing machine				O	O				O	O
	• Stone cutting machine				O	O				O	O
	• Tire forming machine					O				O	O
	• ATC				O	O				O	O
	• Industrial robot			O	O	O		O	O	O	O
	• Materials handling				O	O				O	O
	• Packing machine				O	O				O	O
	• Construction machine					O					O
Semiconductor facilities	• Prober	O						O		O	
	• Wire bonder		O	O				O	O	O	
	• PCB driller			O	O			O	O	O	
	• Slicer	O	O					O			
	• Dicer	O	O					O			
	• Chip mounter			O	O			O	O	O	
	• IC handler			O	O					O	
	• Scanner			O	O					O	
	• Lithographic machine	O	O					O	O	O	
Others	• Measuring / inspection equipment	O	O	O	O					O	
	• Three-dimensional measuring equipment	O	O	O	O			O	O	O	
	• Medical equipment		O	O	O					O	O
	• OA equipment				O	O				O	O
	• Railway cars					O				O	O
	• Stage systems					O					O
	• Pneumatic equipment				O	O				O	O

Only "slight preload (Z1, ZZ)" and "fine clearance (Z0, ZT)" are available for normal grade (PN and PC).
For interchangeable type, only accuracy grade "PC," and preload (ZZ) and (ZT) are available.
Refer to Page A115 for the explanation of accuracy grade and preload.

A-Ⅰ-3.5　Available Length of Rail (single rail)

- Table Ⅰ-3•5 and Table Ⅰ-3•6 show the limitations of rail length (maximum length). However, the limitations vary by accuracy grade.

Table-Ⅰ-3•5　Limitations of rail length (single rail)

Unit：mm

Series	Size Material	05	07	09	12	15	20	25	30	35	45	55	65	85
LH	Special high carbon steel						3960	3960	4000	4000	3990	3960	3900	2520
	Stainless steel						3500	3500	3500					
LS	Special high carbon steel					2000	3960	3960	4000	4000				
	Stainless steel					1700	3500	3500	3500	3500				
LA	Special high carbon steel								4000	4000	3990	3960	3900	
LY	Special high carbon steel					2000	2000	2200	3000	3000	3000	3000	3000	
LE	Stainless steel	150	600	800	1000	1200								
LU	Special high carbon steel			1200	1800	2000								
	Stainless steel	210	375	600	800	1000								

Table-Ⅰ-3•6　Length limitations of LW Series rails

Unit：mm

Series	Size Material	17	21	27	35	50
LW	Special high carbon steel	1000	1600	2000	2400	3000

- Rails can be butted if user requirement exceeds the rail length shown in the Table. Please consult NSK.
- Exclusive butting rails are standardized and stocked for interchangeable type in LH and LS Series.

Rail designation code of LH butting rail specification
: L1H304000-01Z
(Non-butting rail specification: L1H304000Z)
Rail designation code of LS butting rail specification
: L1S304000JZ
(Non-butting rail specification: L1S304000Z)

A-Ⅰ-4 When Placing Orders

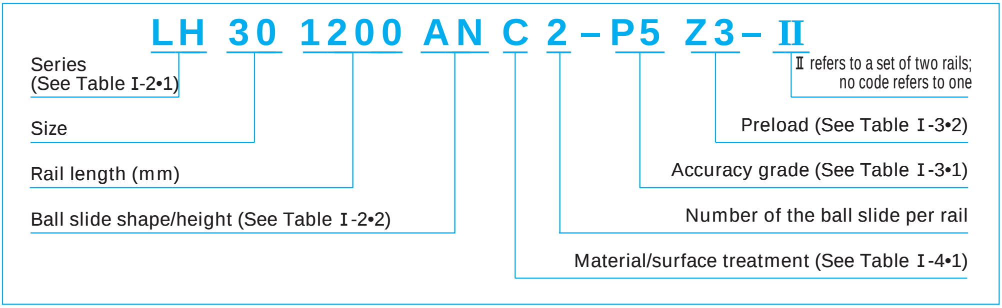
A-Ⅰ-4.1 Specification Number and Reference Number

Specification number : Use a number for inquiry prior to finalize specifications. A code indicates a general specification of the item. Codes are a great help when you need an estimate or when you desire to discuss specifications with us.

Reference number : Alpha-numeric codes are assigned to identify each linear guide assembly after all specifications are finalized.
A reference number appears in the specification drawing for user reference. Use this number when placing an order.

(1) Preloaded assembly

(A) Specification number



(B) Reference number (Series: LH, LA, LY, LW, LE, LU)

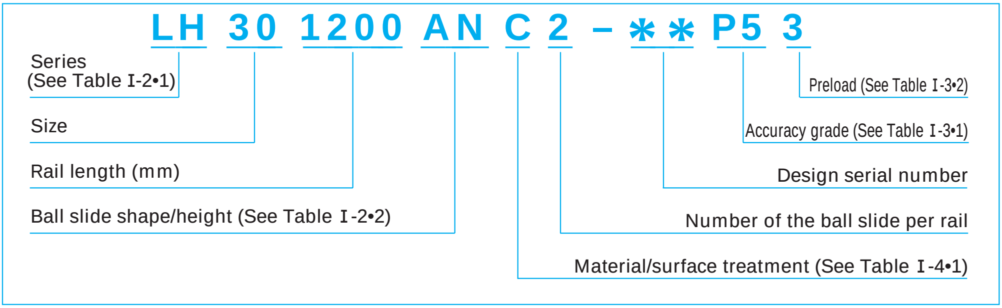


Table Ⅰ-4•1 Material/surface treatment code

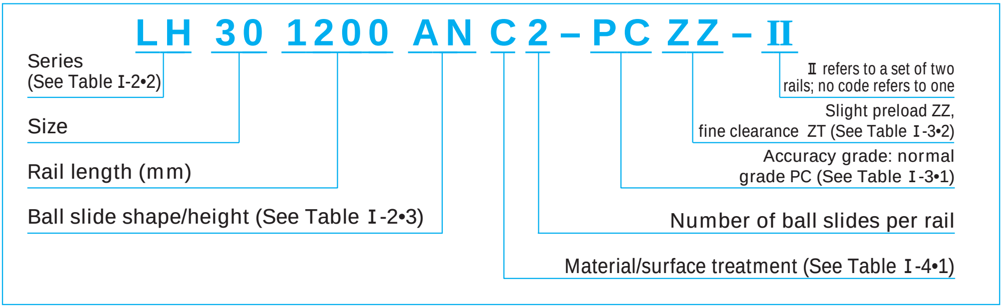
Code	Description
C	Special high carbon steel (NSK standard)
K	Stainless steel
D	Special high carbon steel with surface treatment
H	Stainless steel with surface treatment
Z	Other, special

(2) Interchangeable type

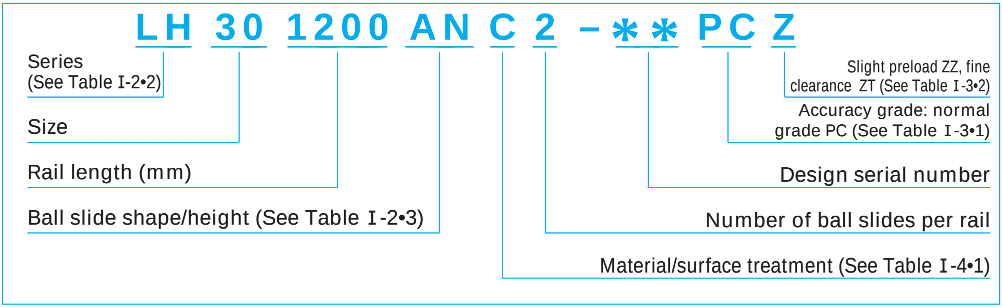
(A) Rails and ball slides as a single item

Component	Preload	Butting or non-butting rail	Material	Reference number (example)
Rail	Slight preload	Regular rail	Special high carbon steel	L1H301240-Z
			Stainless steel	L1H301240-SZ
		Butting rail	Special high carbon steel	L1H304000-01Z
	Fine clearance	Regular rail	Special high carbon steel	L1H301240
			Stainless steel	L1H301240S
		Butting rail	Special high carbon steel	L1H304000-01
Ball slide	Slight preload	—	Special high carbon steel	LAH30ELZ
			Stainless steel	LAH30ELSZ
	Fine clearance	—	Special high carbon steel	LAH30EL
			Stainless steel	LAH30ELS

(B) Assembled item with rail and ball slide (specification number)



(C) Assembled item with rail andball slide (reference number)



Note:Interchangeable assemblies are available only to the normal grade (PC).

A-Ⅰ-4.2 Reference Number of the Standardized Linear Guide in Stock

- NSK keeps a stock of standardized linear guides. Refer to Tables Ⅰ-4•2 to Ⅰ-4•15 for their reference numbers.
- For easy ordering, use the reference number of the standardized linear guide in stock.

Table Ⅰ-4•2 Standardized LH Series in stock (Interchangeable part)

Model	Material	Interchangeable type	Rail reference number	Rail G* dimension	Ball slide reference number	
LH20	Special high carbon steel	Interchangeable with fine clearance	L1H200220 L1H200280 L1H200340 L1H200460 L1H200640 L1H200820 L1H201000 L1H201240	20	LAH20AN LAH20EL LAH20FL	LAH20BN LAH20GL LAH20HL
		Interchangeable with preload	L1H200220Z L1H200280Z L1H200340Z L1H200460Z L1H200640Z L1H200820Z L1H201000Z L1H201240Z		LAH20ANZ LAH20ELZ LAH20FLZ	LAH20BNZ LAH20GLZ LAH20HLZ
	Stainless steel	Interchangeable with fine clearance	L1H200220S L1H200280S L1H200340S L1H200460S L1H200640S L1H200820S L1H201000S L1H201240S		LAH20ANS LAH20ELS LAH20FLS	LAH20BNS LAH20GLS LAH20HLS
		Interchangeable with preload	L1H200220SZ L1H200280SZ L1H200340SZ L1H200460SZ L1H200640SZ L1H200820SZ L1H201000SZ L1H201240SZ		LAH20ANSZ LAH20ELSZ LAH20FLSZ	LAH20BNSZ LAH20GLSZ LAH20HLSZ

*** Refer to the dimension tables for the rail dimension G.**

Table Ⅰ-4•3 Standardized LH Series in stock (Interchangeable part)

Model	Material	Interchangeable type	Rail reference number		Ball slide reference number	
				Rail G* dimension		
LH25	Special high carbon steel	Interchangeable with fine clearance	L1H250220 L1H250280 L1H250340 L1H250460 L1H250640 L1H250820 L1H251000 L1H251240	20	LAH25AN LAH25EL LAH25FL	LAH25BN LAH25GL LAH25HL
		Interchangeable with preload	L1H250220Z L1H250280Z L1H250340Z L1H250460Z L1H250640Z L1H250820Z L1H251000Z L1H251240Z		LAH25ANZ LAH25ELZ LAH25FLZ	LAH25BNZ LAH25GLZ LAH25HLZ
	Stainless steel	Interchangeable with fine clearance	L1H250220S L1H250280S L1H250340S L1H250460S L1H250640S L1H250820S L1H251000S L1H251240S		LAH25ANS LAH25ELS LAH25FLS	LAH25BNS LAH25GLS LAH25HLS
		Interchangeable with preload	L1H250220SZ L1H250280SZ L1H250340SZ L1H250460SZ L1H250640SZ L1H250820SZ L1H251000SZ L1H251240SZ		LAH25ANSZ LAH25ELSZ LAH25FLSZ	LAH25BNSZ LAH25GLSZ LAH25HLSZ

*** Refer to the dimension tables for the rail dimension G.**

Table Ⅰ-4•4 Standardized LH Series in stock (Interchangeable part)

Model	Material	Interchangeable type	Rail reference number		Ball slide reference number	
				Rail G* dimension		
LH30	Special high carbon steel	Interchangeable with fine clearance	L1H300280 L1H300440 L1H300600 L1H300760 L1H301000 L1H301240	20	LAH30AN LAH30EL LAH30FL	LAH30BN LAH30GL LAH30HL
		Interchangeable with preload	L1H300280Z L1H300440Z L1H300600Z L1H300760Z L1H301000Z L1H301240Z		LAH30ANZ LAH30ELZ LAH30FLZ	LAH30BNZ LAH30GLZ LAH30HLZ
	Stainless steel	Interchangeable with fine clearance	L1H300280S L1H300440S L1H300600S L1H300760S L1H301000S L1H301240S		LAH30ANS LAH30ELS LAH30FLS	LAH30BNS LAH30GLS LAH30HLS
		Interchangeable with preload	L1H300280SZ L1H300440SZ L1H300600SZ L1H300760SZ L1H301000SZ L1H301240SZ		LAH30ANSZ LAH30ELSZ LAH30FLSZ	LAH30BNSZ LAH30GLSZ LAH30HLSZ
LH35	Special high carbon steel	Interchangeable with fine clearance	L1H350280 L1H350440 L1H350600 L1H350760 L1H351000 L1H351240	20	LAH35AN LAH35EL LAH35FL	LAH35BN LAH35GL LAH35HL
		Interchangeable with preload	L1H350280Z L1H350440Z L1H350600Z L1H350760Z L1H351000Z L1H351240Z		LAH35ANZ LAH35ELZ LAH35FLZ	LAH35BNZ LAH35GLZ LAH35HLZ

*** Refer to the dimension tables for the rail dimension G.**

Table Ⅰ-4•5 Standardized LH Series in stock (Interchangeable part)

Model	Material	Interchangeable type	Rail reference number		Ball slide reference number	
				Rail G dimension		
LH45	Special high carbon steel	Interchangeable with fine clearance	—	—	LAH45AN LAH45EL LAH45FL	LAH45BN LAH45GL LAH45HL
		Interchangeable with preload	—		LAH45ANZ LAH45ELZ LAH45FLZ	LAH45BNZ LAH45GLZ LAH45HLZ
LH55	Special high carbon steel	Interchangeable with fine clearance	—	—	LAH55AN LAH55EL LAH55FL	LAH55BN LAH55GL LAH55HL
		Interchangeable with preload	—		LAH55ANZ LAH55ELZ LAH55FLZ	LAH55BNZ LAH55GLZ LAH55HLZ
LH65	Special high carbon steel	Interchangeable with fine clearance	—	—	LAH65AN LAH65EL LAH65FL	LAH65BN LAH65GL LAH65HL
		Interchangeable with preload	—		LAH65ANZ LAH65ELZ LAH65FLZ	LAH65BNZ LAH65GLZ LAH65HLZ

Rails of LH45 and larger are not standardized stock.

Table Ⅰ-4•6 Standardized LS Series in stock (Interchangeable part)

Model	Material	Interchangeable type	Rail reference number		Ball slide reference number	
				Rail G* dimension		
LS15	Special high carbon steel	Interchangeable with fine clearance	L1S150160(T)** L1S150220(T)** L1S150280(T)** L1S150340(T)** L1S150460(T)** L1S150640(T)** L1S150820(T)** L1S151000(T)**	20	LAS15AL LAS15EL LAS15FL	LAS15CL LAS15KL
		Interchangeable with preload	L1S150160TZ L1S150220TZ L1S150280TZ L1S150340TZ L1S150460TZ L1S150640TZ L1S150820TZ L1S151000TZ		LAS15ALZ LAS15ELZ LAS15FLZ	LAS15CLZ LAS15KLZ
	Stainless steel	Interchangeable with fine clearance	L1S150160TS L1S150220TS L1S150280TS L1S150340TS L1S150460TS L1S150640TS L1S150820TS L1S151000TS		LAS15ALS LAS15ELS LAS15FLS	LAS15CLS LAS15KLS
		Interchangeable with preload	L1S150160STZ L1S150220STZ L1S150280STZ L1S150340STZ L1S150460STZ L1S150640STZ L1S150820STZ L1S151000STZ		LAS15ALSZ LAS15ELSZ LAS15FLSZ	LAS15CLSZ LAS15KLSZ

*** Refer to the dimension tables for the rail dimension G.**

****A rail, of which reference number has a letter T, is a standard rail with bolt holes for M4. Reference number without letter T indicates that a rail is a standard with bolt holes for M3. Both items are stocked as the standard rail.**

Table Ⅰ-4•7 Standardized LS Series in stock (Interchangeable part)

Model	Material	Interchangeable type	Rail reference number		Ball slide reference number
				Rail G* dimension	
LS20	Special high carbon steel	Interchangeable with fine clearance	L1S200220 L1S200280 L1S200340 L1S200460 L1S200640 L1S200820 L1S201000 L1S201240	20	LAS20AL LAS20CL LAS20EL LAS20KL LAS20FL
		Interchangeable with preload	L1S200220Z L1S200280Z L1S200340Z L1S200460Z L1S200640Z L1S200820Z L1S201000Z L1S201240Z		LAS20ALZ LAS20CLZ LAS20ELZ LAS20KLZ LAS20FLZ
	Stainless steel	Interchangeable with fine clearance	L1S200220S L1S200280S L1S200340S L1S200460S L1S200640S L1S200820S L1S201000S L1S201240S		LAS20ALS LAS20CLS LAS20ELS LAS20KLS LAS20FLS
		Interchangeable with preload	L1S200220SZ L1S200280SZ L1S200340SZ L1S200460SZ L1S200640SZ L1S200820SZ L1S201000SZ L1S201240SZ		LAS20ALSZ LAS20CLSZ LAS20ELSZ LAS20KLSZ LAS20FLSZ

*** Refer to the dimension tables for the rail dimension G.**

Table Ⅰ-4•8 Standardized LS Series in stock (randomly-matching items)

Model	Material	Interchangeable type	Rail reference number		Ball slide reference number
				Rail G* dimension	
LS25	Special high carbon steel	Interchangeable with fine clearance	L1S250220 L1S250280 L1S250340 L1S250460 L1S250640 L1S250820 L1S251000 L1S251240	20	LAS25AL LAS25CL LAS25EL LAS25KL LAS25FL
		Interchangeable with preload	L1S250220Z L1S250280Z L1S250340Z L1S250460Z L1S250640Z L1S250820Z L1S251000Z L1S251240Z		LAS25ALZ LAS25CLZ LAS25ELZ LAS25KLZ LAS25FLZ
	Stainless steel	Interchangeable with fine clearance	L1S250220S L1S250280S L1S250340S L1S250460S L1S250640S L1S250820S L1S251000S L1S251240S		LAS25ALS LAS25CLS LAS25ELS LAS25KLS LAS25FLS
		Interchangeable with preload	L1S250220SZ L1S250280SZ L1S250340SZ L1S250460SZ L1S250640SZ L1S250820SZ L1S251000SZ L1S251240SZ		LAS25ALSZ LAS25CLSZ LAS25ELSZ LAS25KLSZ LAS25FLSZ

*** Refer to the dimension tables for the rail dimension G.**

Table Ⅰ-4•9 Standardized LS Series in stock (Interchangeable part)

Model	Material	Interchangeable type	Rail reference number		Ball slide reference number	
				Rail G* dimension		
LS30	Special high carbon steel	Interchangeable with fine clearance	L1S300280 L1S300440 L1S300600 L1S300760 L1S301000 L1S301240	20	LAS30AL LAS30EL LAS30FL	LAS30CL LAS30KL
		Interchangeable with preload	L1S300280Z L1S300440Z L1S300600Z L1S300760Z L1S301000Z L1S301240Z		LAS30ALZ LAS30ELZ LAS30FLZ	LAS30CLZ LAS30KLZ
	Stainless steel	Interchangeable with fine clearance	L1S300280S L1S300440S L1S300600S L1S300760S L1S301000S L1S301240S		LAS30ALS LAS30ELS LAS30FLS	LAS30CLS LAS30KLS
		Interchangeable with preload	L1S300280SZ L1S300440SZ L1S300600SZ L1S300760SZ L1S301000SZ L1S301240SZ		LAS30ALSZ LAS30ELSZ LAS30FLSZ	LAS30CLSZ LAS30KLSZ
LS35	Special high carbon steel	Interchangeable with fine clearance	L1S350280 L1S350440 L1S350600 L1S350760 L1S351000 L1S351240	20	LAS35AL LAS35EL LAS35FL	LAS35CL LAS35KL
		Interchangeable with preload	L1S350280Z L1S350440Z L1S350600Z L1S350760Z L1S351000Z L1S351240Z		LAS35ALZ LAS35ELZ LAS35FLZ	LAS35CLZ LAS35KLZ
	Stainless steel	Interchangeable with fine clearance	L1S350280S L1S350440S L1S350600S L1S350760S L1S351000S L1S351240S		LAS35ALS LAS35ELS LAS35FLS	LAS35CLS LAS35KLS
		Interchangeable with preload	L1S350280SZ L1S350440SZ L1S350600SZ L1S350760SZ L1S351000SZ L1S351240SZ		LAS35ALSZ LAS35ELSZ LAS35FLSZ	LAS35CLSZ LAS35KLSZ

*** Refer to the dimension tables for the rail dimension G.**

Table Ⅰ-4•10 Standardized LW Series in stock (Preloaded assembly)

Model	Material	Reference number		Rail dimension (mm)	
		Z0 preload	Z1 preload	Rail length	G* dimension
LW17EL	Special high carbon steel	LW170510EL2A01PNZ0 LW170750EL2A01PNZ0 LW170990EL2A01PNZ0	LW170510EL2A02PNZ1 LW170750EL2A02PNZ1 LW170990EL2A02PNZ1	510 750 990	15
LW21EL	Special high carbon steel	LW210530EL2A01PNZ0 LW211030EL2A01PNZ0 LW211530EL2A01PNZ0	LW210530EL2A02PNZ1 LW211030EL2A02PNZ1 LW211530EL2A02PNZ1	530 1030 1530	15
LW27EL	Special high carbon steel	LW270520EL2A01PNZ0 LW271000EL2A01PNZ0 LW271540EL2A01PNZ0	LW270520EL2A02PNZ1 LW271000EL2A02PNZ1 LW271540EL2A02PNZ1	520 1000 1540	20
LW35EL	Special high carbon steel	LW351000EL2A01PNZ0 LW351560EL2A01PNZ0 LW352040EL2A01PNZ0	LW351000EL2A01PNZ1 LW351560EL2A01PNZ1 LW352040EL2A01PNZ1	1000 1560 2040	20
LW50EL	Special high carbon steel	LW501000EL2A01PNZ0 LW501560EL2A01PNZ0 LW502040EL2A01PNZ0	LW501000EL2A01PNZ1 LW501560EL2A01PNZ1 LW502040EL2A01PNZ1	1000 1560 2040	20

*** Refer to the dimension tables for the rail dimension G.**

Table Ⅰ-4•11 Standardized LW Series in stock (Interchangeable part)

Model	Material	Interchangeable type	Rail reference number		Ball slide reference number
				Rail G* dimension	
LW17	Special high carbon steel	Interchangeable with fine clearance	L1W170430 L1W170670 L1W170990	15	LAW17EL
LW21	Special high carbon steel	Interchangeable with fine clearance	L1W210430 L1W210680 L1W210980	15	LAW21EL
LW27	Special high carbon steel	Interchangeable with fine clearance	L1W270460 L1W270640 L1W270820 L1W271000	20	LAW27EL
LW35	Special high carbon steel	Interchangeable with fine clearance	L1W350440 L1W350600 L1W350760 L1W351000 L1W351240	20	LAW35EL
LW50	Special high carbon steel	Interchangeable with fine clearance	L1W500440 L1W500600 L1W500760 L1W501000 L1W501240	20	LAW50EL

*** Refer to the dimension tables for the rail dimension G.**

Table Ⅰ-4•12 Standardized LE Series in stock (Preloaded assembly)

Model	Material	Reference number		Rail dimension (mm)	
		Z0 preload	Z1 preload	Rail length	G* dimension
LE07AL	Stainless steel	LE070110AL2AS7PNZ0	LE070110AL2AS8P6Z1	110	10
		LE070200AL2AS7PNZ0	LE070200AL2AS8P6Z1	200	
		LE070290AL2AS7PNZ0	LE070290AL2AS8P6Z1	290	
LE09AL	Stainless steel	LE090110AL2A70PNZ0	LE090110AL2A61P6Z1	110	10
		LE090200AL2A70PNZ0	LE090200AL2A61P6Z1	200	
		LE090290AL2A70PNZ0	LE090290AL2A61P6Z1	290	
LE09TL	Stainless steel	LE090110TL2AS7PNZ0	LE090110TL2AS8P6Z1	110	10
		LE090200TL2AS7PNZ0	LE090200TL2AS8P6Z1	200	
		LE090290TL2AS7PNZ0	LE090290TL2AS8P6Z1	290	
LE12AL	Stainless steel	LE120150AL2AS7PNZ0	LE120150AL2AS8P6Z1	150	15
		LE120310AL2AS7PNZ0	LE120310AL2AS8P6Z1	310	
		LE120470AL2AS7PNZ0	LE120470AL2AS8P6Z1	470	
LE15AL	Stainless steel	LE150230AL2AS7PNZ0	LE150230AL2AS8P6Z1	230	15
		LE150430AL2AS7PNZ0	LE150430AL2AS8P6Z1	430	
		LE150670AL2AS7PNZ0	LE150670AL2AS8P6Z1	670	

*** Refer to the dimension tables for the rail dimension G.**

Table Ⅰ-4•13 Standardized LE Series in stock (Interchangeable part)

Model	Material	Interchangeable type	Rail reference number		Ball slide reference number
				Rail G* dimension	
LE09	Stainless steel	Interchangeable with fine clearance	L1E090110S	10	LAE09AR LAE09TR
			L1E090200S		
			L1E090290S		
			L1E090380S		
LE12	Stainless steel	Interchangeable with fine clearance	L1E120150S	15	LAE12AR
			L1E120310S		
			L1E120470S		
			L1E120790S		
LE15	Stainless steel	Interchangeable with fine clearance	L1E150230S	15	LAE15AR
			L1E150430S		
			L1E150670S		
			L1E150990S		

*** Refer to the dimension tables for the rail dimension G.**

Table Ⅰ-4•14 Standardized LU Series in stock (Preloaded assembly)

Model	Material	Reference number		Rail dimension (mm)	
		Z0 preload	Z1 preload	Rail length	G* dimension
LU07AL	Special high carbon steel	LU070085AL2AS7PNZ0 LU070145AL2AS7PNZ0 LU070235AL2AS7PNZ0	LU070085AL2AS8P6Z1 LU070145AL2AS8P6Z1 LU070235AL2AS8P6Z1	85 145 235	5
LU09AL	Special high carbon steel	LU090115AL2A70PNZ0 LU090195AL2A70PNZ0 LU090275AL2A70PNZ0	LU090115AL2A61P6Z1 LU090195AL2A61P6Z1 LU090275AL2A61P6Z1	115 195 275	7.5
	Stainless steel	LU090115AL2AS7PNZ0 LU090195AL2AS7PNZ0 LU090275AL2AS7PNZ0	LU090115AL2AS8P6Z1 LU090195AL2AS8P6Z1 LU090275AL2AS8P6Z1	115 195 275	7.5
LU09TL	Stainless steel	LU090115TL2AS7PNZ0 LU090195TL2AS7PNZ0 LU090275TL2AS7PNZ0	LU090115TL2AS8P6Z1 LU090195TL2AS8P6Z1 LU090275TL2AS8P6Z1	115 195 275	7.5
LU12AL	Special high carbon steel	LU120170AL2A70PNZ0 LU120270AL2A70PNZ0 LU120470AL2A70PNZ0	LU120170AL2A61P6Z1 LU120270AL2A61P6Z1 LU120470AL2A61P6Z1	170 270 470	10
	Stainless steel	LU120170AL2AS7PNZ0 LU120270AL2AS7PNZ0 LU120470AL2AS7PNZ0	LU120170AL2AS8P6Z1 LU120270AL2AS8P6Z1 LU120470AL2AS8P6Z1	170 270 470	10
LU12TL	Special high carbon steel	LU120170TL2A70PNZ0 LU120270TL2A70PNZ0 LU120470TL2A70PNZ0	LU120170TL2A61P6Z1 LU120270TL2A61P6Z1 LU120470TL2A61P6Z1	170 270 470	10
	Stainless steel	LU120170TL2AS7PNZ0 LU120270TL2AS7PNZ0 LU120470TL2AS7PNZ0	LU120170TL2AS8P6Z1 LU120270TL2AS8P6Z1 LU120470TL2AS8P6Z1	170 270 470	10
LU15AL	Special high carbon steel	LU150230AL2A70PNZ0 LU150430AL2A70PNZ0 LU150670AL2A70PNZ0	LU150230AL2A61P6Z1 LU150430AL2A61P6Z1 LU150670AL2A61P6Z1	230 430 670	15
	Stainless steel	LU150230AL2AS7PNZ0 LU150430AL2AS7PNZ0 LU150670AL2AS7PNZ0	LU150230AL2AS8P6Z1 LU150430AL2AS8P6Z1 LU150670AL2AS8P6Z1	230 430 670	15

*** Refer to the dimension tables for the rail dimension G.**

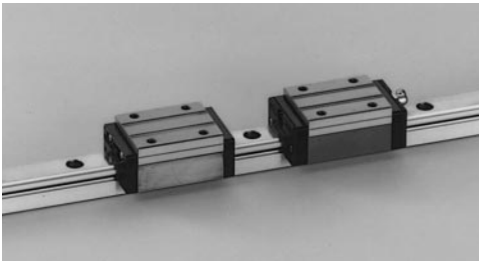
Table Ⅰ-4•15 Standardized LU Series in stock (Interchangeable part)

Model	Material	Interchangeable type	Rail reference number		Ball slide reference number
				Rail G* dimension	
LU09	Stainless steel	Interchangeable with fine clearance	L1U090115S L1U090195S L1U090275S L1U090115TS L1U090195TS L1U090275TS	7.5	LAU09ARS LAU09TRS
LU12	Stainless steel	Interchangeable with fine clearance	L1U120170S L1U120270S L1U120470S L1U120170TS L1U120270TS L1U120470TS	10	LAU12ARS LAU12TRS
LU15	Special high carbon steel/ Stainless steel	Interchangeable with fine clearance	L1U150230 L1U150430 L1U150670 L1U150990 L1U150230S L1U150430S L1U150670S L1U150990S	15	LAU15AL LAU15ALS

*** Refer to the dimension tables for the rail dimension G.**

A-Ⅰ-5 Model Number and Dimension Table of NSK Linear Guides

A-Ⅰ-5.1 LH Series



(1) High self-aligning capability (rolling direction)

Same as the DF combination in angular contact bearings, self-aligning capability is high because the cross point of the contact lines of balls and grooves comes inside, reducing moment rigidity.

This increases the capacity to absorb the error of installation.

(2) High load carrying capacity to vertical direction

The contact angle is set at 50 degrees, increasing load carrying capacity as well as rigidity in vertical direction.

(3) High resistance against shock load

The bottom ball groove is formed in gothic-arch and the center of the top and bottom grooves are offset as shown in Fig.Ⅰ-5•2. The vertical load is generally carried by the top rows, at where balls are contacting at two points. Because of this design, the bottom rows will carry load when a large impact load is applied vertically as shown in Fig.Ⅰ-5•3. This assures high resistance to the shock load.

(4) Highly accurate As shown in Fig.

Ⅰ-5.4, fixing the master rollers is easy thanks to the gothic-arch groove. This makes easy and accurate measuring of ball grooves.

(5) Interchangeable rail and ball slide (prompt delivery)

Randomly matching rails and ball slides are stocked as standardized interchangeable items. This reduces delivery time.

(6) Easy to handle, and designed with safety in mind.

Balls are retained in the retainer, therefore they do not fall out when theball slider is withdrawn from the rail.

(7) Abundant models and sizes

Each series has various models of ball slides, rendering the linear guide available for numerous uses.

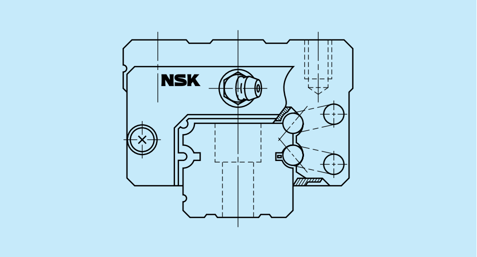


Fig. Ⅰ-5.1 LH Series

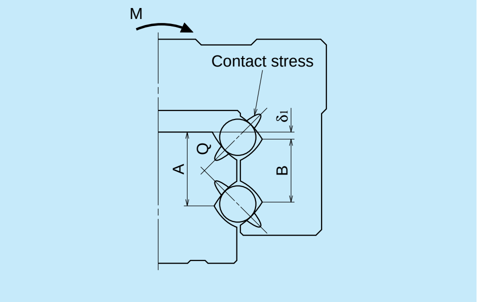


Fig. Ⅰ-5.2 Enlarged illustration of the offset gothic-arch

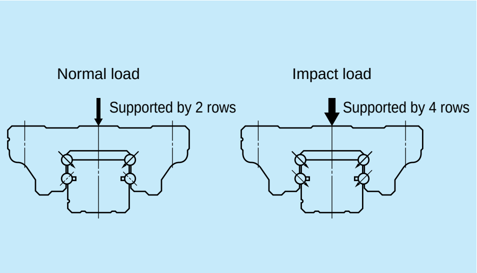
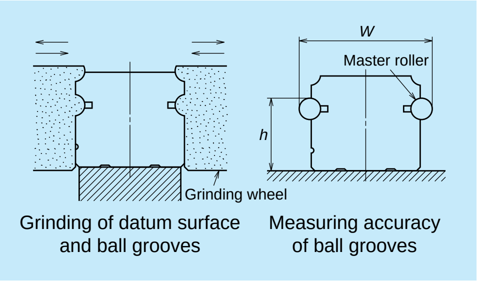


Fig. Ⅰ-5.3 When load is applied



Grinding of datum surface and ball grooves

Measuring accuracy of ball grooves

Fig. Ⅰ-5.4 Rail grinding and measuring

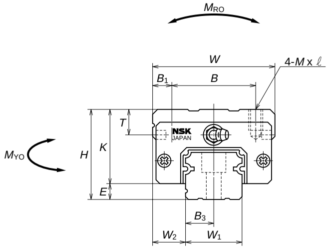
Dimensions of LH Series (Preloaded assembly)

LH-AN (High load type)
LH-BN (Super high load type)

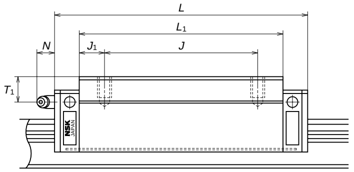
- **Specification number of preloaded assembly (Custom made assembly)**

LH35 0840 AN C 2 – PN Z0 – Ⅱ

- **Model number**: LH35
- **Rail length (mm)**: 0840
- **Ball slide shape**: AN
- **Material/surface treatment (See Page A24)**: C
  - **C: Standard material**
  - **K: Stainless steel (only for LH20-30)**
- **Number of ball slides per rail**: 2
- **Accuracy grade**: PN
  - **PN normal grade**
  - **P6 precision grade**
  - **P5 high precision grade**
  - **P4 super precision grade**
  - **P3 ultra precision grade**
- **Preload code**: Z0
  - **Z0 fine clearance**
  - **Z1 slight preload**
  - **Z3 medium preload**
- **Ⅱ refers to a set of 2 linear guides; no code refers to one**: Ⅱ



BN type



AN type

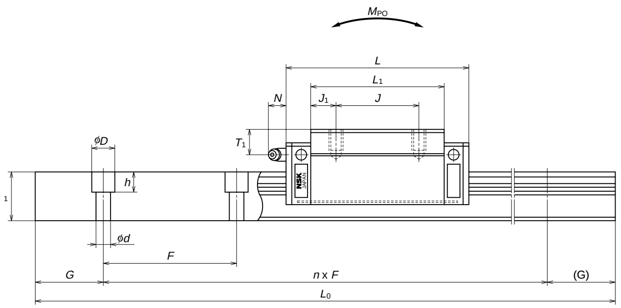


Table. Ⅰ-5•1

Unit: mm

Model No.	Assembly			Ball slide													Rail							Basic load rating					Ball dia.	Weight	
	Height			Width	Length	Mounting tap hole								Grease fitting			Width	Height	Pitch	Mounting bolt hole		G (recommended)	Max. length $L_{0max.}$ ( ) for stainless	Dynamic	Static	Static moment				Ball slide	Rail
	H	E	W_2	W	L	B	J	M x pitch x ℓ	B_1	L_1	J_1	K	T	Hole size	T_1	N	W_1	H_1	F	d x D x h	B_3			C	C_0	M_{RO}	M_{PO}	M_{YO}	D_W		
																								(N[kgf])		(N・m[kgf・m])				(kg)	(kg/m)
LH20AN	30	5	12	44	69.8	32	36	M5×0.8×6	6	50	7	25	12	M6×0.75	5	11	20	18	60	6×9.5×8.5	10	20	3960 (3500)	14200 [1450]	25100 [2560]	216 [22]	177 [18]	177 [18]	3.968	0.33	2.6
LH20BN					91.8		50			72	11													18200 [1860]	39500 [4020]	305 [31]	345 [35]	345 [35]		0.48	
LH25AN	40	7	12.5	48	79	35	35	M6×1×9	6.5	58	11.5	33	12	M6×0.75	10	11	23	22	60	7×11×9	11.5	20	3960 (3500)	21000 [2140]	39000 [4000]	355 [36]	315 [32]	305 [31]	4.762	0.55	3.6
LH25BN					107		50			86	18													26900 [2740]	52500 [5340]	470 [48]	530 [54]	520 [53]		0.82	
LH30AN	45	9	16	60	85.6	40	40	M8×1.25×10	10	59	9.5	36	14	M6×0.75	10	11	28	26	80	9×14×12	14	20	4000 (3500)	25700 [2620]	45000 [4570]	490 [50]	355 [36]	355 [36]	5.556	0.77	5.2
LH30BN					124.6		60			98	19													37500 [3800]	71500 [7310]	785 [80]	845 [86]	835 [85]		1.3	
LH35AN	55	9.5	18	70	109	50	50	M8×1.25×12	10	80	15	45.5	15	M6×0.75	15	11	34	29	80	9×14×12	17	20	4000	39000 [3960]	68500 [7010]	940 [96]	735 [75]	715 [73]	6.350	1.5	7.2
LH35BN					143		72			114	21													49500 [5060]	97500 [9930]	1330 [136]	1410 [144]	1380 [141]		2.1	
LH45AN	70	14	20.5	86	139	60	60	M10×1.5×17	13	105	22.5	56	17	PT1/8	20	13	45	38	105	14×20×17	22.5	22.5	3990	66000 [6740]	119000 [12100]	2120 [216]	1670 [170]	1650 [168]	7.937	3	12.3
LH45BN					171		80			137	28.5													79500 [8130]	146000 [14900]	2590 [264]	2460 [251]	2430 [248]		3.9	
LH55AN	80	15	23.5	100	163	75	75	M12×1.75×18	12.5	126	25.5	65	18	PT1/8	21	13	53	44	120	16×23×20	26.5	30	3960	97500 [9940]	168000 [17100]	3600 [367]	2870 [293]	2820 [288]	9.525	4.7	16.9
LH55BN					201		95			164	34.5													118000 [12000]	207000 [21100]	4400 [449]	4250 [435]	4150 [426]		6.1	
LH65AN	90	16	31.5	126	193	76	70	M16×2×20	25	147	38.5	74	23	PT1/8	19	13	63	53	150	18×26×22	31.5	35	3900	150000 [15100]	240000 [24500]	6150 [629]	4850 [495]	4750 [484]	11.906	7.7	24.3
LH65BN					253		120			207	43.5													189000 [19300]	320000 [32700]	8150 [834]	8350 [850]	8150 [830]		10.8	

LH-EL (High load type)
LH-GL (Super high load type)

- **Specification number of preloaded assembly (Custom made assembly)**

LH35 0840 EL C 2 – PN Z0 – Ⅱ

Model number

Rail length (mm)

Ball slide shape

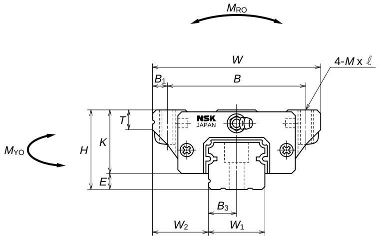
Material/surface treatment (See Page A24)
- **C: Standard material**
- **K: Stainless steel (only for LH20-30)**

Number of ball slides per rail

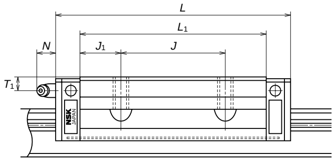
Accuracy grade
- **PN normal grade**
- **P6 precision grade**
- **P5 high precision grade**
- **P4 super precision grade**
- **P3 ultra precision grade**

Preload code
- **Z0 fine clearance**
- **Z1 slight preload**
- **Z3 medium preload**

Ⅱ refers to a set of 2 linear guides; no code refers to one



GL type



EL type

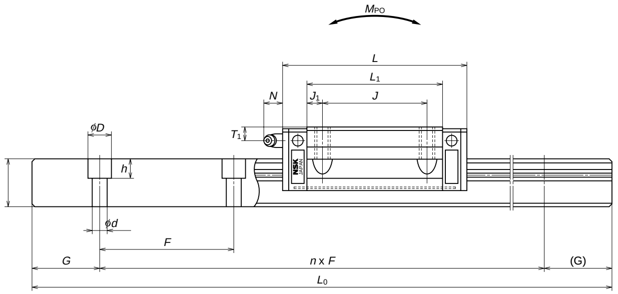


Table. Ⅰ-5•2

Unit: mm

Model No.	Assembly			Ball slide												
	Height			Width	Length	Mounting tap hole								Grease fitting		
	H	E	W_2	W	L	B	J	M x pitch x ℓ	B_1	L_1	J_1	K	T	Hole size	T_1	N
LH20EL	30	5	21.5	63	69.8	53	40	M6×1×10	5	50	5	25	10	M6×0.75	5	11
LH20GL					91.8					72	16					
LH25EL	36	7	23.5	70	79	57	45	M8×1.25×16	6.5	58	6.5	29	11	M6×0.75	6	11
LH25GL					107					86	20.5					
LH30EL	42	9	31	90	98.6	72	52	M10×1.5×18	9	72	10	33	11	M6×0.75	7	11
LH30GL					124.6					98	23					
LH35EL	48	9.5	33	100	109	82	62	M10×1.5×20	9	80	9	38.5	12	M6×0.75	8	11
LH35GL					143					114	26					
LH45EL	60	14	37.5	120	139	100	80	M12×1.75×24	10	105	12.5	46	13	PT1/8	10	13
LH45GL					171					137	28.5					
LH55EL	70	15	43.5	140	163	116	95	M14×2×28	12	126	15.5	55	15	PT1/8	11	13
LH55GL					201					164	34.5					
LH65EL	90	16	53.5	170	193	142	110	M16×2×24	14	147	18.5	74	23	PT1/8	19	13
LH65GL					253					207	48.5					
LH85GL	110	18	65	215	303	185	140	M20×2.5×30	15	243	51.5	92	30	PT1/8	23	13

Model No.	Rail							Basic load rating					Ball dia.	Weight	
	Width	Height	Pitch	Mounting bolt hole		G	Max. length	Dynamic	Static	Static moment				Ball slide	Rail
						(recommended)	$L_{0max.}$ ( ) for stainless	C	C_0	M_{RO}	M_{PO}	M_{YO}	D_W		
	W_1	H_1	F	d x D x h	B_3			(N[kgf])		(N · m[kgf · m])				(kg)	(kg/m)
LH20EL	20	18	60	6×9.5×8.5	10	20	3960 (3500)	14200 [1450]	25100 [2560]	216 [22]	177 [18]	177 [18]	3.968	0.45	2.6
LH20GL								18200 [1860]	39500 [4020]	305 [31]	345 [35]	345 [35]		0.65	
LH25EL	23	22	60	7×11×9	11.5	20	3960 (3500)	21000 [2140]	39000 [4000]	355 [36]	315 [32]	305 [31]	4.762	0.63	3.6
LH25GL								26900 [2740]	52500 [5340]	470 [48]	530 [54]	520 [53]		0.93	
LH30EL	28	26	80	9×14×12	14	20	4000 (3500)	29200 [2980]	54000 [5490]	590 [60]	490 [50]	480 [49]	5.556	1.2	5.2
LH30GL								37500 [3800]	71500 [7310]	785 [80]	845 [86]	835 [85]		1.6	
LH35EL	34	29	80	9×14×12	17	20	4000	39000 [3960]	68500 [7010]	940 [96]	735 [75]	715 [73]	6.350	1.7	7.2
LH35GL								49500 [5060]	97500 [9930]	1330 [136]	1410 [144]	1380 [141]		2.4	
LH45EL	45	38	105	14×20×17	22.5	22.5	3990	66000 [6740]	119000 [12100]	2120 [216]	1670 [170]	1650 [168]	7.937	3	12.3
LH45GL								79500 [8130]	146000 [14900]	2590 [264]	2460 [251]	2430 [248]		3.9	
LH55EL	53	44	120	16×23×20	26.5	30	3960	97500 [9940]	168000 [17100]	3600 [367]	2870 [293]	2820 [288]	9.525	5	16.9
LH55GL								118000 [12000]	207000 [21100]	4400 [449]	4250 [435]	4150 [426]		6.5	
LH65EL	63	53	150	18×26×22	31.5	35	3900	150000 [15100]	240000 [24500]	6150 [629]	4850 [495]	4750 [484]	11.906	10	24.3
LH65GL								189000 [19300]	320000 [32700]	8150 [834]	8350 [850]	8150 [830]		14.1	
LH85GL	85	65	180	24×35×28	42.5	45	2520	279000 [28500]	484000 [49400]	17000 [1730]	16100 [1640]	15700 [1600]	14.287	24.5	38.3

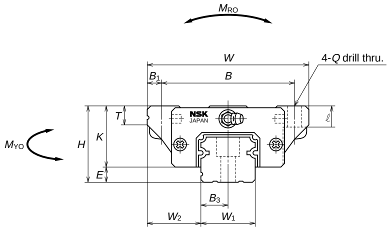
LH85 is the item on order.

LH-FL (High load type)
LH-HL (Super high load type)

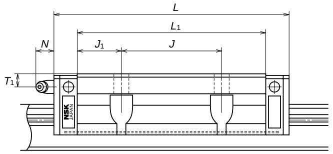
- **Specification number of preloaded assembly (Custom made assembly)**

LH35 0840 FL C 2 – PN Z0 – Ⅱ

- **Model number**: LH35
- **Rail length (mm)**: 0840
- **Ball slide shape**: FL
- **Material/surface treatment (See Page A24)**: C
  - C: Standard material
  - K: Stainless steel (only for LH20-30)
- **Number of ball slides per rail**: 2
- **Accuracy grade**: PN
  - PN normal grade
  - P6 precision grade
  - P5 high precision grade
  - P4 super precision grade
  - P3 ultra precision grade
- **Preload code**: Z0
  - Z0 fine clearance
  - Z1 slight preload
  - Z3 medium preload
- **Ⅱ refers to a set of 2 linear guides; no code refers to one**: Ⅱ



HL type



FL type

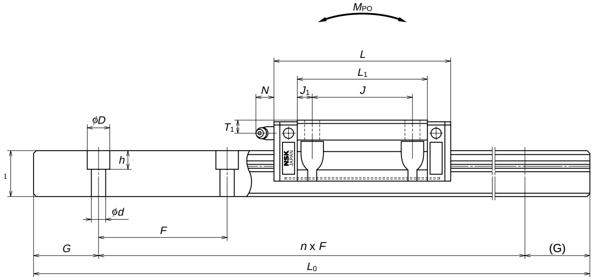


Table. Ⅰ-5•3

Unit: mm

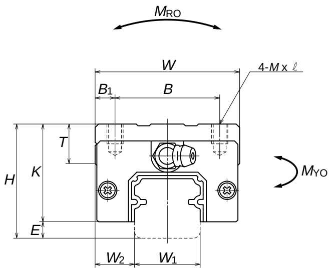
Model No.	Assembly			Ball slide													Rail							Basic load rating					Ball dia.	Weight	
	Height			Width	Length	Mounting hole								Grease fitting			Width	Height	Pitch	Mounting bolt hole		G (recommended)	Max. length $L_{0max.}$ ( ) for stainless	Dynamic	Static	Static moment				Ball slide	Rail
	H	E	W_2	W	L	B	J	Q x ℓ	B_1	L_1	J_1	K	T	Hole size	T_1	N	W_1	H_1	F	d x D x h	B_3			C	C_0	M_{RO}	M_{PO}	M_{YO}	D_W	(kg)	(kg/m)
																								(N[kgf])		(N · m[kgf · m])					
LH20FL	30	5	21.5	63	69.8	53	40	6×10	5	50	5	25	10	M6×0.75	5	11	20	18	60	6×9.5×8.5	10	20	3960 (3500)	14200 [1450]	25100 [2560]	216 [22]	177 [18]	177 [18]	3.968	0.45	2.6
LH20HL					91.8					72	16													18200 [1860]	39500 [4020]	305 [31]	345 [35]	345 [35]		0.65	
LH25FL	36	7	23.5	70	79	57	45	7×10	6.5	58	6.5	29	11	M6×0.75	6	11	23	22	60	7×11×9	11.5	20	3960 (3500)	21000 [2140]	39000 [4000]	355 [36]	315 [32]	305 [31]	4.762	0.63	3.6
LH25HL					107					86	20.5													26900 [2740]	52500 [5340]	470 [48]	530 [54]	520 [53]		0.93	
LH30FL	42	9	31	90	98.6	72	52	9×12	9	72	10	33	11	M6×0.75	7	11	28	26	80	9×14×12	14	20	4000 (3500)	29200 [2980]	54000 [5490]	590 [60]	490 [50]	480 [49]	5.556	1.2	5.2
LH30HL					124.6					98	23													37500 [3800]	71500 [7310]	785 [80]	845 [86]	835 [85]		1.6	
LH35FL	48	9.5	33	100	109	82	62	9×13	9	80	9	38.5	12	M6×0.75	8	11	34	29	80	9×14×12	17	20	4000	39000 [3960]	68500 [7010]	940 [96]	735 [75]	715 [73]	6.350	1.7	7.2
LH35HL					143					114	26													49500 [5060]	97500 [9930]	1330 [136]	1410 [144]	1380 [141]		2.4	
LH45FL	60	14	37.5	120	139	100	80	11×15	10	105	12.5	46	13	PT1/8	10	13	45	38	105	14×20×17	22.5	22.5	3990	66000 [6740]	119000 [12100]	2120 [216]	1670 [170]	1650 [168]	7.937	3	12.3
LH45HL					171					137	28.5													79500 [8130]	146000 [14900]	2590 [264]	2460 [251]	2430 [248]		3.9	
LH55FL	70	15	43.5	140	163	116	95	14×18	12	126	15.5	55	15	PT1/8	11	13	53	44	120	16×23×20	26.5	30	3960	97500 [9940]	168000 [17100]	3600 [367]	2870 [293]	2820 [288]	9.525	5	16.9
LH55HL					201					164	34.5													118000 [12000]	207000 [21100]	4400 [449]	4250 [435]	4150 [426]		6.5	
LH65FL	90	16	53.5	170	193	142	110	16×24	14	147	18.5	74	23	PT1/8	19	13	63	53	150	18×26×22	31.5	35	3900	150000 [15100]	240000 [24500]	6150 [629]	4850 [495]	4750 [484]	11.906	10	24.3
LH65HL					253					207	48.5													189000 [19300]	320000 [32700]	8150 [834]	8350 [850]	8150 [830]		14.1	
LH85HL	110	18	65	215	303	185	140	18×30	15	243	51.5	92	30	PT1/8	23	13	85	65	180	24×35×28	42.5	45	2520	279000 [28500]	484000 [49400]	17000 [1730]	16100 [1640]	15700 [1600]	14.287	24.5	38.3

LH85 is the item on order.

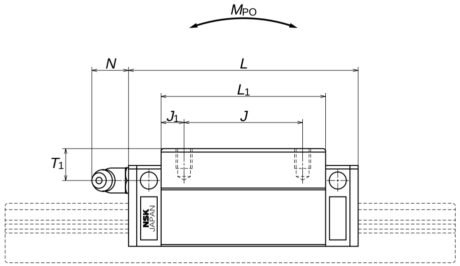
Dimensions of LH Series (Interchangeable ball slide)

LAH-AN (High load type)
LAH-BN (Super high load type)

- See "A-Ⅰ-4.2. Reference Number of the Standardized Linear Guide in Stock" in Page A26 for reference number of each interchangeable part.



AN type



BN type

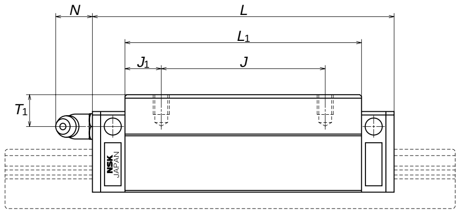


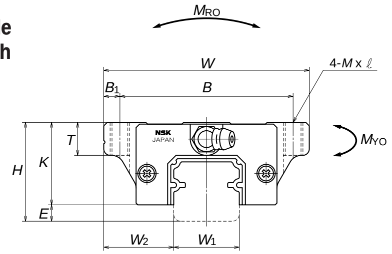
Table. Ⅰ-5•4

Unit: mm

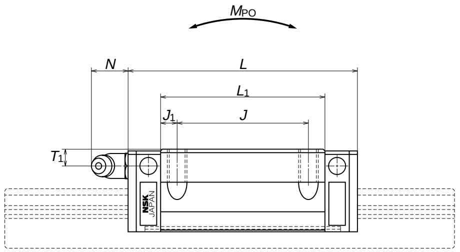
Model No.	Assembly			Ball slide													Basic load rating					Ball dia.	Weight
	Height			Width	Length	Mounting tap hole								Grease fitting			Dynamic	Static	Static moment				Ball slide
	H	E	W_2	W	L	B	J	M x pitch x ℓ	B_1	L_1	J_1	K	T	Hole size	T_1	N	C	C_0	M_{RO}	M_{PO}	M_{YO}	D_W	
																	(N[kgf])		(N · m[kgf · m])				(kg)
LAH20AN	30	5	12	44	69.8	32	36	M5×0.8×6	6	50	7	25	12	M6×0.75	5	11	14200 [1450]	25100 [2560]	216 [22]	177 [18]	177 [18]	3.968	0.33
LAH20BN					91.8		50			72	11						18200 [1860]	39500 [4020]	305 [31]	345 [35]	345 [35]		0.48
LAH25AN	40	7	12.5	48	79	35	35	M6×1×9	6.5	58	11.5	33	12	M6×0.75	10	11	21000 [2140]	39000 [4000]	355 [36]	315 [32]	305 [31]	4.762	0.55
LAH25BN					107		50			86	18						26900 [2740]	52500 [5340]	470 [48]	530 [54]	520 [53]		0.82
LAH30AN	45	9	16	60	85.6	40	40	M8×1.25×10	10	59	9.5	36	14	M6×0.75	10	11	25700 [2620]	45000 [4570]	490 [50]	355 [36]	355 [36]	5.556	0.77
LAH30BN					124.6		60			98	19						37500 [3800]	71500 [7310]	785 [80]	845 [86]	835 [85]		1.3
LAH35AN	55	9.5	18	70	109	50	50	M8×1.25×12	10	80	15	45.5	15	M6×0.75	15	11	39000 [3960]	68500 [7010]	940 [96]	735 [75]	715 [73]	6.350	1.5
LAH35BN					143		72			114	21						49500 [5060]	97500 [9930]	1330 [136]	1410 [144]	1380 [141]		2.1
LAH45AN	70	14	20.5	86	139	60	60	M10×1.5×17	13	105	22.5	56	17	PT1/8	20	13	66000 [6740]	119000 [12100]	2120 [216]	1670 [170]	1650 [168]	7.937	3
LAH45BN					171		80			137	28.5						79500 [8130]	146000 [14900]	2590 [264]	2460 [251]	2430 [248]		3.9
LAH55AN	80	15	23.5	100	163	75	75	M12×1.75×18	12.5	126	25.5	65	18	PT1/8	21	13	97500 [9940]	168000 [17100]	3600 [367]	2870 [293]	2820 [288]	9.525	4.7
LAH55BN					201		95			164	34.5						118000 [12000]	207000 [21100]	4400 [449]	4250 [435]	4150 [426]		6.1
LAH65AN	90	16	31.5	126	193	76	70	M16×2×20	25	147	38.5	74	23	PT1/8	19	13	150000 [15100]	240000 [24500]	6150 [629]	4850 [495]	4750 [484]	11.906	7.7
LAH65BN					253		120			207	43.5						189000 [19300]	320000 [32700]	8150 [834]	8350 [850]	8150 [830]		10.8

LAH-EL (High load type)
LAH-GL (Super high load type)

- See "A-Ⅰ-4.2. Reference Number of the Standardized Linear Guide in Stock" in Page A26 for reference number of each interchangeable part.



EL type



GL type

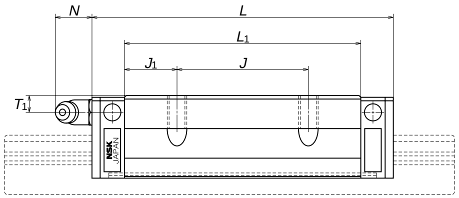


Table. Ⅰ-5•5

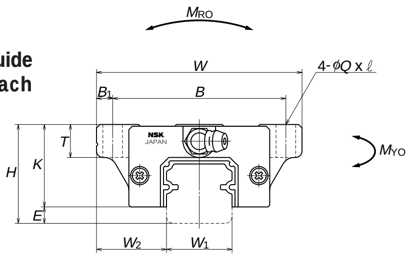
Unit: mm

Model No.	Assembly			Ball slide													Basic load rating					Ball dia.	Weight
	Height			Width	Length	Mounting tap hole								Grease fitting			Dynamic	Static	Static moment				Ball slide
	H	E	W_2	W	L	B	J	M x pitch x ℓ	B_1	L_1	J_1	K	T	Hole size	T_1	N	C	C_0	M_{RO}	M_{PO}	M_{YO}	D_w	
																	(N[kgf])		(N・m[kgf・m])				(kg)
LAH20EL	30	5	21.5	63	69.8	53	40	M6×1×10	5	50	5	25	10	M6×0.75	5	11	14200 [1450]	25100 [2560]	216 [22]	177 [18]	177 [18]	3.968	0.45
LAH20GL					91.8					72	16						18200 [1860]	39500 [4020]	305 [31]	345 [35]	345 [35]		0.65
LAH25EL	36	7	23.5	70	79	57	45	M8×1.25×16	6.5	58	6.5	29	11	M6×0.75	6	11	21000 [2140]	39000 [4000]	355 [36]	315 [32]	305 [31]	4.762	0.63
LAH25GL					107					86	20.5						26900 [2740]	52500 [5340]	470 [48]	530 [54]	520 [53]		0.93
LAH30EL	42	9	31	90	98.6	72	52	M10×1.5×18	9	72	10	33	11	M6×0.75	7	11	29200 [2980]	54000 [5490]	590 [60]	490 [50]	480 [49]	5.556	1.2
LAH30GL					124.6					98	23						37500 [3800]	71500 [7310]	785 [80]	845 [86]	835 [85]		1.6
LAH35EL	48	9.5	33	100	109	82	62	M10×1.5×20	9	80	9	38.5	12	M6×0.75	8	11	39000 [3960]	68500 [7010]	940 [96]	735 [75]	715 [73]	6.350	1.7
LAH35GL					143					114	26						49500 [5060]	97500 [9930]	1330 [136]	1410 [144]	1380 [141]		2.4
LAH45EL	60	14	37.5	120	139	100	80	M12×1.75×24	10	105	12.5	46	13	PT1/8	10	13	66000 [6740]	119000 [12100]	2120 [216]	1670 [170]	1650 [168]	7.937	3
LAH45GL					171					137	28.5						79500 [8130]	146000 [14900]	2590 [264]	2460 [251]	2430 [248]		3.9
LAH55EL	70	15	43.5	140	163	116	95	M14×2×28	12	126	15.5	55	15	PT1/8	11	13	97500 [9940]	168000 [17100]	3600 [367]	2870 [293]	2820 [288]	9.525	5
LAH55GL					201					164	34.5						118000 [12000]	207000 [21100]	4400 [449]	4250 [435]	4150 [426]		6.5
LAH65EL	90	16	53.5	170	193	142	110	M16×2×24	14	147	18.5	74	23	PT1/8	19	13	150000 [15100]	240000 [24500]	6150 [629]	4850 [495]	4750 [484]	11.906	10
LAH65GL					253					207	48.5						189000 [19300]	320000 [32700]	8150 [834]	8350 [850]	8150 [830]		14.1

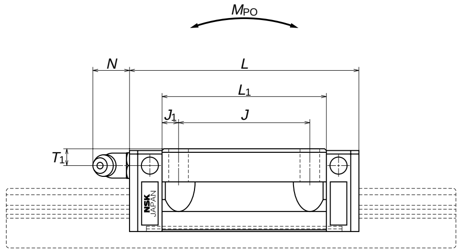
Standard stock

LAH-FL (High load type)
LAH-HL (Super high load type)

- **See "A-Ⅰ-4.2. Reference Number of the Standardized Linear Guide in Stock" in Page A26 for reference number of each interchangeable part.**



FL type



HL type

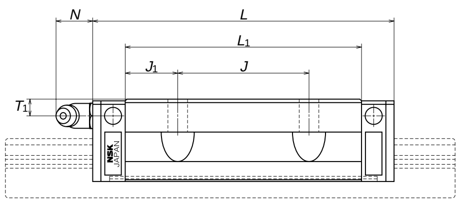


Table. Ⅰ-5•6

Unit: mm

Model No.	Assembly			Ball slide										Grease fitting			Basic load rating					Ball dia.	Weight
	Height			Width	Length	Mounting hole											Dynamic	Static	Static moment				Ball slide
	H	E	W_2	W	L	B	J	Q x ℓ	B_1	L_1	J_1	K	T	Hole size	T_1	N	C	C_0	M_{RO}	M_{PO}	M_{YO}	D_w	
																	(N[kgf])		(N・m[kgf・m])				(kg)
LAH20FL	30	5	21.5	63	69.8	53	40	6×10	5	50	5	25	10	M6×0.75	5	11	14200 [1450]	25100 [2560]	216 [22]	177 [18]	177 [18]	3.968	0.45
LAH20HL					91.8					72	16						18200 [1860]	39500 [4020]	305 [31]	345 [35]	345 [35]		0.65
LAH25FL	36	7	23.5	70	79	57	45	7×10	6.5	58	6.5	29	11	M6×0.75	6	11	21000 [2140]	39000 [4000]	355 [36]	315 [32]	305 [31]	4.762	0.63
LAH25HL					107					86	20.5						26900 [2740]	52500 [5340]	470 [48]	530 [54]	520 [53]		0.93
LAH30FL	42	9	31	90	98.6	72	52	9×12	9	72	10	33	11	M6×0.75	7	11	29200 [2980]	54000 [5490]	590 [60]	490 [50]	480 [49]	5.556	1.2
LAH30HL					124.6					98	23						37500 [3800]	71500 [7310]	785 [80]	845 [86]	835 [85]		1.6
LAH35FL	48	9.5	33	100	109	82	62	9×13	9	80	9	38.5	12	M6×0.75	8	11	39000 [3960]	68500 [7010]	940 [96]	735 [75]	715 [73]	6.350	1.7
LAH35HL					143					114	26						49500 [5060]	97500 [9930]	1330 [136]	1410 [144]	1380 [141]		2.4
LAH45FL	60	14	37.5	120	139	100	80	11×15	10	105	12.5	46	13	PT1/8	10	13	66000 [6740]	119000 [12100]	2120 [216]	1670 [170]	1650 [168]	7.937	3
LAH45HL					171					137	28.5						79500 [8130]	146000 [14900]	2590 [264]	2460 [251]	2430 [248]		3.9
LAH55FL	70	15	43.5	140	163	116	95	14×18	12	126	15.5	55	15	PT1/8	11	13	97500 [9940]	168000 [17100]	3600 [367]	2870 [293]	2820 [288]	9.525	5
LAH55HL					201					164	34.5						118000 [12000]	207000 [21100]	4400 [449]	4250 [435]	4150 [426]		6.5
LAH65FL	90	16	53.5	170	193	142	110	16×24	14	147	18.5	74	23	PT1/8	19	13	150000 [15100]	240000 [24500]	6150 [629]	4850 [495]	4750 [484]	11.906	10
LAH65HL					253					207	43.5						189000 [19300]	320000 [32700]	8150 [834]	8350 [850]	8150 [830]		14.1

Standard stock

Dimensions of LH Series (Interchangeable rail)

Dimensions of LH Series (Interchangeable rail)

Regular rails	Butting rails
L1H (Fine clearance)	L1H-01 (Fine clearance)
L1H-Z (Slight preload)	L1H-01Z (Slight preload)

- **See " A-Ⅰ-4•2 Reference Number of the Standardized Linear Guide in Stock" on Page A26 for reference number of each interchangeable part.**

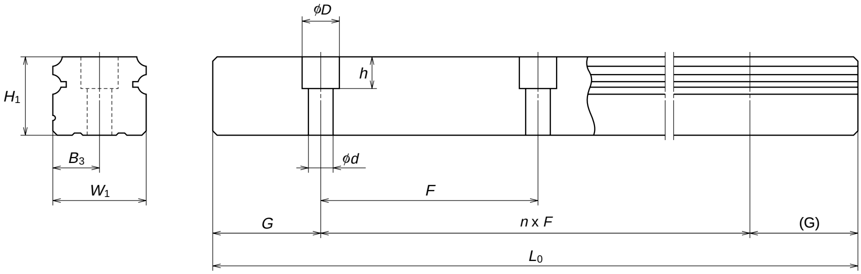


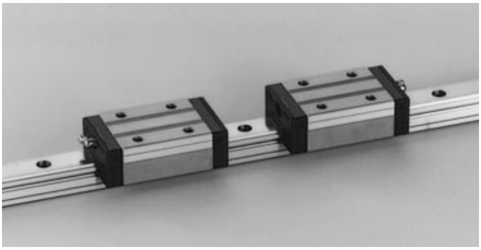
Table Ⅰ-5•7

Unit: mm

Model No.	Rail							Weight
	Width W_1	Height H_1	Pitch F	Mounting bolt hole $d \times D \times h$	B_3	G Recommended	Max. length L_{0MAX}	Rail (Kg/m)
L1H20	20	18	60	6×9.5×8.5	10	20	3960	2.6
L1H25	23	22	60	7×11×9	11.5	20	3960	3.6
L1H30	28	26	80	9×14×12	14	20	4000	5.2
L1H35	34	29	80	9×14×12	17	20	4000	7.2
L1H45	45	38	105	14×20×17	22.5	22.5	3990	12.3
L1H55	53	44	120	16×23×20	26.5	30	3960	16.9
L1H65	63	53	150	18×26×22	31.5	35	3900	24.3

G dimension is $1/2F^{\,0}_{-0.5}$ for butting rail.

A-Ⅰ-5.2 LS Series



(1) High self aligning capability (rolling direction)

Same as the DF combination in angular contact bearings, self-aligning capability is high because the cross point of the contact lines of balls and grooves comes inside, reducing moment rigidity. This increases the capacity to absorb the error of installation.

(2) High load carrying capacity to vertical direction

The contact angle is set at 50 degrees, increasing load carrying capacity as well as rigidity against the load in vertical direction.

(3) High resistance against shock load

The bottom ball groove is formed in gothic-arch and the center of the top and bottom grooves are offset as shown in Fig. Ⅰ-5•6. The vertical load is usually carried by top 2 rows at where balls are contacting at two points. Because of this design, the bottom rows will carry the load when a large impact load is applied as shown in Fig. Ⅰ-5•7. This assures high resistance to the shock load.

(4) Highly accurate

As shown in Fig. Ⅰ-5•8, fixing the measuring rollers is simple thanks to the gothic-arch groove. This makes easy and accurate measuring of ball- grooves.

(5) Interchangeable rail and ball slide (short delivery time)

Randomly matching rails and ball slides are stocked as standardized interchangeable items. This reduces delivery time.

(6) Easy to handle, and designed with safety in mind.

Balls are retained in the retainer and do not fall out when the ball slide is withdrawn from the rail.

(7) Abundant models and sizes come in series.

Each series have several ball slide models, rendering the linear guide available for numerous uses. The LS Series also has standardized long stainless- steel rail (maximum: 3 500 mm).

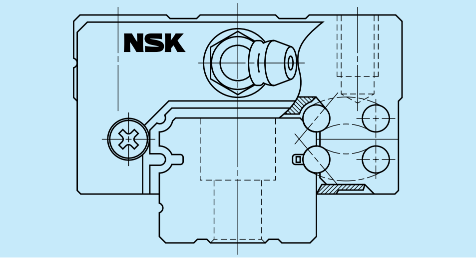


Fig. Ⅰ-5•5 LS Series

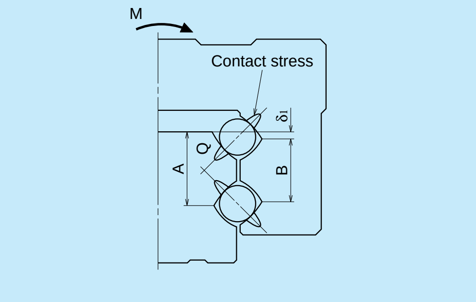


Fig. Ⅰ-5•6 Enlarged illustration: Offset gothic-arch

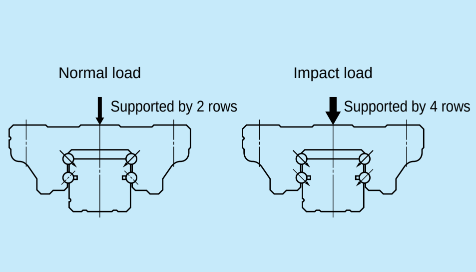
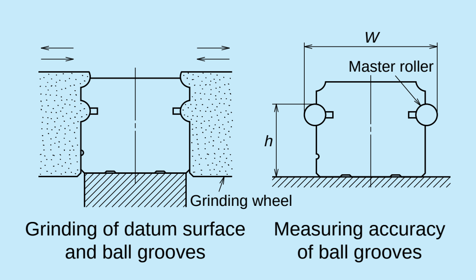


Fig. Ⅰ-5•7 When load is applied



Grinding of datum surface and ball grooves

Measuring accuracy of ball grooves

Fig. Ⅰ-5•8 Rail-grinding and measuring

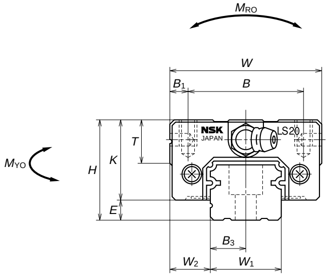
Dimensions of LS Series (Preloaded assembly)

LS-CL (Medium load type)
LS-AL (High load type)

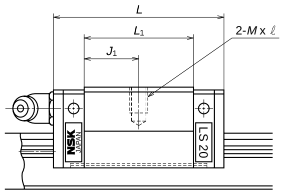
- **Specification number of preloaded assembly (Custom made assembly)**

L H 3 5 0 8 4 0 A L C 2 – P N Z 0 – Ⅱ

- **Model number**: LH35
- **Rail length (mm)**: 0840
- **Ball slide shape**: AL
- **Material/surface treatment (See Page A24)**: C
  - **C: Standard material**
  - **K: Stainless steel**
- **Number of ball slides per rail**: 2
- **Accuracy grade**: PN
  - **PN normal grade**
  - **P6 precision grade**
  - **P5 high precision grade**
  - **P4 super precision grade**
  - **P3 ultra precision grade**
- **Preload code**: Z0
  - **Z0 fine clearance**
  - **Z1 slight preload**
  - **Z3 medium preload**
- **Ⅱ refers to a set of 2 linear guides; no code refers to one**



CL type



AL type

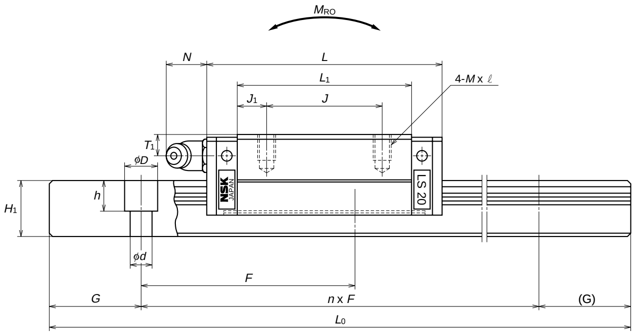


Table. Ⅰ-5•8

Unit: mm

Model No.	Assembly			Ball slide													Rail							Basic load rating					Ball dia.	Weight	
	Height			Width	Length	Mounting tap hole								Grease fitting			Width	Height	Pitch	Mounting bolt hole		G (recommended)	Max. length $L_{0max.}$ ( ) for stainless	Dynamic	Static	Static moment				Ball slide	Rail
	H	E	W_2	W	L	B	J	M x pitch x ℓ	B_1	L_1	J_1	K	T	Hole size	T_1	N	W_1	H_1	F	d x D x h	B_3			C	C_0	M_{RO}	M_{PO}	M_{YO}	D_W	(kg)	(kg/m)
																								(N[kgf])		(N · m[kgf · m])					
LS15CL	24	4.6	9.5	34	40.4	26	—	M4×0.7×6	4	23.6	11.8	19.4	10	φ 3	6	3	15	12.5	60	✻ 3.5×6×4.5 4.5×7.5×5.3	7.5	20	2000 (1700)	4550 [465]	8300 [845]	39 [4]	20 [2]	20 [2]	2.778	0.14	1.4
LS15AL					56.8		26			40	7													6700 [685]	12500 [1270]	69 [7]	49 [5]	49 [5]		0.20	
LS20CL	28	6	11	42	47.2	32	—	M5×0.8×7	5	30	15	22	12	M6×0.75	5.5	11	20	15.5	60	6×9.5×8.5	10	20	3960 (3500)	6550 [670]	12200 [1240]	88 [9]	39 [4]	39 [4]	3.175	0.19	2.3
LS20AL					65.2		32			48	8													8900 [910]	17500 [1780]	127 [13]	88 [9]	88 [9]		0.28	
LS25CL	33	7	12.5	48	59.6	35	—	M6×1×9	6.5	38	19	26	12	M6×0.75	7	11	23	18	60	7×11×9	11.5	20	3960 (3500)	10600 [1080]	18600 [1900]	137 [14]	69 [7]	69 [7]	3.968	0.34	3.1
LS25AL					81.6		35			60	12.5													14400 [1470]	29100 [2970]	245 [25]	206 [21]	196 [20]		0.51	
LS30CL	42	9	16	60	67.4	40	—	M8×1.25×12	10	42	21	33	13	M6×0.75	8	11	28	23	80	7×11×9	14	20	4000 (3500)	15900 [1620]	26500 [2700]	245 [25]	108 [11]	108 [11]	4.762	0.58	4.8
LS30AL					96.4		40			71	15.5													23400 [2390]	43000 [4400]	470 [48]	355 [36]	355 [36]		0.85	
LS35CL	48	10.5	18	70	77	50	—	M8×1.25×12	10	49	24.5	37.5	14	M6×0.75	8.5	11	34	27.5	80	9×14×12	17	20	4000 (3500)	22100 [2250]	36000 [3650]	410 [42]	177 [18]	177 [18]	5.556	0.86	7.0
LS35AL					108		50			80	15													32500 [3320]	58500 [5940]	775 [79]	570 [58]	560 [57]		1.3	

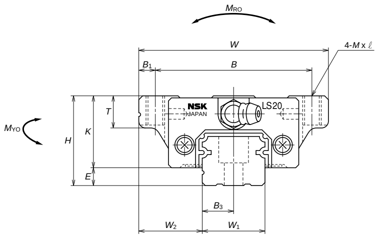
✻Either M3 (3.5x6x4.5) or M4 (4.5x7.5x5.3) is available for mounting LS15 rail. "T" is added to the end of length code in the reference number of interchangeable rail with M4 mounting hole.

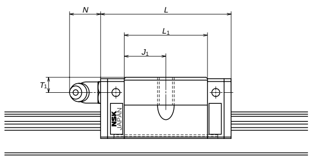
LS-EL (High load type)

**• Specification number of preloaded assembly
(Custom made assembly)**

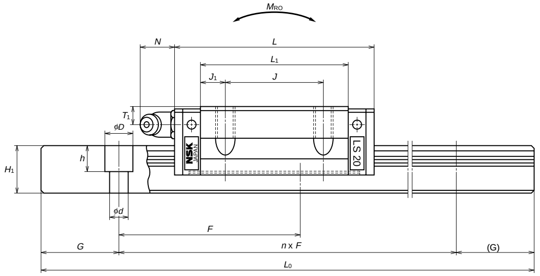
LH35 0840 EL C 2 – PN Z0 – Ⅱ

- **Model number** (LH35)
- **Rail length (mm)** (0840)
- **Ball slide shape** (EL)
- **Material/surface treatment (See Page A24)** (C)
  - **C: Standard material**
  - **K: Stainless steel**
- **Number of ball slides per rail** (2)
- **Accuracy grade** (PN)
  - **PN normal grade**
  - **P6 precision grade**
  - **P5 high precision grade**
  - **P4 super precision grade**
  - **P3 ultra precision grade**
- **Preload code** (Z0)
  - **Z0 fine clearance**
  - **Z1 slight preload**
  - **Z3 medium preload**
- **Ⅱ refers to a set of 2 linear guides; no code refers to one** (Ⅱ)





JL type



EL type

Table. Ⅰ-5•9

Unit: mm

Model No.	Assembly			Ball slide													Rail							Basic load rating					Ball dia.	Weight	
	Height			Width	Length	Mounting tap hole								Grease fitting			Width	Height	Pitch	Mounting bolt hole		G	Max. length	Dynamic	Static	Static moment				Ball slide	Rail
	H	E	W_2	W	L	B	J	M x pitch x ℓ	B_1	L_1	J_1	K	T	Hole size	T_1	N	W_1	H_1	F	d x D x h	B_3	(recommended)	L_{0max}. ( ) for stainless	C	C_0	M_{RO}	M_{PO}	M_{YO}	D_W	(kg)	(kg/m)
																								(N[kgf])		(N · m[kgf · m])					
LS15JL	24	4.6	18.5	52	40.4	41	—	M5×0.8×6	5.5	23.6	11.8	19.4	8	ϕ3	6	3	15	12.5	60	✻ 3.5×6×4.5 4.5×7.5×5.3	7.5	20	2000 (1700)	4550 [465]	8300 [845]	39 [4]	20 [2]	20 [2]	2.778	0.17	1.4
LS15EL					56.8		26			40	7													6700 [685]	12500 [1270]	69 [7]	49 [5]	49 [5]		0.26	
LS20JL	28	6	19.5	59	47.2	49	—	M6×1×10	5	30	15	22	10	M6×0.75	5.5	11	20	15.5	60	6×9.5×8.5	10	20	3960 (3500)	6550 [670]	12200 [1240]	88 [9]	39 [4]	39 [4]	3.175	0.24	2.3
LS20EL					65.2		32			48	8													8900 [910]	17500 [1780]	127 [13]	88 [9]	88 [9]		0.35	
LS25JL	33	7	25	73	59.6	60	—	M8×1.25×12	6.5	38	19	26	11	M6×0.75	7	11	23	18	60	7×11×9	11.5	20	3960 (3500)	10600 [1080]	18600 [1900]	137 [14]	69 [7]	69 [7]	3.968	0.44	3.1
LS25EL					81.6		35			60	12.5													14400 [1470]	29100 [2970]	245 [25]	206 [21]	196 [20]		0.66	
LS30JL	42	9	31	90	67.4	72	—	M10×1.5×18	9	42	21	33	11	M6×0.75	8	11	28	23	80	7×11×9	14	20	4000 (3500)	15900 [1620]	26500 [2700]	245 [25]	108 [11]	108 [11]	4.762	0.76	4.8
LS30EL					96.4		40			71	15.5													23400 [2390]	43000 [4400]	470 [48]	355 [36]	355 [36]		1.2	
LS35JL	48	10.5	33	100	77	82	—	M10×1.5×20	9	49	24.5	37.5	12	M6×0.75	8.5	11	34	27.5	80	9×14×12	17	20	4000 (3500)	22100 [2250]	36000 [3650]	410 [42]	177 [18]	177 [18]	5.556	1.2	7.0
LS35EL					108		50			80	15													32500 [3320]	58500 [5940]	775 [79]	570 [58]	560 [57]		1.7	

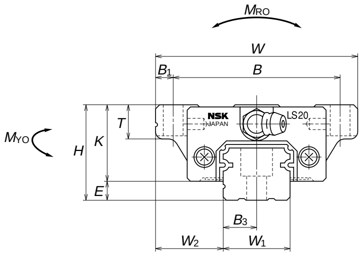
✻Either M3 (3.5x6x4.5) or M4 (4.5x7.5x5.3) is available for mounting LS15 rail. "T" is added to the end of length code in the reference number of interchangeable rail with M4 mounting hole.

LS-KL (Medium load type)
LS-FL (High load type)

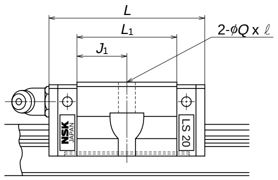
- **Specification number of preloaded assembly (Custom made assembly)**

LH35 0840 FL C 2 – PN Z0 – Ⅱ

- **Model number** (LH35)
- **Rail length (mm)** (0840)
- **Ball slide shape** (FL)
- **Material/surface treatment (See Page A24)** (C)
  - **C: Standard material**
  - **K: Stainless steel**
- **Number of ball slides per rail** (2)
- **Accuracy grade** (PN)
  - **PN normal grade**
  - **P6 precision grade**
  - **P5 high precision grade**
  - **P4 super precision grade**
  - **P3 ultra precision grade**
- **Preload code** (Z0)
  - **Z0 fine clearance**
  - **Z1 slight preload**
  - **Z3 medium preload**
- **Ⅱ refers to a set of 2 linear guides; no code refers to one** (Ⅱ)



KL type



FL type

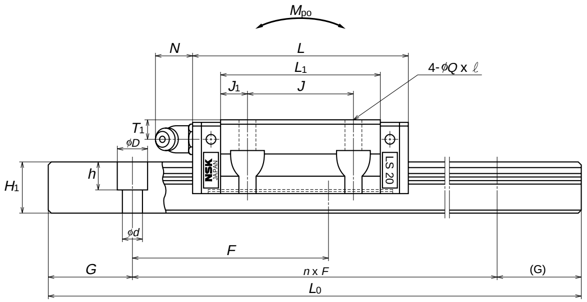


Table. Ⅰ-5•10

Unit: mm

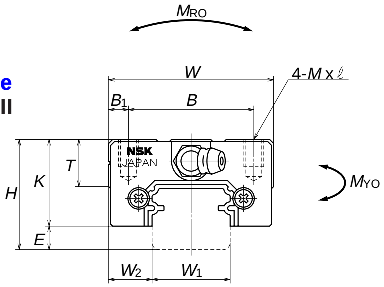
Model No.	Assembly			Ball slide													Rail							Basic load rating					Ball dia.	Weight	
	Height			Width	Length	Mounting hole								Grease fitting			Width	Height	Pitch	Mounting bolt hole		G (recommended)	Max. length L_{0max}. ( ) for stainless	Dynamic	Static	Static moment				Ball slide	Rail
	H	E	W_2	W	L	B	J	Q x ℓ	B_1	L_1	J_1	K	T	Hole size	T_1	N	W_1	H_1	F	d x D x h	B_3			C (N[kgf])	C_0 (N[kgf])	M_{RO} (N・m[kgf・m])	M_{PO} (N・m[kgf・m])	M_{YO} (N・m[kgf・m])	D_W	(kg)	(kg/m)
LS15KL	24	4.6	18.5	52	40.4	41	—	4.5×7	5.5	23.6	11.8	19.4	8	ϕ3	6	3	15	12.5	60	✻ 3.5×6×4.5 4.5×7.5×5.3	7.5	20	2000 (1700)	4550 [465]	8300 [845]	39 [4]	20 [2]	20 [2]	2.778	0.17	1.4
LS15FL					56.8		26			40	7													6700 [685]	12500 [1270]	69 [7]	49 [5]	49 [5]		0.26	
LS20KL	28	6	19.5	59	47.2	49	—	5.5×9	5	30	15	22	10	M6×0.75	5.5	11	20	15.5	60	6×9.5×8.5	10	20	3960 (3500)	6550 [670]	12200 [1240]	88 [9]	39 [4]	39 [4]	3.175	0.24	2.3
LS20FL					65.2		32			48	8													8900 [910]	17500 [1780]	127 [13]	88 [9]	88 [9]		0.35	
LS25KL	33	7	25	73	59.6	60	—	7×10	6.5	38	19	26	11	M6×0.75	7	11	23	18	60	7×11×9	11.5	20	3960 (3500)	10600 [1080]	18600 [1900]	137 [14]	69 [7]	69 [7]	3.968	0.44	3.1
LS25FL					81.6		35			60	12.5													14400 [1470]	29100 [2970]	245 [25]	206 [21]	196 [20]		0.66	
LS30KL	42	9	31	90	67.4	72	—	9×12	9	42	21	33	11	M6×0.75	8	11	28	23	80	7×11×9	14	20	4000 (3500)	15900 [1620]	26500 [2700]	245 [25]	108 [11]	108 [11]	4.762	0.76	4.8
LS30FL					96.4		40			71	15.5													23400 [2390]	43000 [4400]	470 [48]	355 [36]	355 [36]		1.2	
LS35KL	48	10.5	33	100	77	82	—	9×13	9	49	24.5	37.5	12	M6×0.75	8.5	11	34	27.5	80	9×14×12	17	20	4000 (3500)	22100 [2250]	36000 [3650]	410 [42]	177 [18]	177 [18]	5.556	1.2	7.0
LS35FL					108		50			80	15													32500 [3320]	58500 [5940]	775 [79]	570 [58]	560 [57]		1.7	

✻Either M3 (3.5x6x4.5) or M4 (4.5x7.5x5.3) is available for mounting LS15 rail. "T" is added to the end of length code in the reference number of interchangeable rail with M4 mounting hole.

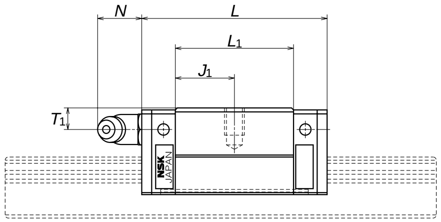
Dimensions of LS Series (Interchangeable ball slide)

LAS-CL (Medium load type)
LAS-AL (High load type)

- **See "Table Ⅰ-4•6 Standardized LS series in stock" on Page A30 for reference number of each interchangeable ball slide.**



CL type



AL type

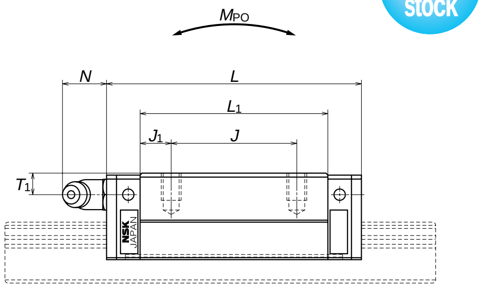


Table. Ⅰ-5•11

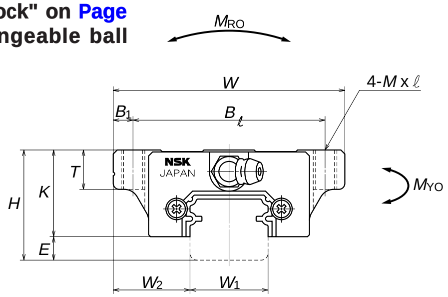
Unit: mm

Model No.	Assembly: Height H	E	W_2	Ball slide: Width W	Length L	Mounting tap hole: B	J	M x pitch x ℓ	B_1	L_1	J_1	K	T	Grease fitting: Hole size	T_1	N	Basic load rating: Dynamic C (N[kgf])	Static C_0 (N[kgf])	Static moment M_{RO} (N・m[kgf・m])	M_{PO}	M_{YO}	Ball dia. D_w	Weight Ball slide (kg)
LAS15CL	24	4.6	9.5	34	40.4	26	—	M4×0.7×6	4	23.6	11.8	19.4	10	ϕ 3	6	3	4550 [465]	8300 [845]	39 [4]	20 [2]	20 [2]	2.778	0.14
LAS15AL					56.8		26			40	7						6700 [685]	12500 [1270]	69 [7]	49 [5]	49 [5]		0.20
LAS20CL	28	6	11	42	47.2	32	—	M5×0.8×7	5	30	15	22	12	M6×0.75	5.5	11	6550 [670]	12200 [1240]	88 [9]	39 [4]	39 [4]	3.175	0.19
LAS20AL					65.2		32			48	8						8900 [910]	17500 [1780]	127 [13]	88 [9]	88 [9]		0.28
LAS25CL	33	7	12.5	48	59.6	35	—	M6×1×9	6.5	38	19	26	12	M6×0.75	7	11	10600 [1080]	18600 [1900]	137 [14]	69 [7]	69 [7]	3.968	0.34
LAS25AL					81.6		35			60	12.5						14400 [1470]	29100 [2970]	245 [25]	206 [21]	196 [20]		0.51
LAS30CL	42	9	16	60	67.4	40	—	M8×1.25×12	10	42	21	33	13	M6×0.75	8	11	15900 [1620]	26500 [2700]	245 [25]	108 [11]	108 [11]	4.762	0.58
LAS30AL					96.4		40			71	15.5						23400 [2390]	43000 [4400]	470 [48]	355 [36]	355 [36]		0.85
LAS35CL	48	10.5	18	70	77	50	—	M8×1.25×12	10	49	24.5	37.5	14	M6×0.75	8.5	11	22100 [2250]	36000 [3650]	410 [42]	177 [18]	177 [18]	5.556	0.86
LAS35AL					108		50			80	15						32500 [3320]	58500 [5940]	775 [79]	570 [58]	560 [57]		1.3

Standard stock

LAS-EL (High load type)

- See "Table Ⅰ-4•6 Standardized LS series in stock" on Page A30 for reference number of each interchangeable ball slide.



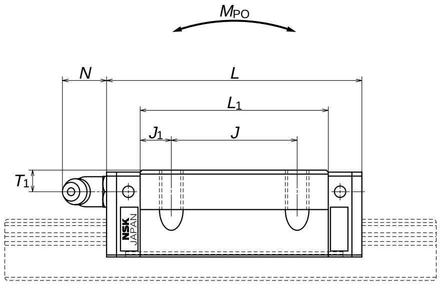


Table. Ⅰ-5•12

Unit: mm

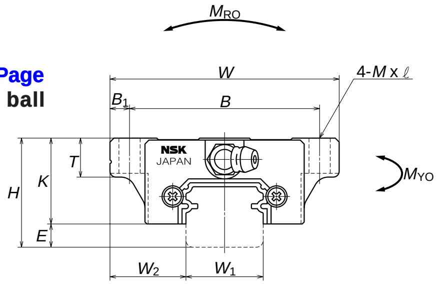
Model No.	Assembly			Ball slide									
	Height			Width	Length	Mounting tap hole							
	H	E	W_2	W	L	B	J	M x pitch x ℓ	B_1	L_1	J_1	K	T
LAS15EL	24	4.6	18.5	52	56.8	41	26	M5×0.8×6	5.5	40	7	19.4	8
LAS20EL	28	6	19.5	59	65.2	49	32	M6×1×10	5	48	8	22	10
LAS25EL	33	7	25	73	81.6	60	35	M8×1.25×12	6.5	60	12.5	26	11
LAS30EL	42	9	31	90	96.4	72	40	M10×1.5×18	9	71	15.5	33	11
LAS35EL	48	10.5	33	100	108	82	50	M10×1.5×20	9	80	15	37.5	12

Model No.				Basic load rating					Ball dia.	Weight
	Grease fitting			Dynamic	Static	Static moment				Ball slide (kg)
				C	C_0	M_{RO}	M_{PO}	M_{YO}		
	Hole size	T_1	N	(N[kgf])		(N · m[kgf · m])			D_w	
LAS15EL	ϕ 3	6	3	6700 [685]	12500 [1270]	69 [7]	49 [5]	49 [5]	2.778	0.26
LAS20EL	M6×0.75	5.5	11	8900 [910]	17500 [1780]	127 [13]	88 [9]	88 [9]	3.175	0.35
LAS25EL	M6×0.75	7	11	14400 [1470]	29100 [2970]	245 [25]	206 [21]	196 [20]	3.968	0.66
LAS30EL	M6×0.75	8	11	23400 [2390]	43000 [4400]	470 [48]	355 [36]	355 [36]	4.762	1.2
LAS35EL	M6×0.75	8.5	11	32500 [3320]	58500 [5940]	775 [79]	570 [58]	560 [57]	5.556	1.7

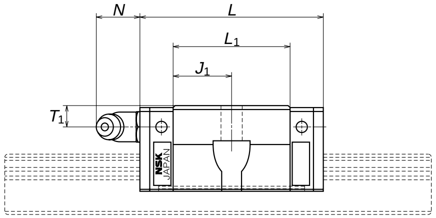
Standard stock

LAS-KL (Medium load type)
LAS-FL (High load type)

- **See "Table Ⅰ-4•6 Standardized LS series in stock" on Page A30 for reference number of each interchangeable ball slide.**



KL type



FL type

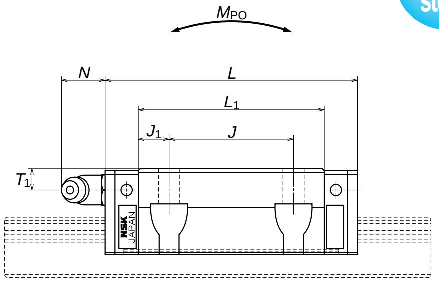


Table. Ⅰ-5•13

Unit: mm

Model No.	Assembly			Ball slide													Basic load rating					Ball dia.	Weight
	Height			Width	Length	Mounting hole								Grease fitting			Dynamic	Static	Static moment				Ball slide (kg)
	H	E	W_2	W	L	B	J	Q x ℓ	B_1	L_1	J_1	K	T	Hole size	T_1	N	C	C_0	M_{RO}	M_{PO}	M_{YO}	D_w	
																	(N[kgf])		(N・m[kgf・m])				
LAS15KL	24	4.6	18.5	52	40.4	41	—	4.5×7	5.5	23.6	11.8	19.4	8	ϕ 3	6	3	4550 [465]	8300 [845]	39 [4]	20 [2]	20 [2]	2.778	0.17
LAS15FL					56.8		26			40	7						6700 [685]	12500 [1270]	69 [7]	49 [5]	49 [5]		0.26
LAS20KL	28	6	19.5	59	47.2	49	—	5.5×9	5	30	15	22	10	M6 x 0.75	5.5	11	6550 [670]	12200 [1240]	88 [9]	39 [4]	39 [4]	3.175	0.24
LAS20FL					65.2		32			48	8						8900 [910]	17500 [1780]	127 [13]	88 [9]	88 [9]		0.35
LAS25KL	33	7	25	73	59.6	60	—	7×10	6.5	38	19	26	11	M6 x 0.75	7	11	10600 [1080]	18600 [1900]	137 [14]	69 [7]	69 [7]	3.968	0.44
LAS25FL					81.6		35			60	12.5						14400 [1470]	29100 [2970]	245 [25]	206 [21]	196 [20]		0.66
LAS30KL	42	9	31	90	67.4	72	—	9×12	9	42	21	33	11	M6 x 0.75	8	11	15900 [1620]	26500 [2700]	245 [25]	108 [11]	108 [11]	4.762	0.76
LAS30FL					96.4		40			71	15.5						23400 [2390]	43000 [4400]	470 [48]	355 [36]	355 [36]		1.2
LAS35KL	48	10.5	33	100	77	82	—	9×13	9	49	24.5	37.5	12	M6 x 0.75	8.5	11	22100 [2250]	36000 [3650]	410 [42]	177 [18]	177 [18]	5.556	1.2
LAS35FL					108		50			80	15						32500 [3320]	58500 [5940]	775 [79]	570 [58]	560 [57]		1.7

Dimensions of LS Series (Interchangeable rail)

Standard stock

Regular rails Butting rails
L1S (Fine clearance) L1S···J (Fine clearance)
L1S-Z (slight Preload) L1S···JZ (slight Preload)

- **See "Table Ⅰ-4•6 Standardized LS series in stock" on Page A30 for reference number of each interchangeable rail.**

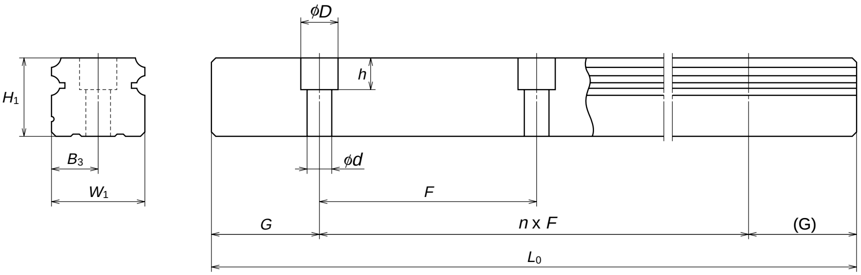


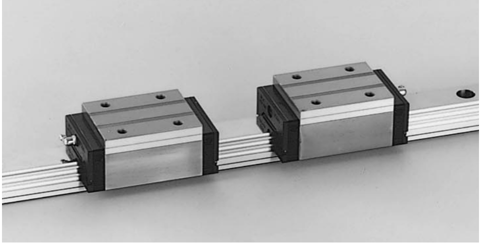
Table Ⅰ-5•14

Unit: mm

Model No.	Rail							Weight
	Width W_1	Height H_1	Pitch F	Mounting bolt hole $d \times D \times h$	B_3	G Recommended	Max. length $L_{0MAX.}$ ( ) for stainless	Rail (Kg/m)
L1S15	15	12.5	60	3.5×6×4.5* 4.5×7.5×5.3	7.5	20	2000 (1700)	1.4
L1S20	20	15.5	60	6×9.5×8.5	10	20	3960 (3500)	2.3
L1S25	23	18	60	7×11×9	11.5	20	3960 (3500)	3.1
L1S30	28	23	80	7×11×9	14	20	4000 (3500)	4.8
L1S35	34	27.5	80	9×14×12	17	20	4000 (3500)	7.0

G dimension is $1/2F^{0}_{-0.5}$ for butting rail.
* Bolt holes of L1S15 is available in M3 (3.5 x 6 x 4.5) and M4 (4.5 x 7 x 5.3).
Please refer to Page A30 for their reference numbers.

A-Ⅰ-5.3 LA Series



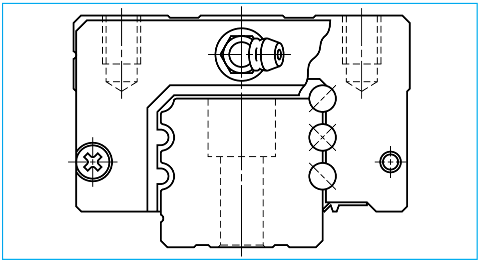


Fig. Ⅰ-5•9 LA Series

(1) High rigidity and high load carrying capacity

A set of three ball grooves is made on both sides. This contributes to the increased rigidity and load carrying capacity. The top and bottom groove are formed in the circular arc, with a closer radius of ball, which ensures great rigidity and load carrying capacity. With the gothic-arch center groove, rigidity and load carrying capacity are further increased.

(2) Moderate friction

A well-balanced combination of 2-point contacts at the top and bottom grooves and 4 points contact at the center groove provides moderate friction while ensuring rigidity by appropriate preload.

(3) Load distribution four directions

Contact angle is set at 45 degrees in all grooves, dispersing the load to four rows irrespective of load direction. This realizes equal rigidity and load carrying capacity in vertical and lateral directions and provides well-balanced design.

(4) Strong against shock load

Load from any direction, vertical and lateral, is received by four rows at all times. The number of the row which receives the load is larger than in other linear guides, making this series stronger against shock load.

(5) Highly accurate

Fixing the measuring rollers is easy thanks to the gothic-arch groove. Ball-groove measuring is accurate and simple. This benefits a highly precise and stable processing.

(6) The dust protection design

The rail's cross section is designed as simple as possible. Furthermore, the improved seal enhances the sealing function. Inner seal is available as an option.

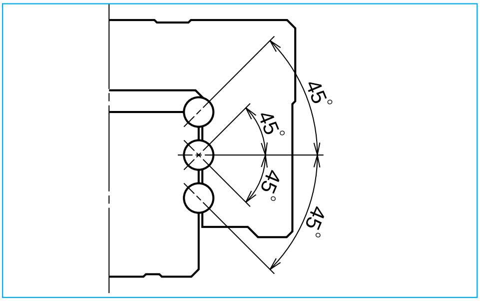


Fig. Ⅰ-5•10 Super rigidity design

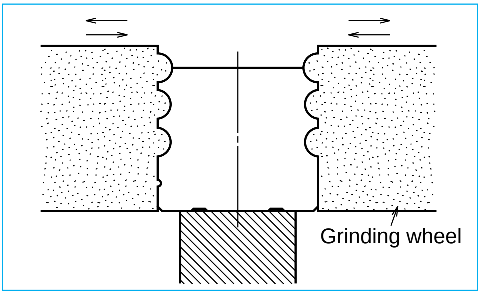


Fig. Ⅰ-5•11 Rail grinding

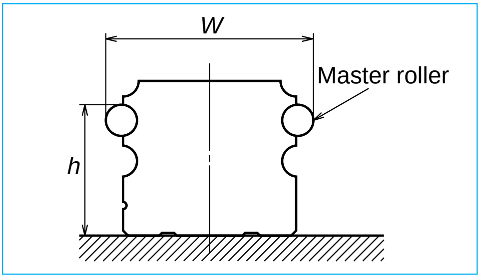


Fig. Ⅰ-5•12 Measuring groove accuracy

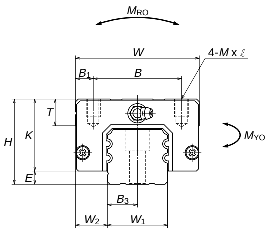
Dimensions of LA Series (Preloaded assembly)

LA-AL (High load type)
LA-BL (Super high load type)

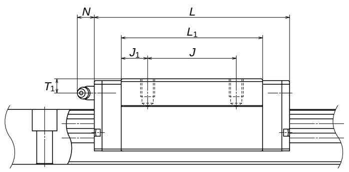
- **Specification number of preloaded assembly (Custom made assembly)**

LA35 0840 AL C 2 – P6 Z3 – Ⅱ

- **LA35**: **Model number**
- **0840**: **Rail length (mm)**
- **AL**: **Ball slide shape**
- **C**: **Material/surface treatment**
- **2**: **Number of ball slides per rail**
- **P6**: **Accuracy grade**
  - **P6 precision grade**
  - **P5 high precision grade**
  - **P4 super precision grade**
  - **P3 ultra precision grade**
- **Z3**: **Pre load code**
  - **Z3 medium preload**
  - **Z4 heavy preload**
- **Ⅱ**: **Ⅱ refers to a set of 2 linear guides; no code refers to one**



AL type



BL type

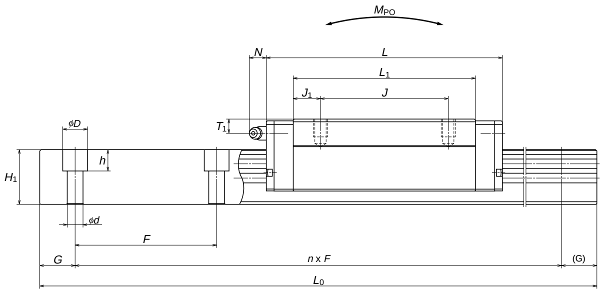


Table. Ⅰ-5•15

Unit: mm

Model No.	Assembly Height H	E	W_2	Ball slide Width W	Length L	Mounting tap hole B	J	M x pitch x ℓ	B_1	L_1	J_1	K	T	Grease fitting Hole size	T_1	N
LA35AL	48	7.5	18	70	110.6	50	50	M8×1.25×10	10	80	15	40.5	15	M6×0.75	8	11
LA35BL					144.6		72			114	21					
LA45AL	60	10	20.5	86	141.4	60	60	M10×1.5×16	13	105	22.5	50	17	PT1/8	10	13
LA45BL					173.4		80			137	28.5					
LA55AL	70	12	23.5	100	165.4	75	75	M12×1.75×16	12.5	126	25.5	58	18	PT1/8	11	13
LA55BL					203.4		95			164	34.5					

Model No.	Rail Width W_1	Height H_1	Pitch F	Mounting bolt hole d x D x h	B_3	G (recommended)	Max. length L_{0max}	Basic load rating Dynamic C (N[kgf])	Static C_0 (N[kgf])	Static moment M_{RO} (N・m[kgf・m])	M_{PO}	M_{YO}	Ball dia. D_W	Weight Ball slide (kg)	Rail (kg/m)
LA35AL	34	30.8	80	9×14×12	17	20	4000	49400 [5050]	82800 [8450]	1070 [109]	920 [94]	920 [94]	5.556	1.3	7.7
LA35BL								64600 [6600]	120000 [12300]	1560 [159]	1890 [193]	1890 [193]		1.6	
LA45AL	45	36	105	14×20×17	22.5	22.5	3990	73000 [7450]	124000 [12700]	2190 [223]	1790 [183]	1790 [183]	6.350	2.5	12.0
LA45BL								89100 [9100]	166000 [17000]	2910 [297]	3100 [315]	3100 [315]		3.2	
LA55AL	53	43.2	120	16×23×20	26.5	30	3960	117000 [12000]	195000 [19900]	4000 [410]	3550 [360]	3550 [360]	7.937	3.9	17.2
LA55BL								138000 [14100]	246000 [25200]	5100 [520]	5500 [560]	5500 [560]		5.1	

LA Series does not have a ball retainer. Be aware that balls fall out when the ball slider is withdrawn from the rail.

LA-AN (High load type)
LA-BN (Super high load type)

- **Specification number of preloaded assembly (Custom made assembly)**

LA35 0840 AN C 2 –P6 Z3 – Ⅱ

Model number (LA35)

Rail length (mm) (0840)

Ball slide shape (AN)

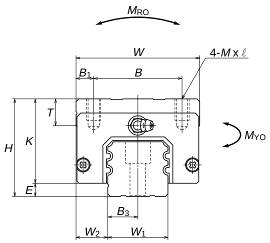
Material/surface treatment (C)

Number of ball slides per rail (2)

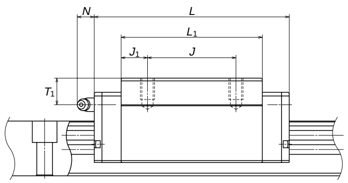
Accuracy grade (P6)
- **P6 precision grade**
- **P5 high precision grade**
- **P4 super precision grade**
- **P3 ultra precision grade**

Pre load code (Z3)
- **Z3 medium preload**
- **Z4 heavy preload**

Ⅱ refers to a set of 2 linear guides; no code refers to one (Ⅱ)



AN type



BN type

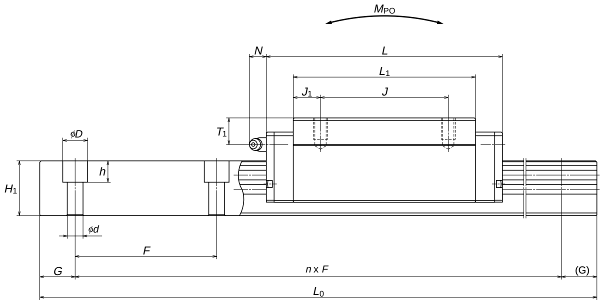


Table. Ⅰ-5•16

Unit: mm

Model No.	Assembly			Ball slide												
	Height			Width	Length	Mounting tap hole								Grease fitting		
	H	E	W_2	W	L	B	J	M x pitch x ℓ	B_1	L_1	J_1	K	T	Hole size	T_1	N
LA30AN	45	7.5	16	60	100.2	40	40	M8×1.25×11	10	72	16	37.5	14	M6×0.75	9.5	11
LA30BN					126.2		60			98	19					
LA35AN	55	7.5	18	70	110.6	50	50	M8×1.25×12	10	80	15	47.5	15	M6×0.75	15	11
LA35BN					144.6		72			114	21					
LA45AN	70	10	20.5	86	141.4	60	60	M10×1.5×16	13	105	22.5	60	17	PT1/8	20	13
LA45BN					173.4		80			137	28.5					
LA55AN	80	12	23.5	100	165.4	75	75	M12×1.75×18	12.5	126	25.5	68	18	PT1/8	21	13
LA55BN					203.4		95			164	34.5					
LA65AN	90	14	31.5	126	196.2	76	70	M16×2×19	25	147	38.5	76	22	PT1/8	19	13
LA65BN					256.2		120			207	43.5					

Model No.	Rail							Basic load rating					Ball dia.	Weight	
	Width	Height	Pitch	Mounting bolt hole		G	Max. length	Dynamic	Static	Static moment				Ball slide	Rail
	W_1	H_1	F	d x D x h	B_3	(recommended)	L_{0max}	C	C_0	M_{RO}	M_{PO}	M_{YO}	D_w		
								(N[kgf])		(N・m[kgf・m])				(kg)	(kg/m)
LA30AN	28	28	80	9×14×12	14	20	4000	35700 [3650]	60700 [6200]	635 [65]	580 [59]	580 [59]	4.762	0.9	5.8
LA30BN								46500 [4750]	88600 [9050]	940 [96]	1190 [121]	1190 [121]		1.3	
LA35AN	34	30.8	80	9×14×12	17	20	4000	49400 [5050]	82800 [8450]	1070 [109]	920 [94]	920 [94]	5.556	1.5	7.7
LA35BN								64600 [6600]	120000 [12300]	1560 [159]	1890 [193]	1890 [193]		2.1	
LA45AN	45	36	105	14×20×17	22.5	22.5	3990	73000 [7450]	124000 [12700]	2190 [223]	1790 [183]	1790 [183]	6.350	3.0	12.0
LA45BN								89100 [9100]	166000 [17000]	2910 [297]	3100 [315]	3100 [315]		3.9	
LA55AN	53	43.2	120	16×23×20	26.5	30	3960	117000 [12000]	195000 [19900]	4000 [410]	3550 [360]	3550 [360]	7.937	4.7	17.2
LA55BN								138000 [14100]	246000 [25200]	5100 [520]	5500 [560]	5500 [560]		6.1	
LA65AN	63	55	150	18×26×22	31.5	35	3900	210000 [21500]	323000 [33000]	8050 [820]	6650 [680]	6650 [680]	10.318	7.7	25.9
LA65BN								275000 [28100]	475000 [48500]	11800 [1200]	13600 [1390]	13600 [1390]		10.8	

LA Series does not have a ball retainer. Be aware that balls fall out when the ball slider is withdrawn from the rail.

LA-EL (High load type)
LA-GL (Super high load type)

- **Specification number of preloaded assembly (Custom made assembly)**

L A 3 5 0 8 4 0 E L C 2 – P 6 Z 3 – Ⅱ

Model number (L A 3 5)

Rail length (mm) (0 8 4 0)

Ball slide shape (E L)

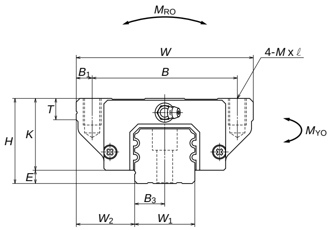
Material/surface treatment (C)

Number of ball slides per rail (2)

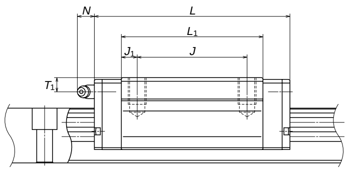
Accuracy grade (P 6)
- P6 precision grade
- P5 high precision grade
- P4 super precision grade
- P3 ultra precision grade

Pre load code (Z 3)
- Z3 medium preload
- Z4 heavy preload

Ⅱ refers to a set of 2 linear guides; no code refers to one (Ⅱ)



EL type



GL type

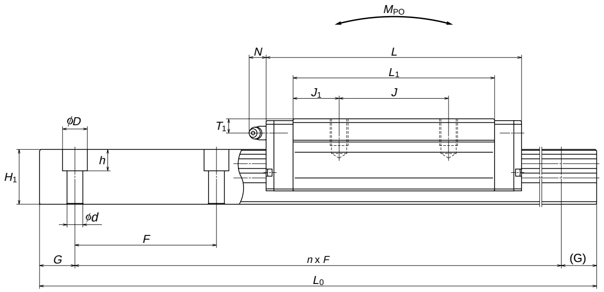


Table. Ⅰ-5•17

Unit: mm

Model No.	Assembly			Ball slide												
	Height			Width	Length	Mounting tap hole								Grease fitting		
	H	E	W_2	W	L	B	J	M x pitch x ℓ	B_1	L_1	J_1	K	T	Hole size	T_1	N
LA30EL	42	7.5	31	90	100.2	72	52	M10×1.5 thru	9	72	10	34.5	11	M6×0.75	6.5	11
LA30GL					126.2					98	23					
LA35EL	48	7.5	33	100	110.6	82	62	M10×1.5×15	9	80	9	40.5	12	M6×0.75	8	11
LA35GL					144.6					114	26					
LA45EL	60	10	37.5	120	141.4	100	80	M12×1.75×18	10	105	12.5	50	13	PT1/8	10	13
LA45GL					173.4					137	28.5					
LA55EL	70	12	43.5	140	165.4	116	95	M14×2×21	12	126	15.5	58	15	PT1/8	11	13
LA55GL					203.4					164	34.5					
LA65EL	90	14	53.5	170	196.2	142	110	M16×2×24	14	147	18.5	76	22	PT1/8	19	13
LA65GL					256.2					207	48.5					

Model No.	Rail							Basic load rating					Ball dia.	Weight	
	Width	Height	Pitch	Mounting bolt hole		G (recommended)	Max. length	Dynamic	Static	Static moment				Ball slide	Rail
	W_1	H_1	F	d x D x h	B_3		L_{0max}	C	C_0	M_{RO}	M_{PO}	M_{YO}	D_W	(kg)	(kg/m)
								(N[kgf])		(N・m[kgf・m])					
LA30EL	28	28	80	9×14×12	14	20	4000	35700 [3650]	60700 [6200]	635 [65]	580 [59]	580 [59]	4.762	1.3	5.8
LA30GL								46500 [4750]	88600 [9050]	940 [96]	1190 [121]	1190 [121]		1.8	
LA35EL	34	30.8	80	9×14×12	17	20	4000	49400 [5050]	82800 [8450]	1070 [109]	920 [94]	920 [94]	5.556	1.9	7.7
LA35GL								64600 [6600]	120000 [12300]	1560 [159]	1890 [193]	1890 [193]		2.6	
LA45EL	45	36	105	14×20×17	22.5	22.5	3990	73000 [7450]	124000 [12700]	2190 [223]	1790 [183]	1790 [183]	6.350	3.3	12.0
LA45GL								89100 [9100]	166000 [17000]	2910 [297]	3100 [315]	3100 [315]		4.3	
LA55EL	53	43.2	120	16×23×20	26.5	30	3960	117000 [12000]	195000 [19900]	4010 [410]	3550 [360]	3550 [360]	7.937	5.5	17.2
LA55GL								138000 [14100]	246000 [25200]	5100 [520]	5500 [560]	5500 [560]		7.2	
LA65EL	63	55	150	18×26×22	31.5	35	3900	210000 [21500]	323000 [33000]	8050 [820]	6650 [680]	6650 [680]	10.318	11.0	25.9
LA65GL								275000 [28100]	475000 [48500]	11800 [1200]	13600 [1390]	13600 [1390]		15.5	

LA Series does not have a ball retainer. Be aware that balls fall out when the ball slider is withdrawn from the rail.

LA-FL (High load type)
LA-HL (Super high load type)

- **Specification number of preloaded assembly (Custom made assembly)**

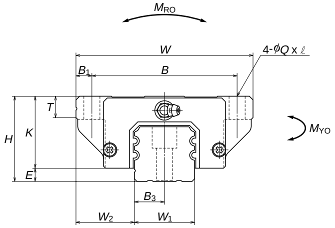
L W 3 5 0 8 4 0 F L C 2 – P 6 Z 0 – Ⅱ

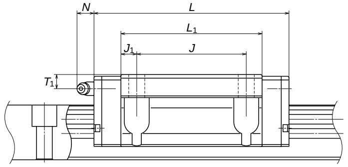
Model number (LW35)
Rail length (mm) (0840)
Ball slide shape (FL)
Material/surface treatment (C)
Number of ball slides per rail (2)

Accuracy grade (P6)
- **P6 precision grade**
- **P5 high precision grade**
- **P4 super precision grade**
- **P3 ultra precision grade**

Pre load code (Z0)
- **Z3 medium preload**
- **Z4 heavy preload**

Ⅱ refers to a set of 2 linear guides; no code refers to one (Ⅱ)




FL type

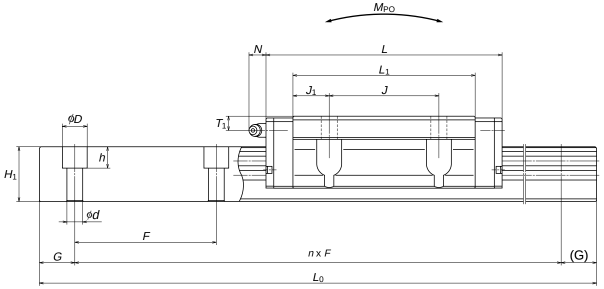

HL type

Table. Ⅰ-5•18

Unit: mm

Model No.	Assembly			Ball slide												
	Height			Width	Length	Mounting hole								Grease fitting		
	H	E	W_2	W	L	B	J	Q x ℓ	B_1	L_1	J_1	K	T	Hole size	T_1	N
LA30FL	42	7.5	31	90	100.2	72	52	9×12	9	72	10	34.5	11	M6×0.75	6.5	11
LA30HL					126.2					98	23					
LA35FL	48	7.5	33	100	110.6	82	62	9×13	9	80	9	40.5	12	M6×0.75	8	11
LA35HL					144.6					114	26					
LA45FL	60	10	37.5	120	141.4	100	80	11×15	10	105	12.5	50	13	PT1/8	10	13
LA45HL					173.4					137	28.5					
LA55FL	70	12	43.5	140	165.4	116	95	14×18	12	126	15.5	58	15	PT1/8	11	13
LA55HL					203.4					164	34.5					
LA65FL	90	14	53.5	170	196.2	142	110	16×23	14	147	18.5	76	22	PT1/8	19	13
LA65HL					256.2					207	48.5					

Model No.	Rail							Basic load rating					Ball dia.	Weight	
	Width	Height	Pitch	Mounting bolt hole		G	Max. length	Dynamic	Static	Static moment				Ball slide	Rail
	W_1	H_1	F	d x D x h	B_3	(recommended)	L_{0max}	C	C_0	M_{RO}	M_{PO}	M_{YO}	D_w	(kg)	(kg/m)
								(N[kgf])		(N・m[kgf・m])					
LA30FL	28	28	80	9×14×12	14	20	4000	35700 [3650]	60700 [6200]	635 [65]	580 [59]	580 [59]	4.762	1.3	5.8
LA30HL								46500 [4750]	88600 [9050]	940 [96]	1190 [121]	1190 [121]		1.8	
LA35FL	34	30.8	80	9×14×12	17	20	4000	49400 [5050]	82800 [8450]	1070 [109]	920 [94]	920 [94]	5.556	1.9	7.7
LA35HL								64600 [6600]	120000 [12300]	1560 [159]	1890 [193]	1890 [193]		2.6	
LA45FL	45	36	105	14×20×17	22.5	22.5	3990	73000 [7450]	124000 [12700]	2190 [223]	1790 [183]	1790 [183]	6.350	3.3	12.0
LA45HL								89100 [9100]	166000 [17000]	2910 [297]	3100 [315]	3100 [315]		4.3	
LA55FL	53	43.2	120	16×23×20	26.5	30	3960	117000 [12000]	195000 [19900]	4000 [410]	3550 [360]	3550 [360]	7.937	5.5	17.2
LA55HL								138000 [14100]	246000 [25200]	5100 [520]	5500 [560]	5500 [560]		7.2	
LA65FL	63	55	150	18×26×22	31.5	35	3900	210000 [21500]	323000 [33000]	8050 [820]	6650 [680]	6650 [680]	10.318	11.0	25.9
LA65HL								275000 [28100]	475000 [48500]	11800 [1200]	13600 [1390]	13600 [1390]		15.5	

LA Series does not have a ball retainer. Be aware that balls fall out when the ball slider is withdrawn from the rail.

A-Ⅰ-5.4 LY Series

(1) Equal load carrying capacity in four directions.

Contact angle is set at 45 degrees. Therefore, rigidity and load carrying capacity are equal in vertical and lateral directions.

(2) High rigidity

All four grooves are of gothic-arch. The center of the top and bottom grooves are offset.

It is designed in such way that the contact lines of balls in top and bottom grooves cross outside as shown in Fig.Ⅰ-5•14 (DB combination). This increases moment rigidity.

With preload higher than medium level (Z3, Z4), ball contact is made at four points as shown in Fig.Ⅰ-5•15. The increase in contact points enhances both rigidity and load carrying capacity.

(3) High resistance against shock load

Four rows support the load when a high load, such as shock, is applied.

(4) Absorbs vibration (higher than medium preload).

The contact point becomes four under the preload which is higher than medium level (Z3, Z4). This slightly increases the friction coefficient, and enhances vibration-absorbing capacity.

(5) Detects abnormal level of error in installation.

When the error in installation is too large, unlike other series, the friction to the four-groove gothic-arch suddenly becomes large. Thus the abnormality is detected and a warning is signaled.

(6) Easy to handle, and designed with safety in mind.

Balls are retained in the retainer and do not fall out when a ball slide is withdrawn from the rail.

(7) Highly accurate.

As shown in Fig. Ⅰ-5•16, fixing the master rollers to the groove is easy thanks to the gothic-arch groove. Groove measuring is accurate.

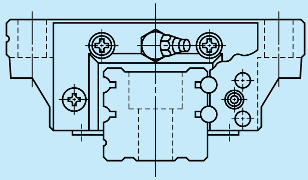


Fig. Ⅰ-5•13 LY Series

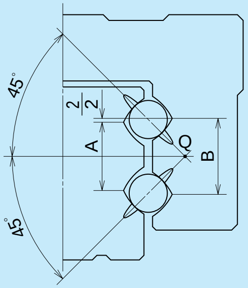


Fig. Ⅰ-5•14 High rigidity design (DB combination)

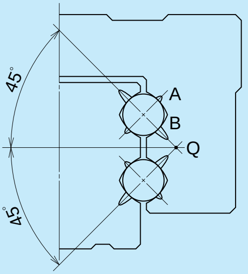
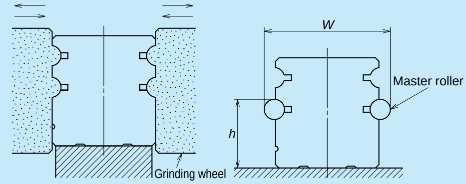


Fig. Ⅰ-5•15 Ball contact under high preload



Grinding of datum face and ball grooves

Measuring accuracy of ball grooves

Fig. Ⅰ-5•16 Rail grinding and measuring

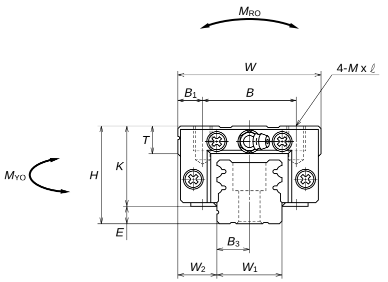
Dimensions of LY Series (Preloaded assembly)

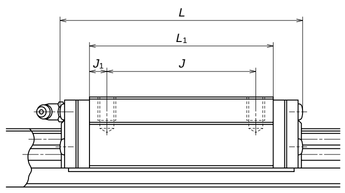
LY-AL (High load type)
LY-BL (Super high load type)

- **Specification number of preloaded assembly (Custom made assembly)**

LY35 0840 AL C 2－P6 Z0－Ⅱ

- **Model number** (LY35)
- **Rail length(mm)** (0840)
- **Ball slide shape** (AL)
- **Material/surface treatment** (C)
- **Number of ball slides per rail** (2)
- **Accuracy grade** (P6)
  - P6 precision grade
  - P5 high precision grade
  - P4 super precision grade
  - P3 ultra precision grade
- **Preload code** (Z0)
  - Z0 fine clearance
  - Z1 slight preload
  - Z3 medium preload
  - Z4 heavy preload
- **Ⅱ refers to a set of 2 linear guides; no code refers to one**




BL type

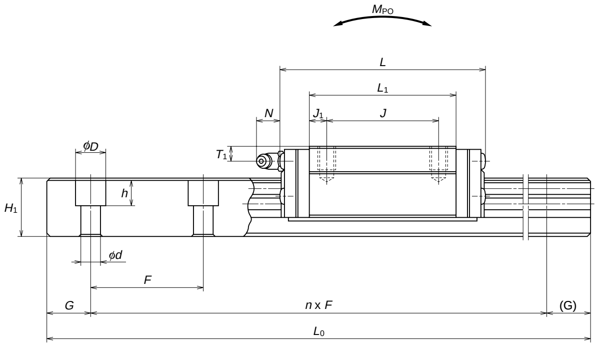

AL type

Table. Ⅰ-5•19

Unit: mm

Model No.	Assembly: Height H	E	W_2	Ball slide: Width W	Length L	Mounting tap hole: B	J	M x pitch x ℓ	B_1	L_1	J_1	K	T	Grease fitting: Hole size	T_1	N
LY15AL	24	4.5	9.5	34	55	26	26	M4×0.7×6	4	39	6.5	19.5	10	φ3	5	3
LY20AL	30	7	12	44	69.4	32	36	M5×0.8×8	6	50	7	23	12	φ3	5	3
LY20BL					85.4		50			66	8					
LY25AL	36	5.5	12.5	48	80.8	35	35	M6×1×10	6.5	58	11.5	30.5	10	M6×0.75	6	11
LY25BL					102.8		50			80	15					
LY30AL	42	7.5	16	60	95.2	40	40	M8×1.25×11	10	68	14	34.5	11	M6×0.75	6.5	11
LY30BL					115.2		60			88						
LY35AL	48	7.5	18	70	110.4	50	50	M8×1.25×12	10	80	15	40.5	12	M6×0.75	8	11
LY35BL					133.4		72			103	15.5					
LY45AL	60	10	20.5	86	137	60	60	M10×1.5×16	13	102	21	50	13	PT1/8	10	13
LY45BL					169		80			134	27					
LY55AL	70	13	23.5	100	160	75	75	M12×1.75×18	12.5	120	22.5	57	15	PT1/8	11	13
LY55BL					200		95			160	32.5					

Model No.	Rail: Width W_1	Height H_1	Pitch F	Mounting bolt hole d x D x h	B_3	G (recommended)	Max. length L_{0max}	Basic load rating: Dynamic C (N[kgf])	Static C_0 (N[kgf])	Static moment M_{RO} (N・m[kgf・m])	M_{PO}	M_{YO}	Ball dia. D_W	Weight: Ball slide (kg)	Rail (kg/m)
LY15AL	15	14	60	4.5×7.5×5.3	7.5	20	2000	5950 [605]	7300 [745]	69 [7]	49 [5]	49 [5]	3.175	0.16	1.6
LY20AL	20	19	60	6×9.5×8.5	10	20	2000	9550 [975]	11100 [1130]	137 [14]	88 [9]	88 [9]	3.968	0.3	2.9
LY20BL								11700 [1190]	15100 [1540]	147 [15]	137 [14]	137 [14]		0.41	
LY25AL	23	22.5	60	7×11×9	11.5	20	2200	17100 [1740]	26000 [2650]	305 [31]	206 [21]	206 [21]	3.968	0.49	3.9
LY25BL								22500 [2290]	38500 [3910]	345 [35]	430 [44]	430 [44]		0.66	
LY30AL	28	27.5	80	9×14×12	14	20	3000	25200 [2570]	37500 [3840]	530 [54]	355 [36]	355 [36]	4.762	0.82	5.8
LY30BL								30500 [3120]	49500 [5030]	570 [58]	600 [61]	600 [61]		1.0	
LY35AL	34	31	80	9×14×12	17	20	3000	35000 [3590]	51000 [5220]	880 [90]	580 [59]	580 [59]	5.556	1.3	7.9
LY35BL								42500 [4330]	67000 [6850]	920 [94]	940 [96]	940 [96]		1.6	
LY45AL	45	37.5	105	14×20×17	22.5	22.5	3000	51500 [5260]	77500 [7880]	1790 [183]	1160 [118]	1160 [118]	6.350	2.5	12.7
LY45BL								63500 [6450]	104000 [10600]	1830 [187]	1880 [192]	1880 [192]		3.2	
LY55AL	53	45	120	16×23×20	26.5	30	3000	79500 [8090]	113000 [11500]	3050 [313]	2020 [206]	2020 [206]	7.937	3.9	17.9
LY55BL								99000 [10100]	154000 [15700]	3400 [345]	3400 [346]	3400 [346]		5.1	

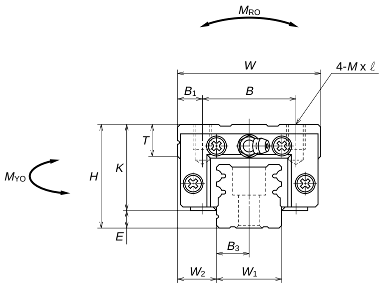
LY15 and 20 have a single row of balls on each right and left side.

LY-AN (High load type)
LY-BN (Super high load type)

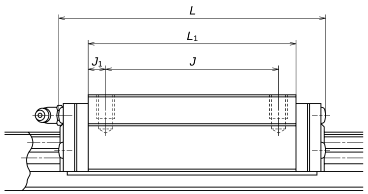
- **Specification number of preloaded assembly (Custom made assembly)**

LY35 0840 AN C 2 – P6 Z0 – Ⅱ

- **Model number**
- **Rail length(mm)**
- **Ball slide shape**
- **Material/surface treatment**
- **Number of ball slides per rail**
- **Accuracy grade**
  - **P6 precision grade**
  - **P5 high precision grade**
  - **P4 super precision grade**
  - **P3 ultra precision grade**
- **Preload code**
  - **Z0 fine clearance**
  - **Z1 slight preload**
  - **Z3 medium preload**
  - **Z4 heavy preload**
- **Ⅱ refers to a set of 2 linear guides; no code refers to one**



BN type



AN type

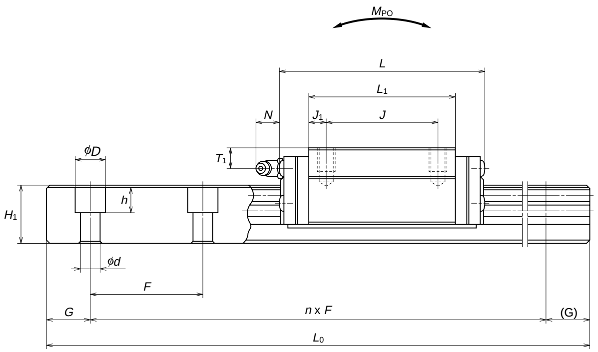


Table. Ⅰ-5•20

Unit: mm

Model No.	Assembly			Ball slide													Rail							Basic load rating					Ball dia.	Weight	
	Height			Width	Length	Mounting tap hole								Grease fitting			Width	Height	Pitch	Mounting bolt hole		G	Max. length	Dynamic	Static	Static moment				Ball slide	Rail
	H	E	W_2	W	L	B	J	M x pitch x ℓ	B_1	L_1	J_1	K	T	Hole size	T_1	N	W_1	H_1	F	d x D x h	B_3	(recommended)	L_{0max}	C	C_0	M_{RO}	M_{PO}	M_{YO}	D_w	(kg)	(kg/m)
																								(N[kgf])		(N・m[kgf・m])					
LY15AN	28	4.5	9.5	34	55	26	26	M4×0.7×6	4	39	6.5	23.5	11	ϕ3	9	3	15	14	60	4.5×7.5×5.3	7.5	20	2000	5950 [605]	7300 [745]	69 [7]	49 [5]	49 [5]	3.175	0.2	1.6
LY25AN	40	5.5	12.5	48	80.8	35	35	M6×1×10	6.5	58	11.5	34.5	12	M6×0.75	10	11	23	22.5	60	7×11×9	11.5	20	2200	17100 [1740]	26000 [2650]	305 [31]	206 [21]	206 [21]	3.968	0.58	3.9
LY25BN					102.8		50			80	15													22500 [2290]	38500 [3910]	345 [35]	430 [44]	430 [44]		0.78	
LY30AN	45	7.5	16	60	95.2	40	40	M8×1.25×11	10	68	14	37.5	14	M6×0.75	9.5	11	28	27.5	80	9×14×12	14	20	3000	25200 [2570]	37500 [3840]	530 [54]	355 [36]	355 [36]	4.762	0.91	5.8
LY30BN					115.2		60			88														30500 [3120]	49500 [5030]	570 [58]	600 [61]	600 [61]		1.1	
LY35AN	55	7.5	18	70	110.4	50	50	M8×1.25×12	10	80	15	47.5	15	M6×0.75	15	11	34	31	80	9×14×12	17	20	3000	35000 [3590]	51000 [5220]	880 [90]	580 [59]	580 [59]	5.556	1.6	7.9
LY35BN					133.4		72			103	15.5													42500 [4330]	67000 [6850]	920 [94]	940 [96]	940 [96]		2	
LY45AN	70	10	20.5	86	137	60	60	M10×1.5×16	13	102	21	60	17	PT1/8	20	13	45	37.5	105	14×20×17	22.5	22.5	3000	51500 [5260]	77500 [7880]	1790 [183]	1160 [118]	1160 [118]	6.350	3.2	12.7
LY45BN					169		80			134	27													63500 [6450]	104000 [10600]	1830 [187]	1880 [192]	1880 [192]		4.1	
LY55AN	80	13	23.5	100	160	75	75	M12×1.75×18	12.5	120	22.5	67	18	PT1/8	21	13	53	45	120	16×23×20	26.5	30	3000	79500 [8090]	113000 [11500]	3050 [313]	2020 [206]	2020 [206]	7.937	4.8	17.9
LY55BN					200		95			160	32.5													99000 [10100]	154000 [15700]	3400 [345]	3400 [346]	3400 [346]		6.3	
LY65AN	90	14	31.5	126	184.6	76	70	M16×2×23	25	137	33.5	76	23	PT1/8	19	13	63	53	150	18×26×22	31.5	35	3000	168000 [17100]	226000 [23000]	8350 [853]	5350 [544]	5350 [544]	10.318	8	25.1
LY65BN					244.6		120			197	38.5													225000 [22900]	340000 [34800]	10200 [1040]	9750 [994]	9750 [994]		11.2	

LY15 has a single row of balls on each right and left side.

Remarks: There are no LY20AN or LY20BN. LY20AL is equivalent to LY20AN. LY20BL is equivalent to LY20BN. (See Page A77)

LY-EL (High load type)
LY-GL (Super high load type)
LY-TL (High-load type, small installation tap hole)

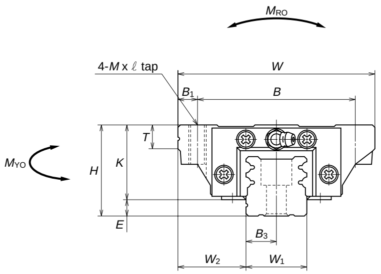
- **Specification number of preloaded assembly (Custom made assembly)**

LY35 0840 EL C 2 – P6 Z0 – Ⅱ

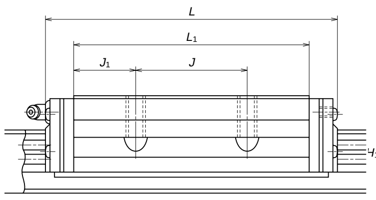
LY35: Model number
0840: Rail length(mm)
EL: Ball slide shape
C: Material/surface treatment
2: Number of ball slides per rail
P6: Accuracy grade
- P6 precision grade
- P5 high precision grade
- P4 super precision grade
- P3 ultra precision grade

Z0: Preload code
- Z0 fine clearance
- Z1 slight preload
- Z3 medium preload
- Z4 heavy preload

Ⅱ: Ⅱ refers to a set of 2 linear guides; no code refers to one



GL type



EL, TL type

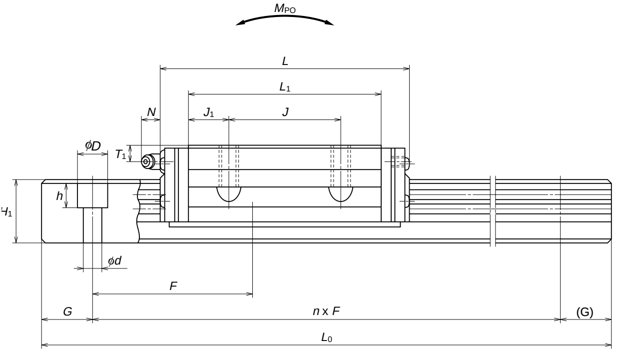


Table. Ⅰ-5•21

Unit: mm

Model No.	Assembly			Ball slide													Rail							Basic load rating					Ball dia.	Weight	
	Height			Width	Length	Mounting tap hole								Grease fitting			Width	Height	Pitch	Mounting bolt hole		G (recommended)	Max. length	Dynamic	Static	Static moment				Ball slide	Rail
	H	E	W_2	W	L	B	J	M x pitch x ℓ	B_1	L_1	J_1	K	T	Hole size	T_1	N	W_1	H_1	F	d x D x h	B_3		L_{0max}	C	C_0	M_{RO}	M_{PO}	M_{YO}	D_W		
																								(N[kgf])		(N・m[kgf・m])				(kg)	(kg/m)
LY15EL	24	4.5	16	47	55	38	30	M5×0.8×8	4.5	39	4.5	19.5	8	ϕ3	5	3	15	14	60	4.5×7.5×5.3	7.5	20	2000	5950 [605]	7300 [745]	69 [7]	49 [5]	49 [5]	3.175	0.2	1.6
LY20EL	30	7	21.5	63	69.4	53	40	M6×1×10	5	50	5	23	10	ϕ3	5	3	20	19	60	6×9.5×8.5	10	20	2000	9550 [975]	11100 [1130]	137 [14]	88 [9]	88 [9]	3.968	0.37	2.9
LY20GL					85.4					66	13													11700 [1190]	15100 [1540]	147 [15]	137 [14]	137 [14]		0.51	
LY25EL	36	5.5	23.5	70	80.8	57	45	M8×1.25×16	6.5	58	6.5	30.5	11	M6×0.75	6	11	23	22.5	60	7×11×9	11.5	20	2200	17100 [1740]	26000 [2650]	305 [31]	206 [21]	206 [21]	3.968	0.66	3.9
LY25GL					102.8					80	17.5													22500 [2290]	38500 [3910]	345 [35]	430 [44]	430 [44]		0.83	
LY30EL	42	7.5	31	90	95.2	72	52	M10×1.5×18	9	68	8	34.5	11	M6×0.75	6.5	11	28	27.5	80	9×14×12	14	20	3000	25200 [2570]	37500 [3840]	530 [54]	355 [36]	355 [36]	4.762	1.1	5.8
LY30GL					115.2			M10×1.5×18		88	18													30500 [3120]	49500 [5030]	570 [58]	600 [61]	600 [61]		1.3	
LY30TL					95.2			M8×1.25×18		68	8													25200 [2570]	37500 [3840]	530 [54]	355 [36]	355 [36]		1.1	
LY35EL	48	7.5	33	100	110.4	82	62	M10×1.5×20	9	80	9	40.5	12	M6×0.75	8	11	34	31	80	9×14×12	17	20	3000	35000 [3590]	51000 [5220]	880 [90]	580 [59]	580 [59]	5.556	1.7	7.9
LY35GL					133.4					103	20.5													42500 [4330]	67000 [6850]	920 [94]	940 [96]	940 [96]		2.0	
LY45EL	60	10	37.5	120	137	100	80	M12×1.75×24	10	102	11	50	13	PT1/8	10	13	45	37.5	105	14×20×17	22.5	22.5	3000	51500 [5260]	77500 [7880]	1790 [183]	1160 [118]	1160 [118]	6.350	3.2	12.7
LY45GL					169					134	27													63500 [6450]	104000 [10600]	1830 [187]	1880 [192]	1880 [192]		3.9	
LY55EL	70	13	43.5	140	160	116	95	M14×2×28	12	120	12.5	57	14	PT1/8	11	13	53	45	120	16×23×20	26.5	30	3000	79500 [8090]	113000 [11500]	3050 [313]	2020 [206]	2020 [206]	7.937	4.9	17.9
LY55GL					200					160	32.5													99000 [10100]	154000 [15700]	3400 [345]	3400 [346]	3400 [346]		6.1	
LY65EL	90	14	53.5	170	184.6	142	110	M16×2×37	14	137	13.5	76	23	PT1/8	19	13	63	53	150	18×26×22	31.5	35	3000	168000 [17100]	226000 [23000]	8350 [853]	5350 [544]	5350 [544]	10.318	9.3	25.1
LY65GL					244.6					197	43.5													225000 [22900]	340000 [34800]	10200 [1040]	9750 [994]	9750 [994]		12.3	

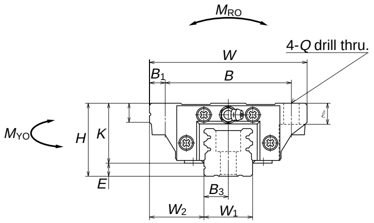
LY15 and 20 have a single row of balls on each right and left side.

LY-FL (High load type)
LY-HL (Super high load type)

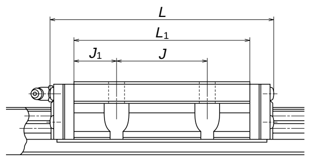
- **Specification number of preloaded assembly (Custom made assembly)**

LY35 0840 FL C 2 – P6 Z0 – Ⅱ

- Model number
- Rail length(mm)
- Ball slide shape
- Material/surface treatment
- Number of ball slides per rail
- Accuracy grade
  - P6 precision grade
  - P5 high precision grade
  - P4 super precision grade
  - P3 ultra precision grade
- Preload code
  - Z0 fine clearance
  - Z1 slight preload
  - Z3 medium preload
  - Z4 heavy preload
- Ⅱ refers to a set of 2 linear guides; no code refers to one



HL type



FL type

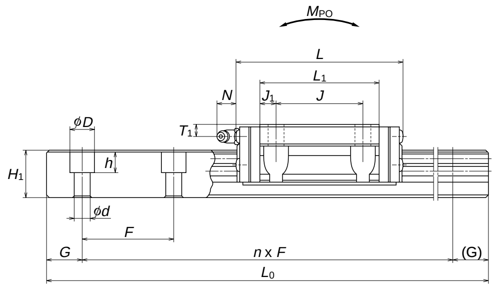


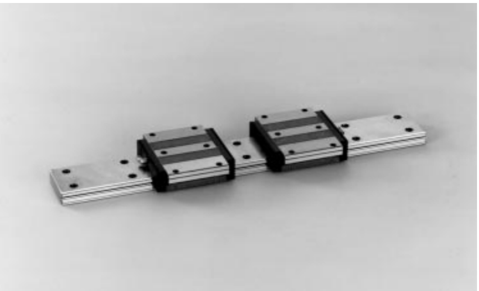
Table. Ⅰ-5•22

Unit: mm

Model No.	Assembly			Ball slide													Rail							Basic load rating					Ball dia.	Weight	
	Height			Width	Length	Mounting hole								Grease fitting			Width	Height	Pitch	Mounting bolt hole		G	Max. length	Dynamic	Static	Static moment				Ball slide	Rail
	H	E	W_2	W	L	B	J	$Q \times \ell$	B_1	L_1	J_1	K	T	Hole size	T_1	N	W_1	H_1	F	$d \times D \times h$	B_3	(recommended)	L_{0max}	C	C_0	M_{RO}	M_{PO}	M_{YO}	D_w	(kg)	(kg/m)
																								(N[kgf])		(N・m[kgf・m])					
LY15FL	24	4.5	16	47	55	38	30	4.5×7	4.5	39	4.5	19.5	8	ϕ3	5	3	15	14	60	4.5×7.5×5.3	7.5	20	2000	5950 [605]	7300 [745]	69 [7]	49 [5]	49 [5]	3.175	0.2	1.6
LY20FL	30	7	21.5	63	69.4	53	40	6×9	5	50	5	23	10	ϕ3	5	3	20	19	60	6×9.5×8.5	10	20	2000	9550 [975]	11100 [1130]	137 [14]	88 [9]	88 [9]	3.968	0.37	2.9
LY20HL					85.4					66	13													11700 [1190]	15100 [1540]	147 [15]	137 [14]	137 [14]		0.51	
LY25FL	36	5.5	23.5	70	80.8	57	45	7×10	6.5	58	6.5	30.5	11	M6×0.75	6	11	23	22.5	60	7×11×9	11.5	20	2200	17100 [1740]	26000 [2650]	305 [31]	206 [21]	206 [21]	3.968	0.66	3.9
LY25HL					102.8					80	17.5													22500 [2290]	38500 [3910]	345 [35]	430 [44]	430 [44]		0.83	
LY30FL	42	7.5	31	90	95.2	72	52	9×12	9	68	8	34.5	11	M6×0.75	6.5	11	28	27.5	80	9×14×12	14	20	3000	25200 [2570]	37500 [3840]	530 [54]	355 [36]	355 [36]	4.762	1.1	5.8
LY30HL					115.2					88	18													30500 [3120]	49500 [5030]	570 [58]	600 [61]	600 [61]		1.3	
LY35FL	48	7.5	33	100	110.4	82	62	9×13	9	80	9	40.5	12	M6×0.75	8	11	34	31	80	9×14×12	17	20	3000	35000 [3590]	51000 [5220]	880 [90]	580 [59]	580 [59]	5.556	1.7	7.9
LY35HL					133.4					103	20.5													42500 [4330]	67000 [6850]	920 [94]	940 [96]	940 [96]		2.0	
LY45FL	60	10	37.5	120	137	100	80	11×15	10	102	11	50	13	PT1/8	10	13	45	37.5	105	14×20×17	22.5	22.5	3000	51500 [5260]	77500 [7880]	1790 [183]	1160 [118]	1160 [118]	6.350	3.2	12.7
LY45HL					169					134	27													63500 [6450]	104000 [10600]	1830 [187]	1880 [192]	1880 [192]		3.9	
LY55FL	70	13	43.5	140	160	116	95	14×17	12	120	12.5	57	14	PT1/8	11	13	53	45	120	16×23×20	26.5	30	3000	79500 [8090]	113000 [11500]	3050 [313]	2020 [206]	2020 [206]	7.937	4.9	17.9
LY55HL					200					160	32.5													99000 [10100]	154000 [15700]	3400 [345]	3400 [346]	3400 [346]		6.1	
LY65FL	90	14	53.5	170	184.6	142	110	16×23	14	137	13.5	76	23	PT1/8	19	13	63	53	150	18×26×22	31.5	35	3000	168000 [17100]	226000 [23000]	8350 [853]	5350 [544]	5350 [544]	10.318	9.3	25.1
LY65HL					244.6					197	43.5													225000 [22900]	340000 [34800]	10200 [1040]	9750 [994]	9750 [994]		12.3	

LY15 and 20 have a single row of balls on each right and left side.

A-Ⅰ-5.5 LW Series (Wide rail type)



(1) Ideal for use of single rail

Thanks to the wide rail, rigidity and load carrying capacity are high against moment load from rolling direction. This makes LW linear guides ideal in use of single rail linear guide as the guide way bearing.

(2) Large load carrying capacity against vertical direction

Contact angle is set at 50 degrees. This enhances load carrying capacity from vertical direction as well as rigidity.

(3) High resistance to shock load

Same as the LH and LS series, the offset gothic-arch grooves supports a large load, such as a shock, by four rows.

(4) High accuracy

Fixing master rollers is easy thanks to the gothic-arch groove. This makes easy and accurate measuring of ball grooves.

(5) Interchangeable rail and ball slide (short delivery time)

Randomly matching rails and ball slides are stocked as standardized interchangeable items. This reduces delivery time.

(6) Easy to handle, and designed with safety in mind.

Balls are retained in the retainer and do not fall out when a ball slide is withdrawn from the rail.

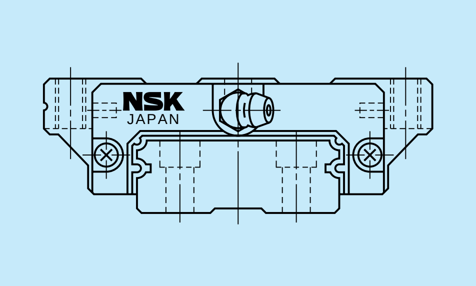


Fig. Ⅰ-5•17 LW Series

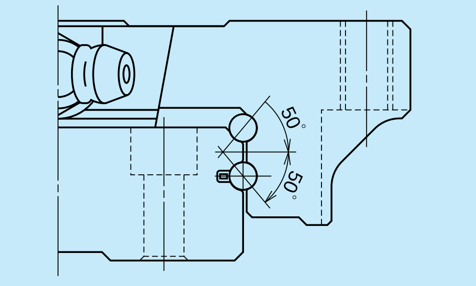


Fig. Ⅰ-5•18 Balls in contact

Dimensions of LW Series (Preloaded assembly)

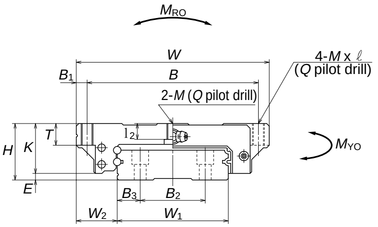
LW-EL (Wide rail type)

- **Specification number of preloaded assembly (Custom made assembly)**

LW35 1000 EL C 2 – PN Z1

- **LW35**: **Model number**
- **1000**: **Rail length (mm)**
- **EL**: **Ball slide shape**
- **C**: **Material/surface treatment**
- **2**: **Number of ball slides per rail**
- **PN**: **Accuracy grade**
  - **PN normal grade**
  - **P6 precision grade**
  - **P5 high precision grade**
- **Z1**: **Preload code**
  - **Z0 fine clearance**
  - **Z1 slight preload**

- **Standardized items in stock. See "Tables I-4.10 Standardized LW Series in stock" in Page A34.**



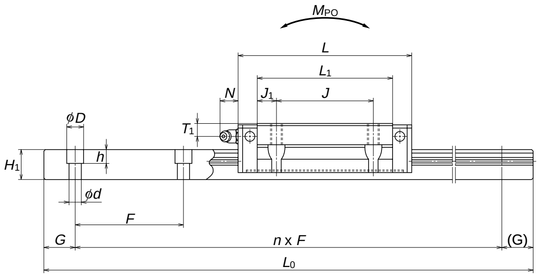


Table. I-5•23

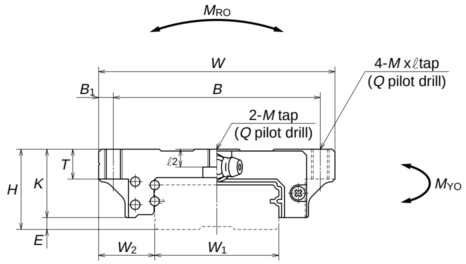
Unit: mm

Model No.	Assembly			Ball slide															Rail								Basic load rating					Ball dia.	Weight	
	Height			Width	Length	Mounting hole										Grease fitting			Width	Height		Pitch	Mounting bolt hole		G	Max. length	Dynamic	Static	Static moment				Ball slide	Rail
	H	E	W_2	W	L	B	J	M x pitch x ℓ	$ℓ_2$	Q	B_1	L_1	J_1	K	T	Hole size	T_1	N	W_1	H_1	B_2	F	d x D x h	B_3	(recommended)	L_{0max}	C	C_0	M_{RO}	M_{PO}	M_{YO}	D_W	(kg)	(kg/m)
																											(N[kgf])		(N · m[kgf · m])					
LW17EL	17	2.5	13.5	60	51.4	53	26	M4×0.7×6	3.2	3.3	3.5	35	4.5	14.5	6	φ 3	4	3	33	8.7	18	40	4.5×7.5×5.3	7.5	15	1000	4200 [430]	9100 [930]	114 [11.6]	36 [3.7]	33 [3.4]	2.381	0.2	2.1
LW21EL	21	3	15.5	68	58.8	60	29	M5×0.8×8	3.7	4.4	4	41	6	18	8	M6×0.75	4.5	11	37	10.5	22	50	4.5×7.5×5.3	7.5	15	1600	4700 [480]	10600 [1080]	147 [15]	47 [4.8]	44 [4.5]	2.381	0.3	2.9
LW27EL	27	4	19	80	74	70	40	M6×1×10	6	5.3	5	56	8	23	10	M6×0.75	6	11	42	15	24	60	4.5×7.5×5.3	9	20	2000	9800 [1000]	21600 [2200]	350 [35.6]	140 [14.3]	135 [13.8]	3.175	0.5	4.7
LW35EL	35	4	25.5	120	108	107	60	M8×1.25×14	9	6.8	6.5	84	12	31	14	M6×0.75	8	11	69	19	40	80	7×11×9	14.5	20	2400	25700 [2620]	52500 [5340]	1470 [149.5]	535 [54.4]	525 [53.5]	4.762	1.5	9.6
LW50EL	50	4.5	36	162	140.6	144	80	M10×1.5×18	14	8.6	9	108	14	45.5	18	PT1/8	14	14	90	24	60	80	9×14×12	15	20	3000	47500 [4840]	91500 [9350]	3400 [347]	1260 [128.9]	1240 [126.2]	6.350	4	15.8

Dimensions of LW Series (Interchangeable ball slide)

LAW-EL (Wide rail type)

- **Standardized items in stock. See "Tables Ⅰ-4•11 Standardized LW Series in stock" in Page A34.**



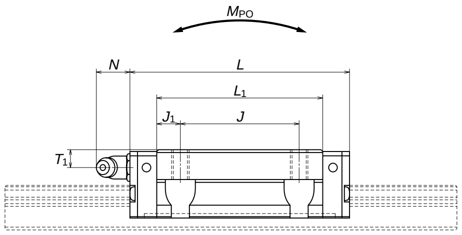


Table. Ⅰ-5•24

Unit: mm

Model No.	Assembly			Ball slide															Basic load rating					Ball dia.	Weight
	Height			Width	Length	Mounting tap hole										Grease fitting			Dynamic	Static	Static moment				Ball slide
	H	E	W_2	W	L	B	J	M x pitch x ℓ	ℓ_2	Q	B_1	L_1	J_1	K	T	Hole size	T_1	N	C	C_0	M_{RO}	M_{PO}	M_{YO}	D_w	(kg)
																			(N[kgf])		(N・m[kgf・m])				
LAW17EL	17	2.5	13.5	60	51.4	53	26	M4×0.7×6	3.2	3.3	3.5	35	4.5	14.5	6	ϕ 3	4	3	4200 [430]	9120 [930]	114 [11.6]	36 [3.7]	33 [3.4]	2.381	0.2
LAW21EL	21	3	15.5	68	58.8	60	29	M5×0.8×8	3.7	4.4	4	41	6	18	8	M6×0.75	4.5	11	4700 [480]	10600 [1080]	147 [15]	47 [4.8]	44 [4.5]	2.381	0.3
LAW27EL	27	4	19	80	74	70	40	M6×1×10	6	5.3	5	56	8	23	10	M6×0.75	6	11	9800 [1000]	21600 [2200]	350 [35.6]	140 [14.3]	135 [13.8]	3.175	0.5
LAW35EL	35	4	25.5	120	108	107	60	M8×1.25×14	9	6.8	6.5	84	12	31	14	M6×0.75	8	11	25700 [2620]	52500 [5340]	1470 [149.5]	535 [54.4]	525 [53.5]	4.762	1.5
LAW50EL	50	4.5	36	162	140.6	144	80	M10×1.5×18	14	8.6	9	108	14	45.5	18	PT1/8	14	14	47500 [4840]	91500 [9350]	3400 [347]	1260 [128.9]	1240 [126.2]	6.350	4

Dimensions of LW Series (Interchangeable ball slide)

Standard stock

Regular rails

L1W (fine clearance)

- See Standardized LE Series in stock in Page A34 for reference number.

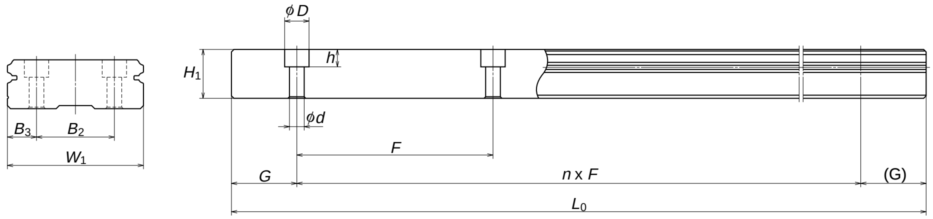


Table. Ⅰ-5•25

Unit: mm

Model No.	Rail								
	Width W_1	Height H_1	B_2	Pitch F	Mounting bolt hole $d \times D \times h$	B_3	G (recommended)	Max. length L_{0max}	Weight (Kg/m)
L1W17	33	8.7	18	40	4.5×7.5×5.3	7.5	15	1000	2.1
L1W21	37	10.5	22	50	4.5×7.5×5.3	7.5	15	1600	2.9
L1W27	42	15	24	60	4.5×7.5×5.3	9	20	2000	4.7
L1W35	69	19	40	80	7×11×9	14.5	20	2400	9.6
L1W50	90	24	60	80	9×14×12	15	20	3000	15.8

A-Ⅰ-5.6 LE Series (Miniature wide rail type)

(1) Ideal for use of single rail

LE Series linear guides are miniature, wide rail type. Thanks to the wide rail, load carrying capacity is high against moment load from rolling direction.

(2) Equal load carrying capacity in vertical and lateral directions

Contact angle is set at 45 degrees, equally dispersing the load from vertical and lateral directions. This also provides equal rigidity in the two directions.

(3) Guides are super-thin.

Super-thin guides owe their design to the single ball groove on right and left sides (gothic-arch).

(4) Highly accurate

Fixing the master rollers is easy thanks to the gothic-arc groove. Groove measuring is accurate and easy.

(5) Stainless steel is standard.

Rails and ball slides are made of martensitic stainless steel.

(6) Interchangeable rails and ball slides (short delivery time).

Randomly-matching rails and ball slides are stocked as standardized interchangeable items. This reduces delivery time.

(7) Ball retainer is available in some series.

Some series come with a ball retainer (ball slide model: AR and TR). Balls are retained in the retainer and do not fall out when a ball slide is withdrawn from the rail (interchangeable ball slides come with a ball retainer).

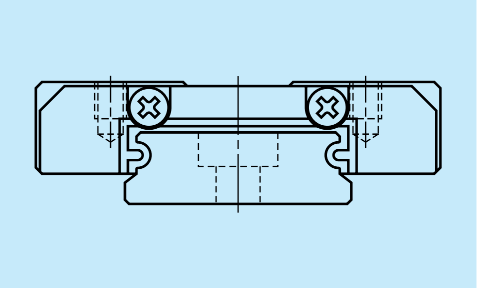


Table Ⅰ-5•19 LE Series

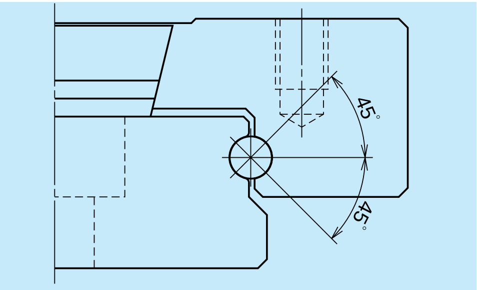


Table Ⅰ-5•20 Balls are in contact

Dimensions of LE Series

LE-AL (Wide rail, miniature)
LE-TL (Wide rail, miniature, large mounting tap hole)
LE-AR (Wide rail, miniature, with ball retainer)
LE-TR (Wide rail, miniature, large mounting tap hole, with ball retainer)

- **Specification number**

LE12 0310 AL K 2 – PN Z0

Model number

Rail length (mm)

Ball slide shape

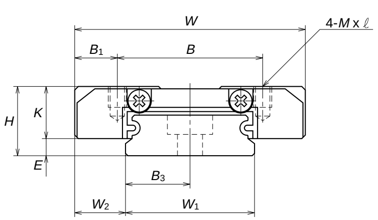
Material/surface treatment

Number of ball slides per rail

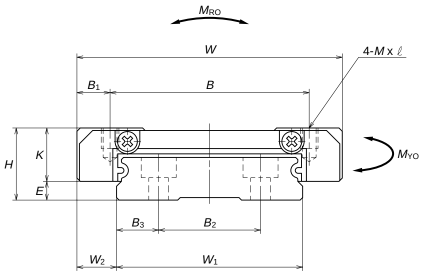
Preload code
- Z0 fine clearance
- Z1 slight preload

Accuracy grade
- PN normal grade
- P6 precision grade
- P5 high precision grade

- **Standardized items in stock. See "Table Ⅰ-4•10 Standardized LE Series in stock" in Page A35.interchangeable rail.**



LE05, 07, 09, 12



LE15

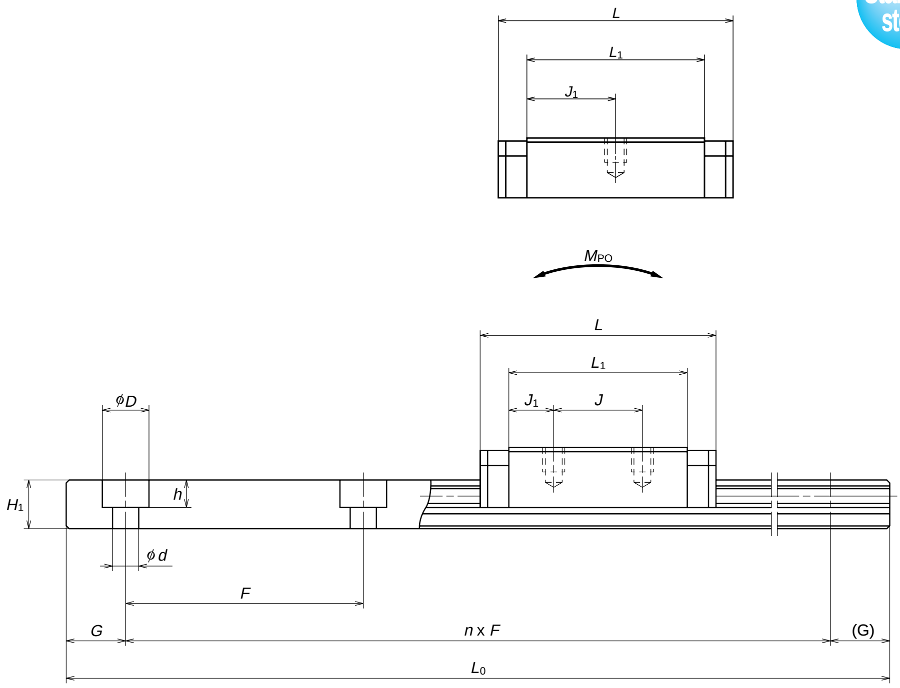


Table. Ⅰ-5•26

Unit: mm

Model No.	Assembly			Ball slide												Rail						Basic load rating					Ball dia.	Weight	
	Height			Width	Length	Mounting tap hole							Width	Height		Pitch	Mounting bolt hole		G	Max. length	Dynamic	Static	Static moment				Ball slide	Rail
	H	E	W_2	W	L	B	J	M x pitch x ℓ	B_1	L_1	J_1	K	W_1	H_1	B_2	F	d x D x h	B_3	(recommended)	L_{0max}	C	C_0	M_{RO}	M_{PO}	M_{YO}	D_W		
																					(N[kgf])		(N·m[kgf·m])				(g)	(g/100mm)
LE05AL	6.5	1.4	3.5	17	24	13	—	M2.5×0.45×2	2	17	8.5	5.1	10	4	—	20	3×5×1.6	5	7.5	150	570 [58]	900 [92]	4 [0.4]	2 [0.2]	2 [0.2]	1.2	11	34
LE07TL	9	2	5.5	25	31	19	10	M3×0.5×3	3	21.2	5.6	7	14	5.2	—	30	3.5×6×3.2	7	10	600	1270 [130]	1960 [200]	13 [1.3]	5 [0.5]	5 [0.5]	1.587	25	55
LE09AL **LE09TL**	12	4	6	30	39	21	12	M2.6×0.45×3 M3×0.5×3	4.5	27.6	7.8	8	18	7.5	—	30	3.5×6×4.5	9	10	800	2450 [250]	3750 [380]	32 [3.3]	17 [1.7]	17 [1.7]	2	40	95
LE09AR **LE09TR**	12	4	6	30	39.8	21	12	M2.6×0.45×3 M3×0.5×3	4.5	27.6	7.8	8	18	7.5	—	30	3.5×6×4.5	9	10	800	2450 [250]	3750 [380]	32 [3.3]	17 [1.7]	17 [1.7]	2	40	95
LE12AL **LE12AR**	14	4	8	40	44 45	28	15	M3×0.5×4	6	31	8	10	24	8.5	—	40	4.5×8×4.5	12	15	1000	3550 [360]	5300 [540]	59 [6.0]	24 [2.4]	24 [2.4]	2.381	75	140
LE15AL **LE15AR**	16	4	9	60	55 56.6	45	20	M4×0.7×4.5	7.5	38.4	9.2	12	42	9.5	23	40	4.5×8×4.5	9.5	15	1200	6200 [630]	8750 [890]	174 [17.7]	48 [4.9]	48 [4.9]	3.175	150	275

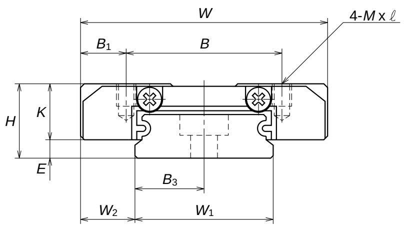
LE has only two mounting tap holes.

LE-BL (High load type, wide rail, miniature)
LE-UL (High load type, wide rail, miniature, large mounting tap hole)

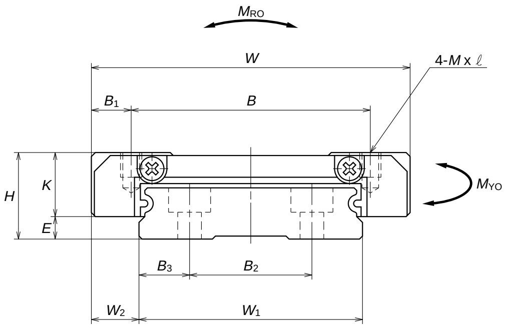
• Specification number

LE12 0310 BL K 2 – P6 Z0 –Ⅱ

- **Model number**
- **Rail length (mm)**
- **Ball slide shape**
- **Material/surface treatment**
- **Number of ball slides per rail**
- **Accuracy grade**
  - **• PN normal grade**
  - **• P6 precision grade**
  - **• P5 high precision grade**
- **Preload code**
  - **• Z0 fine clearance**
  - **• Z1 slight preload**
- **Ⅱ refers to a set of 2 linear guides; no code refers to one**



LE07, 09, 12



LE15

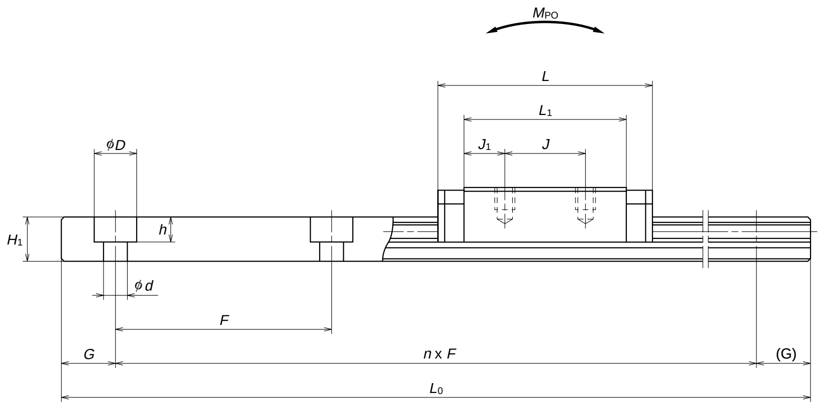


Table. Ⅰ-5•27

Unit: mm

Model No.	Assembly			Ball slide												Rail						Basic load rating					Ball dia.	Weight	
	Height			Width	Length	Mounting tap hole							Width	Height		Pitch	Mounting bolt hole		G	Max. length	Dynamic	Static	Static moment				Ball slide	Rail
																			(recommended)		C	C_0	M_{RO}	M_{PO}	M_{YO}			
	H	E	W_2	W	L	B	J	M x pitch x ℓ	B_1	L_1	J_1	K	W_1	H_1	B_2	F	d x D x h	B_3		L_{0max}	(N[kgf])		(N・m[kgf・m])			D_W	(g)	(g/100mm)
LE07UL	9	2	5.5	25	42	19	19	M3×0.5×3	3	32.2	6.6	7	14	5.2	—	30	3.5×6×3.2	7	10	600	1670 [170]	2940 [300]	21 [2.1]	13 [1.3]	13 [1.3]	1.587	39	55
LE09BL **LE09UL**	12	4	6	30	50.5	23	24	M2.6×0.45×3 M3×0.5×3	3.5	39	7.5 7.5	8	18	7.5	—	30	3.5×6×4.5	9	10	800	3140 [320]	5390 [550]	43 [4.4]	30 [3.1]	30 [3.1]	2	58	95
LE12BL	14	4	8	40	59	28	28	M3×0.5×4	6	46	9	10	24	8.5	—	40	4.5×8×4.5	12	15	1000	4610 [470]	7740 [790]	85 [8.7]	52 [5.3]	52 [5.3]	2.381	115	140
LE15BL	16	4	9	60	74.5	45	35	M4×0.7×4.5	7.5	57.8	11.4	12	42	9.5	23	40	4.5×8×4.5	9.5	15	1200	8230 [840]	13000 [1330]	259 [26.4]	112 [11.4]	112 [11.4]	3.175	235	275

LE-CL (Medium load type, wide rail, miniature)
LE-SL (Medium load type, wide rail, miniature, large mounting tap hole)

- **Specification number**

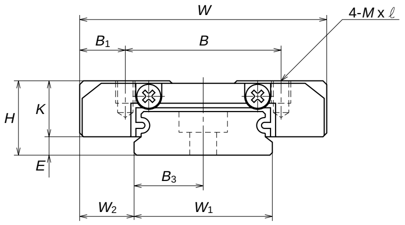
L E 1 2 0 1 3 0 C L K 2 – P 6 Z 0 – II

Model number
Rail length (mm)
Ball slide shape
Material/surface treatment
Number of ball slides per rail

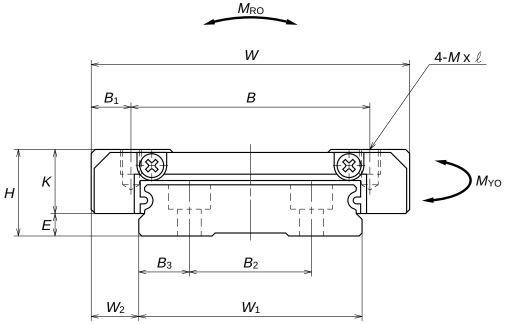
Ⅱ refers to a set of 2 linear guides; no code refers to one

Preload code
- **Z0 fine clearance**
- **Z1 slight preload**

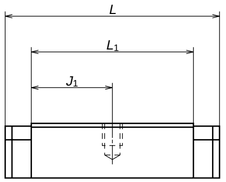
Accuracy grade
- **PN normal grade**
- **P6 precision grade**
- **P5 high precision grade**



LE05, 07, 09, 12



LE15



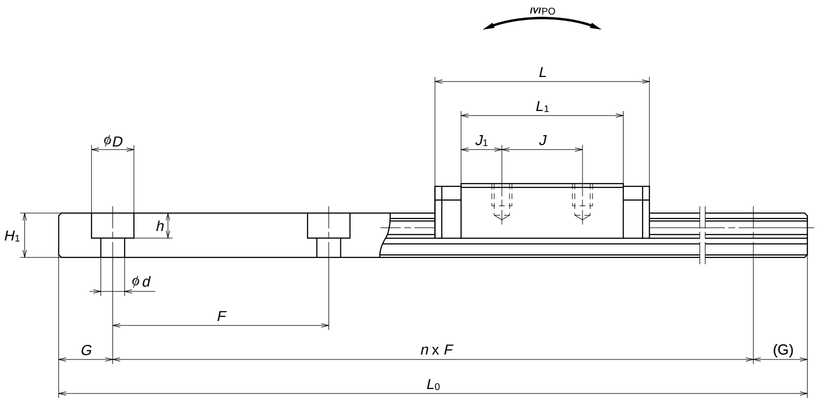


Table. Ⅰ-5•28

Unit: mm

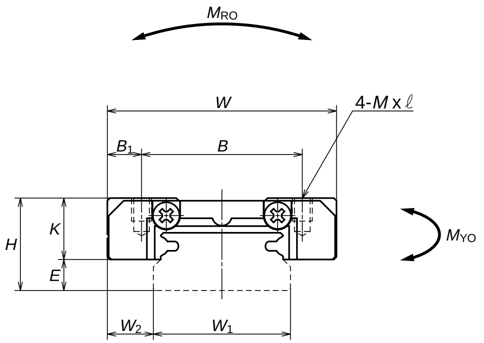
Model No.	Assembly			Ball slide									Rail								Basic load rating					Ball dia.	Weight	
	Height			Width	Length	Mounting tap hole							Width	Height		Pitch	Mounting bolt hole		G	Max. length	Dynamic	Static	Static moment				Ball slide	Rail
																			(recommended)		C	C_0	M_{RO}	M_{PO}	M_{YO}			
	H	E	W_2	W	L	B	J	M x pitch x ℓ	B_1	L_1	J_1	K	W_1	H_1	B_2	F	d x D x h	B_3		L_{0max}	(N[kgf])		(N · m[kgf · m])			D_w	(g)	(g/100mm)
LE05CL	6.5	1.4	3.5	17	20	13	—	M2.5×0.45×2	2	13	6.5	5.1	10	4	—	20	3×5×1.6	5	7.5	150	470 [48]	685 [70]	3 [0.3]	1 [0.1]	1 [0.1]	1.2	8	34
LE07SL	9	2	5.5	25	22.5	19	—	M3×0.5×3	3	12.6	6.3	7	14	5.2	—	30	3.5×6×3.2	7	10	600	785 [80]	980 [100]	7 [0.7]	2 [0.2]	2 [0.2]	1.587	17	55
LE09CL **LE09SL**	12	4	6	30	26.5	21	—	M2.6×0.45×3 M3×0.5×3	4.5	15	7.5	8	18	7.5	—	30	3.5×6×4.5	9	10	800	1570 [160]	1960 [200]	16 [1.6]	4 [0.4]	4 [0.4]	2	25	95
LE12CL	14	4	8	40	30.5	28	—	M3×0.5×4	6	17.5	8.75	10	24	8.5	—	40	4.5×8×4.5	12	15	1000	2260 [230]	2840 [290]	31 [3.2]	8 [0.8]	8 [0.8]	2.381	50	140
LE15CL	16	4	9	60	41.4	45	—	M4×0.7×4.5	7.5	24.8	12.4	12	42	9.5	23	40	4.5×8×4.5	9.5	15	1200	4220 [430]	5000 [510]	99 [10.1]	19 [1.9]	19 [1.9]	3.175	110	275

CL and SL types have only twomounting tap holes in the center.

Dimensions of LE Series (Interchangeable ball slide)

LAE-AR (miniature, with ball retainer)
LAE-TR (miniature, large mounting tap hole, with ball retainer)

- **Standardized items in stock. See tables for "Standardized LE Series in stock" in Page A35.**



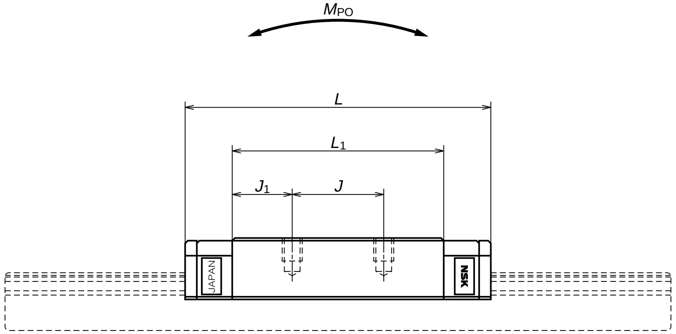


Table. Ⅰ-5•29

Unit: mm

Model No.	Assembly			Ball slide									Basic load rating					Ball dia.	Weight
	Height			Width	Length	Mounting tap hole							Dynamic	Static	Static moment				Ball slide
	H	E	W_2	W	L	B	J	M x pitch x ℓ	B_1	L_1	J_1	K	C	C_0	M_{RO}	M_{PO}	M_{YO}	D_w	
													(N[kgf])		(N・m[kgf・m])				(g)
LAE09AR **LAE09TR**	12	4	6	30	39.8	21	12	M2.6×0.45×3 M3×0.5×3	4.5	27.6	7.8	8	2450 [250]	3750 [380]	32 [3.3]	17 [1.7]	17 [1.7]	1.587	40
LAE12AR	14	4	8	40	45	28	15	M3×0.5×4	6	31	8	10	3550 [360]	5300 [540]	59 [6.0]	24 [2.4]	24 [2.4]	2.381	75
LAE15AR	16	4	9	60	56.6	45	20	M4×0.7×4.5	7.5	38.4	9.2	12	6200 [630]	8570 [890]	174 [17.7]	48 [4.9]	48 [4.9]	3.175	150

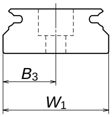
Table of rail size for LE Series (Interchangeable rail)

Standard stock

Regular rail

L1E (fine clearance)

- **See Standardized LE Series in stock in Page A35 for reference number.**



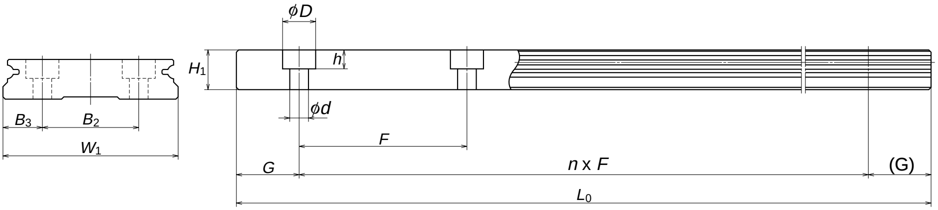


Table. Ⅰ-5•30

Unit: mm

Model No.	Rail								Weight
	Width	Height				Mounting bolt hole	G	Max. length	
	W_1	H_1	F	B_2	B_3	d x D x h	(recommended)	L_{0max}	(g/100mm)
L1E09	18	7.5	30	—	9	3.5×6×4.5	10	800	95
L1E12	24	8.5	40	—	12	4.5×8×4.5	15	1000	140
L1E15	42	9.5	40	23	9.5	4.5×8×4.5	15	1200	275

A-Ⅰ-5.7 LU Series (Miniature type)

(1) Super-small type.

This compact guide owes its design to the single ball groove on both right and left sides (gothic-arch) .

(2) Equal load carrying capacity in vertical and lateral directions

Contact angle is set at 45 degrees, equally load carrying capacity in vertical and lateral directions. This also provides equal rigidity in both directions.

(3) Stainless steel is also standardized.

Items made of the martensitic stainless steel are available as standard.

(4) Interchangeable rails and ball slides (short delivery time)

Randomly matching rails and ball slides are stocked as standardized items. This reduces delivery time.

(5) Some series have a ball retainer.

Ball slide types AR and TR come with a ball retainer. Balls are retained in the retainer and do not fall out when the bearing is withdrawn from the rail. (Ball slides of interchangeable parts as well as LU15AL come with a ball cage.)

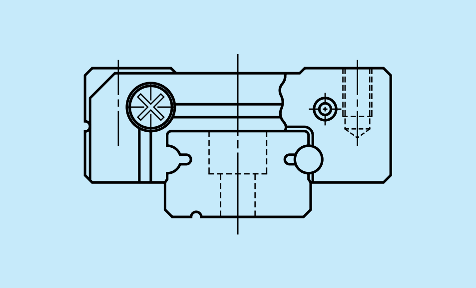


Fig. Ⅰ-5•21 LU Series

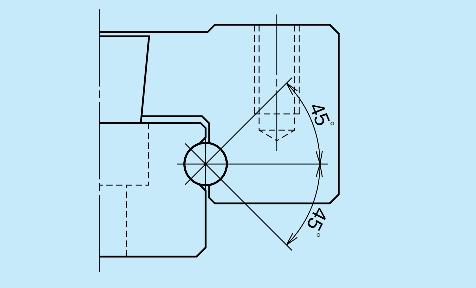


Fig. Ⅰ-5•22 Balls are in contact.

Dimensions of LU Series

LU-AL (Miniature)
LU-TL (Miniature, large mounting tap hole)
LU-AR (miniature, with a ball cage)
LU-TR (Miniature, large mounting tap hole, with a ball retainer)

- **Specification number**

LU12 0270 AL C 2 – PN Z0 – Ⅱ

Model number (LU12)

Rail length (mm) (0270)

Ball slide shape (AL)

Material/surface treatment (See A24) (C)
- **C: Standard material (without a ball retainer 09-15)**
- **K: Stainless steel**

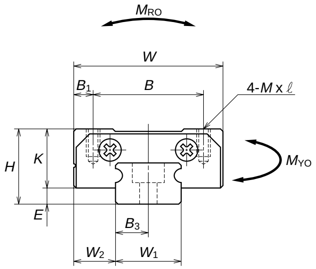
Number of the ball slides per rail (2)

Accuracy grade (PN)
- **PN Normal grade**
- **P6 Precision grade**
- **P5 High precision grade**
- **P4 Super precision grade**

Preload code (Z0)
- **Z0 fine clearance**
- **Z1 slight preload**

Ⅱ refers to a set of 2 linear guides; no code refers to one

- **Standardized items in stock. See tables for "Standardized LU Series in stock" in Page A36.**



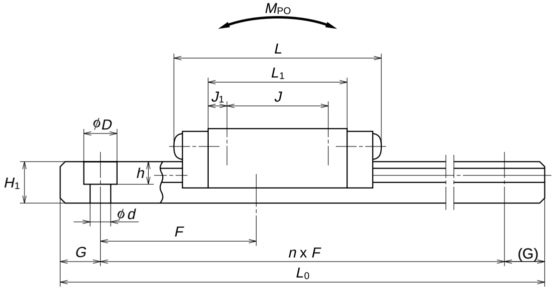


Table. Ⅰ-5•31

Unit: mm

Model No.	Assembly			Ball slide											Rail					Basic load rating					Ball dia.	Weight	
	Height			Width	Length	Mounting tap hole							Width	Height	Pitch	Mounting bolt hole		G (recommended)	Max. length L_{0MAX}. ( ) for stainless	Dynamic	Static	Static moment				Ball slide	Rail
	H	E	W_2	W	L	B	J	M x pitch x ℓ	B_1	L_1	J_1	K	W_1	H_1	F	d x D x h	B_3			C	C_0	M_{RO}	M_{PO}	M_{YO}	D_W	(g)	(g/100mm)
																				(N[kgf])		(N・m[kgf・m])					
LU05TL	6	1	3.5	12	18	8	—	M2×0.4×1.5	2	12	6	5	5	3.2	15	2.3×3.3×1.5	2.5	5	— (210)	430 [44]	620 [63]	3 [0.3]	0.7 [0.07]	0.7 [0.07]	1.2	4	11
LU07AL	8	1.5	5	17	20.4	12	8	M2×0.4×2.4	2.5	13.6	2.8	6.5	7	4.7	15	2.4×4.2×2.3	3.5	5	— (375)	880 [90]	1180 [120]	5 [0.5]	3 [0.3]	3 [0.3]	1.587	10	23
LU09AL **LU09TL**	10	2.2	5.5	20	27	15	13 10	M2×0.4×2.5 M3×0.5×3	2.5	18	2.5 4	7.8	9	5.5	20	2.6×4.5×3 3.5×6×4.5	4.5	7.5	1200 (600)	1470 [150]	1670 [170]	12 [1.2]	7 [0.7]	7 [0.7]	2	17	35
LU09AR **LU09TR**	10	2.2	5.5	20	30	15	13 10	M2×0.4×2.5 M3×0.5×3	2.5	20	3.5 5	7.8	9	5.5	20	2.6×4.5×3 3.5×6×4.5	4.5	7.5	— (600)	1180 [120]	1770 [180]	9 [0.9]	5 [0.5]	5 [0.5]	1.587	19	35
LU12AL **LU12TL**	13	3	7.5	27	34	20	15	M2.5×0.45×3 M3×0.5×3.5	3.5	21.8	3.4	10	12	7.5	25	3×5.5×3.5 3.5×6×4.5	6	10	1800 (800)	2160 [220]	2450 [250]	22 [2.2]	12 [1.2]	12 [1.2]	2.381	38	65
LU12AR **LU12TR**	13	3	7.5	27	35.2	20	15	M2.5×0.45×3 M3×0.5×3.5	3.5	21.8	3.4	10	12	7.5	25	3×5.5×3.5 3.5×6×4.5	6	10	— (800)	2160 [220]	2450 [250]	22 [2.2]	12 [1.2]	12 [1.2]	2.381	38	65
LU15AL	16	4	8.5	32	43.6	25	20	M3×0.5×4	3.5	27	3.5	12	15	9.5	40	3.5×6×4.5	7.5	15	2000 (1000)	4300 [440]	4500 [460]	42 [4.3]	22 [2.2]	22 [2.2]	3.175	70	105

LU05TL, LU07TL, LU0-9TL come in stainless steel only.
LU05TL has only two mounting tap holes in the center.

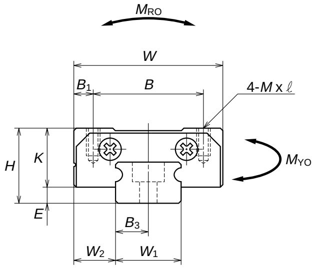
To fix rail of LU05TL, use M2 x 0.4 cross-recessed pan head machine screw for precision instrument.
(JCIS 10-70 No. 0 pan head machine screw No.1.)
(JCIS : Japanese Camera Industrial Standard.)

LU-BL (High load type, miniature)
LU-UL (High load type, miniature, large mounting tap hole)

- **Specification number**

LU12 0270 BL C 2 –PN Z0– Ⅱ

Code	Meaning
LU12	Model number
0270	Rail length (mm)
BL	Ball slide shape
C	Material/surface treatment (See A24) • C: Standard material • K: Stainless steel
2	Number of the ball slides per rail
PN	Accuracy grade • PN Normal grade • P6 Precision grade • P5 High precision grade • P4 Super precision grade
Z0	Preload code • Z0 fine clearance • Z1 slight preload
Ⅱ	Ⅱ refers to a set of 2 linear guides; no code refers to one



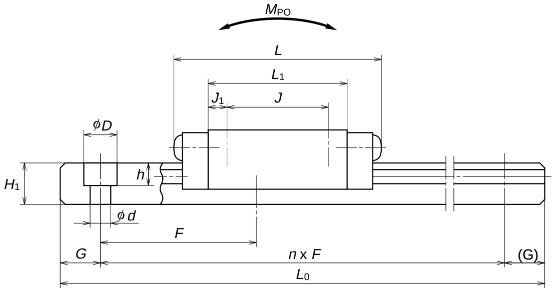


Table. Ⅰ-5•32

Unit: mm

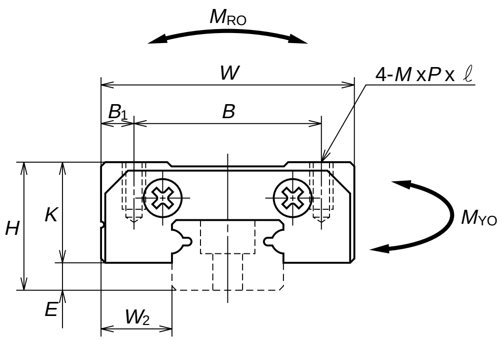
Model No.	Assembly			Ball slide									Rail							Basic load rating					Ball dia.	Weight	
	Height			Width	Length	Mounting tap hole							Width	Height	Pitch	Mounting bolt hole		G	Max. length	Dynamic	Static	Static moment				Ball slide	Rail
	H	E	W_2	W	L	B	J	M x pitch x ℓ	B_1	L_1	J_1	K	W_1	H_1	F	d x D x h	B_3	(recommended)	L_{0MAX} ( ) for stainless	C	C_0	M_{RO}	M_{PO}	M_{YO}	D_W	(g)	(g/100mm)
																				(N[kgf])		(N · m[kgf · m])					
LU09BL **LU09UL**	10	2.2	5.5	20	41	15	16	M2×0.4×2.5 M3×0.5×3	2.5	31.2	7.6	7.8	9	5.5	20	2.6×4.5×3 3.5×6×4.5	4.5	7.5	1200 (600)	2160 [220]	3350 [340]	16 [1.6]	15 [1.5]	15 [1.5]	2	29	35
LU12BL **LU12UL**	13	3	7.5	27	47.5	20	20	M2.5×0.45×3 M3×0.5×3.5	3.5	35.3	7.65	10	12	7.5	25	3×5.5×3.5 3.5×6×4.5	6	10	1800 (800)	3150 [320]	4700 [480]	28 [2.9]	25 [2.6]	25 [2.6]	2.381	59	65
LU15BL	16	4	8.5	32	61	25	25	M3×0.5×4	3.5	44.4	9.7	12	15	9.5	40	3.5×6×4.5	7.5	15	2000 (1000)	6550 [670]	9400 [960]	71 [7.2]	63 [6.4]	63 [6.4]	3.175	107	105

Standard stock

Dimensions of LU Series (Interchangeable ball slide)

LAU-AR (Miniature, with a ball retainer)
LAU-TR (Miniature, large mounting tap hole, with a ball retainer)

- Standardized items in stock. See tables for "Standardized LU Series in stock" in Page A37.



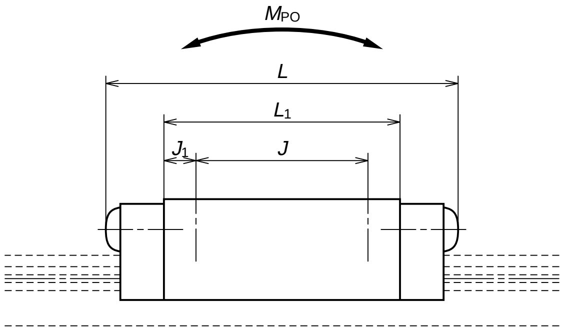


Table. Ⅰ-5•33

Unit: mm

Model No.	Assembly			Ball slide									Basic load rating					Ball dia.	Weight
	Height			Width	Length	Mounting tap hole							Dynamic	Static	Static moment				Ball slide
	H	E	W_2	W	L	B	J	M x pitch x ℓ	B_1	L_1	J_1	K	C	C_0	M_{RO}	M_{PO}	M_{YO}	D_w	
													(N[kgf])		(N・m[kgf・m])				(g)
LAU09AR **LAU09TR**	10	2.2	5.5	20	30	15	13 10	M2×0.4×2.5 M3×0.5×3	2.5	20	3.5 5	7.8	1180 [120]	1770 [180]	9 [0.9]	5 [0.5]	5 [0.5]	1.587	19
LAU12AR **LAU12TR**	13	3	7.5	27	35.2	20	15	M2.5×0.45×3 M3×0.5×3.5	3.5	21.8	3.4	10	2160 [220]	2450 [250]	22 [2.2]	12 [1.2]	12 [1.2]	2.381	38
LAU15AL	16	4	8.5	32	43.6	25	20	M3×0.5×4	3.5	27	3.5	12	4300 [440]	4500 [460]	42 [4.3]	22 [2.2]	22 [2.2]	3.175	70

LAU09 and 12 are available only in stainless steel.

Dimensions of LU Series (Interchangeable rail)

Standard stock

Regular rail

L1U (fine clearance)

- See Standardized LU Series in stock in Page A37 for reference codes of interchangeable items.

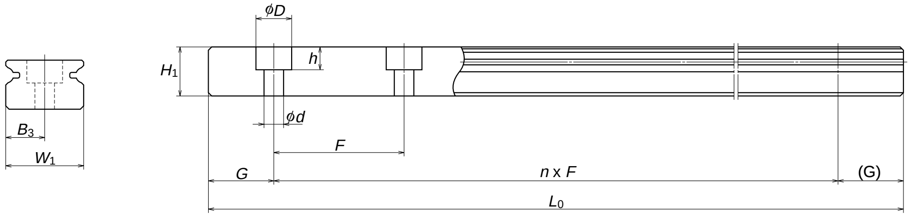


Table. Ⅰ-5•34

Unit: mm

Model No.	Rail							Weight
	Width W_1	Height H_1	F	B_3	Mounting bolt hole $d \times D \times h$	G (recommended)	Max. length $L_{0MAX.}$ ( ) for stainless	(g/100mm)
L1U09*S **L1U09*TS**	9	5.5	20	4.5	2.6×4.5×3 3.5×6×4.5	7.5	(600)	35
L1U12*S **L1U12*TS**	12	7.5	25	6	3×5.5×3.5 3.5×6×4.5	10	(800)	65
L1U15	15	9.5	40	7.5	3.5×6×4.5	15	2000 (1000)	105

The mark (*) denotes the length of rail (unit: mm).

A-I-5.8 LL Series

(1) Super light-weight, and compact

This compact guide has a single ball groove on both right and left sides (gothic arch). Rails and ball slides are made of stainless steel plate, therefore they are lightweight.

Also, the ball groove is made outside the ball slide to reduce overall size and to obtain high speed.

(2) Stainless steel is standard.

Rails and bearings are made of martensitic stainless steel.

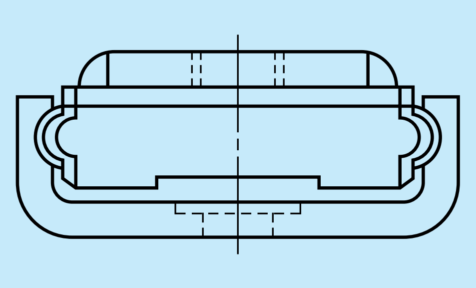


Fig. I-5•23 LL Series

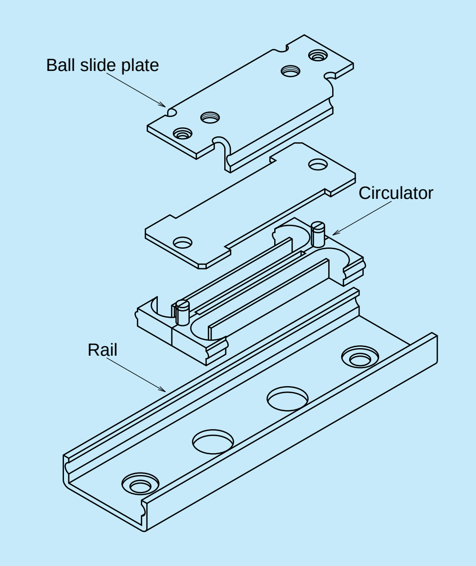


Fig. I-5•24 LL Series structure

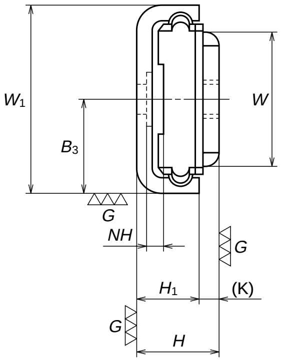
Dimensions of LL Series

LL (Miniature, light-weight)

- **Specification number**

LL15 060 PL 1-PN Z0

Model number
Rail length (mm)
Ball slide shape
Number of ball slides per rail
Accuracy grade: Only PN normal grade is available.
Preload: Only Z0 fine clearance is available.



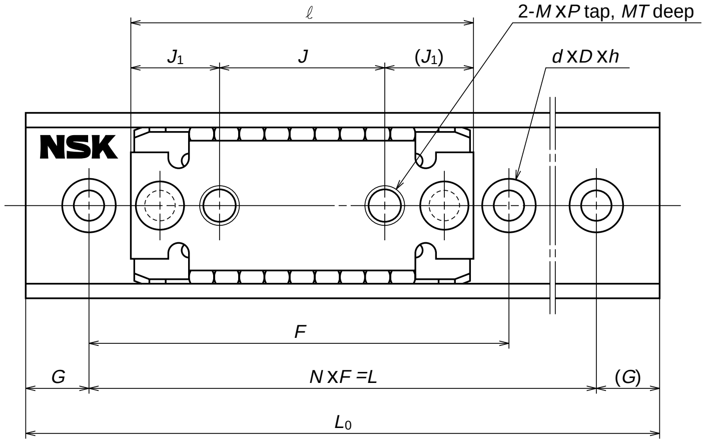


Table. I-5•35

Unit: mm

Model No.	Assembly		Ball slide										Rail					Basic load rating					Ball dia.	Weight	
	Height		Width	Length	Mounting tap hole					Height	Pitch		Mounting bolt hole				Rail length	Dynamic	Static	Static moment				Ball slide	Rail
	H	W_1	W	ℓ	J	M x pitch	MT	J_1	K	H_1	F	N	d x D x h	NH	B_3	G	L_0	C	C_0	M_{RO}	M_{PO}	M_{YO}	D_w	(g)	(g)
																		(N[kgf])		(N·m[kgf·m])					
LL15	6.5	15	10.6	27	13	M3×0.5	1.2	7	1.5	5	30	1	2.4×5×0.4	1.2	7.5	5	40	880 [90]	785 [80]	7 [0.7]	3 [0.3]	3 [0.3]	2	6	9
											40	1				10	60								11
											30	2				7.5	75								13
											40	2				5	90								16
											50	2				10	120								21

Remarks:

1. LL Series does not have a ball retainer. Be aware that the balls fall out when a bearing is withdrawn from the rail.
2. Seal Is not available. Please provide the dust-prevention measures on the equipment.
3. Do not use an installation screw on the ball slide which exceeds MT (maximum screw depth allowance) in the dimension table.

A-Ⅰ-6 Guide to Technical Services

(1) CAD drawing data

NSK offers CAD data for linear guides. Data are available on magnetic tape (M/T) or floppy disk (FD).

Available format	Media		
	M/T	FD(3.5”)	FD(5.25”)
CADAM	O		
IGES	O		
MICRO-CADAM		O	O
DXF		O	O

- Data in drawings are filed in the actual size (some parts are simplified). You can use these data without processing.
- Drawings are three-views projection.
- Dimension lines are omitted to render the data as standard drawing for database.

Data offered by CAD
- **NSK linear guides**
  - **LH Series**
  - **LS Series**
  - **LA Series**
  - **LY Series**
  - **LW Series**
  - **LE Series**
  - **LU Series**

(2) Technical support

For inquiries and advice, call the number below.
Linear Motion Engineering Department, Precision Machinery & Parts

Technology Center
Tel: 027-254-7718 (Japan)
Or call your local NSK representative.

A-Ⅰ-7 Linear Guide: Handling Precautions

NSK linear guides are of high quality and are easy to use. NSK places importance on safety in design. For maximum safety, please follow precautions as outlined below.

(1) Lubrication

Confirm lubrication

a. If your linear guide is of rust prevention specification, thoroughly wipe the rust prevention oil, and put lubricant inside of ball slide before using.

b. If you are using oil as lubricant, the oil may not reach the ball groove depending on how the ball slide is installed. Consult NSK in such case.

(2) Handling

Handll with carl

Do not disassemble

Do not drok

Do not impose shock

a. Interchangeable ball slides (randomly matching types between rail and ball slide) are installed to the provisional rail when they leave the factory. Handle the ball slide with care during installation to the rail.

b. Do not disassemble the guide unless absolutely necessary. Not only does it allow dust to enter, but it lessens precision.

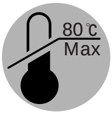
c. Ball slide may move by simply leaning the rail. Make sure that the ball slide does not disengage from the rail.

d. Standard end cap is made of plastic. Beating it or hitting it against an object may cause damage.

(3) Precautions in use

Prevent rust

Watch for hanging upside-down



Temperature limitation

a. Make every effort to not allow dust and foreign objects to enter.

b. The temperature of the place where linear guides are used should not exceed 80 (excluding heat-resistant type linear guides). A higher temperature may damage the plastic end cap.

c. If the user cuts the rail, thoroughly remove burrs and sharp edges on the cut surface.

d. When hanging upside-down (e.g. the rail is installed upside-down on the ceiling in which the ball slide faces downward), should the end cap be damaged, causing the balls to fall out, the ball slide may be detached from the rail and fall. For such use, take measures including installing a safety device.

(4) Storage

Store in the correct position

a. Linear guide may bend if the rail is stored in inappropriate position. Place it on a suitable surface, and store it in a flat position.

A-Ⅱ Technical Description of NSK Linear Guides

A-Ⅱ-1 Accuracy

A-Ⅱ-1.1 Accuracy Standard

- Table Ⅱ-1•1, Figure Ⅱ-1•1 and Figure Ⅱ-1•2 show accuracy characteristics.

Table Ⅱ-1•1 Definition of accuracy

Characteristics	Definition (Figures Ⅱ-1•1, Ⅱ-1•2)
Mounting height H	Distance from A (rail bottom datum face) to C (ball slide top face)
Variation of H	Variation of H between assembled ball slides installed in the rails of a set of linear guide
Mounting width W_2 or W_3	Distance from B (rail side datum face) to D (ball slide side datum face). Applicable only to the reference linear guide.
Variation of W_2 or W_3	Difference of the width (W_2 or W_3) between the assembled ball slides which are installed in the same rail. Applicable only to the reference linear guide.
Running parallelism of ball slide, face C to face A	Variation of C (ball slide top face) to A (rail bottom datum face) when ball slide is moving.
Running parallelism of ball slide, face D to face B	Variation of D (ball slide side datum face) to B (rail side datum face) when a ball slide is moving.

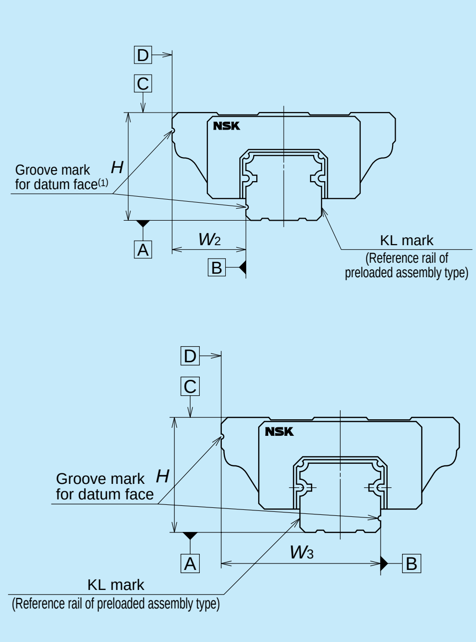


Fig. Ⅱ-1.1 Assembled accuracy (Height and width)

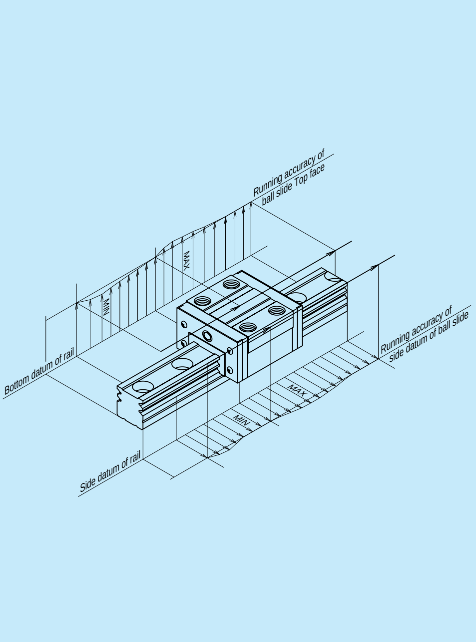


Fig. Ⅱ-1.2 Running parallelism of ball slide

Mounting width: W_2, W_3

- Mounting width differs depending on the arrangement of the datum faces of the rail and ball slide on the reference linear guide (indicated as KL on the rail). (Fig. Ⅱ-1•3 and Fig. Ⅱ-1•4)

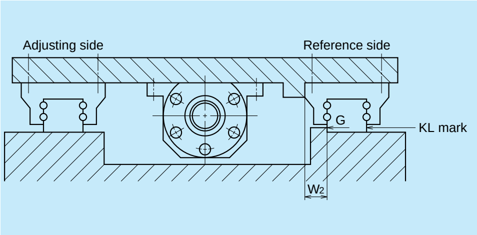


Fig. Ⅱ-1•3 Mounting width W_2

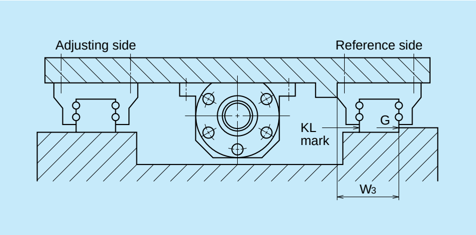


Fig. Ⅱ-1•4 Mounting width W_3

A-Ⅱ-1.2 Running Parallelism of Ball Slide

- Running parallelism of ball slide is common in all series. Specifications of all accuracy grades are shown in Table Ⅱ-1•2.

However, applicable accuracy grades differ by series. Please refer to "**Table Ⅰ-3.1 Accuracy grade and applicable series**" on page A20.

Table Ⅱ-1•2 Running parallelism of ball slide

Unit: μm

	Preloaded assembly (Non-interchangeable)					Interchangeable type
Rail over all length (mm)	Ultra precision P3	Super precision P4	High precision P5	Precision grade P6	Normal grade PN	Normal grade PC
~50	2	2	2	6	12	12
50~80	2	2	3	7	13	13
80~125	2	2	3.5	8	14	14
125~200	2	2	4	9	15	15
200~250	2	2.5	5	10	17	17
250~315	2	2.5	5	11	17	17
315~400	2	3	6	11	18	18
400~500	2	3	6	12	19	19
500~630	2	3.5	7	13	20	20
630~800	2	4.5	8	14	22	22
800~1000	2.5	5	9	16	23	23
1000~1250	3	6	10	17	25	25
1250~1600	4	7	11	19	27	27
1600~2000	4.5	8	13	21	29	29
2000~2500	5	10	15	22	31	31
2500~3150	6	11	17	25	33	33
3150~4000	9	16	23	30	38	38

A-Ⅱ-1.3 Accuracy Standard in Each Series

LH, LS, LA, LY, LW Series

Table Ⅱ-1.3 shows accuracy standards of the preloaded assembly in LH, LS, LA, LY and LW Series. Table Ⅱ-1.4 shows accuracy standards of LH Series interchangeable type. Table Ⅱ-1•5 shows accuracy standards of LS and LW Series interchangeable type.

Table Ⅱ-1•3 Tolerance of preloaded assembly in LH, LS, LA, LY and LW Series Unit: μm

Accuracy grade Characteristic	Ultra precision P3	Super precision P4	High precision P5	Precision grade P6	Normal grade PN
Mounting height H Variation of H (all ball slides installed in rails for a set of linear guides)	±10 3	±10 5	±20 7	±40 15	±80 25
Mounting width W_2 or W_3 Variation of W_2 or W_3 (all ball slides on the reference linear guide)	±15 3	±15 7	±25 10	±50 20	±100 30
Running parallelism of ball slide, face C to face A Running parallelism of ball slide, face D to face B	Refer to Table Ⅱ-1•2, Figure Ⅱ-1•5 and Figure Ⅱ-1•6				

Table Ⅱ-1•4 Tolerance of interchangeable type in LH Series • Normal grade (PC) Unit: μm

	Model No. Characteristic	LH20	LH25, 30, 35	LH45, 55, 65
Interchangeable type with clearance	Mounting height H Variation of H	±30 60	±35 70	±45 90
	Mounting width W_2 or W_3 Variation of width W_2 or W_3	±40 80	±40 80	±50 100
	Running parallelism of ball slide, face C to face A Running parallelism of ball slide, face D to face B	Refer to Table Ⅰ-1•2, Figure Ⅰ-3•1, Figure Ⅰ-3•2		
Interchangeable type with preload	Mounting height H Variation of H	±30 60		
	Mounting width W_2 or W_3 Variation of W_2 or W_3 (W_2 or W_3)	±40 80		±50 100
	Running parallelism of ball slide, face C to face A running parallelism, face C to face B	Refer to Table Ⅱ-1•2, Figure Ⅱ-1•5 and Figure Ⅱ-1•6		

Table Ⅱ-1.5 Tolerance of interchangeable type in LS and LW Series • Normal grade (PC) Unit: μm

Model No. Characteristic	LS15, 20, 25, 30, 35 LW17, 21, 27, 35, 50
Mounting height H Variation of H	±30 60
Mounting width W_2 or W_3 Variation of width W_2 or W_3	±30 60
Running parallelism of ball slide, face C to face A Running parallelism of ball slide, face D to face B	Refer to Table Ⅱ-1•2, Figure Ⅱ-1•5 and Figure Ⅱ1•6

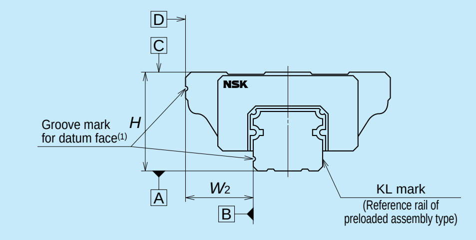


Fig Ⅱ-1•5 Mounting width (W_2)

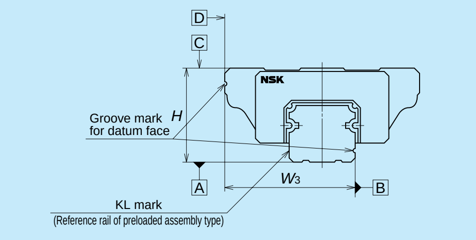


Fig Ⅱ-1•6 Mounting width (W_3)

LE, LU Series

Table Ⅱ-1•6 shows tolerance of preloaded assembly in LE and LU Series. Table Ⅱ-1•7 shows tolerance of LE and LU Series intercahngeable type.

Table Ⅱ-1•6 Tolerance of preloaded assembly in LE and LU Series

Unit: μm

Accuracy grade Characteristic	Super precision P4	High precision P5	Precision grade P6	Normal grade PN
Mounting height H Variation of H (all ball slides installed in rails for a set of linear guides)	±10 5	±15 7	±20 15	±40 25
Mounting width W_2 or W_3 Variation of W_2 or W_3 (all ball slides on the reference linear guide)	±15 7	±20 10	±30 20	±50 30
Running parallelism of ball slide, face C to face A Running parallelism of ball slide, face D to face B	Refer to Table Ⅱ-1•2, Figure Ⅱ-3•7 and Figure Ⅱ-1•8			

Table Ⅱ-1•7 Tolerance of interchangeable type in LE and LU Series Normal grade (PC)

Unit: μm

Model No. Characteristic	LU09, 12, 15 LE09, 12, 15
Mounting height H Variation of H	±20 40
Mounting width W_2 or W_3 Variation of width W_2 or W_3	±20 40
Running parallelism of ball slide, face C to face A Running parallelism of ball slide, face D to face B	Refer to Table I-1•2, Fig. Ⅱ-3•7 and Fig. Ⅱ-1•8

Indication of idatum face in LE and LU Series is different from other series. Refer to Table Ⅱ-1•8.

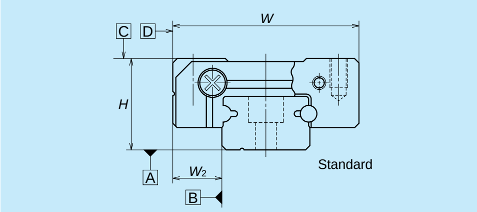


Fig. Ⅱ-1•7 Mounting width (W_2)

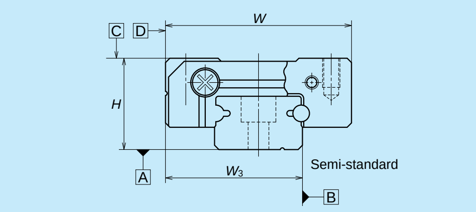
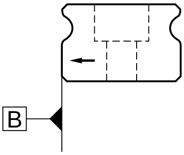
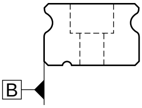
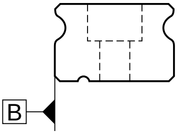
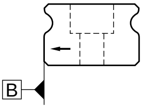


Fig. Ⅱ-1•8 Mounting width (W_3)

Table Ⅱ-1.8 Indication of rail datum face in LE and LU Series

Model No. Material	LU05,07, 09 LE05, 07, 09, 12	LU12, 15	LE15 LE09,12 (with a ball retainer)
Special high carbon steel			
Stainless steel			

LL Series

Table Ⅱ-1•9 shows tolerance of LL Series.

Table Ⅱ-1•9 Tolerance of LL Series
Normal grade (PN)

Unit: μm

Model No. / Characteristic	LL15
Mounting height	±20
Running parallelism, face C to face A Running parallelism, face D to face B	20 (See Fig. Ⅱ-1•9)

A-Ⅱ-2 Preload and Rigidity

A-Ⅱ-2.1 Preload and rigidity

- In NSK linear guides, slight size changes of balls, which are going to be inserted in the ball slide, controls clearance and amount of preload.
- In NSK linear guide, rigidity is further increased and elastic deformation is reduced by applying preload.
- In general, a load range in which the preload is effective becomes about 2.8 times of the preload (Fig. Ⅱ-2•1).
- Fig. Ⅱ-2•2 shows the relationship of ball slide deformation by external vertical load and preload. LY35 is used as a case.
- The following show the definition of linear guide rigidity.

1) Radial rigidity: Rigidity of vertical and lateral directions -- up/down and right/left (Fig. Ⅱ-2•3).
2) Moment rigidity: Three moment directions -- pitching, rolling, and yawing (Fig. Ⅱ-2•4).

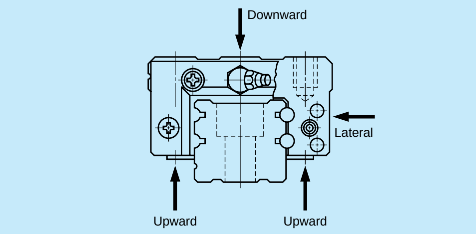


Fig. Ⅱ-2•3 Radial rigidity

- Since two rails and four ball slides are used in general as a pair, considering only the radial rigidity is sufficient.

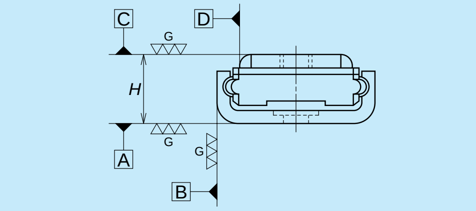


Fig. Ⅱ-1•9 Standard LL

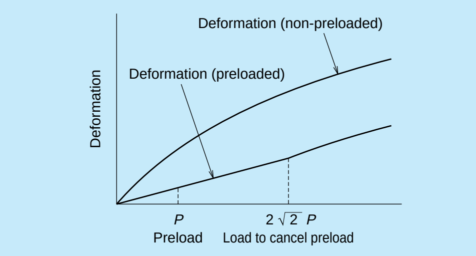


Fig. Ⅱ-2•1 Elastic deformation

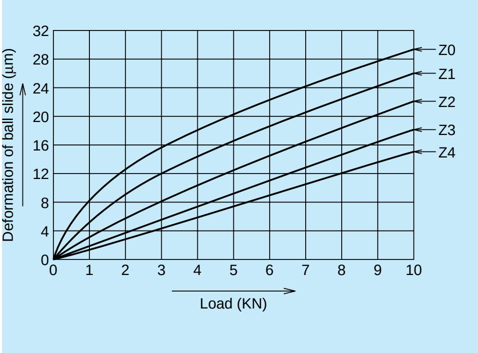


Fig. Ⅱ-2•2 Rigidity of LY35, downward direction load (example)

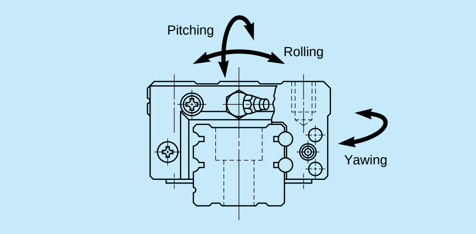


Fig. Ⅱ-2•4 Moment rigidity

- However, in cases as shown in Fig. Ⅱ-2•5, Fig. Ⅱ-2•6 and Fig. Ⅱ-2•7, it is necessary to take into account the moment rigidity in addition to the radial rigidity.

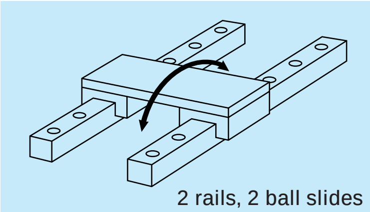


Fig. Ⅱ-2•5 Pitching direction

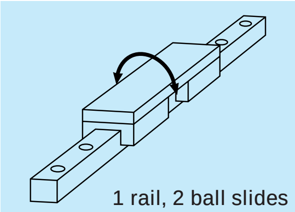


Fig. Ⅱ-2•6 Rolling direction

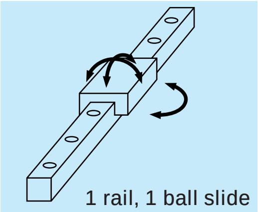


Fig. Ⅱ-2•7 All directions

A-Ⅱ-2.2 Preload and Rigidity of Each Series

LH Series (Preloaded assembly)

Table Ⅱ-2•1 shows preload and rigidity of preloaded assembly of LH Series.

Table Ⅱ-2•1 Preload and rigidity of preloaded assembly of LH Series

	Model No.	Preload N [kgf]		Rigidity N/μm [kgf/μm]			
				Vertical directions		Lateral direction	
		Slight preload Z1	Medium preload Z3	Slight preload Z1	Medium preload Z3	Slight preload Z1	Medium preload Z3
High load type	LH20 AN,EL,FL	147 [15]	835 [85]	186 [19]	335 [34]	137 [14]	245 [25]
	LH25 AN,EL,FL	196 [20]	1270 [130]	206 [21]	380 [39]	147 [15]	284 [29]
	LH30 AN	245 [25]	1570 [160]	216 [22]	400 [41]	157 [16]	294 [30]
	LH30 EL,FL	294 [30]	1770 [180]	265 [27]	480 [49]	186 [19]	355 [36]
	LH35 AN,EL,FL	390 [40]	2350 [240]	305 [31]	560 [57]	216 [22]	390 [40]
	LH45 AN,EL,FL	635 [65]	3900 [400]	400 [41]	745 [76]	284 [29]	540 [55]
	LH55 AN,EL,FL	980 [100]	5900 [600]	490 [50]	910 [93]	345 [35]	645 [66]
	LH65 AN,EL,FL	1470 [150]	8900 [910]	580 [59]	1070 [109]	400 [41]	755 [77]
Super high load type	LH20 BN,GL,HL	196 [20]	1080 [110]	265 [27]	480 [49]	196 [20]	355 [36]
	LH25 BN,GL,HL	245 [25]	1570 [160]	294 [30]	560 [57]	216 [22]	400 [41]
	LH30 BN,GL,HL	390 [40]	2260 [230]	360 [37]	665 [68]	265 [27]	480 [49]
	LH35 BN,GL,HL	490 [50]	2940 [300]	430 [44]	795 [81]	305 [31]	570 [58]
	LH45 BN,GL,HL	785 [80]	4800 [490]	520 [53]	960 [98]	370 [38]	695 [71]
	LH55 BN,GL,HL	1180 [120]	7050 [720]	635 [65]	1170 [119]	440 [45]	835 [85]
	LH65 BN,GL,HL	1860 [190]	11300 [1150]	805 [82]	1480 [151]	550 [56]	1040 [106]
	LH85 BN,GL,HL	2840 [290]	16800 [1710]	1020 [104]	1870 [191]	695 [71]	1300 [133]

Clearance for fine clearance Z0 is 0 ~ 3μm. Therefore, preload is zero.

LH Series (interchangeable type)

Table Ⅱ-2•2 shows clearance and preload of interchangeable in LH Series.

Table Ⅱ-2•2 Clearance and preload of interchangeable type in LH Series

Unit: μm

Model No.	Fine clearance	Slight preload
	ZT	ZZ
LH20	–5〜15	–5〜0
LH25		–5〜0
LH30		–7〜0
LH35		–7〜0
LH45		–7〜0
LH55		–9〜0
LH65		–9〜0

Negative sign indicates preload volume.

LS Series (Preloaded assembly)

Table Ⅱ-2•3 shows preload and rigidity o of LS Series.

Table Ⅱ-2•3 Preload and rigidity of preloaded assembly in LS Series

	Model No.	Preload N [kgf]		Rigidity N/μm [kgf/μm]			
				Vertical directions		Lateral direction	
		Slight preload Z1	Medium preload Z3	Slight preload Z1	Medium preload Z3	Slight preload Z1	Medium preload Z3
High load type	LS15 AL,EL,FL	69 [7]	390 [40]	127 [13]	226 [23]	88 [9]	167 [17]
	LS20 AL,EL,FL	88 [9]	540 [55]	147 [15]	284 [29]	108 [11]	206 [21]
	LS25 AL,EL,FL	147 [15]	880 [90]	206 [21]	370 [38]	147 [15]	275 [28]
	LS30 AL,EL,FL	245 [25]	1370 [140]	255 [26]	460 [47]	186 [19]	345 [35]
	LS35 AL,EL,FL	345 [35]	1960 [200]	305 [31]	550 [56]	216 [22]	400 [41]
Medium load type	LS15 CL,JL,KL	49 [5]	294 [30]	78 [8]	147 [15]	59 [6]	108 [11]
	LS20 CL,JL,KL	69 [7]	390 [40]	108 [11]	186 [19]	78 [8]	137 [14]
	LS25 CL,JL,KL	98 [10]	635 [65]	127 [13]	235 [24]	88 [9]	177 [18]
	LS30 CL,JL,KL	147 [15]	980 [100]	147 [15]	275 [28]	108 [11]	206 [21]
	LS35 CL,JL,KL	245 [25]	1370 [140]	186 [19]	335 [34]	137 [14]	245 [25]

Clearance for fine clearance Z0 is 0 ~3μm. Therefore, preload is zero.
However, Z0 of PN grade is 0 ~15μm.

LS Series (Interchangeable type)

Table Ⅱ-2•4 shows clearance of interchangeable type of LS Series.

Table Ⅱ-2•4 Preload and clearance of interchangeable type of LS Series

Unit: μm

Model No.	Fine clearance	Slight preload
	ZT	ZZ
LS15	–4〜15	–4〜0
LS20	–4〜15	–4〜0
LS25	–5〜15	–5〜0
LS30	–5〜15	–5〜0
LS35	–5〜15	–6〜0

Negative sign indicates preload volume.

LA Series

Table Ⅱ-2•5 shows preload and rigidity of LA Series.
LA Series has two types of preload Z3 (medium preload) and Z4 (heavy preload).

Table Ⅱ-2•5 Preload and rigidity of LA Series

	Model No.	Preload N [kgf]		Rigidity N/μm [kgf/μm]	
		Medium preload Z3	Heavy preload Z4	Medium preload Z3	Heavy preload Z4
High load type	LA30 AN, EL, FL	2450 [250]	3140 [320]	705 [72]	835 [85]
	LA35 AL, AN, EL, FL	3450 [350]	4300 [440]	825 [84]	970 [99]
	LA45 AL, AN, EL, FL	5050 [515]	6350 [650]	1100 [112]	1240 [126]
	LA55 AL, AN, EL, FL	8100 [825]	10200 [1040]	1400 [143]	1540 [157]
	LA65 AN, EL, FL	13800 [1410]	18800 [1920]	1730 [176]	2030 [207]
Super high load type	LA30 BN, GL, HL	3250 [330]	4050 [415]	1000 [102]	1180 [120]
	LA35 BL, BN, GL, HL	4450 [455]	5650 [575]	1200 [122]	1400 [143]
	LA45 BL, BN, GL, HL	6150 [630]	7750 [790]	1450 [148]	1640 [167]
	LA55 BL, BN, GL, HL	9550 [975]	12100 [1230]	1840 [188]	2020 [206]
	LA65 BN, GL, HL	18000 [1840]	24400 [2490]	2450 [250]	2840 [290]

LY Series

Table Ⅱ-2•6 shows preload and rigidity of LY Series.

Table Ⅱ-2•6 Preload and rigidity of LY Series

	Model No.	Preload N [kgf]				Rigidity N/μm [kgf/μm]			
		Slight preload Z1	Light preload Z2	Medium preload Z3	Heavy preload Z4	Slight preload Z1	Light preload Z2	Medium preload Z3	Heavy preload Z4
High load type	LY15 AL,AN,EL,FL	59 [6]	147 [15]	294 [30]	– –	98 [10]	137 [14]	167 [17]	– –
	LY20 AL, EL,FL	98 [10]	245 [25]	490 [50]	– –	127 [13]	167 [17]	216 [22]	– –
	LY25 AL,AN,EL,FL	147 [15]	440 [45]	835 [85]	1180 [120]	167 [17]	284 [29]	390 [40]	460 [47]
	LY30 AL,AN,EL,FL	245 [25]	635 [65]	1270 [130]	1770 [180]	196 [20]	325 [33]	480 [49]	580 [59]
	LY35 AL,AN,EL,FL	345 [35]	880 [90]	1770 [180]	2450 [250]	245 [25]	360 [37]	580 [59]	655 [67]
	LY45 AL,AN,EL,FL	490 [50]	1270 [130]	2550 [260]	3600 [370]	315 [32]	500 [51]	735 [75]	860 [88]
	LY55 AL,AN,EL,FL	785 [80]	1960 [200]	3900 [400]	5600 [570]	370 [38]	600 [61]	880 [90]	1020 [104]
	LY65 AN,EL,FL	1670 [170]	4200 [430]	8450 [860]	11800 [1200]	560 [57]	910 [93]	1340 [137]	1560 [159]
Super high load type	LY20 BL, GL,HL	98 [10]	294 [30]	590 [60]	– –	147 [15]	216 [22]	275 [28]	– –
	LY25 BL,BN,GL,HL	196 [20]	540 [55]	1080 [110]	1570 [160]	226 [23]	360 [37]	540 [55]	645 [66]
	LY30 BL,BN,GL,HL	294 [30]	785 [80]	1570 [160]	2160 [220]	245 [25]	400 [41]	610 [62]	695 [71]
	LY35 BL,BN,GL,HL	440 [45]	1080 [110]	2160 [220]	2940 [300]	305 [31]	450 [46]	685 [70]	805 [82]
	LY45 BL,BN,GL,HL	635 [65]	1570 [160]	3150 [320]	4400 [450]	400 [41]	625 [64]	940 [96]	1100 [112]
	LY55 BL,BN,GL,HL	980 [100]	2450 [250]	5000 [510]	6950 [710]	470 [48]	755 [77]	1140 [116]	1340 [137]
	LY65 BN,GL,HL	2260 [230]	5600 [570]	11300 [1150]	15700 [1600]	805 [82]	1280 [131]	1920 [196]	2230 [227]

Clearance for fine clearance Z0 is 0 ~ 3μm. Therefore, preload is zero.

LW Series (Preloaded assembly)

Table Ⅱ-2•7 shows preload and rigidity of preloaded assembly of LW Series.
Rigidities are for the median of the preload range.

Table Ⅱ-2•7 Preload and rigidity of LW Series

Model No.	Preload N [kgf]		Rigidity N/μm [kgf/μm]	
	Slight preload Z1	Medium preload Z3	Slight preload Z1	Medium preload Z3
LW17 EL	0~245 [0~25]	– –	156 [16]	– –
LW21 EL	0~294 [0~30]	– –	181 [18]	– –
LW27 EL	0~390 [0~40]	– –	226 [23]	– –
LW35 EL	0~490 [0~50]	785 [80]	295 [30]	440 [45]
LW50 EL	0~590 [0~60]	1470 [150]	345 [35]	600 [61]

Clearance of fine clearance Z0 is 0 ~3μm. Therefore, preload is zero.
However, Z0 of PN Grade is 3 ~15μm.

LW Series (Interchangeable type)

Table Ⅱ-2•8 shows in LW Series.

Table Ⅱ-2•8 Clearance of interchangeable type in LW Series

Unit: μm

Model No.	Fine clearance
	ZT
LW17	–3~15
LW21	–3~15
LW27	–4~15
LW35	–5~15
LW50	–5~15

LE Series (Preloaded assembly)

Table Ⅱ-2•9 shows preload and rigidity of preloaded assembly of LE Series. Rigidities are for the median of the preload range.

Table Ⅱ-2•9　Preload and rigidity of LE Series

	Model No.	Preload N [kgf]	Rigidity N/μm [kgf/μm]
		Slight preload Z1	Slight preload Z1
High load type	LE05 AL	0~22 [0~2.3]	36 [3.5]
	LE07　TL	0~29 [0~3]	46 [4.5]
	LE09 AL,TL LE09 AR,TR	0~37 [0~3.8]	61 [6]
	LE12 AL LE12 AR	0~40 [0~4.1]	63 [6.5]
	LE15 AL,AR	0~49 [0~5]	66 [6.5]
Medium load type	LE05 CL	0~19 [0~1.9]	29 [3]
	LE07　SL	0~20 [0~2]	28 [3]
	LE09 CL,SL	0~20 [0~2]	33 [3.5]
	LE12 CL	0~23 [0~2.3]	36 [3.5]
	LE15 CL	0~29 [0~3]	44 [4.5]
Super high load type	LE07　UL	0~43 [0~4.4]	71 [7]
	LE09 BL,UL	0~49 [0~5]	86 [9]
	LE12 BL	0~59 [0~6]	97 [10]
	LE15 BL	0~78 [0~8]	114 [12]

Clearance of fine clearance Z0 is 0 ~3μm. Therefore, preload is zero.
However, Z0 of PN grade is 3 ~10μm.

LE Series (Interchangeable type)

Table Ⅱ-2•10 shows clearance of interchangeable type of LE Series.

Table Ⅱ-2•10　Clearance of interchangeable type of LE Series

Unit: μm

Model No.	Fine clearance
	ZT
LE09	0~15
LE12	
LE15	

LU Series (Preloaded assembly)

Table Ⅱ-2•11 shows preload and rigidity of preloaded assembly of LU Series.
Rigidities are for the median of the preload range.

Table Ⅱ-2•11 Preload and rigidity of LU Series

	Model No.	Preload N [kgf]	Rigidity N/μm [kgf/μm]
		Slight preload Z1	Slight preload Z1
High load type	LU05 TL	0~3.5 [0~0.34]	15 [1.5]
	LU07 AL	0~8 [0~0.8]	22 [2]
	LU09 AL,TL	0~12 [0~1.2]	26 [2.5]
	LU09 AR,TR	0~10 [0~1.0]	30 [3.5]
	LU12 AL,TL	0~17 [0~1.7]	33 [3.5]
	LU12 AR,TR	0~17 [0~1.7]	33 [3.5]
	LU15 AL	0~33 [0~3.4]	45 [4.5]
Super high load type	LU09 BL,UL	0~17 [0~1.7]	43 [4.5]
	LU12 BL,UL	0~25 [0~2.5]	52 [5]
	LU15 BL	0~51 [0~5.2]	75 [7.5]

Clearance of fine clearance Z0 is 0 ~3μm. Therefore, preload is zero.
However, Z0 of PN grade is 3 ~10μm.

LU Series (Interchangeable type)

Table Ⅱ-2•12 shows clearance of interchangeable type of LU Series

Table Ⅱ-2•12 Clearance of interchangeable type of LU Series

Unit: μm

Model No.	Fine clearance
	ZT
LU09	0~15
LU12	
LU15	

LL Series

Table Ⅱ-2•13 shows clearance of LL Series

Table Ⅱ-2•13 Radial clearance

Unit: μm

Model No.	Clearance
LL15	0~10

A-Ⅱ-2.3 Calculating Friction Force by Preload

- Dynamic friction force per one ball slide of the linear guide can be calculated from preload vlue.
- The followings is a simple calculation to obtain the criterion of dynamic friction force.

  For slight preload ZZ of interchangeable type with preload , use preload volume of slight preload Z1 of preloaded assembly.

$F = iP$

F: **Dynamic friction force(N)**
P: **Preload (N)**
i: **Contact coefficient**

Use the following contact coefficient values (*i*).

LH/LS, LW Series : 0.004
LA Series : 0.012
LY, LE, LU Series : 0.026

- The starting friction force when the ball slide begins to move depends on lubrication condition. Roughly estimate it at 1.5 to 2 times of the dynamic friction obtained by the above method.

Calculation example

In case of LH35AN - Z3

$i = 0.004$
$P = 2350$ (N) (from Table Ⅱ-2•1)
$F = iP$
$= 0.004 \times 2350 = 9.4$ (N)

Therefore, the criteria of the dynamic friction force of LH35AN - Z3 is 9.4 N.

For seal friction, refer to "**A-Ⅱ-5 Dust Proof of Linear Guide**."

A-Ⅱ-3 Rating Life

A-Ⅱ-3.1 Rating Life and Basic Load Rating

(1) Life

Although used in appropriate conditions, the linear guide deteriorates after a certain period of operation, and eventually becomes unusable. In broad definition, the period until the linear guide becomes unusable is called "life." There are "fatigue life " caused by flaking, and "life of accuracy deterioration" which is caused by wear.

(2) Rating fatigue life

When the linear guide runs under load, the balls and the rolling contact surface of the grooves are exposed to repetitive load. This brings about fatigue to the material, and generates flaking. Flaking is scale-like damage to the surface of the ball groove.

Total running distance until first appearance of flaking is called "fatigue life." This is "life" in the narrow sense. Fatigue life varies significantly even in linear guides produced in the same lot, and even when they are operated under the same conditions. This is attributable to the inherent variation of the fatigue of the material itself.

"Rating fatigue life" is the total running distance which allows 90% of the group of linear guides of the same reference number to run without causing flaking when they are independently run under the same conditions. Rating fatigue life is sometimes indicated by total operating hours when the linear guides run at a certain speed.

(3) Basic dynamic load rating

- Basic dynamic load rating, which indicates load carrying capacity of the linear guide, is a load whose direction and volume do not change, and which furnishes 50 km of rating fatigue life.
- In case of linear guide, it is a constant load applied to downward direction to the center of the ball slide.
- Value of basic dynamic load rating C is shown in "**Selection Guide to Linear Guides A-Ⅰ-5 Model Number and Dimension Table**."

(4) Calculation of rating fatigue life

In general, rating fatigue life "L" can be calculated from basic dynamic load rating "C" and the load "F" to ball slide using the following formula.

For balls as rolling element $L = 50 \times \left[\frac{C}{F}\right]^{3}$

For rollers as rolling element $L = 50 \times \left[\frac{C}{F}\right]^{\frac{10}{3}}$

L: Rating fatigue life (km)
C: Basic dynamic load rating (N)
F: Load to a ball slide (N)
(dynamic equivalent load)

(5) Dynamic equivalent load

- Load applied to the linear guide (ball slide load) comes from various directions up/down and right/left directions and/or as moment load. Sometimes more than one type of load is applied simultaneously. Sometimes volume and direction of the load may change.

Varying load cannot be used as it is to calculate life of linear guide. Therefore, it is necessary to use a hypothetical load to ball slide with a constant volume which would generate a value equivalent to an actual fatigue life. This is called "dynamic equivalent load." For actual calculation, refer to "**A-Ⅱ-3.2 (4) How to calculate dynamic equivalent load**."

(6) Basic static load rating

- When an excessive load or a momentary large impact is applied to the linear guide, local permanent deformation takes place to the balls and to the rolling contact surface. After exceeding a certain level, the deformation hampers smooth linear guide operation.
- Basic static load rating is a static load when: [Permanent deformation of the balls] + [permanent deformation of the rolling contact surfaces] becomes 0.0001 times of the ball diameter.
- In case of linear guide, it is a load which is applied downward direction to the center of the ball slide.
- Values of basic static load rating C0 are shown in "**Selection Guide to Linear Guide A-Ⅰ-5 Model Number and Dimension Table**."

(7) Basic static moment load rating

- Generally, NSK linear guide uses a set of two rails and four ball slides for the guide way of one axis. Under some operating condition, static moment load should be taken into account.

"M0," which is the limit of static moment load in such use is shown in "**Selection Guide to Linear Guide A-Ⅰ-5 Model Number and Dimension Table**."

A-Ⅱ-3.2 How to Calculate Life

(1) Flow chart to calculate life

Setting operating conditions

Refer to Section (2) .... Page A130

Set operating conditions such as volume of load to the linear guide, installation method, set up of axes, number of ball slide, etc.

Calculating load which applies to each bearing

Refer to Section (3) .... Page A130

Calculate up/down, right/left direction loads and moment load of the linear guide.

Calculating dynamic equivalent load

Refer to Section (4) .... Page A134

Calculate dynamic equivalent load based on the load from each direction which are applied to each linear guide.

Calculating mean effective load

Refer to Section (5) .... Page A136

Calculate mean effective load based on the dynamic equivalent load which changes by the stroke position.

Determining load factor

Refer to Section (6) .... Page A137

Determine load factor to satisfy operating conditions.

Calculating rating life

Refer to Section (7) .... Page A139

Calculate running distance from the life formula.

Checking static load

Refer to Section (8) .... Page A139

Confirm that static load is within permissible range.

Completion

(2) Setting operating condition of linear guide

- First, set operating conditions to determine whether the temporarily selected model satisfies the required life.
- Major operating conditions are as follows. Set all values to calculate applied loads to each ball slide (Refer to Table Ⅱ-3•1).

Axis set up : Horizontal, vertical
Rail combination : Single rail, multiple rail
Applying loads : F_x, F_y and F_z (N)
Ball slide span : l (mm)
Rail span : L (mm)
Point of load action point : X, Y, Z (mm)
Center of driving mechanism : X_b, Y_b, Z_b (mm)
Operating speed : V (mm/sec)
Time in acceleration : t (sec)
Operating frequency (duty cycle)

(3) Calculating load to a ball slide

- Table Ⅱ-3•1 shows a formula to calculate loads that are going to be applied to each assembled ball slide into a machine.
  The Table shows six typical patterns of linear guide installing structure.
- In the Tables, directions indicated by arrows denote "plus" for the applied loads (F_x, F_y, F_z) and the loads which is applied to the ball slide. (F_r, F_s, M_r, M_p, M_y).
- Codes in the Tables are as follows:

F_r : Vertical loads to the ball slide (N)
F_s : Lateral loads to the ball slide (N)
M_r : Rolling moment to the ball slide (N • mm)
M_p : Pitching moment the ball slide (N • mm)
M_y : Yawing moment the ball slide (N • mm)
Suffixes (1, 2, ...) to the above F_r ~ M_y : Ball slide number
F_{xi} : Load applied in X direction (i = 1~n; n is the number of loads applied in X direction) (N)
F_{yj} : Load applied in Y direction (j = 1~n; n is the number of loads applied in Y direction) (N)
F_{zk} : Load applied in Z direction (k = 1~n; n is the number of loads applied in Z direction) (N)
Coordinates (X_{xi}, Y_{xi}, Z_{xi}): Point where load F_{xi} (mm) is applied.
Coordinates (X_{yj}, Y_{yj}, Z_{yj}): Point where load F_{yj} (mm) is applied.
Coordinates (X_{zk}, Y_{zk}, Z_{zk}): Point where load F_{zk} (mm) is applied.
l: Ball slide span (mm)
L: Rail span (mm)
Coordinates (X_b, Y_b, Z_b): Center of driving mechanism

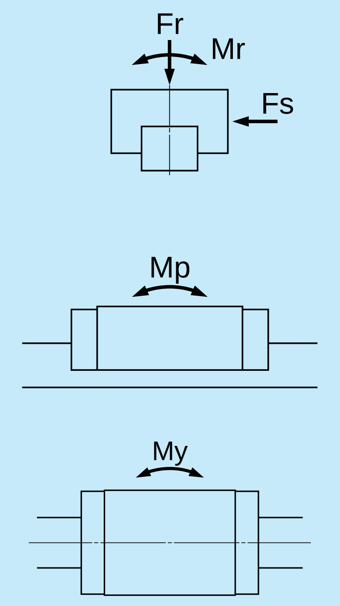
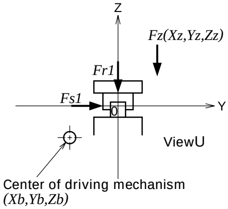
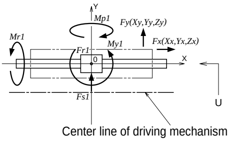


Fig. Ⅱ-3•2

Table Ⅱ-3•1 Loads applied to the ball slides

<table>
<tr><th>Pattern</th><th>Arrangement of ball slides</th><th>Load to ball slide and displacement of Point A</th></tr>
<tr><td>1</td><td>





</td><td>

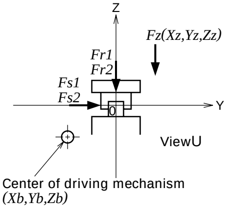
$$Fr_1 = \sum_{k=1}^{n} Fz_k \quad , \quad Fs_1 = \sum_{j=1}^{n} Fy_j$$

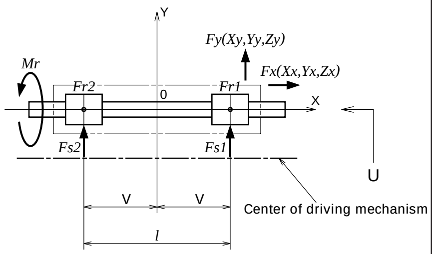
$$Mr_1 = \sum_{j=1}^{n} (Fyj \cdot Zyj) + \sum_{k=1}^{n} (Fzk \cdot Yzk)$$

$$Mp_1 = \sum_{i=1}^{n} \{Fxi \cdot (Zxi - Zb)\} + \sum_{k=1}^{n} (Fzk \cdot Xzk)$$

$$My_1 = -\sum_{i=1}^{n} \{Fxi \cdot (Yxi - Yb)\} + \sum_{j=1}^{n} (Fyj \cdot Xyj)$$

</td></tr>
<tr><td>2</td><td>





</td><td>

$$Fr_1 = \frac{\sum_{k=1}^{n} Fz_k}{2} + \frac{M2}{l} \quad , \quad Fr_2 = \frac{\sum_{k=1}^{n} Fz_k}{2} - \frac{M2}{l}$$

$$Fs_1 = \frac{\sum_{j=1}^{n} Fy_j}{2} + \frac{M3}{l} \quad , \quad Fs_2 = \frac{\sum_{j=1}^{n} Fy_j}{2} - \frac{M3}{l}$$

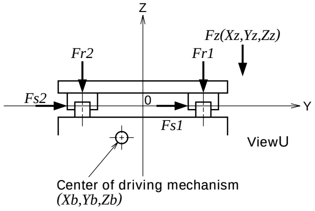
$$Mr_1 = \frac{M1}{2} \quad , \quad Mr_2 = \frac{M1}{2}$$

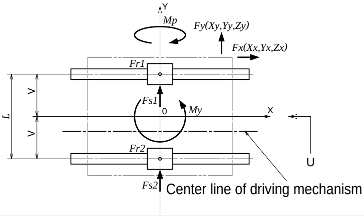
$$M1 = \sum_{j=1}^{n} (Fy_j \cdot Zy_j) + \sum_{k=1}^{n} (Fz_k \cdot Yz_k)$$

$$M2 = \sum_{i=1}^{n} \{Fx_i \cdot (Zx_i - Zb)\} + \sum_{k=1}^{n} (Fz_k \cdot Xz_k)$$

$$M3 = -\sum_{i=1}^{n} \{Fx_i \cdot (Yx_i - Yb)\} + \sum_{j=1}^{n} (Fyj \cdot Xyj)$$

</td></tr>
<tr><td>3</td><td>





</td><td>

$$Fr_1 = \frac{\sum_{k=1}^{n} Fz_k}{2} + \frac{M1}{L} \quad , \quad Fr_2 = \frac{\sum_{k=1}^{n} Fz_k}{2} - \frac{M1}{L}$$

$$Fs_1 = Fs_2 = \frac{\sum_{j=1}^{n} Fy_j}{2}$$

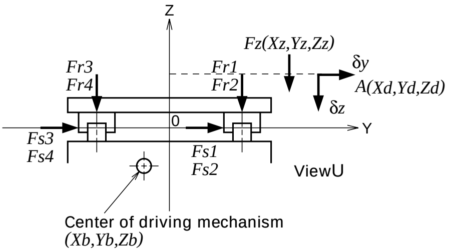
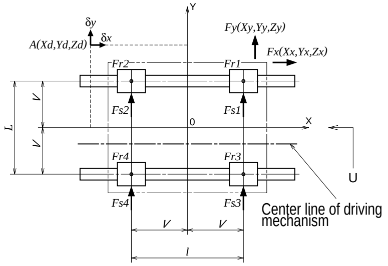
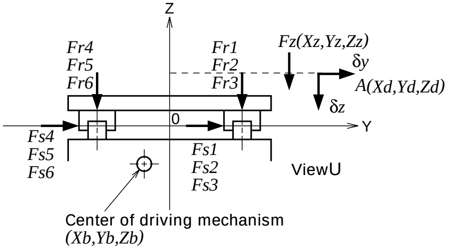
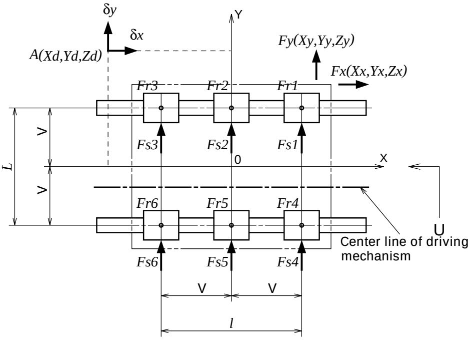
$$Mp_1 = Mp_2 = \frac{M2}{2} \quad , \quad My_1 = My_2 = \frac{M3}{2}$$

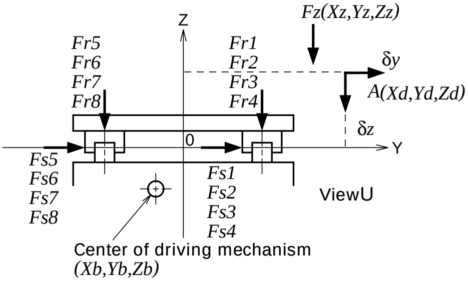
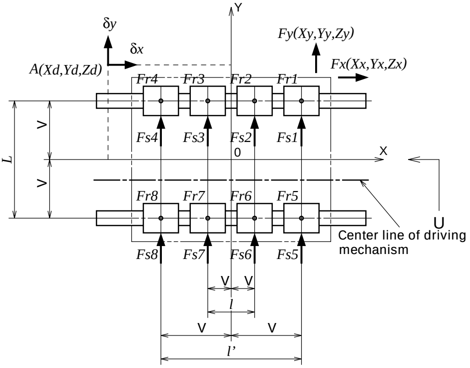
$$M1 = \sum_{j=1}^{n} (Fy_j \cdot Zy_j) + \sum_{k=1}^{n} (Fz_k \cdot Yz_k)$$

$$M2 = \sum_{i=1}^{n} \{Fx_i \cdot (Zx_i - Zb)\} + \sum_{k=1}^{n} (Fz_k \cdot Xz_k)$$

$$M3 = -\sum_{i=1}^{n} \{Fx_i \cdot (Yx_i - Yb)\} + \sum_{j=1}^{n} (Fy_j \cdot Xy_j)$$

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

Pattern	Arrangement of ball slides	Load to ball slide and displacement of Point A
4	 	$Fr_1=\frac{\sum_{k=1}^{n}Fz_k}{4}+\frac{M1}{2L}+\frac{M2}{2l}$, $Fr_2=\frac{\sum_{k=1}^{n}Fz_k}{4}+\frac{M1}{2L}-\frac{M2}{2l}$ $Fr_3=\frac{\sum_{k=1}^{n}Fz_k}{4}-\frac{M1}{2L}+\frac{M2}{2l}$, $Fr_4=\frac{\sum_{k=1}^{n}Fz_k}{4}-\frac{M1}{2L}-\frac{M2}{2l}$ $Fs_1=Fs_3=\frac{\sum_{j=1}^{n}Fy_j}{4}+\frac{M3}{2l}$, $Fs_2=Fs_4=\frac{\sum_{j=1}^{n}Fy_j}{4}-\frac{M3}{2l}$ $M1=\sum_{j=1}^{n}(Fy_j\cdot Zy_j)+\sum_{k=1}^{n}(Fz_k\cdot Yz_k)$ $M2=\sum_{i=1}^{n}\{Fx_i(Zx_i-Zb)\}+\sum_{k=1}^{n}(Fz_k\cdot Xz_k)$ $M3=-\sum_{i=1}^{n}\{Fx_i(Yx_i-Yb)\}+\sum_{j=1}^{n}(Fy_j\cdot Xy_j)$ $\delta x=Y_d\cdot\frac{Fs_2-Fs_1}{l\cdot Ks}+Z_d\cdot\frac{Fr_1-Fr_2}{l\cdot Kr}$ $\delta y=\frac{\sum_{j=1}^{n}Fy_j}{4\cdot Ks}+X_d\cdot\frac{Fs_1-Fs_2}{l\cdot Ks}+Z_d\cdot\frac{Fr_1-Fr_3}{L\cdot Kr}$ $\delta z=\frac{\sum_{k=1}^{n}Fz_k}{4\cdot Kr}+X_d\cdot\frac{Fr_1-Fr_2}{l\cdot Kr}+Y_d\cdot\frac{Fr_1-Fr_3}{L\cdot Kr}$
5	 	$Fr_1=\frac{\sum_{k=1}^{n}Fz_k}{6}+\frac{M1}{3L}+\frac{M2}{2l}$, $Fr_2=\frac{\sum_{k=1}^{n}Fz_k}{6}+\frac{M1}{3L}$ $Fr_3=\frac{\sum_{k=1}^{n}Fz_k}{6}+\frac{M1}{3L}-\frac{M2}{2l}$, $Fr_4=\frac{\sum_{k=1}^{n}Fz_k}{6}-\frac{M1}{3L}+\frac{M2}{2l}$ $Fr_5=\frac{\sum_{k=1}^{n}Fz_k}{6}-\frac{M1}{3L}$, $Fr_6=\frac{\sum_{k=1}^{n}Fz_k}{6}-\frac{M1}{3L}-\frac{M2}{2l}$ $Fs_1=Fs_4=\frac{\sum_{j=1}^{n}Fy_j}{6}+\frac{M3}{2l}$, $Fs_2=Fs_5=\frac{\sum_{j=1}^{n}Fy_j}{6}$ $Fs_3=Fs_6=\frac{\sum_{j=1}^{n}Fy_j}{6}-\frac{M3}{2l}$ $M1=\sum_{j=1}^{n}(Fy_j\cdot Zy_j)+\sum_{k=1}^{n}(Fz_k\cdot Yz_k)$ $M2=\sum_{i=1}^{n}\{Fx_i\cdot(Zx_i-Zb)\}+\sum_{k=1}^{n}(Fz_k\cdot Xz_k)$ $M3=-\sum_{i=1}^{n}\{Fx_i\cdot(Yx_i-Yb)\}+\sum_{j=1}^{n}(Fy_j\cdot Xy_j)$ $\delta x=Y_d\cdot\frac{Fs_3-Fs_1}{l\cdot Ks}+Z_d\cdot\frac{Fr_1-Fr_3}{l\cdot Kr}$ $\delta y=\frac{\sum_{j=1}^{n}Fy_j}{6\cdot Ks}+X_d\cdot\frac{Fs_1-Fs_3}{l\cdot Ks}+Z_d\cdot\frac{Fr_1-Fr_4}{L\cdot Kr}$ $\delta z=\frac{\sum_{k=1}^{n}Fz_k}{6\cdot Kr}+X_d\cdot\frac{Fr_1-Fr_3}{l\cdot Kr}+Y_d\cdot\frac{Fr_1-Fr_4}{L\cdot Kr}$

Pattern	Arrangement of ball slides	Load to ball slide and displacement of Point A
6	 	$Fr_1 = \frac{\sum_{k=1}^{n} Fz_k}{8} + \frac{M1}{4L} + \frac{M2 \cdot l'}{2 \cdot (l^2 + l'^2)}$ $Fr_2 = \frac{\sum_{k=1}^{n} Fz_k}{8} + \frac{M1}{4L} + \frac{M2 \cdot l}{2 \cdot (l^2 + l'^2)}$ $Fr_3 = \frac{\sum_{k=1}^{n} Fz_k}{8} + \frac{M1}{4L} - \frac{M2 \cdot l}{2 \cdot (l^2 + l'^2)}$ $Fr_4 = \frac{\sum_{k=1}^{n} Fz_k}{8} + \frac{M1}{4L} - \frac{M2 \cdot l'}{2 \cdot (l^2 + l'^2)}$ $Fr_5 = \frac{\sum_{k=1}^{n} Fz_k}{8} - \frac{M1}{4L} + \frac{M2 \cdot l'}{2 \cdot (l^2 + l'^2)}$ $Fr_6 = \frac{\sum_{k=1}^{n} Fz_k}{8} - \frac{M1}{4L} + \frac{M2 \cdot l}{2 \cdot (l^2 + l'^2)}$ $Fr_7 = \frac{\sum_{k=1}^{n} Fz_k}{8} - \frac{M1}{4L} - \frac{M2 \cdot l}{2 \cdot (l^2 + l'^2)}$ $Fr_8 = \frac{\sum_{k=1}^{n} Fz_k}{8} - \frac{M1}{4L} - \frac{M2 \cdot l'}{2 \cdot (l^2 + l'^2)}$ $Fs_1 = Fs_5 = \frac{\sum_{j=1}^{n} Fyj}{8} + \frac{M3 \cdot l'}{2 \cdot (l^2 + l'^2)}$ $Fs_2 = Fs_6 = \frac{\sum_{j=1}^{n} Fy_j}{8} + \frac{M3 \cdot l}{2 \cdot (l^2 + l'^2)}$ $Fs_3 = Fs_7 = \frac{\sum_{j=1}^{n} Fy_j}{8} - \frac{M3 \cdot l}{2 \cdot (l^2 + l'^2)}$ $Fs_4 = Fs_8 = \frac{\sum_{j=1}^{n} Fy_j}{8} - \frac{M3 \cdot l'}{2 \cdot (l^2 + l'^2)}$ $M1 = \sum_{j=1}^{n} (Fy_j \cdot Zy_j) + \sum_{k=1}^{n} (Fz_k \cdot Yz_k)$ $M2 = \sum_{i=1}^{n} \{Fx_i \cdot (Zx_i - Zb)\} + \sum_{k=1}^{n} (Fz_k \cdot Xz_k)$ $M3 = -\sum_{i=1}^{n} \{Fx_i \cdot (Yx_i - Yb)\} + \sum_{j=1}^{n} (Fy_j \cdot Xy_j)$ $\delta x = Y_d \cdot \frac{Fs_4 - Fs_1}{l_2 \cdot Ks} + Z_d \cdot \frac{Fr_1 - Fr_4}{l_2 \cdot Kr}$ $\delta y = \frac{\sum_{j=1}^{n} Fy_j}{8 \cdot Ks} + X_d \cdot \frac{Fs_1 - Fs_4}{l_2 \cdot Ks} + Z_d \cdot \frac{Fr_1 - Fr_5}{L \cdot Kr}$ $\delta z = \frac{\sum_{k=1}^{n} Fz_k}{8 \cdot Kr} + X_d \cdot \frac{Fr_1 - Fr_4}{l_2 \cdot Kr} + Y_d \cdot \frac{Fr_1 - Fr_5}{L \cdot Kr}$

(4) Calculation of dynamic equivalent load

- For calculation of dynamic equivalent load, use the load in Table Ⅱ-3•2 which matches the intended use of the linear guide.

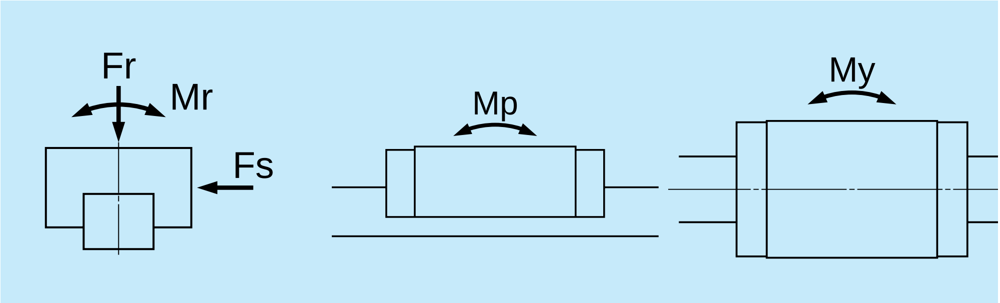
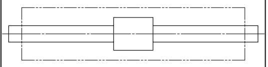
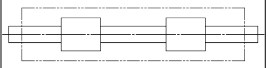
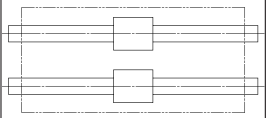
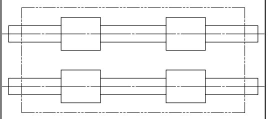


Fig. Ⅱ-3•3

Table Ⅱ-3•2 Loads in the arrangement of linear guides

Pattern	Arrangement of linear guide	Loads necessary to calculate dynamic equivalent load					Dynamic equivalent load
		Load		Moment load			
		Up/down (vertical)	Right/left (lateral)	Rolling	Pitching	Yawing	
1		F_r	F_s	M_r	M_p	M_y	$F_r = F_r$ $F_{se} = F_s \cdot \tan\alpha$ $F_{re} = \mathcal{E}_r \cdot M_r$ $F_{pe} = \mathcal{E}_p \cdot M_p$ $F_{ye} = \mathcal{E}_y \cdot M_y$ α :Contact angle LH, LS, LW Series $\alpha=50^\circ$ LA, LY, LU, LE Series $\alpha=45^\circ$
2		F_r	F_s	M_r			
3		F_r	F_s		M_p	M_y	
4		F_r	F_s				

- Use dynamic equivalent coefficient ε in the table below for easy conversion of moment load to dynamic equivalent load.

- Coefficient of each moment direction is as follows.
  ε_r : Rolling direction
  ε_p : Pitching direction
  ε_y : Yawing direction

Table Ⅱ-3•3 Dynamic equivalent coefficients

Unit:1/m

Model number	ε_r	ε_p	ε_y	Model number	ε_r	ε_p	ε_y	Model number	ε_r	ε_p	ε_y
LH20	142	81	97					LW17	66	125	149
LH20L	142	57	68					LW21	59	108	129
LH25	123	68	81	LA30	105	63	63	LW27	53	76	91
LH25L	123	51	61	LA30L	105	43	43	LW35	32	51	61
LH30A	98	70	83	LA35	84	54	54	LW50	25	38	46
LH30EF	98	58	69	LA35L	84	37	37				
LH30L	98	44	52	LA45	60	41	41	LE05	196	248	248
LH35	78	51	61	LA45L	60	31	31	LE05S	196	323	323
LH35L	78	36	43	LA55	51	33	33	LE07	141	188	188
LH45	60	38	45	LA55L	51	26	26	LE07S	141	349	349
LH45L	60	30	36	LA65	43	29	29	LE07L	141	122	122
LH55	51	31	37	LA65L	43	20	20	LE09	123	149	149
LH55L	51	25	30					LE09S	123	277	277
LH65	43	27	32					LE09L	123	102	102
LH65L	43	20	24					LE12	90	125	125
LH85L	33	17	20	LY15	133	111	111	LE12S	90	233	233
				LY20	100	89	89	LE12L	90	86	86
				LY20L	100	65	65	LE15	50	102	102
				LY25	90	75	75	LE15S	50	174	174
				LY25L	90	51	51	LE15L	50	68	68
LS15	177	116	138	LY30	74	63	63				
LS15S	177	174	208	LY30L	74	48	48	LU05	385	359	359
LS20	127	94	112	LY35	61	54	54	LU07	286	305	305
LS20S	127	136	162	LY35L	61	41	41	LU09	217	242	242
LS25	111	70	83	LY45	46	41	41	LU09L	217	138	138
LS25S	111	108	129	LY45L	46	30	30	LU09R	217	203	203
LS30	94	63	75	LY55	39	35	35	LU12	167	204	204
LS30S	94	102	121	LY55L	39	26	26	LU12L	167	116	116
LS35	76	54	64	LY65	33	31	31	LU15	133	174	174
LS35S	76	87	104	LY65L	33	21	21	LU15L	133	94	94

Definitions of codes appearing at the end of the model number in Table Ⅱ-3•3:

L	: Super-high load type	LH45L
S	: Medium load type	LS25S
No code	: High load type	LY45_
A	: Ball slide shape is square	LH30A (only LH30)
EF	: Ball slide shape is flanged type	LH30EF (only LH30)
R	: Miniature Series with ball retainer	LU09R

- Formula is determined by the relationship of loads in terms of volume. Full dynamic equivalent load can be easily obtained by using each coefficient.

  After obtaining the dynamic equivalent load of the necessary load directions from Table Ⅱ-3•3, use the formulas below to calculate full dynamic equivalent loads.

- When Fr is the largest load : $Fe=Fr+0.5Fse+0.5Fre+0.5Fpe+0.5Fye$
- When Fse is the largest load : $Fe=0.5Fr+Fse+0.5Fre+0.5Fpe+0.5Fye$
- When Fre is the largest load : $Fe=0.5Fr+0.5Fse+Fre+0.5Fpe+0.5Fye$
- When Fpe is the largest load : $Fe=0.5Fr+0.5Fse+0.5Fre+Fpe+0.5Fye$
- When Fye is the largest load : $Fe=0.5Fr+0.5Fse+0.5Fre+0.5Fpe+Fye$

For the values of each dynamic equivalent load in the formulas above, disregard load directions and take the absolute value.

(5) Calculation of mean effective load

When the load to the ball slide deviates, obtain a mean effective load which becomes equal to the life of ball slide under variable load conditions. If the load does not vary, use the dynamic equivalent load as it is.

① When load and running distance vary by phase (Fig. Ⅱ-3•4)

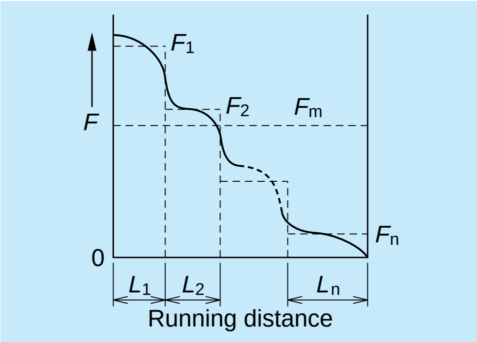


Fig. Ⅱ-3•4 Variable load by phase

Running distance while dynamic equivalent load F_1 is applied: L_1

Running distance while dynamic equivalent load F_2 is applied: L_2

Running distance while dynamic equivalent load F_3 is applied: L_3

• •

Running distancewhile dynamic equivalent load Fn is applied: Ln

From the above, mean effective load Fm can be obtained by the following formula.

$$Fm \quad \sqrt[3]{\frac{1}{L}\left(F_1^3 L_1+F_2^3 L_2+........+F_n^3 L_n\right)}$$

Fm: Mean effective load of the deviating load (N)

L : Running distance (ΣLn)

② When load changes almost lineally (Fig. Ⅱ-3•5)

Approximate mean effective load Fm can be obtained by the following formula.

$$Fm \fallingdotseq \frac{1}{3}(F\text{min}+2F\text{max})$$

Fmin : Minimum value of dynamic equivalent load (N)

Fmax : Maximum value of dynamic equivalent load (N)

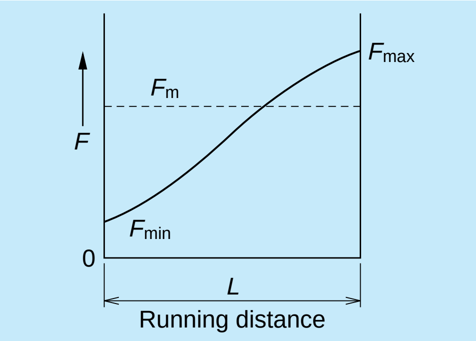
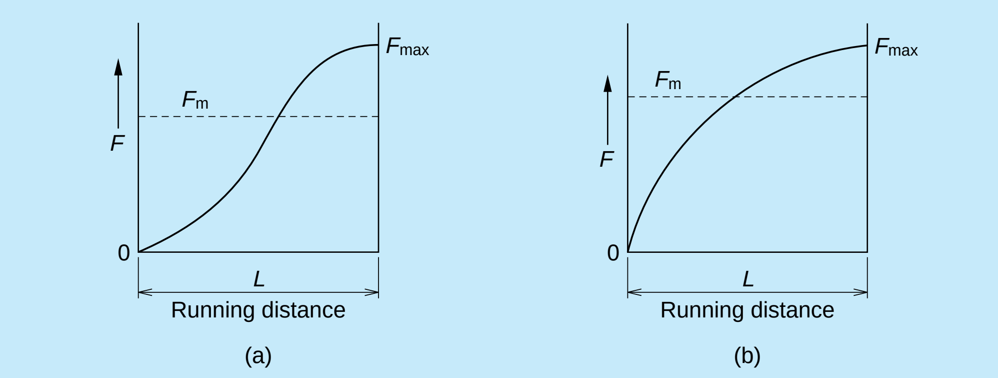


Fig. Ⅱ-3•5 Simple variable load

③ When load changes similar to a sine curve (Fig. Ⅰ-3•6)

At time of (a): $Fm = 0.65\ F\text{max}$

At time of (b): $Fm = 0.75\ F\text{max}$



(a)

(b)

Fig. Ⅱ-3•6 Load that changes similar to a sine curve

(6) Various coefficients

① Load factors

- Although a load applied to the ball slide can be calculated, the actual load becomes larger than the calculated value due to the machine's vibration and impact.
- Therefore, calculation of load on the ball slide should take into consideration the load factors in Table II-3.4.

Table Ⅱ-3•4 Load factor *f*w

Impact/Vibration	Load factor
No external impact/ vibration	1.0~1.5
There is impact/ vibration from outside.	1.5~2.0
There is significant impact / vibration.	2.0~3.0

② Hardness coefficient

- For linear guides, in order to function optimally, both the balls and the rolling contact surface must have a hardness of HRC58 to 62 to an appropriate depth.
- The hardness of NSK linear guide fully satisfies HRC58 to 62. Therefore, in most cases it is not necessary to consider hardness. If the linear guide is made of a special material by a customer's request, as the material hardness is lower than HRC58, use the following formula for adjustment.

$$C_H = f_H \cdot C$$
$$C_{OH} = f_H' \cdot C_o$$

C_H : Basic dynamic load rating adjusted by hardness coefficient

f_H : Hardness coefficient (Refer to Fig. Ⅱ-3.7)

C_{OH} : Basic static load rating adjusted by hardness coefficient

f_H' : Static hardness coefficient (Refer to Fig. Ⅱ-3.7)

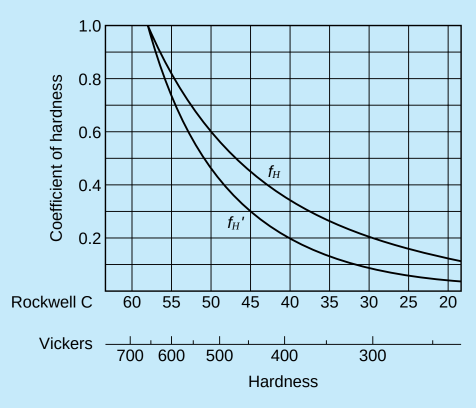


Fig. Ⅱ-3.7 Hardness coefficient

③ Reliability coefficient

- In general, a reliability of 90% is customary. In this case, reliability coefficient is 1. Therefore, the reliability coefficient does not have to be included in calculation.

(7) Calculation of rating life

Life calculating formula in the stroke movement with normal lubrication, the following relationships exist between ball slide mean effective load $F\mathrm{m}$ (N), basic dynamic load rating to load application direction C (N), and rating fatigue life L (Km).

$$L = 50 \times \left(\frac{f_H \cdot C}{f_W \cdot F_m}\right)^n \text{ (Km)}$$

Ball linear guide bearing which uses balls	n= 3
Roller linear guide bearing which uses rollers	n=10/3

f_H : Hardness coefficient

f : Load factor

$F\mathrm{m}$: Mean effective load

Use basic dynamic load rating C to calculate the life.

Note: Do not use basic static load rating C_0, basic static moment rating M_{R0}, M_{P0} or M_{Y0}.

Life as an entire guide way system

In those cases when several ball slides comprise a single guide way system (such as a single-axis table), the life of the ball slide to which the most strenuous condition is applied is considered to be the life of the entire system. For example, in Fig. Ⅱ-3•8, if "Ball slide A" is the ball slide which receives the largest mean effective load, or if "Ball slide A" is the one which has the shortest life, the life of the system is considered to be the life of "Ball slide A."

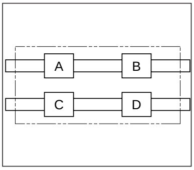


Fig. Ⅱ-3•8 Life of a system

(8) Examination of static load

① Examine from basic static load rating

- Examine static permissible load P_0, which is applied to the ball slide, from basic static load rating C_0 and static permissible load factor $f\mathrm{s}$.

$$P_0 = \frac{C_0}{f\mathrm{s}}$$

When static equivalent load P_0 is a combination of vertical loads $F\mathrm{r}$ and lateral load $F\mathrm{s}$, calculate using formulas below.

For LH, LS, LW Series:

If compressed load and lateral load are combined

$$P_0 = F\mathrm{r} + 1.59F\mathrm{s}$$

If tensile load and lateral load are combined

$$P_0 = 1.34F\mathrm{r} + 1.59F\mathrm{s}$$

For LA, LY, LU, LE Series:

$$P_0 = F\mathrm{r} + F\mathrm{s}$$

- The table below shows guidelines of fs for general industrial use.

Table Ⅱ-3•5

Use conditions	*fs*
Under normal operating conditions	1~2
Operating under vibration/impact	1.5~3

- Basic static load rating is not a destructive force to the balls, rails, or ball slide. The balls can withstand a load more than seven times larger than the basic static load rating . It is sufficient as a safety factor to the destruction load designed for general machines.
- However, when the linear guide is mounted upside down, the strength of the bolt which secures rail and ball slide affects the strength of the entire system. Strength of the bolt and its material should be considered.

② Examining from static moment load rating

- Also examine static permissible load M_0 from basic static moment load M_{p0} and static permissible load factor $f\mathrm{s}$.

$$M_0 = \frac{M_{P0}}{f\mathrm{s}}$$

If more than one moment load in any direction is combined, please consult NSK.

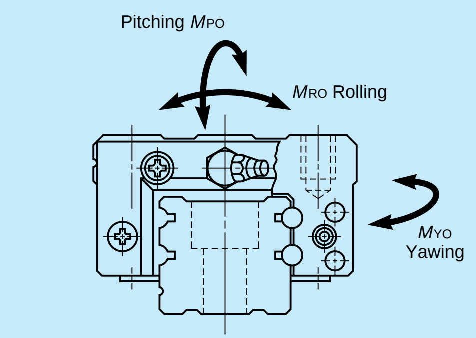


Fig. Ⅱ-3•9 Moment load directions

(9) Precautions for the design in examining the life

The following points must be heeded in examining the life.

In case of oscillating stroke

- If the balls do not rotate all the way, but only halfway, and if this minute stroke is repeated, lubricant disappears from the contact surface of balls and grooves. This generates "fretting," a premature wear. Fretting cannot be entirely prevented, but it can be mitigated.
- A grease which prevents fretting is recommended for oscillating stroke operations. Using a standard grease, life can be markedly prolonged by adding a normal stroke travel (about the ball slide length) once every several thousand cycles.

When applying pitching or yawing moment

- Load applied to the ball rows inside the ball slide is inconsistent if pitching or yawing moment load is applied. Loads are heavy on the balls on each end of the row.
- In such case, a heavy load lubricant grease or oil are recommended. Another countermeasure is using one size larger model of linear guide to reduce the load per ball.
- Moment load is insignificant for 2-rail, 4--ball slides combination which is commonly used.

When an extraordinary large load is applied during stroke

- If an extraordinary large load is applied at certain position of the stroke, calculate not only the life based on the mean effective load, but also the life based on the load in this range.

When calculated life is extraordinarily short

(Less than 3000 km in calculated life, or the load exceeds 10% of the basic dynamic load rating.)

- In such case, the contact pressure to the balls and the rolling contact surface is extraordinarily high.
- Operated under such state continually, the life is significantly affected by the loss of lubrication and the presence of dust, and the actual life becomes shorter than calculated.
- It is necessary to reconsider arrangement, the number of ball slide, and the type of model in order to reduce the load to the ball slide.

A-Ⅱ-4 Lubrication

- Refer to Page D13 for linear guide lubrication.

A-Ⅱ-4.3 Lubrication Accessories

(1) Types of lubrication accessories

- Fig. Ⅱ-4•1 and Ⅱ-4•2 show linear guide grease fittings and tube fittings.
- For standard specifications, the grease fitting is installed at the end of the ball slide. It can be installed on the side of the ball slide as an option. Refer to Fig. Ⅱ-4•3, Fig. Ⅱ-4•4, and Table Ⅱ-4•1.
- When using a piping accessory with M6 x1 screw, which is a piping standard screw, a connector is required to connect to the grease fitting hole on the ball slide, whose installation hole is M6 x 0.75. The connector is available from NSK.

Table Ⅱ-4•1 Location of the grease fitting

Rail width code	Low type	High type	Tap	Depth
	T_2	T_2	S	L
15	4.5	8.5	M6x0.75	8
20	5	–	M6x0.75	8
25	6	10	M6x0.75	8
30	7	10	M6x0.75	8
35	8	15	M6x0.75	8
45	10	20	PS1/8	11
55	11	21	PS1/8	11
65	19	19	PS1/8	11

Unit: mm

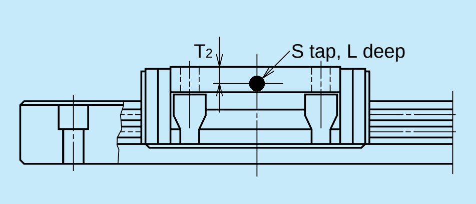


Fig. Ⅱ-4•4 Optional position in LY Series

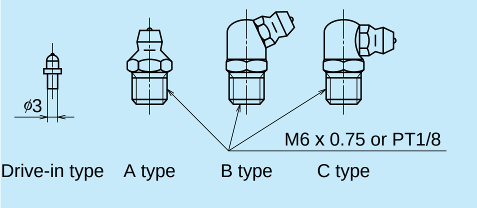
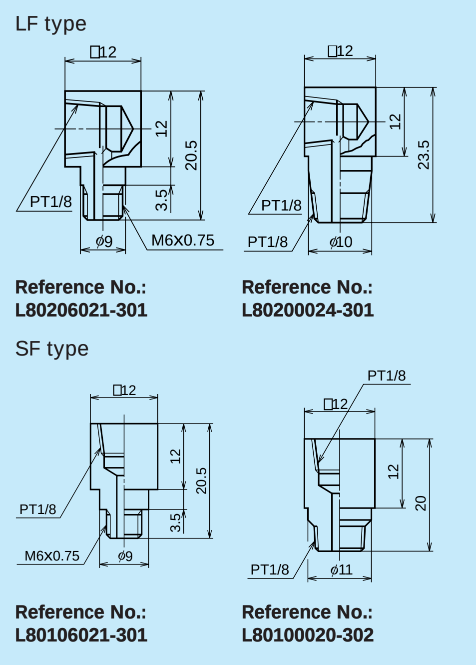


Fig. Ⅱ-4•1 Shapes of grease fitting



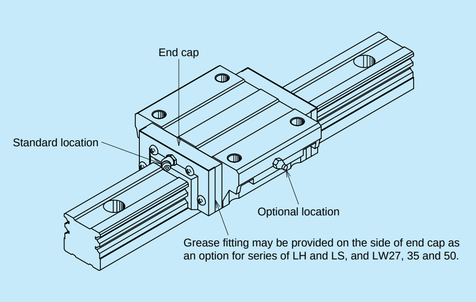
Reference No.: L80206021-301

Reference No.: L80200024-301

Reference No.: L80106021-301

Reference No.: L80100020-302

Fig. Ⅱ-4•2 Linear guide tube fitting



Grease fitting may be provided on the side of end cap as an option for series of LH and LS, and LW27, 35 and 50.

Fig. Ⅱ-4•3 Location of grease fitting

(2) Changing assembly direction of the lubrication accessory

① Changing direction of the grease fitting or tube fitting

Follow the procedures below.

Remove the grease fitting with a spanner.

Wrap the fitting screw section with some sealing tape, flax yarn, or the like.

Put the grease fitting back into the opening, and tighten it. If the torque becomes too large before the grease fitting turns to the desired direction, pull it out. Adjust the thickness of sealing tape, flax yarn or the like, then try again.

Note: The component where the grease fitting is inserted is made of plastic. Excessive tightening of the grease fitting damages the plastic.

② Move the grease fitting to the other side of ball slide

Follow the procedures below.

Illustration at right: Using a spanner, remove the blind plug in the grease fitting installation hole on Face B.

Remove the grease fitting on Face A. Insert the grease fitting in the installation hole on Face B. Take the same steps as the above (1) for adjusting. Insert the blind plug in the grease fitting installation hole on Face A.

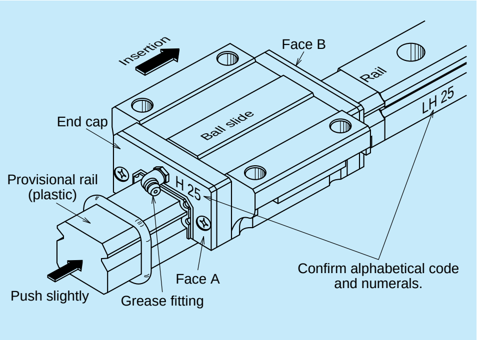


Fig. Ⅱ-4•5 Grease fitting installation

(3) Switching the grease fitting to the side of ball slide

Consult NSK to install the grease fitting to the side of the end cap or the ball slide. This is optional service.

A-Ⅱ-5　Dust Proof of Linear Guide

A-Ⅱ-5.1　Standard Specification

- To keep foreign matters from entering inside the ball slide, NSK linear guide has an end seal on both ends, and an bottom seal at the bottom.
- Table Ⅱ-5•1 shows seals for standard specification for each series.

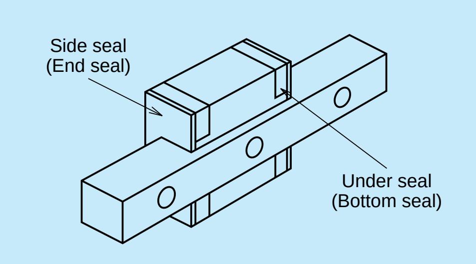


Fig. Ⅱ-5•1

Table Ⅱ-5•1　Standard seals

		End seal	Bottom seal
LH Series		O	O
LS Series		O	O
LA Series		O	O
LY Series		O	O
LW Series		O	O
LE Series		O	Δ
LU Series	LU12,15	O	Δ
	LU05,07,09	Δ	–

O: Installed as standard

Δ: Installed on request

- Seal friction per standard ball slide is shown in Table Ⅱ-5•2.

Table Ⅱ-5•2　Seal friction per ball slide (maximum value)

Unit: N

Series	15	20	25	30	35	45	55	65	85
LH Series	–	6	8	8	10	12	18	20	30
LS Series	4	6	8	8	10	–	–	–	–
LA Series	–	–	–	8	8	9	9	12	–
LY Series	2	2	3	8	10	12	12	13	–

Series	17	21	27	35	50
LW Series	6	8	12	16	20

Series	05	07	09	12	15
LU Series	0.3	0.3	0.5	0.5	0.5
LE Series	–	0.4	0.8	1.0	1.2

A-Ⅱ-5.2 NSK K1 Lubrication Unit

(1) What is K1 Lubrication Unit

- This is a lubrication unit made of porous plastic (polyurethane) which contains a large volume of lubrication oil, and is formed into seal.
- K1 Lubrication Unit is not a simple dust prevention seal. This remarkable seal also serves as a lubrication unit by discharging oil from the plastic.
- Along with the protection plate, a K1 Lubrication Unit is installed between the end cap and the end seal at both ends of the linear guide (Fig. Ⅱ-5•2). KI Lubrication Unit is already equipped at the time of delivery.

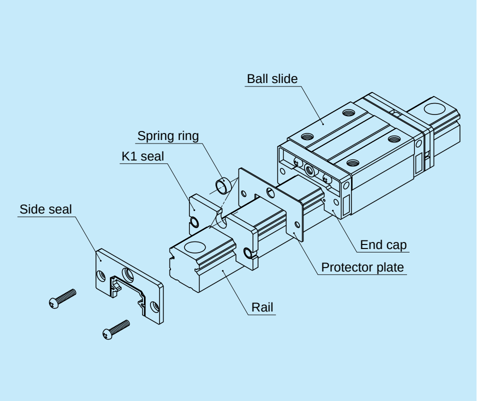


Fig. Ⅱ-5•2

(2) Functions of NSK K1 Lubrication Unit

This Unit is markedly effective as a lubrication oil cup and a highly functional seal in the following occasions.

• Use it when sealed lubricant runs out ········	For production line system (maintenance-free)
• When only a small amount of oil is allowed ···	For clean facility, medical equipment
• When oil is washed away ··················	For food processing machines
• When oil-absorbing dust is present ·········	For woodworking machines

Refer to Page D23 for details.

A-Ⅱ-5.3 Dust proof components

NSK has the following items. Select a suitable type for the operating environment.

Table Ⅱ-5•3 Optional dust proof components

Name	Purpose
NSK K1 lubrication unit	Made of plastic which contains oil. Enhances dust prevention and lubricating functions.
Double seal	Combines two end seals, enhancing sealing function.
Protector	Prevents high-temperature, hard dusts from entering.
Rail cap	Prevents foreign matters such as swarf generated in cutting operation from clogging the rail-mounting hole.
Inner seal	Installed inside the ball slide, and prevents foreign matters from entering the rolling contact surface.
Bellows	Covers the linear guide and feed screw.

(1) Double seal

- A combination of two end seals to enhance seal function.
- When a double seal is installed, the end seal section becomes thicker than the standard item by the size shown in Table Ⅱ-5•4. Take this thickness into consideration in determining the stroke and the size of section in which a ball slide is going to be installed.
- Double-seal set: Can be installed to a completed standard item later on request. It comprises two end seals, a collar, and a small screw for installation (Fig. Ⅱ-5•4).
- Double-seal set for LY Series also has a spacer which is installed between end seals (Fig. Ⅱ-5•5).
- For LA Series, double-seal set can be installed only before shipping from the factory.

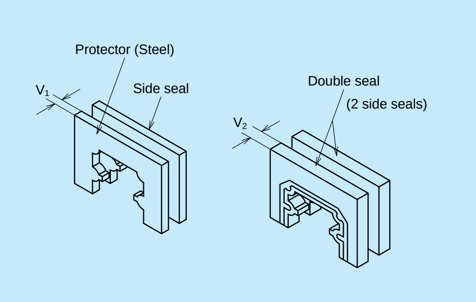


Fig. Ⅱ-5•3

Table Ⅱ-5•4 Thickness of double-seal set (one side)

Unit: mm

Model No.	Double-seal set reference No.	Increased thicknessV$_2$
LH20	LH20WS-01	2.5
LH25	LH25WS-01	2.8
LH30	LH30WS-01	3.6
LH35	LH35WS-01	3.6
LH45	LH45WS-01	4.3
LH55	LH55WS-01	4.3
LH65	LH65WS-01	4.9
LH85	LH85WS-01	6.2
LS15	LS15WS-01	2.8
LS20	LS20WS-01	2.5
LS25	LS25WS-01	2.8
LS30	LS30WS-01	3.6
LS35	LS35WS-01	3.6
LY15	LY15WS-01	3.3
LY20	LY20WS-01	3.3
LY25	LY25WS-01	5.3
LY30	LY30WS-02 *	6.0
LY35	LY35WS-03 **	7.0
LY45	LY45WS-03 **	8.0
LY55	LY55WS-02 *	8.0
LY65	LY65WS-03 **	8.0
LW17	LW17WS-01	2.6
LW21	LW21WS-01	2.8
LW27	LW27WS-01	2.5
LW35	LW35WS-01	3.0
LW50	LW50WS-01	3.6

*) Can be used with a new type of seal. (seal flat type, installed on the stepped rail top face)

**) Can be used with a new type of seal. (seal flat type, flat top face)
Please consult NSK when installing an old type seal.

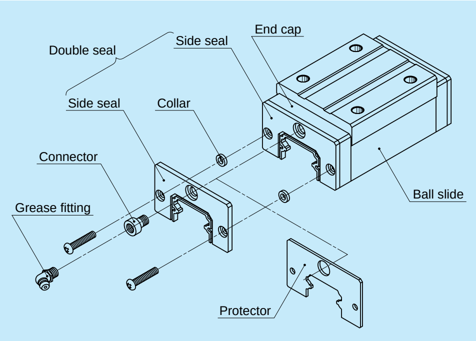


Fig. Ⅱ-5•4

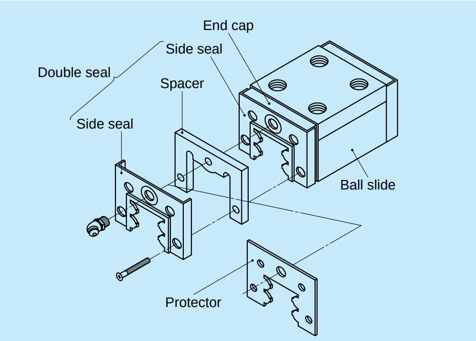


Fig. Ⅱ-5•5

(2) Protector

- A protector is usually installed outside the end seal to prevent high-temperature fine particles such as welding spatter and other hard foreign matters from entering the ball slide.
- Same as the case with a double seal, when a protector is installed, the ball slide becomes longer by the size shown in Table Ⅱ-5.5. Protector is available as a set.
- For LA Series, protector can be installed only before shipping from the factory.

Table Ⅱ-5•5 Thickness of protector set (one side)

Unit: mm

Model No.	Double-seal set reference No.	Increased thicknessV_1
LH20	LH20PT-01	2.9
LH25	LH25PT-01	3.2
LH30	LH30PT-01	4.2
LH35	LH35PT-01	4.2
LH45	LH45PT-01	4.9
LH55	LH55PT-01	4.9
LH65	LH65PT-01	5.5
LH85	LH85PT-01	6.8
LS15	LS15PT-01	3.0
LS20	LS20PT-01	2.7
LS25	LS25PT-01	3.2
LS30	LS30PT-01	4.2
LS35	LS35PT-01	4.2
LY15	LY15PT-01	4.1
LY20	LY20PT-01	4.1
LY25	LY25PT-01	6.1
LY30	LY30PT-02 ∗	6.6
LY35	LY35PT-03 ∗∗	7.6
LY45	LY45PT-03 ∗∗	8.6
LY55	LY55PT-02 ∗	8.6
LY65	LY65PT-03 ∗∗	8.6
LW17	—	—
LW21	—	—
LW27	LW27PT-01	2.9
LW35	LW35PT-01	3.6
LW50	LW50PT-01	4.2

∗) Can be used with a new type of seal. (seal flat type, installed on the stepped rail top face)

∗∗) Can be used with a new type of seal. (seal flat type, installed on the stepped rail top face)
Please consult NSK when installing old type seal.

- A connector (Fig. Ⅱ-5•6) is necessary to install a grease fitting to the end cap after a double seal or protector are assembled. Specify a double seal set with a connector when ordering.

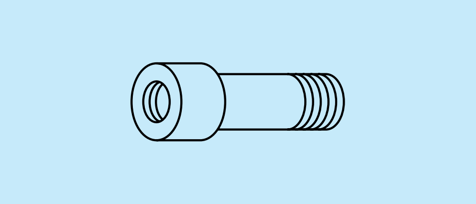


Fig. Ⅱ-5•6 Connector

Reference number examples with connector

(a) Double seal plus connector for LH25:

LH25WSC-0∗

(b) Protector plus connector for LS30:

LS30PTC-0∗

(3) Cap to cover the bolt hole for rail mounting

- After the rail is mounted to the machine base, a cap is used to cover the bolt hole to prevent foreign matters from clogging up the hole or from entering into the ball slide (Fig. Ⅱ-5•7).
- The cap for the bolt hole is made of synthetic resin which is superb in its resistance to oil and wear.
- Table Ⅱ-5•6 shows sizes of the bolts for the each model number as well as reference number of the cap.
- To insert a cap into the rail bolt hole, use a flat tool (Fig. Ⅱ-5•8). Pound the cap gradually until its height becomes flush with the rail top face.

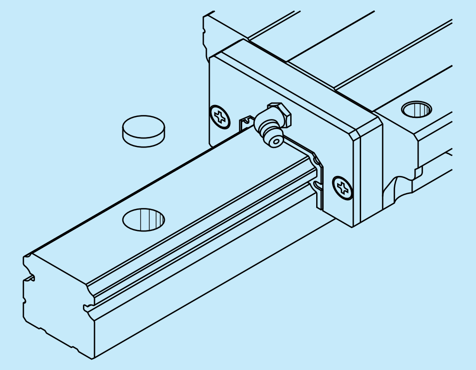


Fig. Ⅱ-5.7

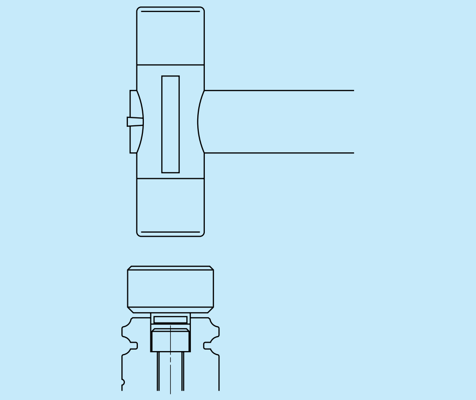


Fig. Ⅱ-5.8

Table Ⅱ-5.6 Caps to cover rail bolt hole

Model No.	Bolt to secure rail	Cap reference number
LS15	M3	L45800003-003
LY15, LW27	M4	L45800004-003
LH20, LS20, LY20	M5	L45800005-003
LH25, LS25, LY25, LS30, LW35	M6	L45800006-003
LH30, LA30, LY30, LH35, LS35, LY35, LW50	M8	L45800008-003
LH45, LA45, LY45	M12	L45800012-003
LH55, LA55, LY55	M14	L45800014-003
LH65, LA65, LY65	M16	L45800016-003
LH85	M22	L45800022-003

(4) Inner seal

- The end seal installed on both ends of the ball slide cannot arrest entire foreign matters, though the missed amount is negligible. An inner seal protects the ball contact surface from such foreign matters which entered inside the ball slide (Fig. II-5.9).
- Inner seal is installed inside the ball slide. Therefore, the appearance in size and the shape are the same as standard ball slide. (Inner seal is already installed before shipped from the factory.)pping.
- It is strongly recommended to use a bellows and a double seal, along with an inner seal, to maintain precision of the linear guide.

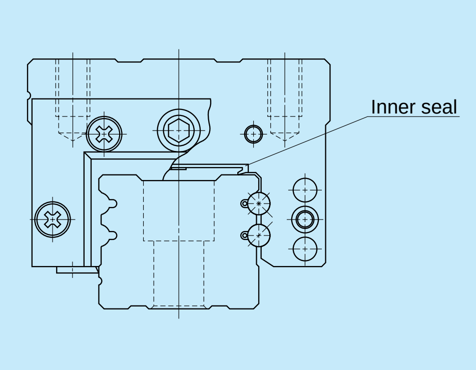


Fig. Ⅱ-5•9 Inner seal when installed

Linear guide which can use inner seal

Inner seal can be manufactured for linear guides shown in Table Ⅱ-5•7.

(5) Bellows

- Bellows covers entire linear guide and ball screw. It has been used widely as a way of protection in an environment where foreign matters are prevalent.
- NSK has bellows exclusively for LH, LS, LA, LY and LW Series. They have a middle bellows and a bellows at both ends. For LY and LH Series, there are low and high type bellows which are in compliance with their ball slide types.
- The high type is used for AN and BN types. The low type is used for FL, EL, HL, GL, AL, BL Types. By combining, the top of the bellows is slightly lower than the top face of the ball slide.
- When a high type bellows is installed to the ball slide with the height code L (such as FL), the top of the bellows becomes higher than the ball slide. But it is advantageous for stroke because the pitch of the bellows becomes larger.

Table Ⅱ-5•7

Series	Model No.
LH Series	LH20, LH25, LH30, LH35, LH45, LH55, LH65, LH85
LS Series	LS20, LS25, LS30, LS35
LA Series	LA30, LA35, LA45, LA55, LA65
LY Series	LY30, LY35, LY45, LY55

① LH and LS Series

∗Installation in the ball slide (Fig. Ⅱ-5•10)

- Remove two machine screws (M2) which secure the end seals to the end of the ball slide (Fig. Ⅱ-5.10).
- Then place a spacer to the hole for securing end seal. Fasten the mounting plate at the end of the bellows to the ball slide with a slightly longer machine screws (provided with the bellows).

∗ Installation in the rail

- To install bellows for LH Series and LS Series, lightly knock a fastener exclusively for bellows to the end of the rail (Fig. Ⅱ-5.10). Then secure the mounting plate at the end of the bellows through the tap hole of the fastener.
- As described above, a bellows can be easily installed in the end of the rail without creating a tap hole on the end of the rail. (This method cannot be used for LH85.)

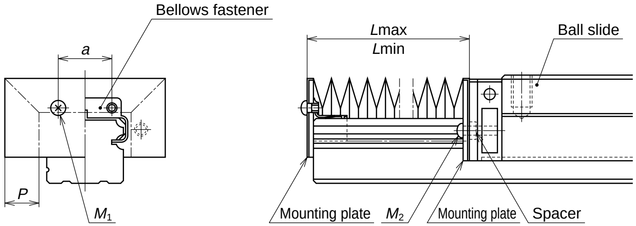


Fig. Ⅱ-5•10

② LY Series

∗ Installation in the ball slide (Fig. Ⅱ-5•11)

- Remove only two machine screws which secure the end seal. (Remove top two screws when four screws are used.) Then, to secure the bellows, drive a slightly longer machine screw (provided with the bellows) into the smaller hole of the mounting plate into the holes from which two machine screws were removed.

∗ Installation in the rail

- Put tap holes to the rail end face. Install the bellows mounting plate to the rail through the tap hole. Use a machine screw. NSK processes the tap holes to the rail end face when ordered with a linear guide.

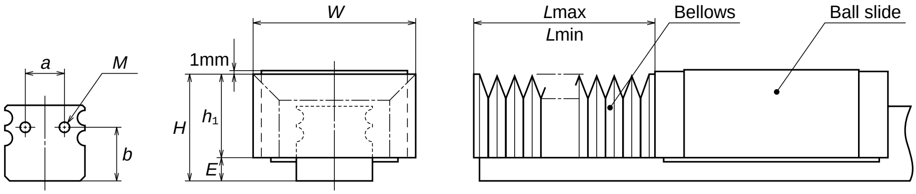


Fig. Ⅱ-5•11

③ LA and LW Series

∗ Installation to the ball slide (Fig. Ⅱ-5•12 and Fig. Ⅱ-5•13)

- Remove two machine screws which secure the end seal. (For LW17 and 21, hold the end cap by hand. Otherwise, the end cap is detached from the ball slide, and the balls inside may spill out.)
- Place a spacer in the securing hole of the end seal, fasten the mounting plate on the end of the bellows using a slightly longer machine screw (provided with the bellows).

∗ **Installation in the rail**

- Same as the case for LY Series, make tap holes to the rail end face. Fix the bellows mounting plate to the rail end face through these tap holes. Use a machine screw. NSK processes a tap hole to the rail end face when ordered with a linear guide.

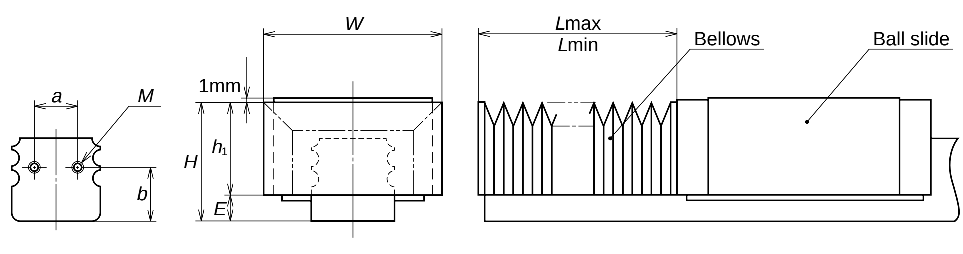


Fig. Ⅱ-5•12

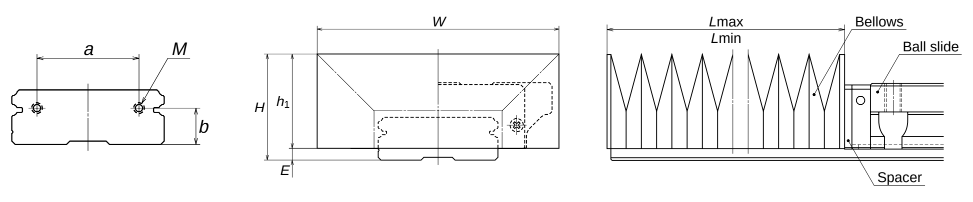


Fig. Ⅱ-5•13

Calculating length of bellows

- Formula is as follows.
- A bellows forms one block (BL) with six folds as shown in Fig. Ⅱ-5•14. Stroke is determined by multiplying by an integer of this BL.
- Length when stretched to maximum size :

Lmax = 7 x P x Number of BL

- Length when contracted to minimum size :

Lmin = 17 x Number of BL

- Stroke : **St = Lmax – Lmin**

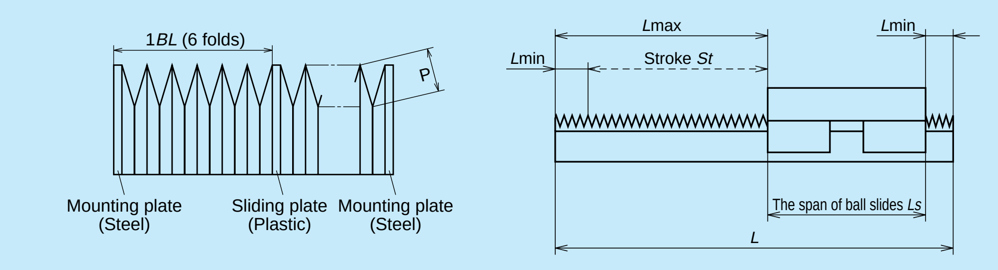
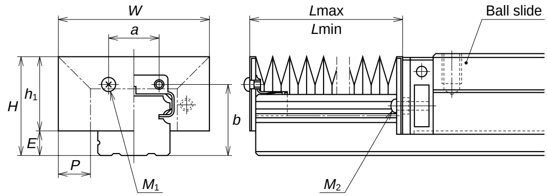


Fig. Ⅱ-5•14

Dimension tables of bellows
LH Series



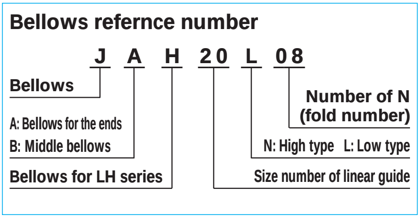


Fig. Ⅱ-5•15 Dimensions of bellows

Table Ⅱ-5•8 Dimensions of bellows

Unit: mm

Model No.	*H*	h_1	*E*	*W*	*P*	*a*	*b*	BL minimum length	M_1Tap x depth	M_2Tap x depth
JAH20N	29.5	24.5	5	48	10	13	22	17	M3 x 5	M2.5 x 16
JAH25L	35	28	7	51	10	16	26	17	M3 x 5	M3 x 18
JAH25N	39	32		61	15					
JAH30L	41	32	9	60	12	18	31	17	M4 x 6	M4 x 22
JAH30N	44	35		66	15					
JAH35L	47	37.5	9.5	72	15	24	34	17	M4 x 6	M4 x 23
JAH35N	54	44.5		82	20					
JAH45L	59	45	14	83	15	32	44.5	17	M5 x 8	M5 x 28
JAH45N	69	55		103	25					
JAH55L	69	54	15	101	20	40	50.5	17	M5 x 8	M5 x 30
JAH55N	79	64		121	30					
JAH65N	89	73	16	131	30	48	61	17	M6 x 8	M6 x 35
JAH85N*	108	90	18	173	40	54*	51*	17	M6 x 8	M8 x 40

∗Bellows is fixed to the tap hole at the rail end for LH85.

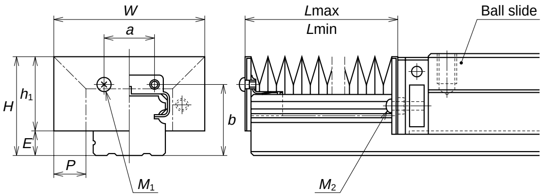
Table Ⅱ-5•9 Numbers of folds (BL) and lengths of bellows

Unit: mm

Model No.	Number of BL	2	4	6	8	10	12	14	16	18	20
	*L*min	34	68	102	136	170	204	238	272	306	340
JAH20N	Stroke	106	212	318	424	530	636	742	848	954	1060
	*L*max	140	280	420	560	700	840	980	1120	1260	1400
JAH25L	Stroke	106	212	318	424	530	636	742	848	954	1060
	*L*max	140	280	420	560	700	840	980	1120	1260	1400
JAH25N	Stroke	176	352	528	704	880	1056	1232	1408	1584	1760
	*L*max	210	420	630	840	1050	1260	1470	1680	1890	2100
JAH30L	Stroke	134	268	402	536	670	804	938	1072	1206	1340
	*L*max	168	336	504	672	840	1008	1176	1344	1512	1680
JAH30N	Stroke	176	352	528	704	880	1056	1232	1408	1584	1760
	*L*max	210	420	630	840	1050	1260	1470	1680	1890	2100
JAH35L	Stroke	176	352	528	704	880	1056	1232	1408	1584	1760
	*L*max	210	420	630	840	1050	1260	1470	1680	1890	2100
JAH35N	Stroke	246	492	738	984	1230	1476	1722	1968	2214	2460
	*L*max	280	560	840	1120	1400	1680	1960	2240	2520	2800
JAH45L	Stroke	176	352	528	704	880	1058	1232	1408	1584	1760
	*L*max	210	420	630	840	1050	1260	1470	1680	1890	2100
JAH45N	Stroke	316	632	948	1264	1580	1896	2212	2528	2844	3160
	*L*max	350	700	1050	1400	1750	2100	2450	2800	3150	3500
JAH55L	Stroke	246	492	738	984	1230	1476	1722	1968	2214	2460
	*L*max	280	560	840	1120	1400	1680	1960	2240	2520	2800
JAH55N	Stroke	386	772	1158	1544	1930	2316	2702	3088	3474	3860
	*L*max	420	840	1260	1680	2100	2520	2940	3360	3780	4200
JAH65N	Stroke	386	772	1158	1544	1930	2316	2702	3088	3474	3860
	*L*max	420	840	1260	1680	2100	2520	2940	3360	3780	4200
JAH85N *f*	Stroke	526	1052	1578	2104	2630	3156	3682	4208	4734	5260
	*L*max	560	1120	1680	2240	2800	3360	3920	4480	5040	5600

Remarks: Values of odd numbers BL (3, 5, 7, ...) can be obtained by adding two values of even number BLs on both sides, then dividing the sum by two.

LS Series



Bellows refernce number

J A S 15 L 08

Bellows

A: Bellows for the ends
B: Middle bellows

Bellows for LS series

Number of N (fold number)

Low type

Size number of linear guide

Fig. Ⅱ-5•16 Dimension of bellows

Table Ⅱ-5•10 Dimensions of bellows

Unit: mm

Model No.	H	h_1	E	W	P	a	b	BL minimum length	M_1Tap x depth	M_2Tap x depth
JAS15L	23.5	18.9	4.6	43	10	8	16.5	17	M3 x 5	M3 x 14
JAS20L	27	21	6	48	10	13	19.7	17	M3 x 5	M2.5 x 14
JAS25L	32	25	7	51	10	15	23.2	17	M3 x 5	M3 x 18
JAS30L	41	32	9	66	15	16	29	17	M4 x 6	M4 x 19
JAS35L	47	36.5	10.5	72	15	22	33.5	17	M4 x 6	M4 x 22

Table Ⅱ-5•11 Numbers of folds (BL) and lengths of bellows

Unit: mm

Model No.	Number of BL	2	4	6	8	10	12	14	16	18	20
	Lmin	34	68	102	136	170	204	238	272	306	340
JAS15L	Stroke	106	212	318	424	530	636	742	848	954	1060
	Lmax	140	280	420	560	700	840	980	1120	1260	1400
JAS20L	Stroke	106	212	318	424	530	636	742	848	954	1060
	Lmax	140	280	420	560	700	840	980	1120	1260	1400
JAS25L	Stroke	106	212	318	424	530	636	742	848	954	1060
	Lmax	140	280	420	560	700	840	980	1120	1260	1400
JAS30L	Stroke	176	352	528	704	880	1056	1232	1408	1584	1760
	Lmax	210	420	630	840	1050	1260	1470	1680	1890	2100
JAS35L	Stroke	176	352	528	704	880	1056	1232	1408	1584	1760
	Lmax	210	420	630	840	1050	1260	1470	1680	1890	2100

Remarks: Values of odd number BL (3, 5, 7, ...) can be obtained by adding two values of even number BLs on both side, then dividing the sum by two.

LA Series

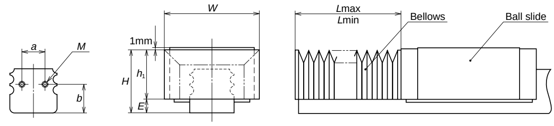
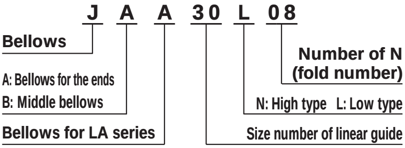


Fig. Ⅱ-5•17　An installed bellows

Bellows refernce number



Bellows

A: Bellows for the ends
B: Middle bellows

Bellows for LA series

Number of N (fold number)

N: High type　L: Low type

Size number of linear guide

Table Ⅱ-5•12　Dimensions of bellow

Unit: mm

Model number of bellows	*H*	h_1	*E*	*W*	*P*	*a*	*b*	Length of BL	Tap (M) xdepth
JAA30L	41	33.5	7.5	60	12	14	17.5	17	M4 x 6
JAA30N	44	36.5	7.5	66	15	14	17.5	17	M4 x 6
JAA35L	47	39.5	7.5	72	15	15	18.8	17	M4 x 6
JAA35N	54	46.5	7.5	82	20	15	18.8	17	M4 x 6
JAA45L	59	49	10	93	20	25	22.5	17	M5 x 8
JAA45N	69	59	10	113	30	25	22.5	17	M5 x 8
JAA55L	69	57	12	101	20	35	27.1	17	M5 x 8
JAA55N	79	67	12	121	30	35	27.1	17	M5 x 8
JAA65N	89	75	14	131	30	40	33.3	17	M5 x 8

Table Ⅱ-5•13　Numbers of folds (BL) and length of bellows

Unit: mm

Type	Model number of bellows	Length of BL	2	4	6	8	10	12	14	16	18	20
		*L*min	34	68	102	136	170	204	238	272	306	340
Low type	JAA30L	Stroke	134	268	402	536	670	804	938	1072	1206	1340
		*L*max	168	336	504	672	840	1008	1176	1344	1512	1680
High type	JAA30N	Stroke	176	352	528	704	880	1056	1232	1408	1584	1760
		*L*max	210	420	630	840	1050	1260	1470	1680	1890	2100
Low type	JAA35L	Stroke	176	352	528	704	880	1056	1232	1408	1584	1760
		*L*max	210	420	630	840	1050	1260	1470	1680	1890	2100
High type	JAA35N	Stroke	246	492	738	984	1230	1476	1722	1968	2214	2460
		*L*max	280	560	840	1120	1400	1680	1960	2240	2520	2800
Low type	JAA45L	Stroke	246	492	738	984	1230	1476	1722	1968	2214	2460
		*L*max	280	560	840	1120	1400	1680	1960	2240	2520	2800
High type	JAA45N	Stroke	386	772	1158	1544	1930	2316	2702	3088	3474	3860
		*L*max	420	840	1260	1680	2100	2520	2940	3360	3780	4200
Low type	JAA55L	Stroke	246	492	738	984	1230	1476	1722	1968	2214	2460
		*L*max	280	560	840	1120	1400	1680	1960	2240	2520	2800
High type	JAA55N	Stroke	386	772	1158	1544	1930	2316	2702	3088	3474	3860
		*L*max	420	840	1260	1680	2100	2520	2940	3360	3780	4200
Low/high type	JAA65L	Stroke	386	772	1158	1544	1930	2316	2702	3088	3474	3860
		*L*max	420	840	1260	1680	2100	2520	2940	3360	3780	4200

Note (1)　Bellows for LY65 is for both low and high types.

Remarks : Values of odd number Bls are obtained by adding values of the even number BLs on both sides, then dividing the sum by two.

LY Series

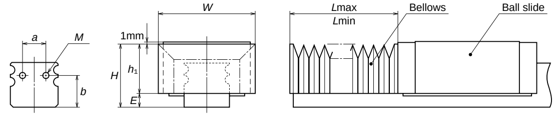


Fig. Ⅱ-5•18 An installed bellows

Bellows refernce number

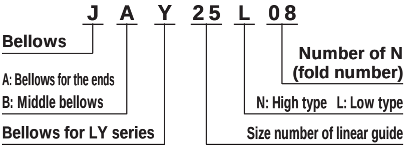


Table Ⅱ-5•14 Dimensions of bellows

Unit: mm

Model number of bellows	*H*	h_1	*E*	*W*	*P*	*a*	*b*	Length of BL	Tap (M) xdepth
JAY25L,JBY25L	35	28	7	51	10	12	15.25	17	M3 x 6
JAY25N,JBY25N	39	32		61	15				
JAY30L,JBY30L	41	32	9	60	12	14	19	17	M4 x 8
JAY30N,JBY30N	44	35		66	15				
JAY35L,JBY35L	47	37.5	9.5	72	15	15	21	17	M4 x 8
JAY35N,JBY35N	54	44.5		82	20				
JAY45L,JBY45L	59	47	12	93	20	25	25	17	M5 x 8
JAY45N,JBY45N	69	57		113	30				
JAY55L,JBY55L	69	54	15	101	20	35	30.5	17	M5 x 8
JAY55N,JBY55N	79	64		121	30				
JAY65N,JBY65N	89	75	14	141	35	40	34.25	17	M6 x 12

Table Ⅱ-5•15 Numbers of folds (BL) and length of bellows

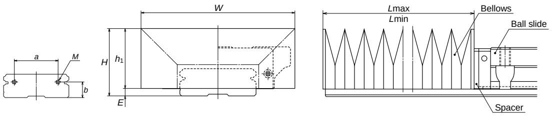
Unit: mm

Type	Model number of bellows	Length of BL	2	4	6	8	10	12	14	16	18	20
		*L*min	34	68	102	136	170	204	238	272	306	340
Low type	JAY25L	Stroke	106	212	318	424	530	636	742	848	954	1060
	JBY25L	*L*max	140	280	420	560	700	840	980	1120	1260	1400
High type	JAY25N	Stroke	176	352	528	704	880	1056	1232	1408	1584	1760
	JBY25N	*L*max	210	420	630	840	1050	1260	1470	1680	1890	2100
Low type	JAY30L	Stroke	134	268	402	536	670	804	938	1072	1206	1340
	JBY30L	*L*max	168	336	504	672	840	1008	1176	1344	1512	1680
High type	JAY30N	Stroke	176	352	528	704	880	1056	1232	1408	1584	1760
	JBY30N	*L*max	210	420	630	840	1050	1260	1470	1680	1890	2100
Low type	JAY35L	Stroke	176	352	528	704	880	1056	1232	1408	1584	1760
	JBY35L	*L*max	210	420	630	840	1050	1260	1470	1680	1890	2100
High type	JAY35N	Stroke	246	492	738	984	1230	1476	1722	1968	2214	2460
	JBY35N	*L*max	280	560	840	1120	1400	1680	1960	2240	2520	2800
Low type	JAY45L	Stroke	246	492	738	984	1230	1476	1722	1968	2214	2460
	JBY45L	*L*max	280	560	840	1120	1400	1680	1960	2240	2520	2800
High type	JAY45N	Stroke	386	772	1158	1544	1930	2316	2702	3088	3474	3860
	JBY45N	*L*max	420	840	1260	1680	2100	2520	2940	3360	3780	4200
Low type	JAY55L	Stroke	246	492	738	984	1230	1476	1722	1968	2214	2460
	JBY55L	*L*max	280	560	840	1120	1400	1680	1960	2240	2520	2800
High type	JAY55N	Stroke	386	772	1158	1544	1930	2316	2702	3088	3474	3860
	JBY55N	*L*max	420	840	1260	1680	2100	2520	2940	3360	3780	4200
Low/high type(1)	JAY65N	Stroke	456	912	1368	1824	2280	2736	3192	3648	4104	4560
	JBY65N	*L*max	490	980	1470	1960	2450	2940	3430	3920	4410	4900

Note (1) Bellows for LY65 is for both low and high types.

Remarks : Values of odd number Bls are obtained by adding values of the even number BLs on both sides, then dividing the sum by two.

LW Series



Bellows refernce number

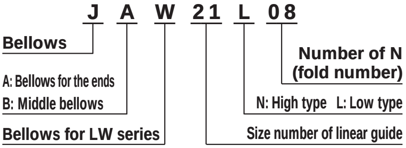


Fig. Ⅱ-5•19

Table Ⅱ-5•16 Dimensions of bellows

Unit: mm

Model number of bellows	*H*	h_1	*E*	*W*	*P*	*a*	*b*	Length of BL	Tap (M) xdepth
JAW17N	25.5	23	2.5	68	15	22	6	17	M3 x 6
JAW21N	29	26	3	75	17	26	7	17	M3 x 6
JAW27N	37	33	4	85	20	28	10	17	M3 x 6
JAW35L	34	30	4	100	14	48	12	17	M4 x 8
JAW35N	41	37		115	20				
JAW50L	46.5	42	4.5	135	20	70	14	17	M4 x 8
JAW50N	56.5	52		160	30				

Table Ⅱ-5•17 Numbers of folds (BL) and length of bellows

Unit: mm

Model No.	Number of BL	2	4	6	8	10	12	14	16	18	20
	*L*min	34	68	102	136	170	204	238	272	306	340
JAW17N	Stroke	176	352	528	704	880	1056	1232	1408	1584	1760
	*L*min	210	420	630	840	1050	1260	1470	1680	1890	2100
JAW21N	Stroke	204	408	612	816	1020	1224	1428	1632	1836	2040
	*L*min	238	476	714	952	1190	1428	1666	1904	2142	2380
JAW27N	Stroke	246	492	738	984	1230	1476	1722	1968	2214	2460
	*L*min	280	560	840	1120	1400	1680	1960	2240	2520	2800
JAW35L	Stroke	162	324	486	648	810	972	1134	1296	1458	1620
	*L*min	196	392	588	784	980	1176	1372	1568	1764	1960
JAW35N	Stroke	218	436	654	872	1090	1308	1526	1744	1962	2180
	*L*min	252	504	756	1008	1260	1512	1764	2016	2268	2520
JAW50L	Stroke	246	492	738	984	1230	1476	1722	1968	2214	2460
	*L*min	280	560	840	1120	1400	1680	1960	2240	2520	2800
JAW50N	Stroke	386	772	1158	1544	1930	2316	2702	3088	3474	3860
	*L*min	420	840	1260	1680	2100	2520	2940	3360	3780	4200

Remarks: Values of odd numbers BL (3, 5, 7, ...) can be obtained by adding two values of even number BLs on both sides, then dividing the sum by two.

A-Ⅱ-6 Rust Prevention and Surface Treatment

A-Ⅱ-6.1 Rust Prevention (Stainless steel)

NSK linear guide is available in stainless steel standard series.

○Stainless steel standard series

LH Series
LS Series
LE Series
LU Series
LL Series

Select from the above when using in the environment which invites rust.

A-Ⅱ-6.2 Surface Treatment

(1) Types of surface treatment

The following are common types of treatment.

○Electrolytic rust prevention black film treatment (low temperature chrome plating)

- Used to prevent corrosion and light reflection, and for cosmetic purpose.

○Fluoride low temperature chrome plating

- Fluoroplastic coating is provided following the electrolytic rust prevention black film treatment.
- Resistance to corrosion is higher than electrolytic rust prevention film treatment.

○Chrome plating for industrial use (Hard chrome plating)

- Has high hardness. Increases resistance to both wear and corrosion.

○Electroless nickel plating

- Creates a film of consistent thickness on complex shaped items.
- For corrosion prevention.

○Phosphate coating

- For corrosion prevention: usually applied prior to painting because this treatment creates porous surface.

○Black oxide treatment (Irontetraxcide film treatment)

- Creates irontetraxide film on the surface. For cosmetic purposes.

(2) Recommended surface treatment

From among the surface treatments above, NSK recommend "electrolytic rust prevention black film treatment" and "fluoride low temperature chrome plating," because of its better results in humidity cabinet test, and cost-effectiveness.

Please refer to Page D5 for the details of humidity cabinet test results.

A-Ⅱ-7 Linear Guides for Special Environments

A-Ⅱ-7.1 Heat-resistant Specifications

- Standard linear guides use plastic for ball recirculation component. The environmental temperature of standard linear guides at maximum is 80℃.
- Use linear guide with heat-resistant specifications under temperatures that exceed this limit.

Table Ⅱ-7•1 Comparison of materials: Standard and heat-resistant specifications

Component	Standard specification	Heat-resistant specification
Rail	Special high carbon steel (equivalent to SUS440C/JIS)	Special high carbon steel (equivalent to SUS440C/JIS)
Ball slide	Special high carbon steel (equivalent to SUS440C/JIS)	Special high carbon steel (equivalent to SUS440C/JIS)
Balls	SUJ2, SUS440C	SUJ2, SUS440C
Ball retainer	Polyacetals	SUS304
Ball retaining wire	SUS304	SUS304
End cap	Polyacetals	SUS316L
Return guide	Polyacetals	SUS316L
End seal	Acrylonitril-butadiene rubber	Fluorine rubber
Bottom seal	Acrylonitril-butadiene rubber	Fluorine rubber

Heat resistant linear guides

LH Series
LS Series
LW Series
LE Series
LU Series

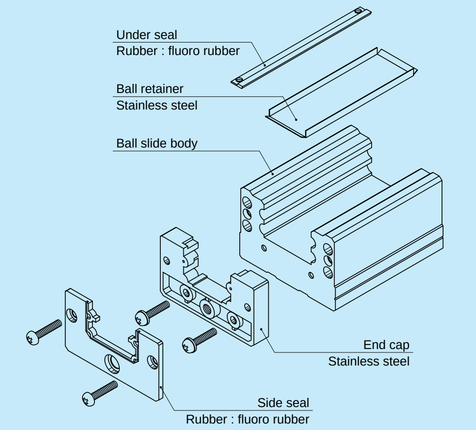


Fig. Ⅱ-7•1

A-Ⅱ-7.2 Vacuum and Clean Specifications

- Due to its abundant experience and technology, NSK manufactures linear guides that can be used in a vacuum or in clean environments. Please consult NSK.
- Linear guide specifications vary for environmental conditions.
  For example, "all stainless steel plus special grease, or solid film lubricant" for vacuum environments.
- NSK has low-dust generating grease "**LG2**" which is ideal for clean environments.
  Refer to Page D1 for details.

A-Ⅱ-8 Noise

- Appropriate design and highly accurate processing technology contribute to reducing noise of NSK linear guides.
- Fig. Ⅱ-8•1 is a noise-level data plot. The product of D_w (mm) ball diameter of linear guide and travel speed V (m/min) is shown on the abscissa. The noise level is shown on the ordinate.
- The plot indicates that the noise levels remain within a narrow straight belt irrespective of the linear guide type (LH25 through LH65 are plotted here).
- Noise level can be estimated; find the ball diameter from the linear guide model number, then incorporate a travel speed.

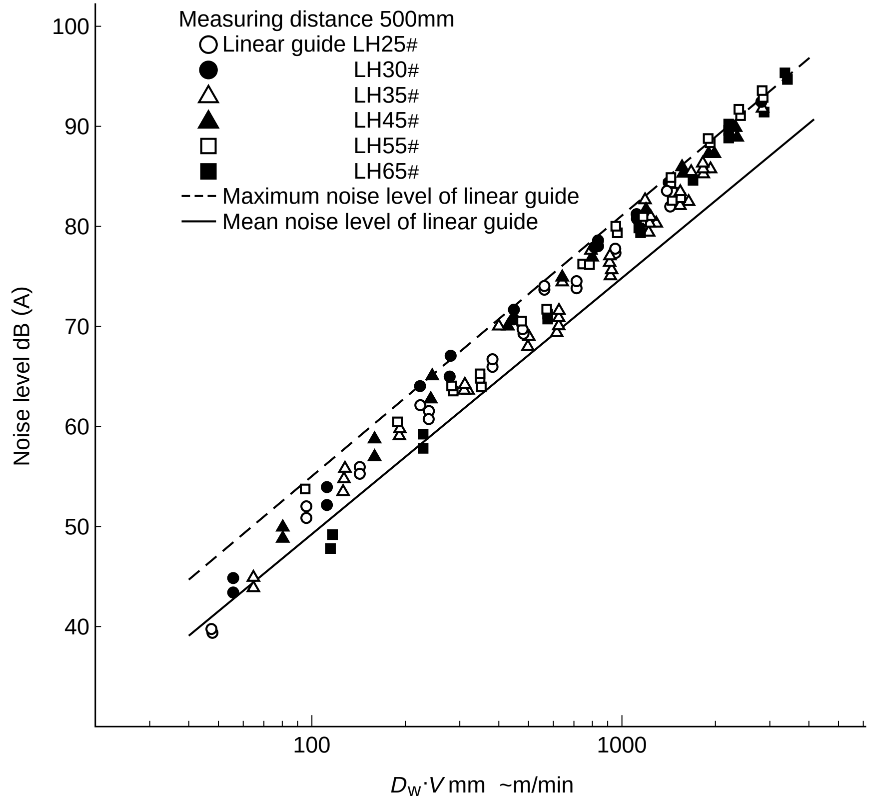


Fig. Ⅱ-8•1 Noise levels of linear guides

Example of estimate

LS30, and the travel speed is 100 m/min.

D_w = 4.762; V = 100 m/min

Therefore,

$D_w \bullet V$ = 4.762 x 100 = 476.2

Therefore, from Fig. Ⅱ-8•1, the noise level is 66 ~ 72dB (A).

A-Ⅱ-9 Arrangement and Mounting of Linear Guide

A-Ⅱ-9.1 Arrangement

- For NSK linear guide, the datum face of the rail and of the ball sldie are marked with either an "datum face groove" or with an "arrow."
- In case that two or more linear guides are used together, one linear guise is designated as a reference side guide, and the rest is adjusting side guide(s). The reference side rail has its reference number, serial number, and "KL" mark on the opposite side of the datum face (Fig. Ⅱ-9•1).
- When the reference side rail is pressed against the mounting faces of machine as well as the ball slide datum face, the variation of mounting width W2 (or W2) must be minimal.

The variations are standardized as accuracy standards (Fig. Ⅱ-9•2, Ⅱ-9•3)

- The ways to indicate the datum faces of LE and LU Series are shown in Table Ⅱ-9•1.

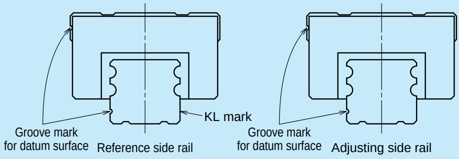


Fig. Ⅱ-9•1

Example of arrangement

- Arrangement of the linear guide must be determined taking into account the table position, its direction (horizontal, vertical, inclined, hanging from the ceiling), stroke, the size of bed and the table in the equipment as a whole. Table II-9.2 shows a common arrangement examples, and features/precautions for each case.

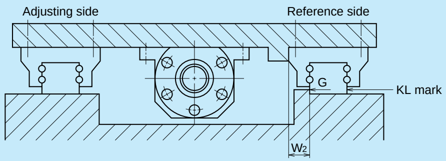


Fig. Ⅱ-9•2 Most common setting of the reference side rail

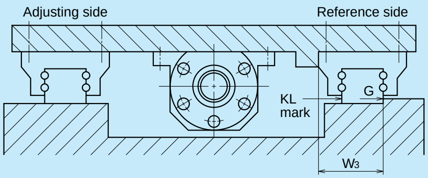


Fig. Ⅱ-9•3 Setting of the refernce side rail in certain occasions

Table Ⅱ-9.1 Marks on the rail datum faces in LE, LU Series

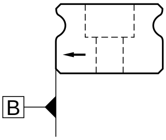
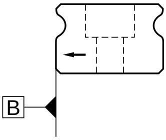
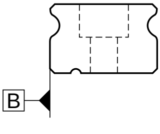
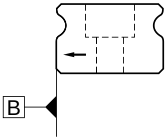
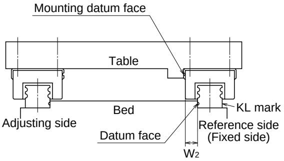
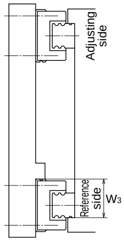
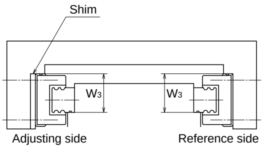
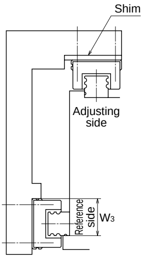
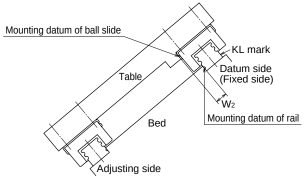
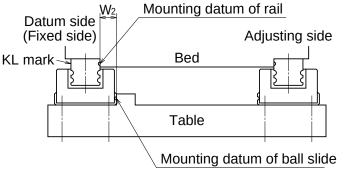
Model No. Material	LU05, 07, 09 LE05, 07, 09, 12	LU12, 15	LE15 LE09, 12 (with a ball retainer)
Special high carbon steel	 B	 B	 B
Stainless steel		 B	

Table Ⅱ-9•2　Arrangement example

Arrangement	Features/Precautions
	• Easy in highly-accurate installation (recommended arrangement)
	• Easy in highly-accurate installation • Lubricant oil may not be supplied to ball slide. Precaution is required in the oil supply design.
	• Slightly difficult for highly-accurate installation • Life of linear guide is affected by mounting accuracy. • When oil lubricant is used, precaution is required in oil supply design.
	• Difficult for highly-accurate installation • For a linear guide mounted in sideways, precaution is required in oil supply design if oil lubricant is used.
	• Rather easy in highly-accurate installation • When oil lubricant is used, precaution is required in oil supply design.
	• Easy in highly-accurate installation if the linear guide is installed to the machine base first, then hang up-side-down along with the machine base. • Ball slide may detach from the rail and fall down if the linear guide is damaged and all the balls in the ball slide fall out. It is necessary to take preventive measures against the falling of the ball slide.

A-Ⅱ-9.2 Mounting Accuracy

(1) Accuracy of the mounting base of machine

- Mounting accuracy of linear guide usually copies the accuracy of the machine base.
- However, when two or more ball slides are assembled to each rail, the table stroke becomes shorter than the mounting surface. This, along with the fact that the mounting error is evenly spread, contributes to a higher table accuracy than the mounting face accuracy, reducing the error to about 1/3 in average (Fig. Ⅱ-9•4).

(2) Installation error

- Mounting error affects mainly three factors: life, friction and accuracy (Table Ⅱ-9•3).

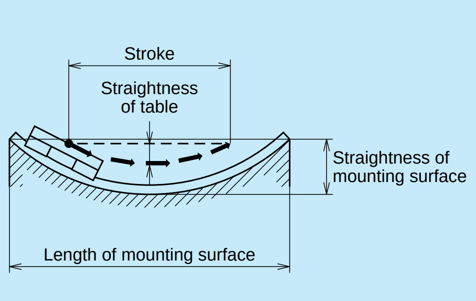
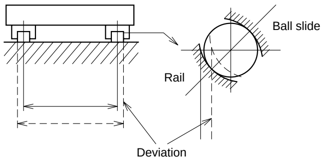
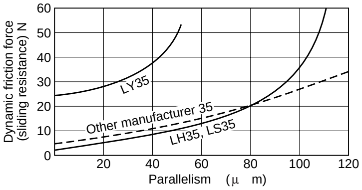
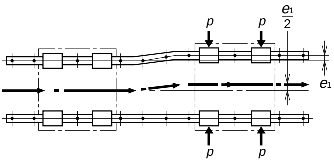


Fig. Ⅱ-9•4

Table Ⅱ-9•3 Influence of mounting error

<table>
<tr><th>Factor</th><th colspan="2">Influence</th></tr>
<tr><td>Life</td><td> </td><td>• Large mounting error generates a force which twists the ball slide and reduces its life.
• It also distorts the contact point of the ball and the groove and changes contact angle, lowering rigidity.</td></tr>
<tr><td>Friction</td><td> </td><td>• LH and LS Series are affected very little by mounting error thanks to their small friction. (self alignment)
• However, being off-set gothic arch grooves, their friction suddenly soars once the mounting error exceeds a certain level.
• Mounting error severely affects friction for LY Series with heavy preload.</td></tr>
<tr><td>Accuracy</td><td> </td><td>• When rigidity of four ball slides are equal, the theoretical straightness becomes 1/2 of the installation error e_1.
• However, this value becomes slightly larger due to deformation of the rail and the machine base.</td></tr>
</table>

(3) Permissible values of mounting error

- Of the three major factors which are affected by the mounting error, NSK focuses on life. By the NSK standard, permissible values of mounting error are the values which allows 5000 km or longer life under the following conditions.
  - Load volume per ball slide is 10% of the basic dynamic load rating C.
  - Rigidity of the machine base is infinite.
- Fig. Ⅱ-9•5 and Ⅱ-9•6 are representing the mounting errors. Their permissible values of mounting error are shown in Table Ⅱ-9•4 to Ⅱ-9•7.

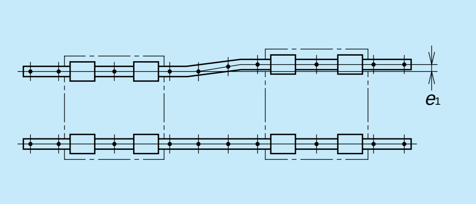


Fig. Ⅱ-9•5

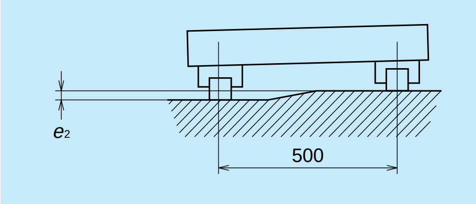


Fig. Ⅱ-9•6

Table Ⅱ-9•4 Permissible values of parallelism for LH Series

Unit: μm

Value	Preload	Model No.							
		LH20	LH25	LH30	LH35	LH45	LH55	LH65	LH85
Permissible values of parallelism in two rails e_1	Z0, ZT	30	40	45	55	65	80	110	120
	Z1, ZZ	20	25	30	35	45	55	70	90
	Z3	15	20	25	30	40	45	60	70
Permissible values of parallelism (height) in two rails e_2	Z0, ZT	375μm/500mm							
	Z1, ZZ, Z3	150μm/500mm							

Table Ⅱ-9•5 Permissible values of parallelism for LS Series

Unit: μm

Value	Preload	Model No.				
		LS15	LS20	LS25	LS30	LS35
Permissible values of parallelism in two rails e_1	Z0, ZT	20	22	30	35	40
	Z1, ZZ	15	17	20	25	30
	Z3	12	15	15	20	25
Permissible values of parallelism (height) in two rails e_2	Z0, ZT	375μm/500mm				
	Z1,ZT,Z3	150μm/500mm				

Table Ⅱ-9•6 Permissible values of parallelism for LA Series

Unit: μm

Value	Preload	Model No.				
		LA30	LA35	LA45	LA55	LA65
Permissible values of parallelism in two rails e_1	Z3	17	20	25	30	40
	Z4	15	17	20	25	30
Permissible values of parallelism (height) in two rails e_2		185μm/500mm				

Table Ⅱ-9•7 Permissible values of parallelism for LY Series

Unit: μm

Value	Preload	Model No.							
		LY15	LY20	LY25	LY30	LY35	LY45	LY55	LY65
Permissible values of parallelism in two rails e_1	Z0	20	25	25	25	30	40	50	60
	Z1	20	25	20	25	30	35	45	50
	Z2	15	20	20	20	25	30	40	45
	Z3	15	20	15	20	20	25	35	40
	Z4	–	–	15	15	20	25	30	35
Permissible values of parallelism (height) in two rails e_2	185μm/500mm								

(4) Running accuracy and the influence of even-off effect

- When installed in a machine base, the linear guide is affected by the flatness of the mounting face of the machine base. However, in the case of two-rails/four-ball slides specification, which is most widely used, the straightness as a table as a whole unit is generally less than the straightness as a single component. This is due to the even-off effect generated by the shorter stroke, compared to rail length, as well as by interaction between the rails, and ball slides.
- Fig. Ⅱ-9•9 shows an actually measured straightness of the table which uses NSK linear guide. In this case, the final straightness of the table is about 1/5 of the straightness of the mounting face.

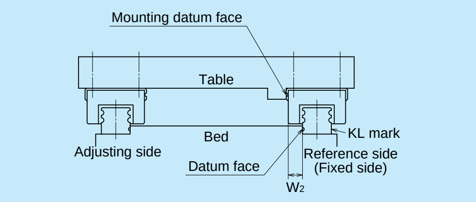


Fig. Ⅱ-9•7

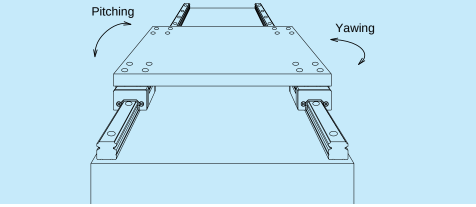
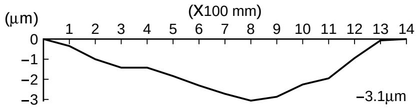
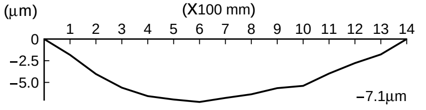
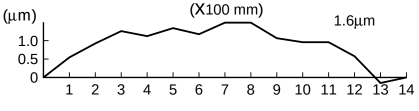
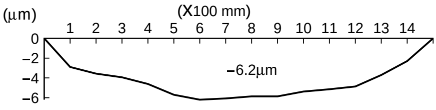
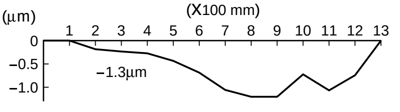
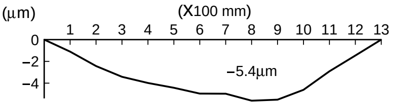
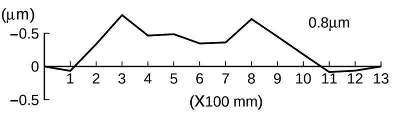
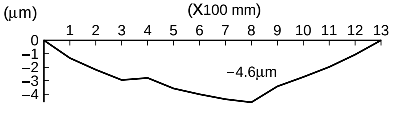
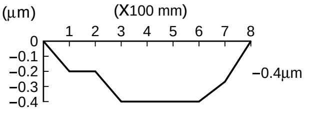
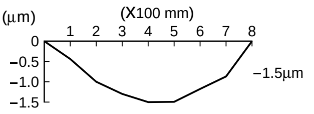


Fig. Ⅱ-9•8

Fig. Ⅱ-9•9 Straightness of the table equipped with linear guide

	Straightness in yawing direction	Straightness in pitching direction
Datum side, mounting surface		
Adjusting side, mounting surface		
Datum side, Linear guide		
Adjusting side, Linear guide		
Table accuracy (assembled result)		

A-Ⅱ-9.3 Installation

(1) Shoulder height of the mounting face of the machine base and corner radius r

- Fig. Ⅱ-9•10, Ⅱ-9•11, and Table Ⅱ-9•9 show shoulder height of the mounting face of the machine base and the size of corner r. These figures are relevant when the linear guide is pressed to the shoulder of the bed or table (the raised section from where the mounting face begins), and horizontally secured to it.
- The shoulder should be thick (wide) enough, so it is not deformed by the pressing force.

(2) Tightening torque of the bolt

- Table Ⅱ-9•8 shows tightening torque of the bolt when the rail is secured to the fixture of ball groove grinding machine.
- Apply same torque in this table when securing the rail to the machine base. Equal accuracy at the time of grinding can be obtained.

Table Ⅱ-9•8 Bolt tightening torque (Bolt material: High carbon chromium steel)

Unit: N·m (kgf·cm)

Bolt size	Tightening torque	Bolt size	Tightening torque
M2.3	0.38(3.9)	M10	43(440)
M2.5	0.58(5.9)	M12	76(770)
M3	1.06(10.8)	M14	122(1240)
M4	2.5(25)	M16	196(2000)
M5	5.1(52)	M18	265(2700)
M6	8.6(88)	M22	520(5300)
M8	22(220)	—	—

(3) Installation procedures

- There are two installation ways depending on the accuracy requirement.
  - a. Installation with high accuracy
  - b. Accuracy is not high, but easy to install
- For both methods, wipe off the rust preventive oil applied to the linear guide. Remove burrs and small bumps on the bed and table mounting face with an oilstone (Fig. Ⅱ-9•12).
  Apply machine oil or similar oil with low viscosity to the mounting face to increase the rust preventive effect.
- Linear guide is a precision product. Handle with care.

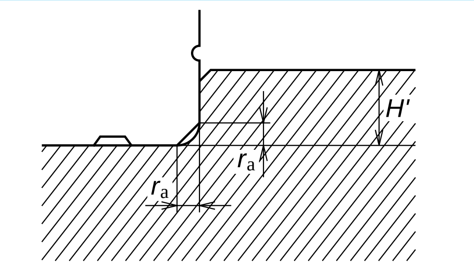


Fig. Ⅱ-9•10 Shoulder for the rail datum face

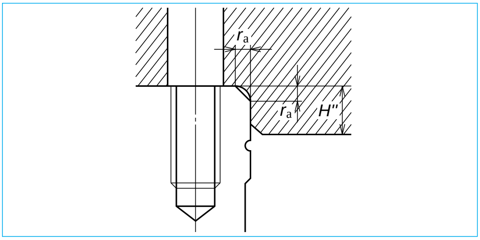


Fig. Ⅱ-9•11 Shoulder for the ball slide datum face

Table Ⅱ-9•9 Height of the shoulder and corner radius of the mounting face

Unit: mm

Rail width	Corner radius r_n (maximum)	Shoulder height for the rail H'	Shoulder height for the ball slide H''
15	0.5	4	4
20	0.5	4.5	5
25	0.5	5	5
30	0.5	6	6
35	0.5	6	6
45	0.7	8	8
55	0.7	10	10
65	1.0	11	11

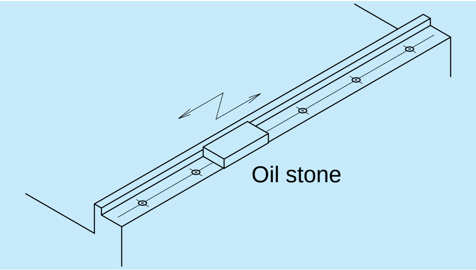


Fig. Ⅱ-9•12

Ⓐ Highly accurate installation

ⓐ Rail installation procedures

ⓐ-1) Machine base has a shoulder on the side where the reference side rail is installed.

① Confirm that the rail is reference side rail, and the datum face of the rail comes to face to face with the shoulder of the bed. Keep the ball slides on the rail, and carefully place the rail on the bed on its mounting face. Temporarily tighten the bolts.
At this time, press the rail from sideways to make the rail tightly contact to the shoulder of the bed. Apply tightening torque to the bolt in Table Ⅱ-9•7 when tightening a shoulder plate (Fig. Ⅱ-9•13).
Refer to "**(4) Various methods to press linear guide sideways**."

② For final tightening of the bolts to secure the rail, tighten the bolt on either end of the rail, then proceed to other end.
If the datum face is on the left side as shown in Fig. Ⅱ-9•14, tighten the bolt at the farthest end first, then proceed to near end.
This way, a bolt rotating force presses the rail against the shoulder. (Therefore, the rail is attached sufficiently tightly against the shoulder by merely pressing the rail by hand. But if there is a danger of applying a lateral impact load, it is necessary to use a shoulder plate to prevent the rail from slipping.)

③ If the mounting face of the bed where the adjusting side rail is installed also has a shoulder, repeat the steps (1) - (2).

④ If there is no shoulder on the mounting face of the bed for the adjusting side rail: Secure a measuring table to the ball slides of the reference side rail (Fig. Ⅱ-9•15). Use this to adjust the parallelism of the adjusting side rail. Check parallelism of the adjusting side rail with a dial gauge from one end of the rail, tightening the bolts one by one.
The measuring table is more stable if secured to two bearings, but one bearing is sufficient.
Parallelism between two rails can also be checked by the same method in Fig. Ⅱ-9•15 when there is a shoulder on the face where the adjusting side rail is installed.

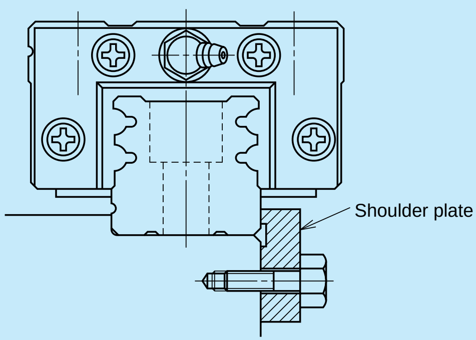


Fig. Ⅱ-9•13 Pressing the rail from sideways

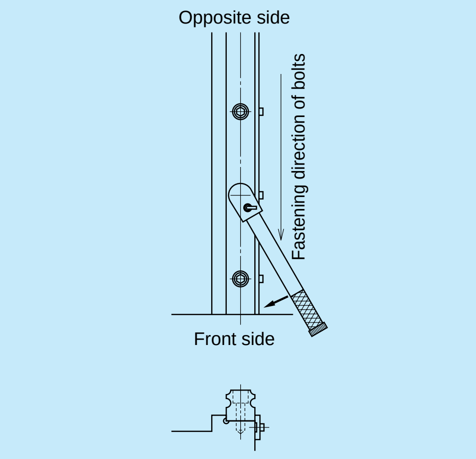


Fig. Ⅱ-9•14 Rail installation

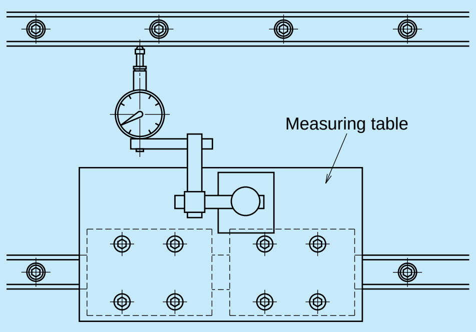


Fig. Ⅱ-9•15 Measuring parallelism

ⓐ-2) When machine base does not have a shoulder on the side where the reference side rail is installed

① Carefully place the reference side rail on the bed on its mounting face. Temporarily tighten the bolts. Do not tighten the bolts all the way, but stop tightening when the bolt enters halfway into the bolt hole. This makes the proceeding steps easier.

② Place the straight edge almost parallel to the reference side rail which is temporarily secured by bolts. (At the both ends of the rail and straight edge, the distance between them shall be almost same.)

③ Once the position of the straight edge is determined, use it as the reference. With a dial gauge, check parallelism with the rail, and adjust the rail if necessary. Then tighten the bolts.
Ensure that the straight edge does not move while the bolts are being tightened.
This procedure should be carried out starting from one end of the rail to the other end. (Fig. Ⅱ-9•16).

④ Finally tighten all bolts with specifieds torque.

⑤ There are two ways for installation of adjusting side rail:
1. Based on the straight edge which is used for reference side rail installation
2. Based on the reference side rail which is installed prior to the adjusting side rail.
In both way, use a dial gauge to measure parallelism.
Other procedures are the same as ①~④, and the ④ for case where there is a shoulder on the machine base.

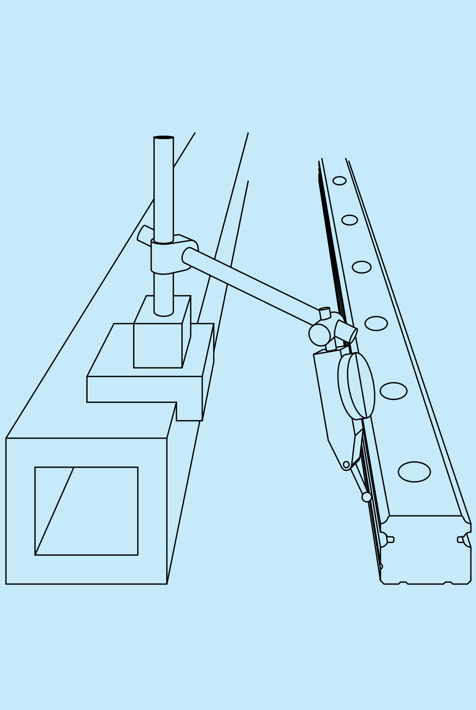


Fig. Ⅱ-9•16

ⓑ Procedures of ball slide installation

ⓑ-1) When table has a shoulder

① Arrange the ball slides so that locations match to their mounting section of the table. Carefully place the table on the ball slides. Temporarily tighten all bolts.

② While pressing the table from sideways, further tighten the bolts which secure the ball slides on the reference side, so the table shoulder and the ball slide's mounting datum face are sufficiently tightly attached.
If a shoulder plate is provided, first tighten the bolts of the plate, then further tighten the bolts to the ball slides (Fig. Ⅱ-9•17).

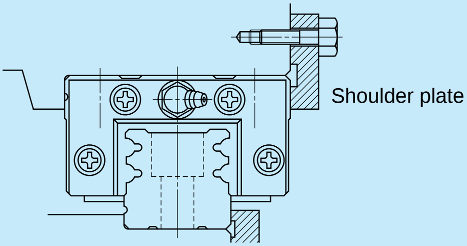


Fig. Ⅱ-9•17 Pressing ball slide from sideways

③ Then, further tighten the bolts for ball slides on the adjusting side rail.
Move the table by hand to confirm that there is no abnormality such as excessive friction force during stroking. (This confirms that the correct installation steps were taken.)

④ Finally, tighten all bolts with standard torque.

ⓑ-2) When table does not have a shoulder

① Arrange the ball slides so that locations match to their mounting section of the table. Carefully place the table on the ball slides. Temporarily tighten bolts to secure ball slides.

② Since the table does not have a shoulder, immediately tighten the bolts further to secure ball slides.

③ Move the table by hand to confirm that there is no abnormality. Finally, tighten all bolts with standard torque.

Ⓑ Easy installation

① Carefully place the reference side rail on the bed. Then tighten the bolts for installation with specified torque.

② Temporarily tighten the bolts on the adjusting side rail.

③ Tighten the ball slides on the reference side rail and one ball slide on the adjustment side rail with specified torque. Leave the rest of the ball slide on the adjusting side rail temporarily tightened (Fig. Ⅱ-9•18).

④ While moving the table with each pitch of the bolt for rail: With specified torque, tighten the rail mounting bolt which is located immediately adjacent to the ball slide on the adjusting side rail that had been finally tightened.
Take this procedure from one end to the other.

⑤ Return the table to the original position once. Then with standard torque, tighten the rest of the ball slides on the adjusting side. Then, by the same procedure as in ④, tighten the rest of the rail mounting bolts with standard torque. Move the table to check any abnormality such as large friction force.

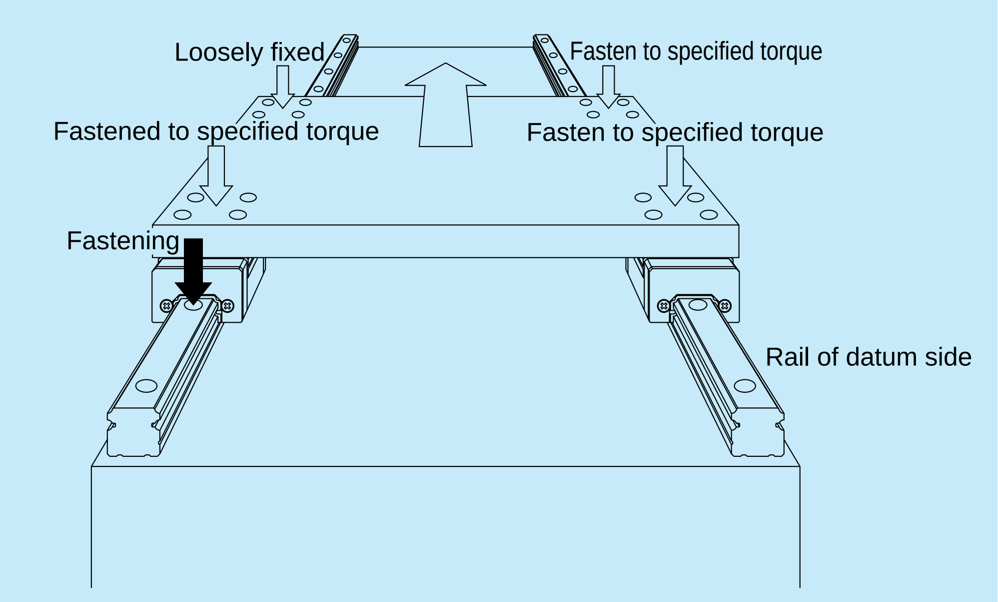


Fig. Ⅱ-9•18　Easy installation

(4) Various methods to press linear guide sideways

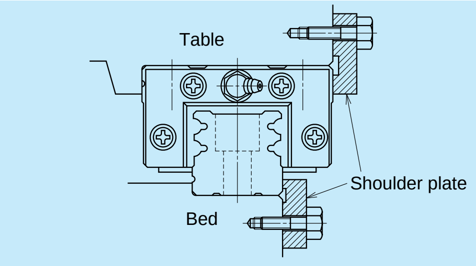


Fig. Ⅱ-9•19 Recommended method

- This method is most widely used, and generally recommended. The ball slide and the rail should stick out slightly from the sides of table and bed. The shoulder plate should have a recess, so the corners of the rail and ball slide do not touch the shoulder plate.

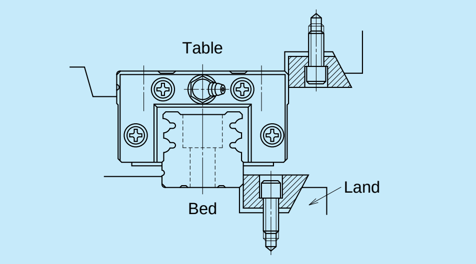


Fig. Ⅱ-9•20 Installation that requires caution

- A tapered block is squeezed in. But the slightest tightening of the bolt generates a large pressing force to the side. Too much tightening may cause the rail to deform, or the land (shown in the figure left) to warp to the right. This method requires caution.

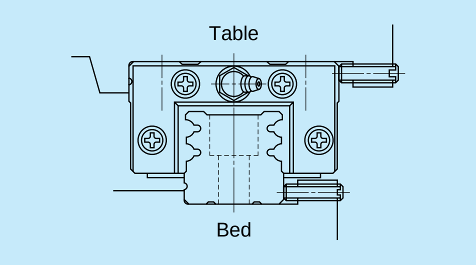


Fig. Ⅱ-9•21

- The bolt that presses rail must be thin due to limited space.

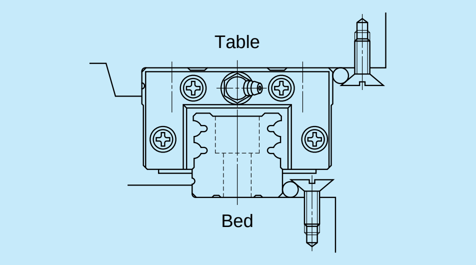


Fig. Ⅱ-9•22

- Press a needle-shape roller with a taper section of the head of a slotted pan head screw. Watch out for the position of the screw.

A-Ⅱ-9.4 Assemble the Interchangeable Linear Guide

- Interchangeable ball slide is assembled on a provisional rail (an inserting tool) when it is delivered (Fig. Ⅱ-9•23).
- NSK standard grease is packed into the ball slide, allowing immediate use.

Assembly procedures of interchangeable linear guide

Follow steps as described below.

① Wipe off the rust preventive oil from the rail and ball slide.

② Match the datum face of rail and the ball slide (groove for installation) as shown in (Fig. Ⅱ-9•24).

③ Align the provisional rail to the rail in the bottom and side faces. Press the provisional rail lightly against the rail, and move the ball slide over the rail (Fig. Ⅱ-9•23).

A-Ⅱ-9.5 Mark for Butting Rails

- A rail which requires the length that exceeds manufactured maximum length comes in butting specification.
- The rail with butting specification are marked with alphabet (A, B, C ...) and an arrow on the opposite side of the mounting datum face. Use the alphabets and arrows for assembly order and direction of the rail (Fig. Ⅱ-9•25).
- The pitch of the rail mounting hole on the butting section should be as F in Fig. Ⅱ-9•26. When two rails are used in parallel, the butted sections should not align. This is to avoid change in the running accuracy of the table at the butted sections.

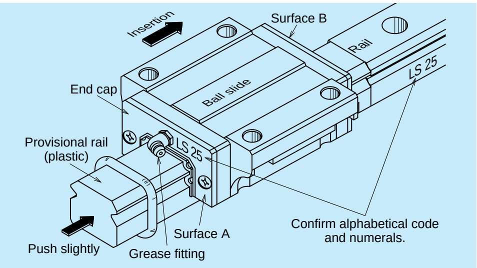


Fig. Ⅱ-9•23 Inserting interchangeable ball slide into the rail

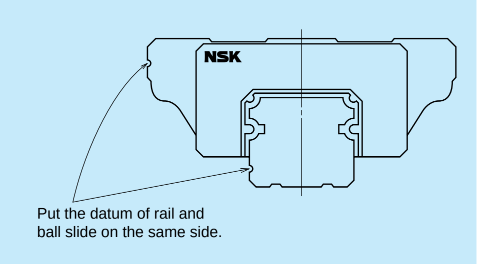


Fig. Ⅱ-9•24

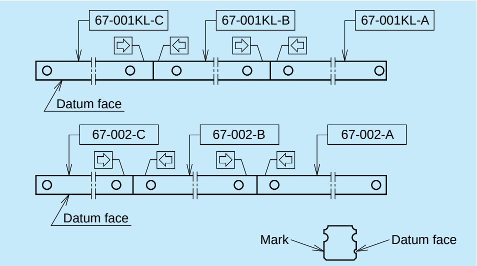


Fig. Ⅱ-9•25

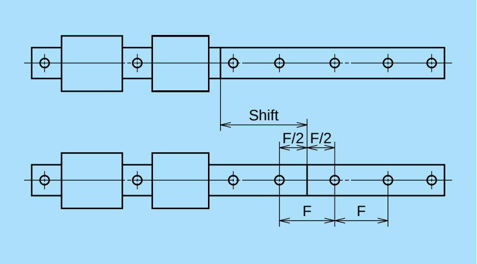


Fig. Ⅱ-9•26

A-Ⅱ-9.6 Handling Preloaded Assembly

- In case of the preloaded assembly (non interchangeable), do not remove ball slides from the rail as a general rule.
- If it is unavoidable to remove ball slide from the rail, make certain to use a provisional rail (a tool used to insert a ball slide to the rail) as shown in Fig. Ⅱ-9•27.
- Provisional rail for each model is in stock.
- Pay due attention to the assembly mark when returning the ball slide back to the rail. Follow the cautions described below.

Mark for assembling ball slide and rail

- Rails of preloaded assembly (not interchangeable) are marked with a reference number and a serial number on the opposite of the datum face.
- Ball slide to be combined are also marked with the same serial number (reference number is not marked).
- Furthermore, ball slides are marked with an arrow. Ball slides should be positioned with their arrows facing each other.
- In case that the ball slides had to be removed from the rail, confirm their serial numbers and the directions of arrows for re-assembly (Fig. Ⅱ-9•28).
- When two or more rails are used in a single set, serial numbers are in sequence if their reference numbers are the same. The linear guide with smallest serial number has the "KL" mark (Fig. Ⅱ-9•29).
- When two or more rails of different refernce number are used in a single set, the rails and ball slides have the same serial number. In this case, when ball slide is removed from the rail, it is confusing which rail each ball slide was previously installed. When removing ball slides from the rail for an unavoidable reason (Fig. Ⅱ-9•30), sufficient precaution is required.

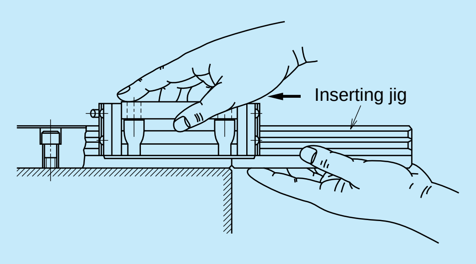


Fig. Ⅱ-9•27

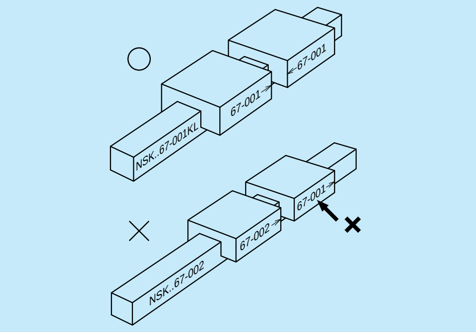


Fig. Ⅱ-9•28

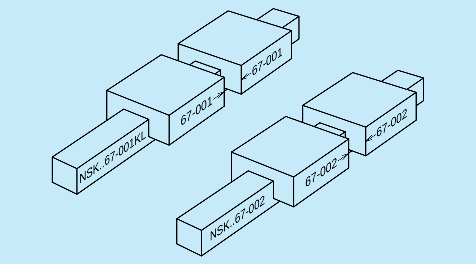


Fig. Ⅱ-9•29 When two rails have the same reference number

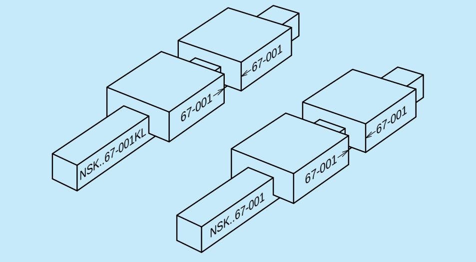


Fig. Ⅱ-9•30 When two rails have different refernce number

A-Ⅱ-10 Drills to Select Linear Guide

A-Ⅱ-10.1 Single Axis Material Handling System

This section explains linear guide selection, life calculation, and deformation at load acting point for a single axis material handling system equipped with linear guide.

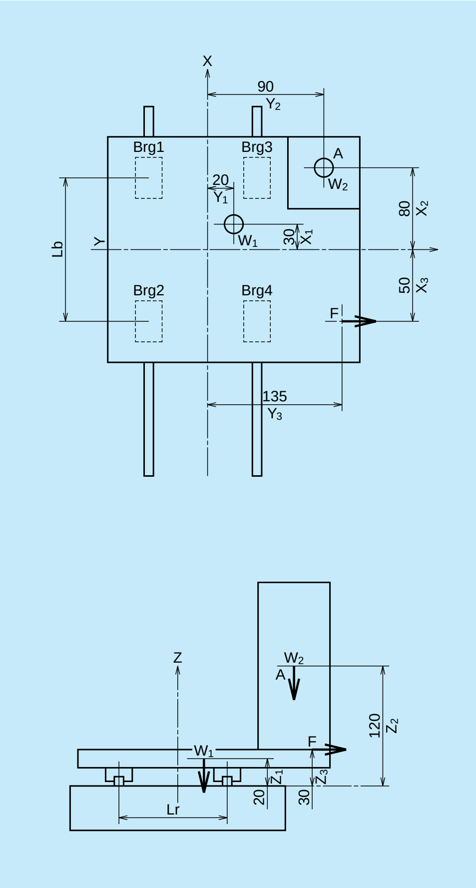


Fig. Ⅱ-10•1 Single axis material handling system

The work load is applied only to one way of stroke. Assume that the load is acting in full stroke as the condition of acting load is unknown.

Specification of Single axis material handling system

Table weight W1 : 150 (N)
Weight of the work W2 : 200 (N)
Acting load F : 200 (N)

Ball slide span L_b : 100 (mm)
Rail span L_r : 90 (mm)

Load point coordinates from the table center (mm)

Load	X coordinate	Y coordinate	Z coordinate
W1	30	−20	20
W2	80	−90	120
F	−50	−135	30

Stroke: 1000 mm
(1 cycle: 2000 mm)

Environment : 10-30 (°C)
Travel speed : 12 (m/min)
Time to reach travel speed : 0.25 (sec)
Operating hour : 16 (hr/day)

(1) Selection of linear guide model

Select a type of linear guide from "**A-Ⅰ-2.1 Types and Characteristics of Linear Guide**." Since this material handling system has 2 rails and 4 ball slides, **LH, LS, and LU Series** are suitable.

(2) Selection of size (model number)

Select a size (model number) from "**A-Ⅱ-3.2 Calculation of Life Expectancy (3) Calculating loads to a ball slide**."

Calculating load *P* per ball slide

Find out potential coefficients ***Kp*1** (for vertical load W1), ***Kp*2** (for vertical load W2) and ***Kp*3** (load F right angle direction to the axis).

From load point coefficients, the potential coefficient ***Kp*1** of vertical direction load **W1** is:

$$Kp1=\left|\frac{X_1}{L_b}\right|+\left|\frac{Y_1}{L_r}\right|=\frac{30}{100}+\frac{20}{90}=0.52$$

From load point coefficients, the potential coefficient Kp2 of vertical load W2 is:

$$Kp2=\left|\frac{X_2}{L_b}\right|+\left|\frac{Y_2}{L_r}\right|=\frac{80}{100}+\frac{90}{90}=1.80$$

From load point coefficients, the potential coefficient F of lateral load is:

$$Kp3=\left|\frac{X_3}{L_b}\right|+\left|\frac{Z_3}{L_r}\right|=\frac{50}{100}+\frac{30}{90}=0.83$$

Therefore, **load *P*** per ball slide is:

$$\begin{aligned}P&=\sum\frac{F}{4}+\sum\frac{Kp\cdot F}{2}\\&=\frac{\mathrm{W1}+\mathrm{W2}+F}{4}+\frac{Kp1\cdot\mathrm{W1}+Kp2\cdot\mathrm{W2}+Kp3\cdot F}{2}\\&=\frac{150+200+200}{4}\\&\quad+\frac{0.52\times150+1.8\times200+0.83\times200}{2}\\&=439.5(\mathrm{N})\end{aligned}$$

Based on this, select **LU15AL** from "**Fig. Ⅰ-3•4 Selection based on the load** "

(3) Calculating life

Calculate life of the selected LU15AL based on "**A-Ⅱ-3.2 Calculation of Life Expectancy.**"

Linear guide LU15AL

Basic dynamic load rating : 4300 (N)
Basic static load rating : 4500 (N)

Load conditions of the linear guide

Table weight W1 : 150 (N)
Weight of the work W2 : 200 (N)
Applied load *F* : 200 (N)
Rail span L_r : 90 (mm)
Ball slide span L_b : 100 (mm)

From the time to reach travel speed and the travel speed, the table acceleration is 0.8m/sec^2. Therefore, it is not necessary to take into account inertial force brought about by table mass.

Calculation of the load applied to ball slide

Calculate two occasions:

1. There is the work mounted on the table.
2. No work mounted on the table.

From Pattern 4 in Table Ⅱ-3•1

There is a work mounted on the table
Vertical direction loads

$$\begin{aligned}M1&=\sum_{j=1}^{n}\left(F_{yj}\cdot Z_{yj}\right)+\sum_{k=1}^{n}\left(F_{zk}\cdot Y_{zk}\right)\\&=F\cdot Z_3+W1\cdot Y_1+W2\cdot Y_2\\&=-200\times30+150\times(-20)+200\times(-90)\\&=-27000\ (\mathrm{N\cdot mm})\end{aligned}$$

$$\begin{aligned}M2&=\sum_{i=1}^{n}\left\{F_{xi}\cdot\left(Z_{xi}-Z_b\right)\right\}+\sum_{k=1}^{n}\left(F_{zk}\cdot X_{zk}\right)\\&=W1\cdot X_1+W2\cdot X_2\\&=150\times30+200\times80\\&=20500\ (\mathrm{N\cdot mm})\end{aligned}$$

$$\begin{aligned}F_{r1}&=\frac{\sum_{k=1}^{n}F_{zk}}{4}+\frac{M1}{2\cdot L}+\frac{M2}{2\cdot\ell}\\&=\frac{W1+W2}{4}+\frac{M1}{2\cdot L_r}+\frac{M2}{2\cdot L_b}\\&=\frac{150+200}{4}+\frac{-27000}{2\times90}+\frac{20500}{2\times100}\\&=40\,(\mathrm{N})\end{aligned}$$

Similarly

$F_{r2}=-165$ (N)
$F_{r3}=\ \ 340$ (N)
$F_{r4}=\ \ 135$ (N)

Lateral direction loads

$$\begin{aligned}M3&=-\sum_{i=1}^{n}\left\{F_{xi}\cdot\left(Y_{xi}-Y_b\right)\right\}+\sum_{j=1}^{n}\left(F_{yj}\cdot X_{yj}\right)\\&=F\cdot X_3\\&=-200\times(-50)\\&=10000\ (\mathrm{N\cdot mm})\end{aligned}$$

$$F_{s1} = F_{s3} = \frac{\sum_{j=1}^{n} F_{yj}}{4} + \frac{M3}{2 \cdot \ell}$$
$$= \frac{F}{4} + \frac{M3}{2L_b}$$
$$= \frac{-200}{4} + \frac{10000}{2 \times 100}$$
$$= 0 \text{ (N)}$$

Similarly

$F_{s2} = F_{s4} = -100$ (N)

No work mounted on the table
Vertical direction load

$$M1 = \sum_{j=1}^{n} \left(F_{yj} \cdot Z_{yj}\right) + \sum_{k=1}^{n} \left(F_{zk} \cdot Y_{zk}\right)$$
$$= F \cdot Z_3 + W1 \cdot Y_1$$
$$= -200 \times 30 + 150 \times (-20)$$
$$= -9000 \text{ (N} \cdot \text{mm)}$$

$$M2 = \sum_{i=1}^{n} \left\{F_{xi}\left(Z_{xi} - Z_b\right)\right\} + \sum_{k=1}^{n} \left(F_{zk} \cdot X_{zk}\right)$$
$$= W1 \cdot X_1$$
$$= 150 \times 30$$
$$= 4500 \text{ (N} \cdot \text{mm)}$$

$$F_{r1} = \frac{\sum_{k=1}^{n} F_{zk}}{4} + \frac{M1}{2 \cdot L} + \frac{M2}{2 \cdot \ell}$$
$$= \frac{W1}{4} + \frac{M1}{2 \cdot L_r} + \frac{M2}{2 \cdot L_b}$$
$$= \frac{150}{4} + \frac{-9000}{2 \times 90} + \frac{4500}{2 \times 100}$$
$$= 10 \text{ (N)}$$

Similarly

$F_{r2} = -35$ (N)
$F_{r3} = 110$ (N)
$F_{r4} = 65$ (N)

Lateral direction loads

$$M3 = -\sum_{i=1}^{n} \left\{F_{xi} \cdot \left(Y_{xi} - Y_b\right)\right\} + \sum_{j=1}^{n} \left(F_{yj} \cdot X_{yj}\right)$$
$$= F \cdot X_3$$
$$= -200 \times (-50)$$
$$= 10000 \text{ (N} \cdot \text{mm)}$$

$$F_{s1} = F_{s3} = \frac{\sum_{j=1}^{n} F_{yj}}{4} + \frac{M3}{2 \cdot \ell}$$
$$= \frac{F}{4} + \frac{M3}{2 \cdot L_b}$$
$$= \frac{-200}{4} + \frac{10000}{2 \times 100}$$
$$= 0 \text{ (N)}$$

Similarly

$F_{s2} = F_{s4} = -100$ (N)

For calculation, take into consideration the positive or negative signs (+, -) for load point coordinate.

Calculation of dynamic equivalent load

Use "A-Ⅱ-3.2 (4) Calculation of dynamic equivalent load."

It matches Position 4 in "**Table Ⅱ-3•2 Loads in the arrangement of linear guides.**" Ball slide loads that must be considered are vertical and lateral direction loads.

In case of LU15AL,

Vertical direction dynamic equivalent load

$$F_r = F_r$$

Lateral direction dynamic equivalent load

$$F_{se} = F_s \tan\alpha = F_s$$

Use the formula for full dynamic equivalent load (Page A136) to calculate F_e.

Results are shown in the table below.

Unit: N

Work mounted	Brg1	Brg2	Brg3	Brg4
F_r $(F_{r1}\sim F_{r4})$	40	−165	340	135
F_{se} $(F_{s1}\sim F_{s4})$	0	−100	0	−100
F_e	40	215	340	185
No work mounted	Brg1	Brg2	Brg3	Brg4
F_r $(F_{r1}\sim F_{r4})$	10	−35	110	65
F_{se} $(F_{s1}\sim F_{s4})$	0	−100	0	−100
F_e	10	118	110	133

From these results, use the largest full dynamic equivalent loads for the calculations hereafter.

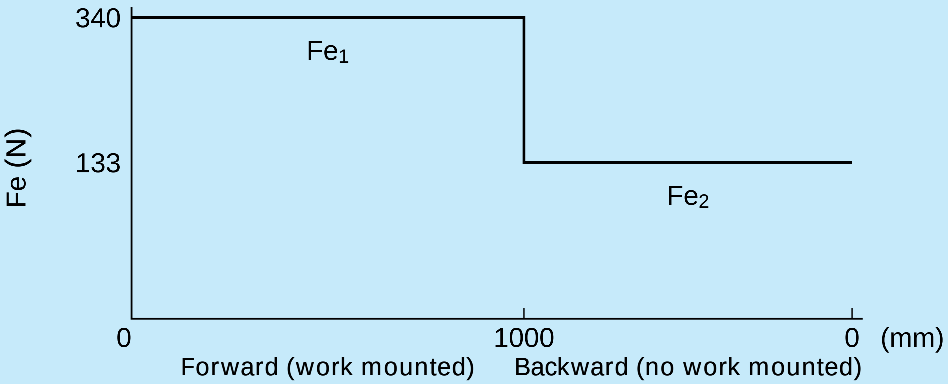
Therefore, the results are:

Work mounted $F_{e1} = 340$ (N)
No work mounted $F_{e2} = 133$(N)

Therefore, the results are:

Calculation of mean effective load

Based on "**A-Ⅱ-3.2 (5) Calculation of mean effective load,**" calculate from the largest full dynamic equivalent loads.



Cycle patterns of full dynamic equivalent load

From the cycle pattern, the mean effective load matches "① **When load and running distance vary by phase.**" Therefore, use the following formula.

Assuming that L is: $L = L_1 + L_2$.

$$Fm = \sqrt[3]{\frac{1}{L}\left(F_{e1}^3 L_1 + F_{e2}^3 L_2\right)}$$

$$= \sqrt[3]{\frac{1}{2000}\left(340^3 \times 1000 + 133^3 \times 1000\right)}$$

$$= 275\ (\mathrm{N})$$

Determine various coefficients

Determine coefficients to use from **"A-Ⅱ-3.2 (6) Various coefficients."**

Load factors

Use conditions are: Travel speed -- 12 m/min; Acceleration -- 0.8m/ sec^2 (0.082G). As the load factor f_W is in the range of 1.0 ~ 1.5, use common value **f_W = 1.2**.

Hardness coefficient

The hardness of NSK linear guides is HRC58 ~ 62. Use a hardness coefficient **f_H= 1** and take the value of basic dynamic load rating as it is.

Calculate rating life

Use **"A-Ⅱ-3.2 (7) Calculation of rating life."**

Linear guide LU15AL's basic dynamic load rating C : 4300 (N)

Mean effective load F_m : 275 (N)

Load factor f_W : 1.2

Hardness coefficient f_H : 1

$$\text{Rating fatigue life } L = 50 \times \left[\frac{f_H \bullet C}{f_W \bullet F_M}\right]^3$$

$$50 \times \left[\frac{1 \times 4300}{1.2 \times 275}\right]^3$$

about 110620 (Km)

Travel speed: 12 m/min; Operating hours: 16hr/Day.

Convert the above rating fatigue life into hours:

$$\frac{110620 \times 1000}{12 \times 60 \times 16} \qquad \text{about } 9600(\text{Day})$$

Examine static load

Based on **"A-Ⅱ-3.2 (8) Examination of static load,"** find out on which ball slide the static equivalent load P_0 becomes largest.

Linear guide LU15AL's basic static load rating C_0: 4500 (N)

Ball slide No. 3 receives the largest load.

P_0 at this time:

$$P_0 = F_r + F_s = 340$$

Therefore, static permissible load coefficient f_s is:

$$f_s = \frac{C_0}{P_0} = \frac{4500}{340} = 13.2$$

There is no problem at this value.

(4) Selection of accuracy grade and preload

Based on **"A-Ⅰ-3.4 (2) Application examples of accuracy grade and preload,"** select accuracy grade PN and preload Z1 for material handling system.

(5) Calculation of deformation

Calculate deformation by the weight of the mounted work W2. From **"Table Ⅱ-2•11"** in "**A-Ⅱ-2 Preload and Rigidity,**" the rigidity of linear guide LU15AL, Z1 pre-load is:

$$K_S = K_r = 45\ (\mathrm{N/m\,m}) = 45000\ (\mathrm{N/mm})$$

Deformation by the weight of the mounted work W_2 can be obtained: Difference in deformation when W_2 applies or does not apply.

From Pattern 4 in Table Ⅱ-3•1 (Page A132)

Work mounted:

$$\delta_{x1} = Y_d \cdot \frac{F_{s2} - F_{s1}}{L_b \cdot K_s} + Z_d \cdot \frac{F_{r1} - F_{r2}}{L_b \cdot K_r}$$

$$= -90 \times \frac{-100 - 0}{100 \times 45000} + 120 \times \frac{40 - (-165)}{100 \times 45000}$$

$$= 0.0075\,(\mathrm{mm}) = 7.5\,(\mu\mathrm{m})$$

Similarly, $\delta_{y1} = -0.0082\,(\mathrm{mm}) = -8.2\,(\mu\,\mathrm{m})$

$\delta_{z1} = 0.0123\,(\mathrm{mm}) = 12.3\,(\mu\,\mathrm{m})$

No work mounted:

$$\delta_{x2}=Y_d\cdot\frac{F_{s2}-F_{s1}}{L_b\cdot K_s}+Z_d\cdot\frac{F_{r1}-F_{r2}}{L_b\cdot K_r}$$

$$=-90\times\frac{-100-0}{100\times45000}+120\times\frac{10-(-35)}{100\times45000}$$

$$=0.0032(\mathrm{mm})=3.2(\mu\mathrm{m})$$

Similarly, $\delta_{y2}=-0.0023\ (\mathrm{mm})=-2.3\ (\mu\mathrm{m})$

$\delta_{z2}=0.0039(\mathrm{mm})=3.9\ (\mu\mathrm{m})$

Therefore, the difference in deformation by whether there is a mounted work or not is as follows:

$\delta_x=\delta_{x1}-\delta_{x2}=7.5-3.2=4.3\,(\mu\mathrm{m})$

$\delta_y=\delta_{y1}-\delta_{y2}=-8.2-(2.3)=-5.9\ (\mu\mathrm{m})$

$\delta_z=\delta_{z1}-\delta_{z2}=12.3-3.9=8.4\,(\mu\mathrm{m})$

A-Ⅱ-10.2 Machining Center

The following is a case calculation for a horizontal type machining center. Arrangements of each axis are shown in Fig. Ⅱ-10•2 and Fig. Ⅱ-10•3.

Operating conditions

Dimensions and load conditions are:

X axis column's weight Wx : 7500 (N)
Y axis spindle head's weight Wy : 2500 (N)
Z axis table's weight Wz : 5500 (N)
X axis rail span XL_r : 450 (mm)
X axis ball slide span XL_b : 310 (mm)
Y axis rail span YL_r : 410 (mm)
Y axis ball slide span YL_b : 308 (mm)
Z axis rail span ZL_r : 660 (mm)
Z axis ball slide span ZL_b : 420 (mm)

X axis stroke : 400 (mm)
Y axis stroke : 350 (mm)
Z axis stroke : 500 (mm)

Average rapid traverse speed : 15(m/min)
(Max. 30(m/min))
Starting accelerating speed : 1(G)
Milling speed : 2.5 (m/min)
Drilling speed : 0.8 (m/min)

Cutting load
Milling process Fx = Fy = 1000 (N)
Drilling process Fz = 3000 (N)

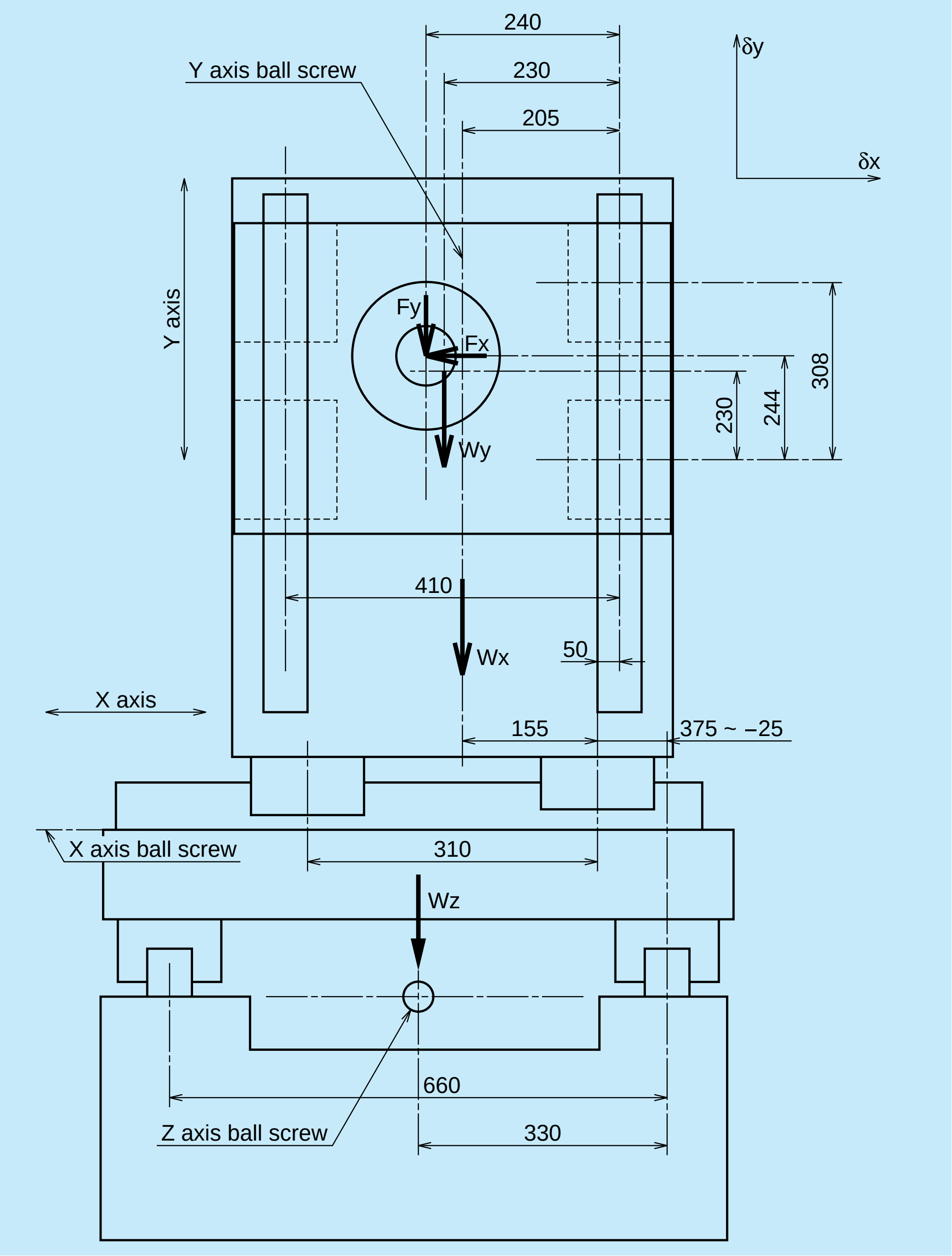


Fig. Ⅱ-10•2 Machining center (front view)

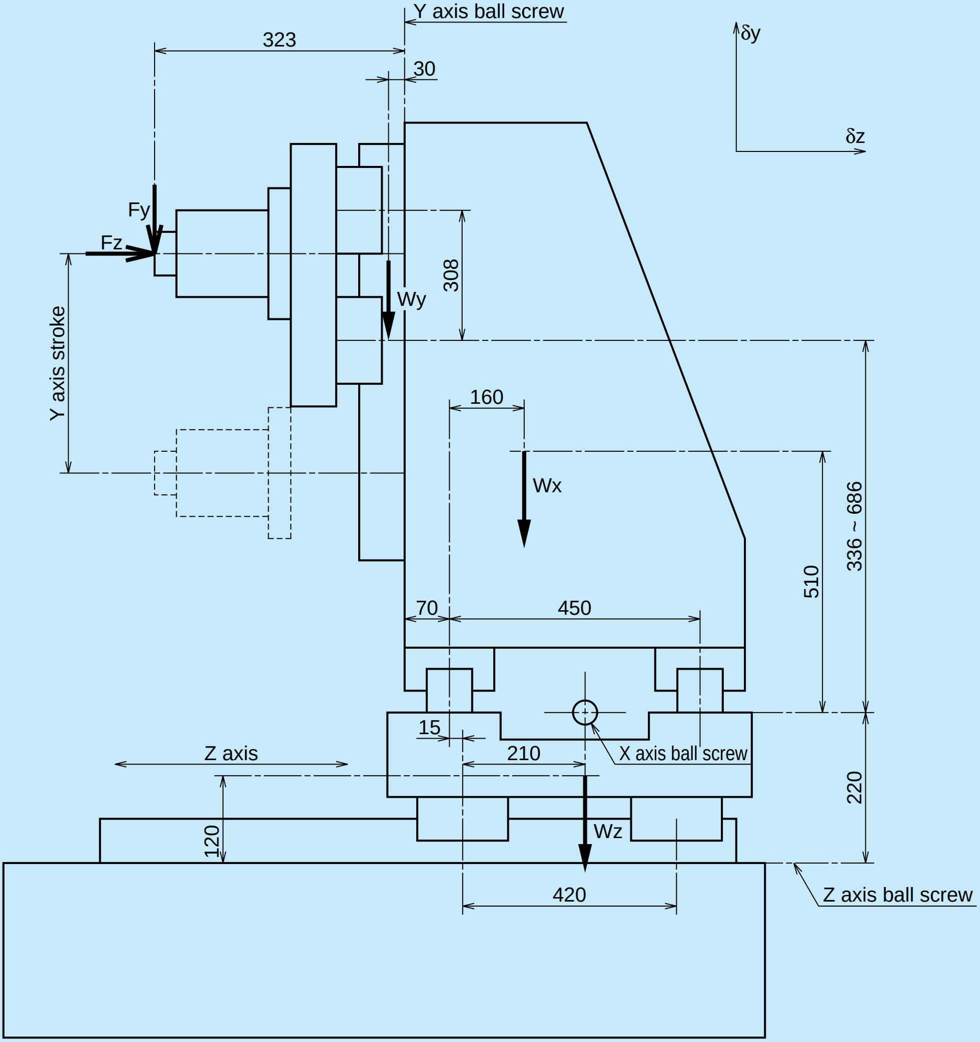


Fig. Ⅱ-10•3 Machining center (side view)

(1) Selection of linear guide model

From the operating conditions, the linear guide should be LY Series which is suitable for the machining center.

(2) Selection of linear guide size (model number)

Start selection from Y axis which has fewer acting loads.

Coordinates of load points are as follows.

Wy (X_{WY}, Y_{WY}, Z_{WY}) = (−25, 76, −30) (mm)
Fx (X_{FX}, Y_{FX}, Z_{FX}) = (−35, 90, −323) (mm)
Fy (X_{FY}, Y_{FY}, Z_{FY}) = (−35, 90, −323) (mm)
Fz (X_{FZ}, Y_{FZ}, Z_{FZ}) = (−35, 90, −323) (mm)
Ball slide span : YL_b **= 308 mm**
Rail span : YL_r **= 410 mm**

First, find out the **load volume *P*** per ball slide in milling process (***P*yf**) and drilling process (***P*yd**). Refer to "**A-Ⅰ-3.2 Selection of linear guide size (model code)**."

Position coefficients at time of milling process
(*W*y, *F*x and *F*y must be considered.)

Regarding *W*y: From load application coordinates

$$Kpy1=\left|\frac{Z_{WY}}{YL_b}\right|+\left|\frac{X_{WY}}{YL_b}\right|=\frac{30}{308}+\frac{25}{308}=0.10+0.08=0.18$$

Regarding *F*x: From load point coordinates

$$Kpy2=\left|\frac{Y_{FX}}{YL_b}\right|+\left|\frac{Z_{FY}}{YL_b}\right|=\frac{90}{308}+\frac{323}{410}=0.29+0.79=1.08$$

Regarding *F*y: From load point coordinates

$$Kpy3=\left|\frac{Z_{FY}}{YL_b}\right|+\left|\frac{X_{FY}}{YL_b}\right|=\frac{323}{308}+\frac{35}{308}=1.05+0.11=1.16$$

Therefore, **load volume Pfy is**:

$$\begin{aligned}Pyf&=\sum\frac{F}{4}+\sum\frac{Kp\cdot F}{2}\\&=\frac{Wy+Fx+Fy}{4}+\frac{Kpy1\cdot Wy+Kpy2\cdot Fx+Kpy3\cdot Fy}{2}\\&=\frac{2500+1000+1000}{4}\\&\quad+\frac{0.18\times2500+1.08\times1000+1.16\times1000}{2}\\&=2470\,(N)\end{aligned}$$

Position coefficients at time of drilling processing
(*W*y and *F*z must be considered.)
Regarding Wy, as in the case for milling process,
$Kpy1 = 0.18$
Regarding *F*z: From load point coefficient

$$Kpy4=\left|\frac{Y_{FZ}}{YL_b}\right|+\left|\frac{X_{FZ}}{YL_r}\right|=\frac{90}{308}+\frac{35}{410}=0.29+0.09=0.38$$

Therefore, **load volume Pyd** is:

$$\begin{aligned}Pyd&=\sum\frac{F}{4}+\sum\frac{Kp\cdot F}{2}\\&=\frac{Wy+Fz}{4}+\frac{Kpx1\cdot Wy+Kpy4\cdot Fz}{2}\\&=\frac{2500+3000}{4}+\frac{0.18\times2500+0.38\times3000}{2}\\&=2170\,(N)\end{aligned}$$

From the above results, for milling process with large values, select a model LY 35 from Fig. Ⅰ-3•4. for Y axis.

Next, determine the linear guide size for X axis. As with Y axis, the distance from the center of the table to the loads and their load points are shown. The stroke position on Y axis is the summit point which imposes strict condition.

Wx (X_{Wx}, Y_{Wx}, Z_{Wx}) = (0, 510, −65) (mm)
Wy (X_{WY}, Y_{WY}, Z_{WY}) = (−25, 916, −325) (mm)
Fx (X_{FX}, Y_{FX}, Z_{FX}) = (−35, 930, −618) (mm)
Fy (X_{FY}, Y_{FY}, Z_{FY}) = (−35, 930, −618) (mm)
Fz (X_{FZ}, Y_{FZ}, Z_{FZ}) = (−35, 930, −618) (mm)
Ball slide span : YL_b **=** 310 (mm)
Rail span : YL_r **=** 0450 (mm)

Also, determine per-ball slide load volume ***P*xf and *P*xd**.

Position coefficients at time of milling process
(*W*x, *W*y, *F*x and *F*y must be considered)

Regarding *W*x: From load point coordinates

$$Kpx1=\left|\frac{X_{WX}}{XL_b}\right|+\left|\frac{Z_{WX}}{XL_r}\right|=\frac{0}{310}+\frac{65}{450}=0+0.14=0.14$$

Regarding *W*y: From load point coordinates

$$Kpx2=\left|\frac{X_{WY}}{XL_b}\right|+\left|\frac{Z_{WY}}{XL_r}\right|=\frac{25}{310}+\frac{325}{450}=0.08+0.72=0.8$$

Regarding *F*x: From load point coordinates

$$Kpx3=\left|\frac{Y_{FX}}{XL_b}\right|+\left|\frac{Z_{FX}}{XL_b}\right|=\frac{930}{310}+\frac{618}{310}=3.00+1.99=4.99$$

Regarding *F*y: From load point coordinates

$$Kpx4=\left|\frac{X_{FY}}{XL_b}\right|+\left|\frac{Z_{FY}}{XL_r}\right|=\frac{35}{310}+\frac{618}{450}=0.11+1.37=1.48$$

Therefore,

$$Pxf = \sum\frac{F}{4} + \sum\frac{Kp \cdot F}{2}$$

$$= \frac{Wx + Wy + Fx + Fy}{4}$$

$$+ \frac{Kpx1 \cdot Wx + Kpx2 \cdot Wy + Kpx3 \cdot Fx + Kpx4 \cdot Fy}{2}$$

$$= \frac{7500 + 2500 + 1000 + 1000}{4}$$

$$+ \frac{0.14 \times 7500 + 0.8 \times 2500 + 4.99 \times 1000 + 1.48 \times 1000}{2}$$

$$= 7760\,(\mathrm{N})$$

Position coefficients at time of drilling process (Wx, Wy and *F*z must be considered)

Regarding *W*x: *K*px1＝0.14

(same as milling process)

Regarding *W*y: *K*px2＝0.80

(same as milling process)

Regarding *F*z: From the load point coordinates

$$Kpx5 = \left|\frac{X_{FZ}}{XL_b}\right| + \left|\frac{Y_{FZ}}{XL_r}\right| = \frac{35}{310} + \frac{930}{450} = 0.11 + 2.07 = 2.18$$

Therefore,

$$Pxd = \sum\frac{F}{4} + \sum\frac{Kp \cdot F}{2}$$

$$= \frac{Wx + Wy + Fz}{4}$$

$$+ \frac{Kpx1 \cdot Wx + Kpx2 \cdot Wy + Kpx5 \cdot Fz}{2}$$

$$= \frac{7500 + 2500 + 3000}{4}$$

$$+ \frac{0.14 \times 7500 + 0.8 \times 2500 + 2.18 \times 3000}{2}$$

$$= 8045\,(\mathrm{N})$$

From the above results, for drilling process with large values, select a model from Fig. Ⅰ-3•4. and LY55 is chosen for *X* axis.

Finally, determine *Z* axis. Similarly, the distance from the center of the table to the loads and their loading points are shown. The stroke positions on *Y* and *X* axes are at stroke end which imposes strict condition.

Wx $(X_{WX},\ Y_{WX},\ Z_{WX}) = (-200,\ 730,\ -65)$ (mm)

Wy $(X_{WY},\ Y_{WY},\ Z_{WY}) = (-225,\ 1136,\ -325)$ (mm)

Wz $(X_{WZ},\ Y_{WZ},\ Z_{WZ}) = (\ 0,\ 120,\ 0)$ (mm)

Fx $(X_{FX},\ Y_{FX},\ Z_{FX}) = (-235,\ 1150,\ -618)$ (mm)

Fy $(X_{FY},\ Y_{FY},\ Z_{FY}) = (-235,\ 1150,\ -618)$ (mm)

Fz $(X_{FZ},\ Y_{FZ},\ Z_{FZ}) = (-235,\ 1150,\ -618)$ (mm)

Ball slide span : ZL_b **=** 420 (mm)

Rail span : ZL_r **=** 660 (mm)

Position coefficients at time of milling process (*W*x, *W*y, *W*z, *F*x and *F*y must be considered)

Regarding *W*x: From load point coordinates

$$Kpz1 = \left|\frac{Z_{WX}}{ZL_b}\right| + \left|\frac{X_{WX}}{ZL_r}\right| = \frac{65}{420} + \frac{200}{660} = 0.15 + 0.30 = 0.45$$

Regarding *W*y: From load point coordinates

$$Kpz2 = \left|\frac{Z_{WY}}{ZL_b}\right| + \left|\frac{X_{WY}}{ZL_r}\right| = \frac{325}{420} + \frac{225}{660} = 0.77 + 0.34 = 1.11$$

Regarding *W*z: From load point coordinates

$$Kpz3 = \left|\frac{Z_{WZ}}{ZL_b}\right| + \left|\frac{X_{WZ}}{ZL_r}\right| = \frac{0}{420} + \frac{0}{660} = 0 + 0 = 0$$

Regarding *F*x: From load point coordinates

$$Kpz4 = \left|\frac{Z_{FX}}{ZL_b}\right| + \left|\frac{Y_{FX}}{ZL_r}\right| = \frac{618}{420} + \frac{1150}{660} = 1.47 + 1.74 = 3.21$$

Regarding *F*y: From load point coordinates

$$Kpx4 = \left|\frac{Z_{FY}}{ZL_b}\right| + \left|\frac{X_{FY}}{ZL_r}\right| = \frac{618}{420} + \frac{235}{660} = 1.47 + 0.36 = 1.83$$

Therefore,

$$Pzf = \sum\frac{F}{4} + \sum\frac{Kp \cdot F}{2}$$

$$= \frac{Wx + Wy + Wz + Fx + Fy}{4}$$

$$+ \frac{Kpz1 \cdot Wx + Kpz2 \cdot Wy + Kpz3 \cdot Wz + Kpz4 \cdot Fx + Kpz5 \cdot Fy}{2}$$

$$= \frac{7500 + 2500 + 5500 + 1000 + 1000}{4}$$

$$+ \frac{0.45 \times 7500 + 1.11 \times 2500 + 0 \times 5500 + 3.21 \times 1000 + 1.83 \times 1000}{2}$$

$$= 9970\,(\mathrm{N})$$

Position coefficients at time of drilling process (*W*x, *W*y, *W*z and *F*z must be considered)

Regarding *W*x: *K*pz1＝0.45

Regarding *W*y: *K*pz2＝1.11

Regarding *W*z: *K*pz3＝0

Regarding *F*z: From the load point coordinates

$$Kp6 = \left|\frac{Y_{FZ}}{ZL_b}\right| + \left|\frac{X_{FZ}}{ZL_b}\right| = \frac{1150}{420} + \frac{235}{420} = 2.74 + 0.56 = 3.30$$

Therefore,

$$
\begin{aligned}
Pzd &= \sum\frac{F}{4}+\sum\frac{Kp\cdot F}{2}\\
&= \frac{Wx+Wy+Wz+Fz}{4}\\
&\quad+\frac{Kpz1\cdot Wx+Kpz2\cdot Wy+Kpz3\cdot Wz+Kpz6\cdot Fz}{2}\\
&= \frac{7500+2500+5500+3000}{4}\\
&\quad+\frac{0.45\times7500+1.11\times2500+0\times5500+3.30\times3000}{2}\\
&= 12650\,(\mathrm{N})
\end{aligned}
$$

From the above results, for drilling process with large values, select a model LY 65 from Fig. Ⅰ-3•4. for Z axis.

The selected linear guides are:

X axis LY55
Y axis LY35
Z axis LY65

(3) Calculation of life expectation

Examination shall be done in three cases, no cutting load; milling process; and drilling process. Inertial force associated with the starting acceleration is not considered in this case. But it must be calculated for more accurate figures.

Calculation of the loads that apply to the ball slide

In case of no cutting load: *F*x = *F*y = *F*z = 0

Calculate load on X, Y, Z axes using **"Table Ⅱ-3•1"** in **"A-Ⅱ-3.2 (3) Calculating load to a ball slide."**

X axis: Loads to consider *W*x, and *W*y
Y axis: Loads to consider *W*y
Z axis: Loads to consider *W*x, *W*y, and *W*z

The table below shows calculation of each load coordinates as stroke end which imposes most strict condition.

Unit: N

Axis	Load direction	Brg1	Brg2	Brg3	Brg4
X axis	Vertical direction F_r	1156	955	4045	3844
	Lateral direction F_s	0	0	0	0
Y axis	Vertical direction F_r	122	−122	122	−122
	Lateral direction F_s	102	−102	102	−102
Z axis	Vertical direction F_r	765	3860	3890	6985
	Lateral direction F_s	0	0	0	0

In case of milling process: *F*x = *F*y = 1000 (N)

Similarly,

X axis: Loads to consider *W*x, *W*y, *F*x, and *F*y
Y axis: Loads to consider *W*y, *F*x, and *F*y
Z axis: Loads to consider *W*x, *W*y, *W*z, *F*x, and *F*y

The table below shows calculation of each load coordinates as stroke end which imposes most strict condition.

Unit: N

Axis	Load direction	Brg1	Brg2	Brg3	Brg4
X axis	Vertical direction F_r	2277	−1039	6539	3224
	Lateral direction F_s	997	−997	997	−997
Y axis	Vertical direction F_r	252	−1040	1040	−252
	Lateral direction F_s	54	−554	54	−554
Z axis	Vertical direction F_r	−771	3796	4453	9020
	Lateral direction F_s	486	−986	486	−986

In case of drilling process: *Fz* = 3000 (N)

X axis: Loads to consider *W*x, *W*y, and *F*z

Y axis: Loads to consider *W*y, and *F*z

Z axis: Loads to consider *W*x, *W*y, *W*z, and *F*z

The table below shows calculation of each load coordinates as a stroke end which imposes most strict condition.

Unit: N

Axis	Load direction	Brg1	Brg2	Brg3	Brg4
X axis	Vertical direction F_r	4256	4055	945	744
	Lateral direction F_s	919	581	919	581
Y axis	Vertical direction F_r	305	938	561	1195
	Lateral direction F_s	102	−102	102	−102
Z axis	Vertical direction F_r	4872	−247	7997	2878
	Lateral direction F_s	839	−839	839	−839

Calculation of dynamic equivalent load

Next, find dynamic equivalent load under each cutting condition. From "Table Ⅱ-3•2" in **"A-Ⅱ-3.2 (4) Calculation of dynamic equivalent load,"** necessary load *F*r, *F*se are, as the linear guide model is LY Series, obtained as follows.

Vertical dynamic equivalent load

$$Fr = Fr$$

Lateral dynamic equivalent load

$$Fse = Fs \cdot \tan\alpha = Fs$$

From above, calculate *F*e using formulas for full dynamic equivalent loads shown in Page A136. From calculation, the largest full dynamic equivalent loads are as follows.

	Largest full dynamic equivalent load *F*e (N)		
	No cutting load	For milling process	For drilling process
X axis	4045	7038	4716
Y axis	173	1317	1246
Z axis	6985	9513	8417

Calculation of mean effective load

Calculate the mean effective loads from full dynamic equivalent loads. If duty cycle in the cutting process is not clear, set at 70% of the largest full dynamic equivalent load in all processes.Therefore,

X axis: 7038 x 0.7 = 4927 (N)

Y axis: 1317 x 0.7 = 922 (N)

Z axis: 9513 x 0.7 = 6659 (N)

Determine various coefficients

Determine based on "**A-Ⅱ-3.2 (6) Various coefficients.**"

In this occasion,

Load coefficient f_W: 1.5

Hardness coefficient f_H: 1

Calculation of rating life

Based on the calculated loads and various coefficients, calculate life from "**A-Ⅱ-3.2 (7) Calculation of rating life.**"

Basic dynamic load rating C

(X axis linear guide LY 55): 79500 (N)

Basic dynamic load rating C

(Y axis linear guide LY 35): 35000 (N)

Basic dynamic load rating C

(Z axis linear guide LY 65): 168000 (N)

Load coefficient f_W: **1.5**

Hardness coefficient f_H: **1**

Rating fatigue life $L=50\times\left[\dfrac{f_H\cdot C}{f_W\cdot F_M}\right]^3$

From this,

In case of X axis $Lx =$ **62235 (km)**

In case of Y axis $Ly =$ **810415 (km)**

In case of Z axis $Lz =$ **237900 (km)**

Examination of static loads based on "A-Ⅱ-3.2 (8)"

Basic static load rating C_0

(X axis linear guide LY 55): 113000

Basic static load rating C_0

(Y axis linear guide LY 35): 51000 (N)

Basic static load rating C_0

(Z axis linear guide LY 65): 226000 (N)

Examine for milling process with large load.

$$\text{X axis } f_s=\frac{C_0}{P_0}=\frac{C_0}{(F_r+F_s)}=\frac{113000}{(6539+997)}=15.0$$

Similarly,

Y axis $f_s = 32.0$

Z axis $f_s = 22.6$

Therefore, there is no problem.

(4) Selection of accuracy grade and preload

For machining center, select accurate grade P5, and Preload Z3.

(5) Calculation of deformation

Calculate deformation at processing points (stroke position is the stroke end positions on Y axis and X axis)

Rigidity of X axis linear guide LY55Z3 : 880 (N/μm)

Rigidity of Y axis linear guide LY35Z3 : 580 (N/μm)

Rigidity of Z axis linear guide LY65Z3 : 1340 (N/μm)

Calculate using Pattern 4 in Table Ⅱ-3•1.

Load conditions	Deformation direction	Deformation of each axis (μm)			Total deformation (μm)
		X axis	Y axis	Z axis	
Table weight alone	δx	−0.7	−0.1	−4.1	−4.9
	δy	−7.4	−0.5	−7.1	−15.0
	δz	−6.8	−0.1	−6.3	−13.2
Milling process	δx	−15.8	−1.8	−8.6	−26.2
	δy	−10.2	−2.5	−9.5	−22.2
	δz	−9.8	−0.5	−8.7	−19.0
Drilling process	δx	−1.5	−0.4	−5.9	−7.8
	δy	2.3	1.1	1.9	5.3
	δz	8.7	1.6	11.2	21.5

Therefore, deformation at processing points at time of milling is:

$\delta x = -26.2 - (-4.9) = -21.3 \ (\mu m)$

$\delta y = -22.2 - (-15.0) = -7.2 \ (\mu m)$

$\delta z = -19.0 - (-13.2) = -5.8 \ (\mu m)$

Deformation at processing points at time of milling:

$\delta x = -7.8 - (-4.9) = -2.9 \ (\mu m)$

$\delta y = 5.3 - (-15.0) = -20.3 \ (\mu m)$

$\delta z = -21.5 - (-13.2) = 34.7 \ (\mu m)$

If a life of this long period is not required, select a smaller linear guide model, and calculate life again.

To reduce deformation at processing point, select a linear guide model with higher rigidity. Then calculate life again.

A-Ⅱ-11 References

The articles in "Motion & Control (NSK Technical Journals)" which refer to NSK linear guides are listed in the table below for user convenience.

"Motion & Control" is compiled to introduce NSK products and its technologies.

For inquiries and orders of "Motion & Controls," please contact your local NSK sales offices, or representatives.

Table Ⅱ-11•1 Motion & Control (NSK Technical Journal): Articles relating to linear guides (1997 ~)

Issue No.	Date of Publication	Articles related to linear guides
No.1	Sep/96	The Current State of Precision Machinery Parts and Product
No.2	Mar/97	Development of "Molded Oil" and Its Application to NSK Linear Guide
No. 3	Dec/97	NSK Linear Guide Interchangeable Miniature Series (Product introduction)
No.4	May/98	New LA Series Linear Guide (Product intridiction)
No.5	Nov/98	Recent Technical Trends in Linear Guides

A-Ⅲ Other Linear Rolling Guide Products

A-Ⅲ-1 Linear Rolling Bushing

A-Ⅲ-1.1 Features

(1) Low friction

Low friction owes to its design: Balls come into point contacts with raceway surface: the balls smoothly re-circulate. There is very little stick slip.

(2) Low noise

Noise level is low due to the ball retainer which is made of a synthetic resin.

(3) High precision

Due to NSK's superb quality control, precision is guaranteed.

(4) Dust prevention

Series with seal is available. The seal has small friction, and is highly durable. Highly dust-preventive double-lip system has been adopted.

(5) Superb durability

The material of outer sleeve is vacuum degassed, highly pure, and is heat-treated with good expertise.

A-Ⅲ-1.2 Models

There are three models

(1) Standard type LB (Fig. Ⅲ-1•1)

This model is the most commonly used, and is the only model that comes with a seal and in super precision grade.

Fig. Ⅲ-1•1 Standard type LB

(2) Adjustable clearance type LB-T (Fig. Ⅲ-1•2)

A part of the outer sleeve is cut open toward the axial direction. Used with a housing which can adjust inside diameter, it makes minute adjustment of the clearance between the linear shaft and the inscribed circle (an imaginary circle that connects the summit of the ball) of linear rolling bushing.

Fig. Ⅲ-1•2 Adjustable Clearance type LB-T

(3) Open type LB-K (Fig. Ⅲ-1•3)

A cut is made in the outer sleeve and retainer, to a width equivalent to one row of the retainer, to the axial direction. The opening is used to hold this linear rolling bushing by a support or base to prevent a long linear shaft from bending.

Fig. Ⅲ-1•3 Open type LB-K

A-Ⅲ-1.3 Accuracy

(1) Accuracy grades

- Standard type LB ····················· High precision grade S, and super precision grade SP are available
- Space adjustment type LB-T ······ } High precision grade S is available
- Open type LB-K ·················· }

(2) Tolerance of rolling linear bushing, linear shaft and housing

Table Ⅲ-1•1 Tolerance for inscribed circle of the linear rolling bushing and shaft diameter

Unit: μm

Nominal dimension/ inscribed circle diameter / shaft diameter (mm)		Tolerance / inscribed circle diameter(1)				Tolerance / width *B*		Tolerance/slot distance of retaining rings *B*n		Recommended tolerance / shaft diameter			
		High precision grade S		Super high precision grade SP		High precision grade S Super high precision grade SP		High precision grade S Super high precision grade SP		High precision grade S		Super high precision grade SP	
over	or less	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower
2.5	6	0	-8	0	-5	0	-120	+240	-240	-6	-14	-4	-9
6	10									-6	-15	-4	-10
10	18									-6	-17	-4	-12
18	30	0	-10	0	-6					-6	-19	-4	-13
30	50	0	-12	0	-8					-7	-23	-5	-16

Table Ⅲ-1•2 Tolerance of linear rolling bush outside diameter, and housing inside diameter

Unit: μm

Nominal dimension / outside diameter / housing inside diameter (mm)		Tolerance / outside diameter D(1)				ccentricity(2)	Tolerance / housing inside diameter			
		High precision grade S		Super high precision grade SP		Super high precision grade SP	High precision grade S		Super high precision grade SP	
over	or less	upper	lower	upper	lower	Maximum	upper	lower	upper	lower
2.5	6	0	-10	0	-7	8	+12	0	+8	0
6	10						+15	0	+9	0
10	18						+18	0	+11	0
18	30	0	-12	0	-8	9	+21	0	+13	0
30	50	0	-14	0	-9	10	+25	0	+16	0

Notes: (1) For adjustable clearance type and open type, figures indicate tolerances before the cut is made.
(2) Eccentricity means the run-out of offset between the centers of outer sleeve diameter and inscribed circle diameter.

A-Ⅲ-1.4 Composition of Reference Number

Example LB 35 N K Y S

Linear rolling bushing

Nominal inscribed circle diameter
(linear shaft nominal diameter)

N ········· With retaining ring groove
No code··· Without retaining ring groove

No code··· Standard type LB
T ········· Adjustable clearance type LB-T
K ········· Open type LB-K

No code ·········· No seal
D ········· Single-side seal
DD ······· Double-side seal

Accuracy grade
S····· High precision grade
SP ·· Super precision grade

Plastic retainer

A-Ⅲ-1.5 Lubrication and Friction

(1) Grease lubrication

① Supply in initial stage

At time of delivery, the linear rolling bushing has a coat of rust preventive agent. Wipe it off with clean kerosene or organic solvent. Dry with an air blower, etc., then apply grease.

Lithium soap based greases with consistency level of 2 are generally used (e.g. NSK Grease No. 1, No. 2, Albania No. 2).

② Replenishment

- Sealed linear rolling bushing is designed to be a disposal item. Therefore, a replenishing grease is considered to be not required. However, if replenishment becomes necessary due to dirty environment or wear of the seal, remove the linear bushing from the shaft and replenish lubricant in the same manner as the initial lubricating.
- For items without seal, wipe off old grease from the linear shaft, and apply new grease.
- Intervals of replenishments is every 100 km in an dirty environment, 500 km in a slightly dirty environment, 1,000 km or no replenishing for a normal environment.

(2) Oil lubricantion

It is not necessary to wash off the rust preventive agent applied before delivery.

Use an oil of ISO viscosity grade VG15-100. Drip the oil on the linear shaft by an oil supply system.

Temperature to use

−30 °C to 50 °C	Viscosity VG15 - 46
50 °C to 80 °C	Viscosity VG46 - 100

Lubricant is removed by the seal if the linear ball bearing has a seal. Therefore, the drip method cannot be used except for single-seal types.

(3) Friction coefficient

The linear rolling bushing has a small dynamic friction coefficient. This contributes to low power loss and temperature rise.

Fig. Ⅲ-4•1 indicates dynamic friction coefficient is merely 0.001-0.004. Also, at the speed of under 60 m/min, there is no danger for the temperature rise.

Friction force can be obtained by the following formula.

$$F = \mu \cdot P \quad \cdots\cdots\cdots\cdots\cdots\cdots \quad (1)$$

In this formula:

F : Friction force (N)

P : Load (vertical load to the shaft center line) (N)

μ : Friction coefficient (dynamic or static)

For a seal type, a seal resistance of 0.3 ~ 2.40N is added to the above.

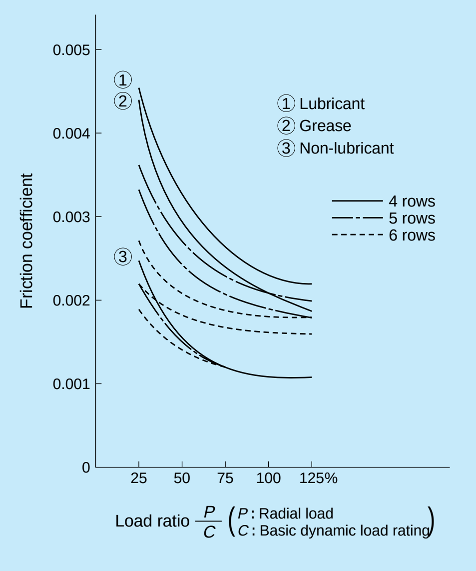


Fig. Ⅲ-1•4 Dynamic friction coefficient of linear rolling bushing

A-Ⅲ-1•6 Range of Conditions to Use

Generally, use under the following conditions.

Please consult NSK when values below exceed these ranges.

Temperature ···· Minus 30 °C to plus 80 °C
Speed ·········· Up to 120 m/min
(excluding oscillation and short strokes)

A-Ⅲ-1•7 Preload and Rigidity

The linear rolling bushing is normally used without applying preload. If high positioning accuracy is required, set the clearance between the linear rolling bush and the shaft at the range of 0 ~ 5 μ m. Slight preload is a general rule (1% of basic dynamic load rating *C* -- see the dimension table).

The dimension table shows theoretical rigidity *K* when clearance with the shaft is zero, and a load of 0.1C is applied to the summit of the ball.

Rigidity K_N, when load is not 0.1C, is obtained by the following formula.

$$K_N = K\,(P/0.1C)^{1/3} \quad (2)$$

In this formula:

K : Rigidity value in the dimension table (N/μ m)
P : Radial load (N)

When the load is applied between the ball raws, the load becomes 1.122 times for 4 ball rows; 0.959 times for 5 ball rows; 0.98 times for 6 ball rows.

A-Ⅲ-1.8 Basic Load Rating and Rated Life

(1) Basic dynamic load rating

Basic dynamic load rating C is: A radial load which allows 90% of a group of linear rolling bush to run a distance of 50 km without suffering damage when they are moved individually.

There is a relationship as below between C and the life

$$L = 50\,f_L^3 \quad (3)$$

$$f_L = C/P \quad (4)$$

In this formula:

L : Rated life (km)
P : Radial load (kgf)
f_L : Life factor (Refer to Fig. Ⅲ-1•5)

This formula is used provided that the shaft rigidity is HRC58 or higher. Rated life is shorter if the shaft is softer. In this case, find the hardness factor f_H from Fig. Ⅲ-1•6, and multiply the value.

$$f_L = C \cdot H/P \quad (5)$$

Or

$$C = P \cdot f_L/f_H \quad (6)$$

Life in time can be obtained by the following formula, substituting for given stroke length, cycle numbers, and running distance:

$$L_h = (L/1.2 \cdot S \cdot n) \times 10^4 \quad (7)$$

In this formula:

L_h : Life hours (h)
L : Rated life (km)
S : Stroke (mm)
n : Cycles per minute (cpm)

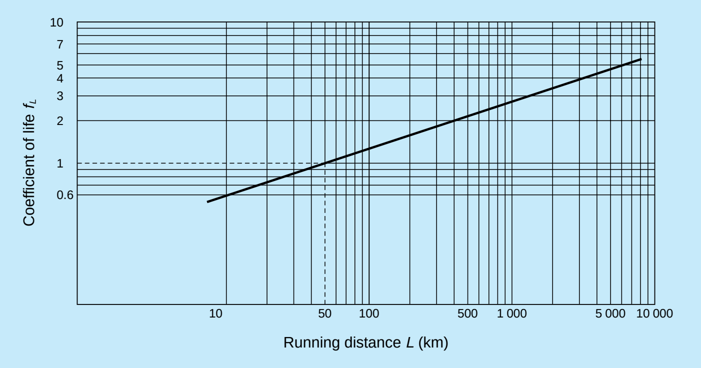


Fig. Ⅲ-1•5 Relationship between life factor and running distance

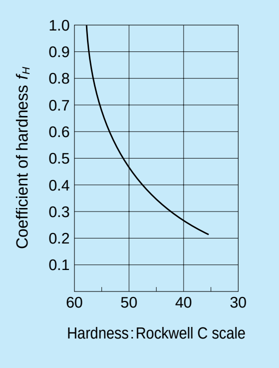


Fig. Ⅲ-1•6 Hardness factor

(2) Basic static load rating

It is a load that the total permanent deformation of outer sleeve, ball and shaft, at the contact point, becomes 0.01% of the ball diameter when this load is applied to the rolling bushing. It is understood in general that this is the applicable load limit which causes this much permanent deformation, nevertheless not hampering operation.

(3) Calculation example

What is the appropriate rolling bushing size if required life is 5,000 hours?

Conditions are:

- Three linear rolling bushings are installed in two parallel shafts, and support a reciprocating table.
- Load 450N is equally distributed to the three bushings.
- The table is required to reciprocate on the shafts at 200 times per minute, at a stroke of 70 mm.
- Hardness of the shaft: HRC 55

$$450/3=150 \text{ (N)}$$

- Load per linear rolling bushing is:

From Formula (7), the required life, when indicated in distance, is:

$$L=5 \times 10^3 \times 1.2 \times 70 \times 200/10^4=8.4 \times 10^3 \text{ (km)}$$

From Fig. 5 and Fig. 6,

Life factor $f_L = 5.6$

Hardness factor $f_H = 0.65$

Therefore, from Formula (6),

$$C=P \times f_L / f_H$$

$$=150 \times 5.6/0.65=1292 \text{(N)}$$

Based on the above, select linear rolling bushing LB30NY with shaft diameter of 30 mm, basic dynamic load rating of 1400 N.

(4) Compensating load rating by ball raw (circuit) position

Load rating of the linear rolling bushing changes by the position of the ball circuit rows.

Permissible load is larger when it is applied to the middle of the ball circuit rows than when it is applied directly above the ball row (Fig. Ⅲ-1•7).

(Radial clearance set at zero in this case.)

Load ratings in the dimension table are in case "A" when it is applied directly above the ball circuit row. If used as in case "B," the load rating becomes larger (Refer to Fig. Ⅲ-1•7).

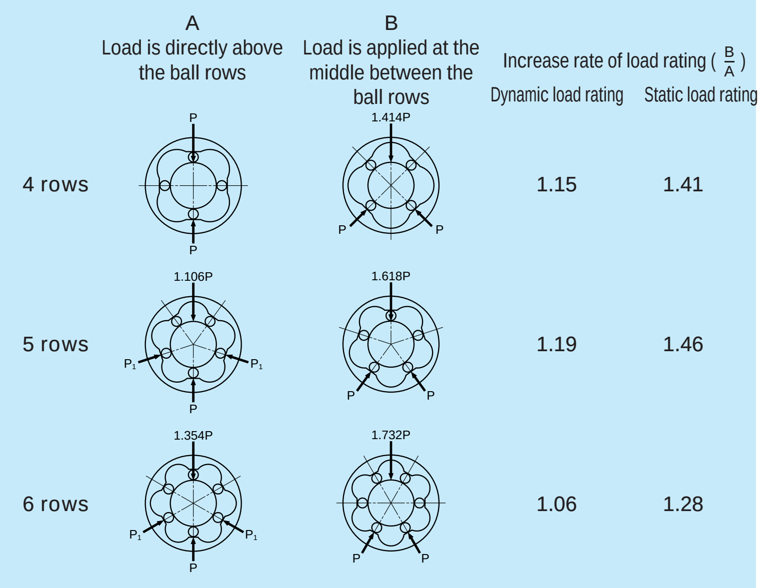


Fig. Ⅲ-1.7 Increasing rate of load rating by position of ball row (B/A)

A-Ⅲ-1.9 Shaft Specification

Harden the shaft surface, where the balls run, with heat treatment to provide the following values.

- Surface hardness ···················· HRC58 or over
- Depth of core hardness at HRC50 or higher
  Depth for LB3 ; 0.3 mm or deeper
  Depth for LB50 ; 1.2 mm or deeper

Roughness of the surface should be:

- For SP grade, and "the clearance for fit" with the ball bushing less than 5μm -
  Less than 0.8S
- For SP grade with "the clearance" of more than 5μm, and for S grade -
  Less than 1.2S

Bending should be:

- LB3 -- 15μm/100 mm
- LB50 -- 100μm/1000 mm

An appropriate clearance for normal use conditions can be obtained when the tolerance in shaft diameter remains within the recommended range (refer to Table Ⅲ-1•1 in Page A186). For operations which require particular accuracy, select the shaft diameter which creates a clearance in the range of 0 ~ 0.005 (mm) for example, when assembled with the rolling bushing.

A-Ⅲ-1.10 Dust Proof

Select a linear rolling bushing with seals to prevent moisture or foreign matters, which are floating in the air, from entering.

A-Ⅲ-1.11 Installation

(1) Combination of shaft and linear rolling bushing

When the linear rolling bushing is installed in a linear motion table for its reciprocating movement, it is necessary to prevent the table from rotating.

In general, for this reason, two shafts, installed with two linear rolling bushings on each, are used.

Fig. Ⅲ-1•8 is an installation example.

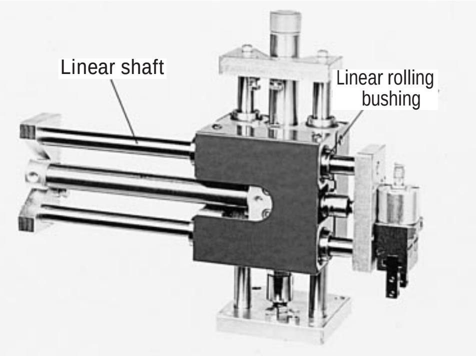


Fig. Ⅲ-1•8 Installation example

(2) Installation of linear rolling bushing

① Standard type installation

Fig. Ⅲ-1•9 shows a method using a retainer ring. Linear rolling bushing can also be secured to the housing using a stop plate and/or screw.

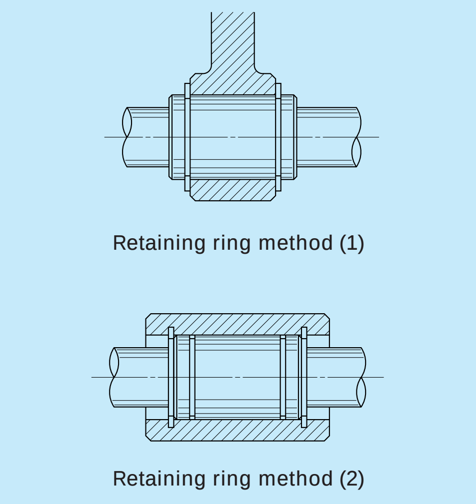


Fig. Ⅲ-1•9 Installation using retaining rings

ⓐ Housing inside diameter should be of a recommended value (Table Ⅲ-1•2, Page A186). The entire rolling bushing contracts and gives excessive preload if: the inside diameter is small ; the roundness or cylindricity is excessive. This may result in an unexpected failure.

ⓑ To install linear rolling bushing, use a tool (Fig. Ⅲ-1•10) and squeeze it in, or use a holder and lightly pound it.

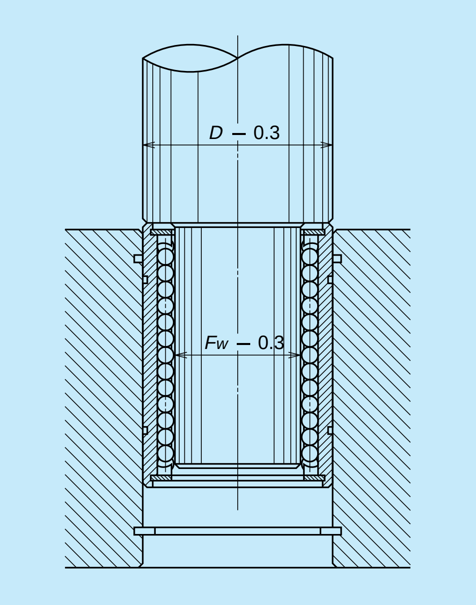


Fig. Ⅲ-1•10 Tool to install a linear rolling bushing

② Installation of adjustable clearance type

Use a housing which can adjust the inside diameter of the rolling bushing. This way, the clearance between the rolling bushing and the linear shaft can be easily adjusted. Arrange the cut-open section of the rolling bushing at a 90-degree angle to the housing's cut-open section. This is the most effective way to evenly distribute deformation toward circumferential direction.

The tolerance of shaft diameter of the adjustable clearance type should be within the recommended range (Refer to Table Ⅲ-1.1 in Page A186). As a general rule, set the preload at slight or light volume. (Do not provide excessive preload.) Use a dial gauge to measure and adjust clearance. However, here is an easy method to adjust .

First, loosen the housing until shaft turns freely. Then narrow the clearance gradually. Stop at the point when the shaft rotation becomes heavy. This creates a clearance zero or light preload.

③ Installation of open type

Use with clearance or with light preload.

Keep the tolerance in shaft diameter within the recommended range (Refer to Table Ⅲ-1.1 in Page A186), so the preload shall not become excessive.

(Unlike the adjustable clearance type, clearance cannot be narrowed by rotating the shaft because the state of shaft rotation does not indicate how narrow the space has become. Narrowing clearance requires caution for open type.)

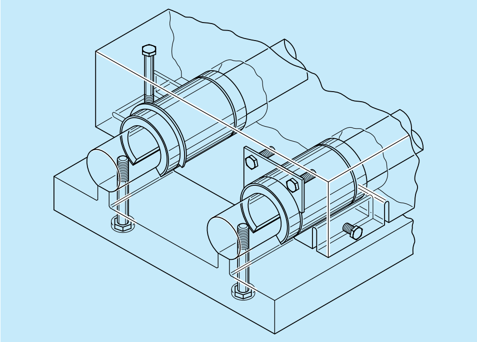


Fig. Ⅲ-1•11 Installation example of an open type

(3) Precaution for installing a shaft in the linear rolling bushing

ⓐ To install two shafts parallel to each other, first install one shaft accurately. Use this as a reference, and install the other parallel to the first shaft. This makes installation easy.

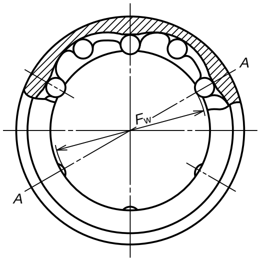
ⓑ Do not incline the shaft when inserting it into the linear rolling bushing. Do not force it to enter by twisting it. This deforms the retainer, and causes the balls to fall out.

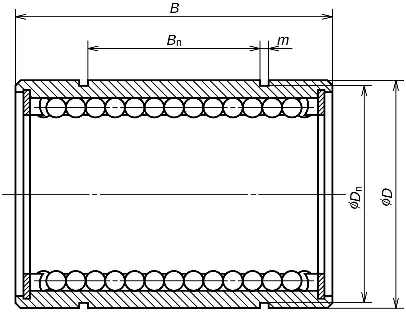
ⓒ Do not use the shaft for rotating movement after the shaft is in the linear rolling bushing. The balls slip and damage the shaft.

ⓓ Do not twist the shaft after it is in the linear rolling bushing. The pressure scars the shaft.

A-Ⅲ-1.12

Model LB (standard type), no seal





Section *A-A*

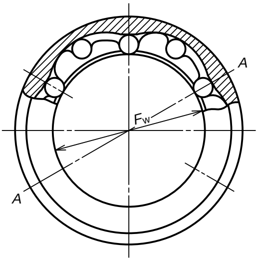
Unit: mm

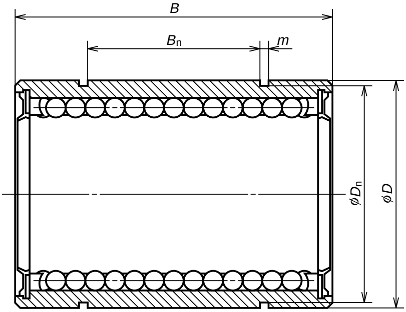
Model No.	Inscribed circle diameter F_w	Outside diameter D	Length B	Retaining ring groove Distance B_n	With m	Bottom diameter D_n	Stiffness(1) N/μm [Kgf/μm]	Number of ball circuit	Weight (kg) (Reference only)	Basic dynamic load rating C N[kgf]	Basic static load rating C_0 N[kgf]
LB3Y	3	7	10	–	–	–	3 [0.32]	4	0.0016	20 [2]	39 [4]
LB4Y	4	8	12	–	–	–	4.5 [0.47]	4	0.0022	29 [3]	59 [6]
LB6NY	6	12	19	11	1.15	11.5	7 [0.72]	4	0.0074	74 [7.5]	147 [15]
(2)LB8ANY	8	15	17	9	1.15	14.3	5.5 [0.56]	4	0.0094	78 [8]	118 [12]
LB8NY	8	15	24	15	1.15	14.3	9.5 [0.99]	4	0.014	118 [12]	226 [23]
LB10NY	10	19	29	19	1.35	18	12 [1.2]	4	0.025	206 [21]	355 [36]
LB12NY	12	21	30	20	1.35	20	13 [1.3]	4	0.028	265 [27]	500 [51]
LB13NY	13	23	32	20	1.35	22	13 [1.3]	4	0.040	294 [30]	510 [52]
LB16NY	16	28	37	23	1.65	26.6	14 [1.4]	4	0.063	440 [45]	635 [65]
LB20NY	20	32	42	27	1.65	30.3	19 [1.9]	5	0.088	610 [62]	1010 [103]
LB25NY	25	40	59	37	1.9	38	35 [3.6]	6	0.267	1000 [102]	1960 [200]
LB30NY	30	45	64	40	1.9	42.5	41 [4.2]	6	0.305	1400 [143]	2500 [255]
LB35NY	35	52	70	45	2.2	49	48 [4.9]	6	0.440	1510 [154]	2800 [286]
LB40NY	40	60	80	56	2.2	57	54 [5.5]	6	0.520	2230 [227]	4000 [410]
LB50NY	50	80	100	68	2.7	76.5	69 [7.0]	6	1.770	4100 [420]	7100 [725]

Note (1): Refer to Section Ⅲ-1•7.

(2): Semi-standard item of which length B is shorter than standard.

Model LB (standard type), with seal





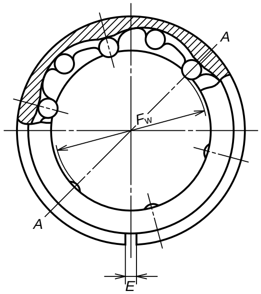
Section *A-A*

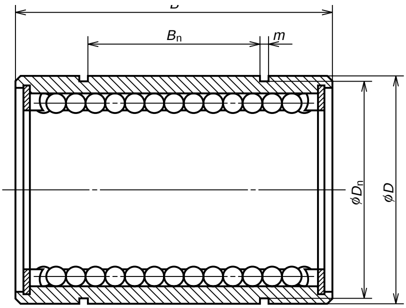
Unit: mm

(1)Model No.	Inscribed circle diameter F_w	Outside diameter D	Length B	Retaining ring groove			Number of ball circuit	Weight (kg) (Reference only)	Basic dynamic load rating C N[kgf]	Basic static load rating C_0 N[kgf]
				Distance B_n	With m	Bottom diameter D_n				
LB6NYDD	6	12	19	11	1.15	11.5	4	0.0074	74 [7.5]	147 [15]
LB8ANYDD	8	15	17	9	1.15	14.3	4	0.0094	78 [8]	118 [12]
LB8NYDD	8	15	24	15	1.15	14.3	4	0.014	118 [12]	226 [23]
LB10NYDD	10	19	29	19	1.35	18	4	0.025	206 [21]	355 [36]
LB12NYDD	12	21	30	20	1.35	20	4	0.028	265 [27]	500 [51]
LB13NYDD	13	23	32	20	1.35	22	4	0.040	294 [30]	510 [52]
LB16NYDD	16	28	37	23	1.65	26.6	4	0.063	440 [45]	635 [65]
LB20NYDD	20	32	42	27	1.65	30.3	5	0.088	610 [62]	1010 [103]
LB25NYDD	25	40	59	37	1.9	38	6	0.267	1000 [102]	1960 [200]
LB30NYDD	30	45	64	40	1.9	42.5	6	0.305	1400 [143]	2500 [255]
LB35NYDD	35	52	70	45	2.2	49	6	0.440	1510 [154]	2800 [286]
LB40NYDD	40	60	80	56	2.2	57	6	0.520	2230 [227]	4000 [410]
LB50NYDD	50	80	100	68	2.7	76.5	6	1.770	4100 [420]	7100 [725]

Note (1) Single-seal type is indicated as LB-D.

Model LB-T (Adjustable clearance type)



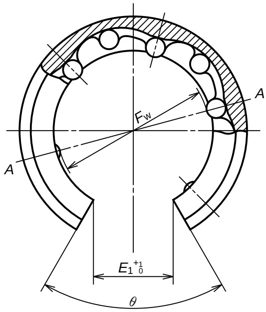


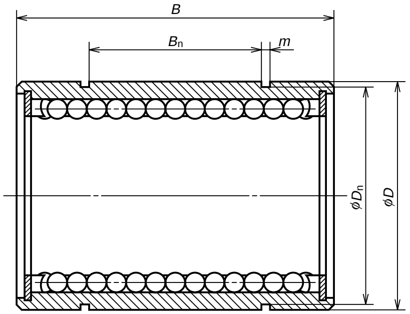
Section *A*-*A*

Unit: mm

Model No.	Inscribed circle diameter F_w	Outside diameter D	Length B	Opening width E	Retaining ring groove			Number of ball circuit	Weight (kg) (Reference only)	Basic dynamic load rating C N[kgf]	Basic static load rating C_0 N[kgf]
					Distance B_n	With m	Bottom diameter D_n				
LB6NTY	6	12	19	0.8	11	1.15	11.5	4	0.0073	74 [7.5]	147 [15]
LB8ANTY	8	15	17	1	9	1.15	14.3	4	0.0093	78 [8]	118 [12]
LB8NTY	8	15	24	1	15	1.15	14.3	4	0.014	118 [12]	226 [23]
LB10NTY	10	19	29	1.5	19	1.35	18	4	0.025	206 [21]	355 [36]
LB12NTY	12	21	30	1.5	20	1.35	20	4	0.028	265 [27]	500 [51]
LB13NTY	13	23	32	1.5	20	1.35	22	4	0.040	294 [30]	510 [52]
LB16NTY	16	28	37	1.5	23	1.65	26.6	4	0.062	440 [45]	635 [65]
LB20NTY	20	32	42	2	27	1.65	30.3	5	0.087	610 [62]	1010 [103]
LB25NTY	25	40	59	2	37	1.9	38	6	0.265	1000 [102]	1960 [200]
LB30NTY	30	45	64	2	40	1.9	42.5	6	0.302	1400 [143]	2500 [255]
LB35NTY	35	52	70	3	45	2.2	49	6	0.44	1510 [154]	2800 [286]
LB40NTY	40	60	80	3	56	2.2	57	6	0.52	2230 [227]	4000 [410]
LB50NTY	50	80	100	3	68	2.7	76.5	6	1.75	4100 [420]	7100 [725]

Model LB-K (Open type)





Section *A-A*

Unit: mm

Model No.	Inscribed circle diameter F_w	Outside diameter D	Length B	Opening width E_1	Opening angle θ	Retaining ring groove			Number of ball circuit	Weight (kg) (Reference only)	Basic dynamic load rating C N[kgf]	Basic static load rating C_0 N[kgf]
						Distance B_n	Width m	Bottom diameter D_n				
LB20NKY	20	32	42	11	60	27	1.65	30.3	4	0.072	610 [62]	1010[103]
LB25NKY	25	40	59	13	50	37	1.9	38	5	0.220	1000[102]	1960[200]
LB30NKY	30	45	64	15	50	40	1.9	42.5	5	0.260	1400[143]	2500[255]
LB35NKY	35	52	70	17	50	45	2.2	49	5	0.370	1510[154]	2800[286]
LB40NKY	40	60	80	20	50	56	2.2	57	5	0.440	2230[227]	4000[410]
LB50NKY	50	80	100	25	50	68	2.7	76.5	5	1.480	4100[420]	7100[725]

A-Ⅲ-2 Crossed Roller Guide

A-Ⅲ-2.1 Structure

Rollers with a retainer (hereinafter refer to as "retainer") are assembled in a pair of rails which have a V-shape groove. (the grooves form a 90-degree angle. Refer to Fig. Ⅲ-2•1, Ⅲ-2•2). Rollers are placed crisscrossed, and are able to support load in all directions, including moment loads.

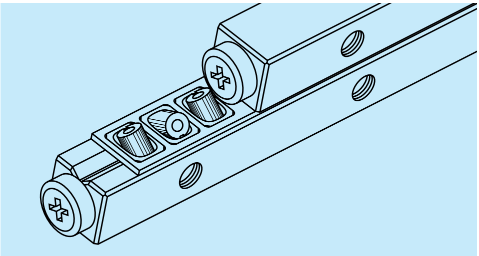


Fig. Ⅲ-2•1 Structure of crossed roller guide

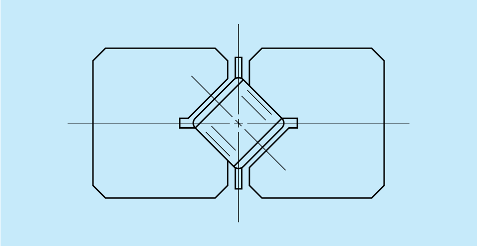


Fig. Ⅲ-2•2 Cross section of a crossed roller guide

A-Ⅲ-2.2 Features

(1) High rigidity

This is attributable to the long contact area between the rollers and their accurately ground rolling surface.

(2) Superbly smooth movement, low noise

The window which directly embraces the roller is made of plastic for smooth and quiet operation, lowering clatter when the retainer and the rollers come into contact.

(3) Less micro-slip

Occasionally, a minute continuous slippage of the retainer to one one direction, called "micro-slip," is caused due to installation error of the rail. After years of testing and research, NSK has developed technology to minimize this.

(4) Easy installation

Installation is easy because the rail bending is minimal, and the bolt hole pitch for installation is precise.

(5) Long durability

The material is vacuum-degassed and highly pure, and is hardened by carburized heat treatment for superb resistance to wear and fatigue.

A-Ⅲ-2.3 Accuracy

Accuracy grade P5 (super precision and high precision grade P6 are available.
Fig. Ⅲ-2•3 shows parallelism of the roller's rolling surface to the mounting datum face.

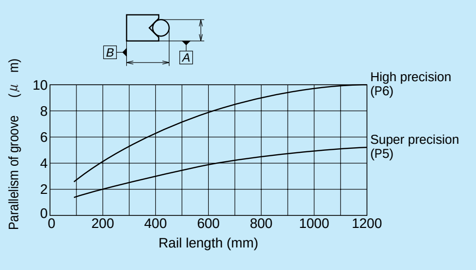


Fig. Ⅲ-2•3 Parallelism of the roller rolling surface

A-III-2.4 Rigidity

The number of the load rollers changes by the direction of the load. This is because the rollers are positioned criss-cross.
That is, in case of Fig. Ⅲ-2•4:

The number of load rollers =1/2 x total roller number
.... (1)

In case of Fig. Ⅲ-2•5:

The number of load rollers = Total roller number
.... (2)

Fig. Ⅲ-2•6 shows changes in elastic deformation when there are 20 load rollers. If the total number of rollers is other than 20, use the graph in Fig. Ⅲ-2•7. Obtain the compensation factor which converts the elastic deformation value at time of 20 load rollers into the value when a specific number of rollers are loaded. That is, obtain a compensation factor on ordinates that correspond to the number of load rollers on the abscissa. Then, multiply this factor by the elastic deformation value (on ordinates) which corresponds to the load (on abscissa) shown in Fig. Ⅲ-2•6.

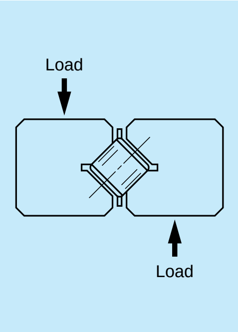


Fig. Ⅲ-2•4

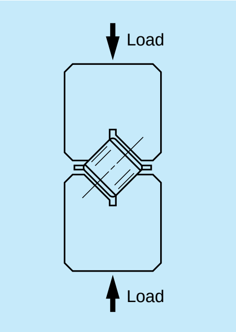


Fig. Ⅲ-2•5

[Calculation example: Elastic deformation]

A retainer which contains 30 rollers (roller diameter 6 mm) is installed on both right and left side (Fig. III-2.8). How large is the elastic deformation of the crossed roller guide when a load of 4kN is applied to the table center?

[Answer]

A load of 2kN is applied to each side of the crossed roller guide. The elastic deformation value on the ordinates which corresponds to the load 2kN on the abscissa (in Fig. Ⅲ-2•6) is:

4.5μm

This application of load is the same as in Fig. Ⅲ-2•4. Therefore, the number of load rollers is one-half of 30, or 15. From Fig. Ⅲ-2•7, the compensation factor on the ordinate which corresponds to 15 rollers on abscissa is:

1.3

Multiply 1.3 by 4.5μm obtained above. The answer is:

$4.5 \times 1.3 \fallingdotseq 6\mu m$

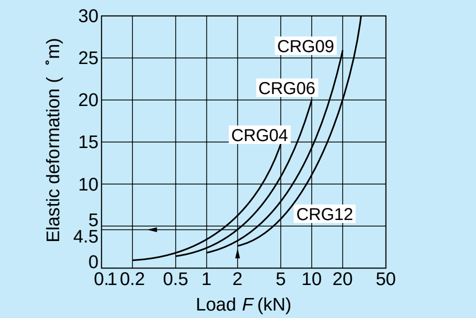


Fig. Ⅲ-2•6 Elastic deformation with 20 rollers

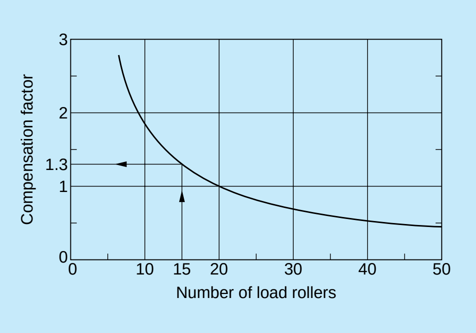


Fig. Ⅲ-2.7 Compensation factor to obtain elastic deformation

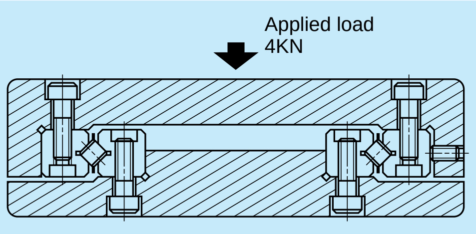


Fig. Ⅲ-2.8 Example calculation of elastic deformation (illustration)

A-Ⅲ-2.5 Friction Force

If installation and lubrication are appropriate, the starting friction coefficient is markedly small as shown below:

μ=0.005

A-Ⅲ-2.6 Lengths of Rail and Retainer

The relationship of rail length L with stroke S is as follows:

When $S \leqq 400$ mm, $L \geqq 1.5S$ ··········· (3)

When $S > 400$mm, $L \geqq S$ ·············· (4)

Since the retainer travels a distance of half of the stroke, the retainer length K is:

$K < L - \frac{S}{2}$ ································ (5)

The retainer does not detach from the rail when condition in Formula (5) is satisfied (Refer to Fig. Ⅲ-2.9).

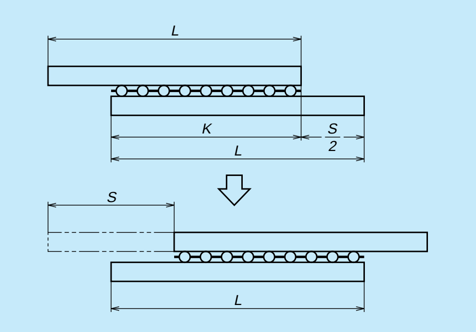


Fig. Ⅲ-2.9 Relationship of rail and retainer

A-Ⅲ-2.7 Lubrication and Dust Proof

For grease lubrication, lithium soap based greases of consistency 1 or 2 are used.

For example; NSK Grease No.1,
NSK Grease No.2,
Albania No.2 (Shell Petroleum)

For oil lubrication, JIS viscosity 32 to 150 is recommended.

When necessary, install a bellows on the rail, or install a seal on the side of the rail to arrest foreign matters and dust as shown in Fig. Ⅲ-2•10.

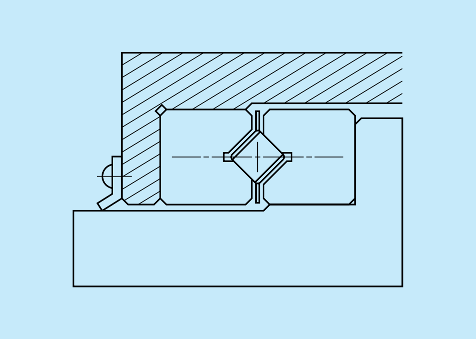


Fig. Ⅲ-2•10 Dust prevention (example)

A-Ⅲ-2.8 Installation

Fig. Ⅲ-2•11 shows the standard installation procedures.

ⓐ Secure Rail 1 and 2 to the bed using the fixing bolts. . Secure Rail 3 to the table with the bolts. Temporarily secure Rail 4 and loosen the side bolt.

ⓑ Match the bed and the table. Insert the retainer in the roller space. At this time, measure the distance from the rail end to the retainer end with a depth gauge to determine its position.
If the roller space is too narrow and the retainer does not go inside, slide Rail 4 toward the side bolt, then insert the retainer.

ⓒ Follow the reading of dial gauge which is previously set, and squeeze in all side bolts until they stop rattling. Do not apply excessive force.
When the side bolts are tightened, the rollers should be in the vicinity of the bolt position.
Then, secure Rail 4 with the fixing bolts.
Finally, install a stopper to the rail end.

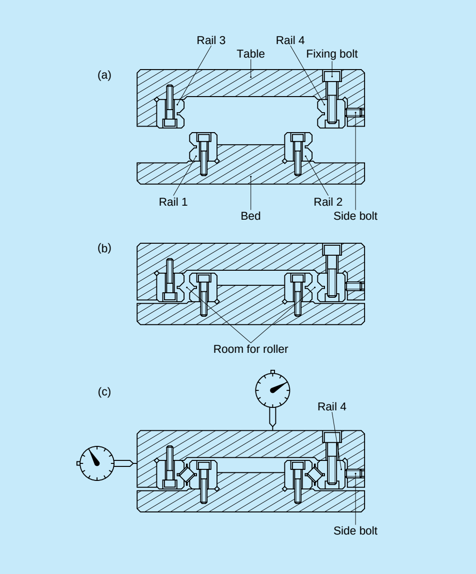


Fig. Ⅲ-2•11 Standard installation procedures

[Regarding preload]

As crossed roller guide has higher rigidity than other linear rolling guides, it does not need preload. It is also difficult to apply preload accurately. Crossed roller guide is usually used without clearance. For highly accurate applications, it is desirable to press the crossed roller guide by means of a bolt over the gib as shown in Fig. Ⅲ-2•12.

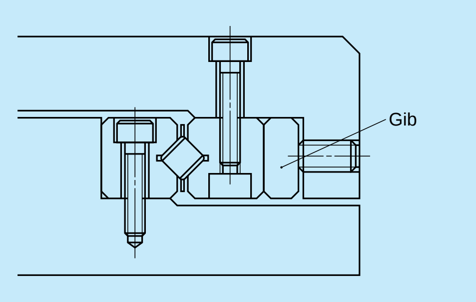


Fig. Ⅲ-2•12 Tightening using a gib

A-Ⅲ-2.9 Basic Static Load Rating

Basic static load rating becomes larger in proportion to the number of the load rollers "n." Obtain basic static load rating per roller C_{01}. Then the basic static load rating Con when the numbers of rollers is n can be obtained as follows.

$$C_{0n} = n \times C_{01} \cdots\cdots (6)$$

Values of C_{01} are shown in the dimension table.

A-Ⅲ-2.10 Basic Dynamic Load Rating and Rated Life

Basic static load rating is based on a rated traveled distance of 50 km. The dimension table shows the value with 20 load rollers. When the number of load rollers is other than 20, a basic dynamic load rating C_n can be obtained by multiplying a compensation factor (obtained from Fig. Ⅲ-2•13.) by C in the dimension table.

(Suffix 'n' is to refer the number of load rollers.)

As an example; Number of load rollers: n = 15.

The compensation factor from Fig. Ⅲ-2•13 is 0.8.

$$C_{15} = 0.8 \times C$$

Therefore, C_{15} is obtained from the following formula.

Rated life (km) is shown in the formula below.

In this formula:

$$L = 50\left(\frac{C_n}{f_w \cdot F_c}\right)^{\frac{10}{3}} \cdots\cdots (7)$$

f_w : Load factor. 1.0 ~ 1.2 under smooth operation

F_c : Computed load which applies to the guide (kN)

Please refer to NSK Linear Guide Technical Description for details.

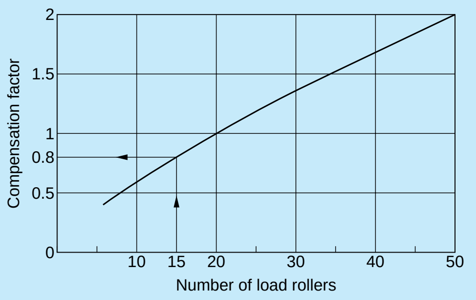


Fig. Ⅲ-2•13 Compensation factor for basic dynamic load rating

A-Ⅲ-2.11 Reference Number and Standard Set for "One-Axis"

Specifications are indicated as a reference number as shown below.

CRG06-380 A P5 N

Model number

Rail length

Shape of the rail cross section
Standard: A Semi-standard: T

Accuracy grade
P5 ·· Super precision grade
P6 ·· High precision grade

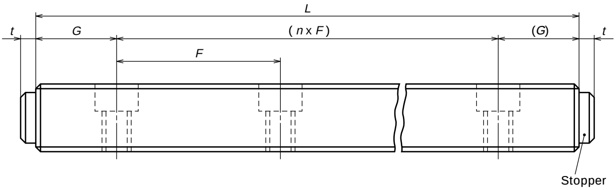
Holes for mounting
Tap hole: N
Drill hole: D

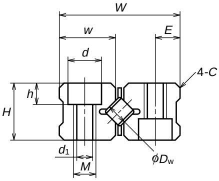
Note (1) : Semi-standard T, a shape of rail cross section, is available only for CRG04. It is lower in H dimension, and wider in W dimension compared with A.

Remarks : Standard set for "one axis" of the guide refers to 4 rails and 2 retainers which usually comprise the guide way for a one axis.

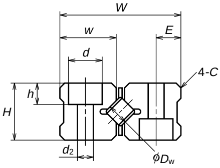
A-Ⅲ-2.12 Dimension Table

Crossed roller guide: Model CRG

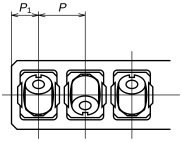




When mounting bolt hole code is N



When mounting bolt hole code is D



Unit: mm

Model No.	D_w	W	H	w	C	E	d	h	d_1	d_2	M	G	F	t	P	P_1	Dynamic load rating C when rollers are 20 N[kgf]	Static load rating C_{01} when roller is one N[kgf]	L Max length	
																			High precision P5	Saper high precision P6
CRG04…A	4	24	12	11.3	0.5	5	8	4.2	4.3	5	M 5×0.8	20	40	2.3	6.5	3.8	9800 [1000]	665 [68]	200	300
CRG04…T	4	26	10	12.3	0.5	5	8	4.2	4.3	5	M 5×0.8	12/15	38/40	2.3	6.5	3.8	9800 [1000]	665 [68]	200	300
CRG06…A	6	31	15	14.5	0.8	6	9.5	5.2	5.2	5.5	M 6×1	25	50	3.2	9.5	5.8	26700 [2720]	1510 [154	400	600
CRG09…A	9	44	22	20.7	1	9	11	6.2	6.8	7	M 8×1.25	50	100	4	14	8	72500 [7420]	3400 [347]	600	900
CRG12…A	12	58	28	27.6	1.5	12	14	8.2	8.5	9	M10×1.5	50	100	5	20	12	130000 [13300]	6050 [616]	900	1200

Remarks: The area which embraces the roller is plastic for the standard retainer. A solid type made of steel plate is available for high temperature resistance.

A-Ⅲ-3 Roller Pack

A-Ⅲ-3.1 Structure

A roller pack comprises a main body which supports load from the guide way block via two rows of rollers; an end cap which change the direction of the re-circulation of rollers at the end of the main body; a side plate which guides the rollers. (Fig. Ⅲ-3•1). Roller pack is one of linear rolling guide of which rollers are allowed to re-circulate infinitely for free from restriction of running range (stroke).

There is a plate spring attached to a side of roller pack to prevent roller pack from falling out when it is turned upside down after assembly.

Other component of the roller pack is spring pin. Spring pin is on the top surface of the roller pack, and makes installation of wedge block and fitting plate easier.

Wedge block is a unit to provide preload (Fig. Ⅲ-3•3) to roller pack; a fitting plate (Fig.Ⅲ-3•2), functioning like a pivot, adjusts misalignment of roller pack automatically. Wedge of wedge block moves up and down, to apply preload, by turning the adjust screw.

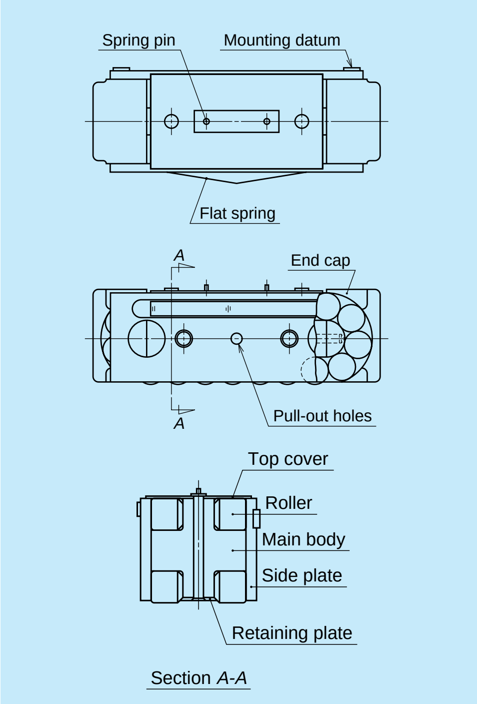


Fig. Ⅲ-3•1 Roller pack

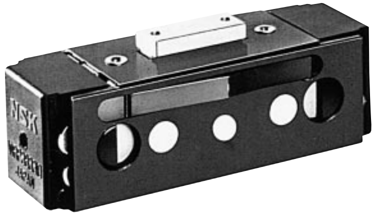


Photo 1 Roller pack

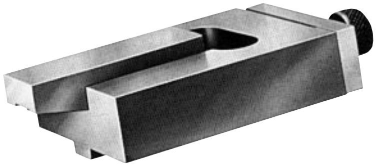


Photo 2 Wedge block

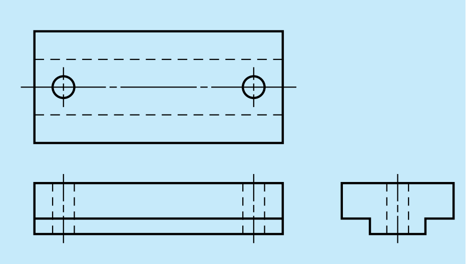


Fig. Ⅲ-3•2 Fitting plate

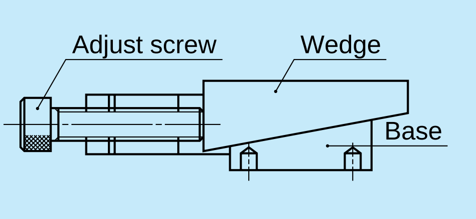


Fig. Ⅲ-3•3 Wedge block

A-Ⅲ-3.2　Features

Roller pack has two remarkable characteristics other linear roller guide bearings do not have.

① **No roller skewing**

If the roller is long relative to its diameter, the roller inclines during operation. This phenomenon is called skewing. Skewing causes problems such as sudden rise in friction force. However, a short roller lacks large load carrying capacity. The roller introduced here solved the skewing problem, yet has a large load carrying capacity:

short rollers are combined into double rows.

② **Load is applied equally.**

This is due to a "fitting plate," a result of "changed way of conceiving." Installation is quite easy: Merely place the fitting plate through the two holes to spring pins. The stop pins are inserted to holes on the top surface of the roller pack. The contact area between the fitting plate and the main body is made small. This way, the self-alignment is automatically accomplished by elastic contact of both parts.

This distributes an equal load to the rollers, far extending the life, compared to conventional roller linear guides.

Other characteristics include: Easy to provide preload by the wedge block; can be installed to vertical shaft; and reduction in noise level.

A-Ⅲ-3.3　Accuracy

The height tolerance of roller pack is 10μm. Roller packs are grouped into a size difference of every 2μm (corded by A ~ E) before delivery (Table Ⅲ-3•1).

Table Ⅲ-3•1　Height Classification

Unit: μm

Category	Code
over　or less	
+3 ~ +5	A
+1 ~ +3	B
-1 ~ +1	C
-3 ~ -1	D
-5 ~ -3	E

A-Ⅲ-3.4　Rigidity

Fig. Ⅲ-3•4 shows the relationship between load and deformation. This includes deformation caused by contact between: the rollers and main body; the rollers and guide way surface; the main body and fitting plate.

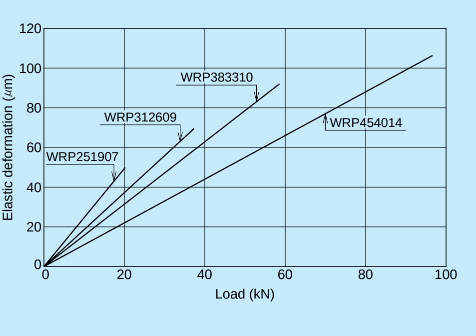


Fig. Ⅲ-3•4　Elastic deformation of the roller pack

A-Ⅲ-3•5　Preload

Fig. Ⅲ-3•5 shows conversions of tightening torque of the wedge block adjust screw into preload volume. Use a dial gauge for accurate measurement.

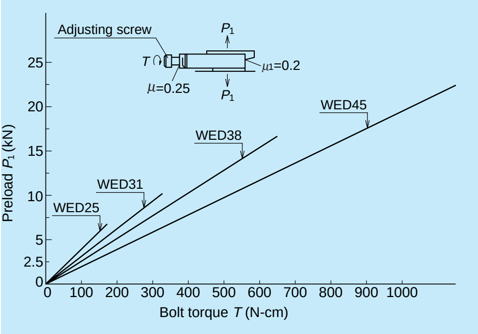


Fig. Ⅲ-3•5　Tightening torque of the adjust screw, and preload volume

A-Ⅲ-3.6 Friction and Lubrication

(1) Lubricants and volume

Mineral oils are commonly used. Since roller pack is used under a relatively heavy load, the oil should, ideally, have high viscosity and provide a strong film. Select from JIS viscosity 32-150.

Criteria of oil supply per roller pack Q (cc/h) can be calculated by the following formula.

$$Q \geqq S \times 1/4 \cdots\cdots\cdots\cdots \quad (1)$$

In this formula, S (stroke) is shown in meters. The oil volume, when the stroke is 1m, per roller pack is more than 0.25 (cc/h). It is more desirable to supply a small amount of oil at short intervals than supplying a large amount at one time. In case of grease lubrication, use a grease of consistency 2. Albania EP2 is widely used.

(2) Friction coefficient

Starting friction coefficient is significantly small at under 0.005.

(3) Seal

It is necessary to install a wiper seal to the guide way surface to prevent foreign matters (swarf from cutting, and other dust) from entering to roller pack to enjoy the full benefit of the designed life of it. The material of the seal should have strong resistance to oil and wear. Felt and synthetic rubber (acrylonitril butadiene rubber) are some of the suitable materials. Fig. Ⅲ-3•6 shows a general method to install the seals.

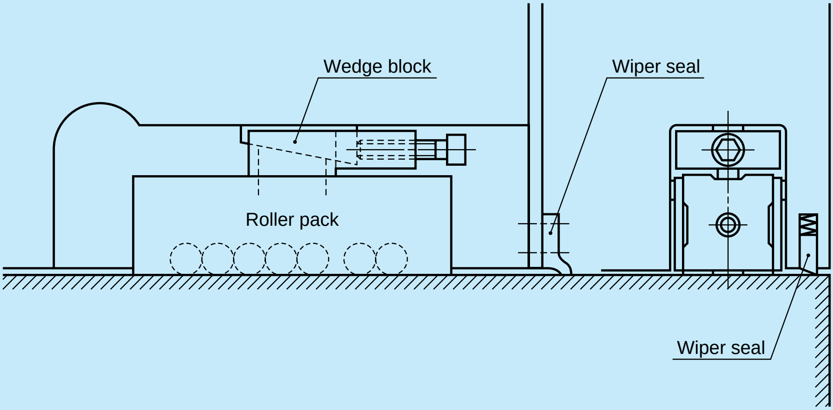


Fig. Ⅲ-3•6 Installation of seal

A-Ⅲ-3.7 Installation

(1) Installation and applying preload

As shown in Fig. Ⅲ-3•7, it is basic that a fitting plate is installed on the roller pack which receives load, and a wedge block is installed on the roller pack which receives no load, but only for preload. All components should be secured with a stop pin, facing toward the direction of movement. To cut costs for processing, it is recommended to divide the pocket (which contains roller pack) into some blocks and secure them with bolts (Fig. Ⅲ-3•7). Preload is provided by the wedge block. Estimate the actual load beforehand, so the preload shall not be lost when a load is applied. A load variation equivalent to up to two times of the preload volume can be absorbed in this case.

(Take into consideration the life in A-Ⅲ-3•8 in determining preload volume.)

(2) Accuracy of way block

The following is the ideal accuracy specification and installation accuracy of way block as a guide face.

Hardness by heat treatment

: More than HRC58 hardened depth 2 mm or more

Surface roughness

: Less than 1.6S

Parallelism as a single unit: Less than 0.010 mm per meter

Parallelism after installation

: Less than 0.020 mm per meter

Please consult NSK when using cast iron or cast steel guide face.

(3) Pocket accuracy

Accuracy of the pocket in which the roller pack is mounted should satisfy the following conditions.

Pocket width

: Roller pack width + 0.10 mm ~ 0.20 mm

Parallelism of the pocket side faces to the guide way face

: Less than 0.010 mm per 100 mm.

Parallelism of the fitting plate (pocket bottom) mounting face to the guide way face and parallelism of the wedge block mounting face to the guide way face :

: Less than 0.040 mm per 100 mm.

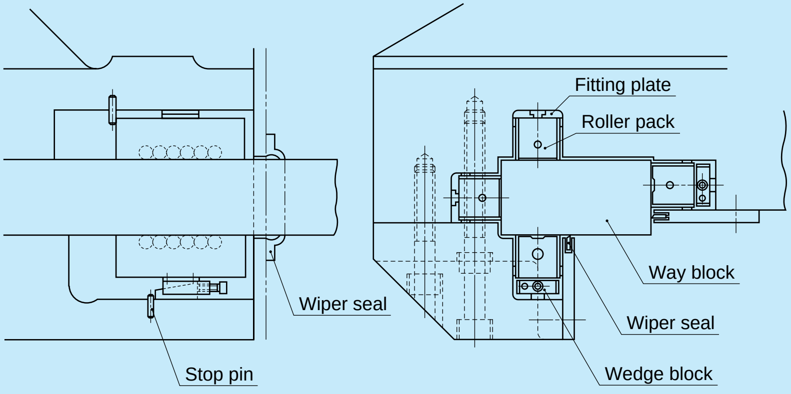


Fig. Ⅲ-3•7 Design of the roller pack pocket (example)

A-Ⅲ-3.8 Rated life

Rated life L (km) is shown in the following formula. In this formula:

$$L = 50\left(\frac{C}{f_w \cdot F_c}\right)^{\frac{10}{3}} \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (2)$$

C : Basic dynamic load rating (kN)

f_w : Load factors. 1.0-~ 1.2 at time of smooth operation

F_c : Calculated load (kN) applied to the roller pack

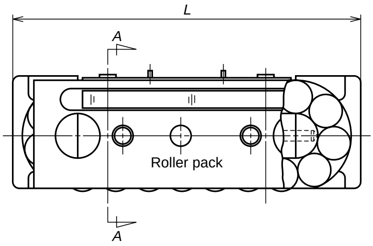
A-Ⅲ-3.9 Disassembly

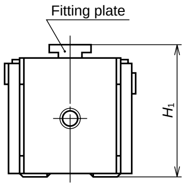
For the roller pack preloaded by the wedge block, remove it in the following manner.

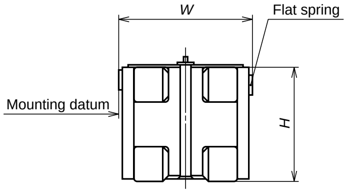
- Loosen the adjust screw of the wedge block. Lightly tap the wedge. In case of light preload, the wedge loosens, and the roller pack can be pulled out.
- When pulling, put the bolt in the tap hole at the end of the end cap, and tug the bolt.
- In case of heavy load, the roller pack could not be pulled out by the above method. Hook a tool to the pull-out hole (Fig. Ⅲ-3.1) on the side plate of the roller pack, and pull out the roller pack.

A-Ⅲ-3.10 Dimension Table

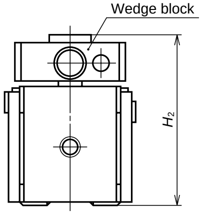
Roller pack: Model WRP







Section *A*-*A*

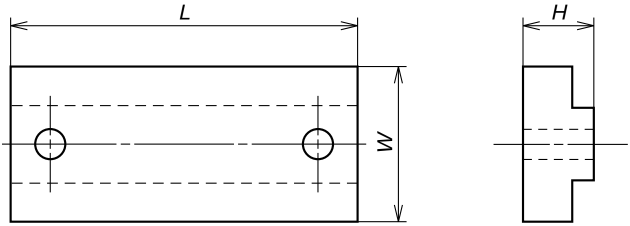


Unit: mm

Model No.	Width *W*	Height ±0.005 *H*	Length *L*	Applicable fitting plate reference No.	Assembled height H_1	Applicable wedge reference No.	Assembled height H_2	Basic dynamic load rating *C* N[kgf]	Basic static load rating C_0 N[kgf]
WRP 251907	25	19	65.5	WFT 25	24	WED 25	31 (30.4 ~ 31.6)	31000 [3190]	40500 [4160]
WRP 312609	31	26	85	WFT 31	31	WED 31	40 (39.4 ~ 40.6)	57000 [5830]	73000 [7430]
WRP 383310	38.1	33.31	104	WFT 38	38.91	WED 38	50.8 (50 ~ 51.5)	91000 [9300]	113000 [11500]
WRP 454014	45	40	138	WFT 45	45	WED 45	60 (59.2 ~ 60.8)	151000 [15350]	191000 [19500]

Remarks : Numbers in the parentheses in column H_2 show the adjustable height range of the wedge block.

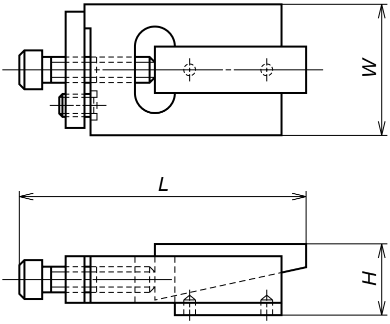
Fitting plate: Model WFT



Unit: mm

Model No.	Width *W*	Height (±0.01) *H*	Length *L*	Applicable Roller pack
WFT 25	10	5	20	WRP 251907
WFT 31	12	5	26	WRP 312609
WFT 38	12.8	5.6	29	WRP 383310
WFT 45	16	5	40	WRP 454014

Wedge block: Model WED



Unit: mm

Model No.	Width *W*	Height *H*	Length *L*	Applicable Roller pack
WED 25	23	12(11.5 ~ 12.5)	47	WRP 251907
WED 31	28	14(13.5 ~ 14.5)	63	WRP 312609
WED 38	35	17.47(16.9 ~ 18.1)	76	WRP 383310
WED 45	40	20(19.2 ~ 20.8)	95	WRP 454014

Remarks : Numbers in the parentheses in column H_2 show adjustable height range of the wedge block.

A-Ⅲ-4　Linear Roller Bearings

A-Ⅲ-4.1　Structure

Linear roller bearing comprises: A single row of rollers; the main body which supports load via rollers; the end cap which turns the roller re-circulating direction at the end of the main body from the loaded zone to the unloaded zone; a retaining wire which prevents rollers from falling out (Fig. Ⅲ-4•1). The main body, as the cylindrical roller bearing, has a rib at both sides. The rib guides the rollers to travel correctly, and assist the rollers to circulate infinitely in the bearing in a stable manner. This contributes to the bearing's linear movement without the restriction of travel range.

NSK also developed a highly functional preload pad (Photo 2) to provide a slight preload to the bearing. Basically, the preload pad comprises parallel plates and bellevile springs, which are installed between a parallel plates, and are adjusted its spring rate.

Preloaded pad can be used in a machine tool in the following manner.

When two bearings are installed with one on the top and the other under the way block (the bearings comprise a set), a preloaded pad is used at the bottom bearing. This provides an equal preload to the top and bottom bearings. This way, to a certain extent, the variation in the load and the uneven thickness of the way block can be absorbed.

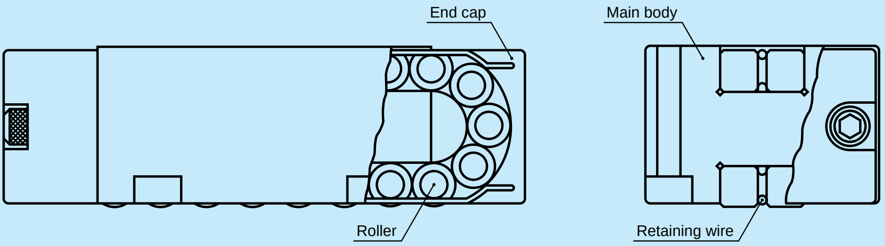


Fig. Ⅲ-4•1　Linear roller bearing

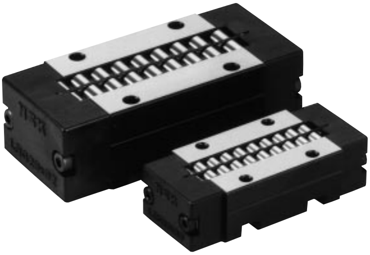


Photo 1　Linear roller bearing

Photo 2　Preload pad

A-Ⅲ-4.2 Features

In addition to the general features of a roller bearing guide such as no-stick slip, small friction resistance, and easy maintenance, the linear roller bearing has several more advantages.

(1) No trouble by roller skewing

Skewing is the inclination of the rollers during operation. It causes friction force to suddenly soar. Skewing is apt to occur when the roller is long relative to its diameter. The proportion of the length and diameter is 1:2 for the products in this series. This is superior to the commonly used 1:3 ratio.

(2) Highly reliable

Retaining the rollers without allowing them to fall out bearing is a crucial function of the linear guide bearing. The simple and highly effective retaining wire has solved such problem for this product series.

(3) Compact design

Despite the load carrying capacity, this series is smaller in size than any other models. This contributes to the application which requires compact design.

(4) High rigidity

The contact area between the bearing and the mounting surface is large to increase rigidity.

A-Ⅲ-4.3 Accuracy

The nominal height difference between bearings is 10μm. The bearings are grouped into every 2μm, and are coded before delivery (Table Ⅲ-4•1).

Table Ⅲ-4•1 Classification of height

Unit: μm

Category			Code
over		or less	
0	~	–2	A
–2	~	–4	B
–4	~	–6	C
–6	~	–8	D
–8	~	–10	E

A-Ⅲ-4.4 Rigidity

Fig. Ⅲ-4•2 shows elastic deformation.

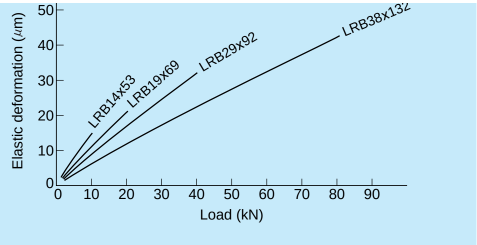


Fig. Ⅲ-4•2 Elastic deformation

A-Ⅲ-4.5 Friction and Lubrication

(1) Lubricants and volume

Mineral oils are used in general. The linear roller bearing is used under relatively heavy load. An oil which has high viscosity and creates a strong oil film is ideal for linear roller guides. Select from JIS viscosity 32-150.

General oil supply for a linear roller bearing Q (cc/h) can be calculated by the following formula.

$$Q \geqq S \times 1/4 \cdots\cdots\cdots\cdots \quad (1)$$

In this formula, S (stroke) is shown in meters. Therefore, when the stroke is 1m, the volume of lubricant per roller bearing is more than 0.25 (cc/h). It is recommended to supply a small amount of oil at short intervals rather than supplying a large amount at one time. In case of grease lubrication, a grease of consistency degree 2, such as Albania EP2, is generally used.

(2) Friction coefficient

Starting friction coefficient is significantly small at under 0.005.

(3) Seal

Install a wiper seal on the way block surface to prevent foreign matters (swarf from cutting, other dust) to realize a full life of the linear roller bearing. The material of the seal should have strong resistance against oil and wear. Felt and synthetic rubber (acrylonitril-butadien rubber) are some of the suitable materials.

A-Ⅲ-4.6 Installation

Secure the linear roller bearing using four bolts. The bearing main body has four holes for mounting.

Accuracy of way block
The ideal accuracy specification and mounting accuracy of a way block as a guide way surface are as follows.

Hardness by heat treatment
:More than HRC58 hardened depth
2 mm or more
Surface roughness
: Less than 1.6S
Parallelism as a single unit
:Less than 0.010 mm per 1 m
Parallelism after installation
:Less than 0.020 mm per 1 m

Please consult NSK when using cast iron or cast steel guide way.

A-Ⅲ-4.7 Rated life

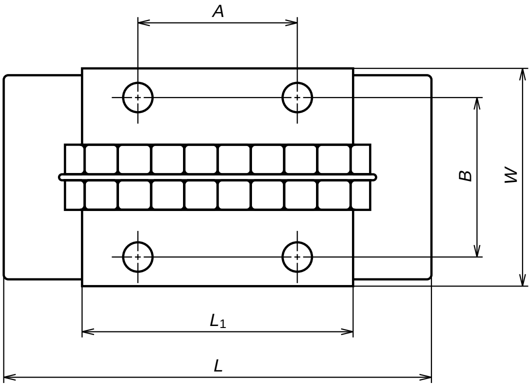
Rated life *L* (km) is shown in the following formula.
In this formula:

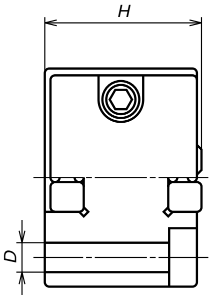
$$L = 50\left(\frac{@C\ \ @}{f_w \bullet F_c}\right)^{\frac{10}{3}} \cdots\cdots\cdots\cdots\cdots\cdots (2)$$

C: Basic dynamic load rating (kN)
f_w : Load factor. 1.0 ~ 1.2 at time of smooth operation
F_c : Calculated load applied on the bearing (kN)

A-Ⅲ-4.8 Dimension Table

Linear roller bearing Model: LRB



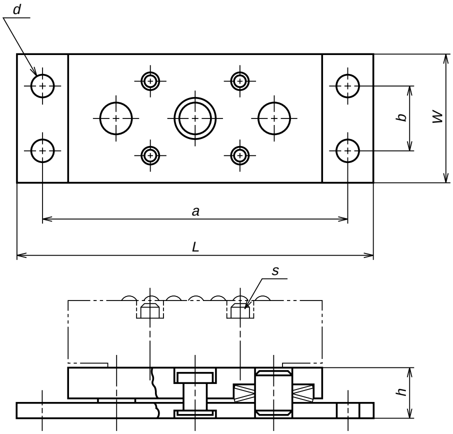


Unit: mm

Model No.	Width W	Height $H^{0}_{-0.010}$	Length L	L_1	Roller Diameter× length	Mounting bolt hole D	Bolt hole distance		Basic dynamic load rating C N[kgf]	Basic static load rating C_0 N[kgf]
							A	B		
LRB 14×53	26.5	14.29	52.8	32.8	ϕ4×8	ϕ3.4	19	19.3	15400 [1570]	21900 [2230]
LRB 19×69	30.5	19.05	68.6	44.6	ϕ5×10	ϕ3.4	25.4	23.3	27000 [2750]	39000 [3960]
LRB 29×92	41.5	28.58	92.0	59	ϕ7.5×15	ϕ4.5	38.1	32.7	57500 [5850]	76500 [7810]
LRB 38×132	51.4	38.10	132.0	88	ϕ10×20	ϕ5.5	50.8	41.5	119000 [12100]	159000 [16200]

Remarks: Bearings are grouped into heights of every 2μm before delivery.

Preload pad　Model: PRP



Unit: mm

Model No.	Applicable linear roller bearing	Height (no-load) *h* max	Compressed height *h* min	h min Load when fully compressed (N)	*W*	*L*	*d*	*a*	*b*	*s* Hex. Socket cap screw
PRP 14×53	LRB 14×53	10.23	9.53	1570	26	72	ϕ4.5	62	14	M3×16
PRP 19×69	LRB 19×69	11.53	11.10	2650	30	96	ϕ4.5	86	18	M3×19
PRP 29×92	LRB 29×92	13.13	12.70	6450	41	120	ϕ4.5	110	27	M3×25
PRP 38×132	LRB 38×132	16.28	15.88	12000	51	157	ϕ4.5	147	35	M5×38

A-Ⅲ-5 Cam Follower

A-Ⅲ-5.1 Structure and Characteristics

The outer ring of the bearing functions as a rolling ring (Fig. Ⅲ-5•1). This rolling ring is thick and tough. The rollers are crowned needle rollers, and have a large load carrying capacity. This provides high impact load resistance. The surface of the stud is core-hardened to provide durability against wear, and toughness.

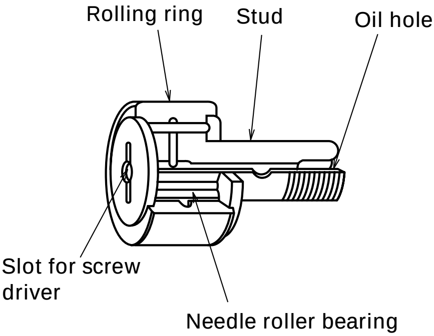


Fig. Ⅲ-5.1 Structure of Cam follower

A-Ⅲ-5.2 Types

(1) Bearing models

There are four models: With/ without a retainer and oil/grease lubricant (Table Ⅲ-5•1).

Table Ⅲ-5.1. Bearing models

Bearing model	Description
FCR	Full complement of rollers, no seal (oil is supplied later)
FCRS	Full complement of rollers, with seal (grease is sealed in)
FCJ	With retainer, no seal (oil is supplied later)
FCJS	With retainer, with seal (grease is sealed in)

(2) Appearances

Specifications of the exterior appearance include: Shape of the slot for the "screw driver" on the end of the stud; With/without an eccentric bush to be secured to the stud; Oil hole; Shape of outer surface of the rolling ring.

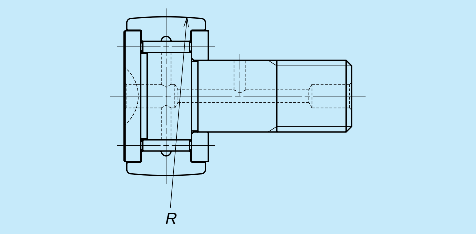


Fig. Ⅲ-5•2 Cam follower with sphere shaped outer surface

Table Ⅲ-5•2 Exterior appearances

Deference in appearance	Code for appearance	Description
Screw driver slot at the end of stud	(no code)	Hole for Philip's screwdriver
	B	Hole for hexagonal socket screw keys
Eccentric bush to be secured to the stud	(no code)	No eccentric bush
	E	With eccentric bush
Oil hole	(no code)	Simple round hole
	P	Pipe tap for oil hole
Rolling ring outer surface	(no code)	Cylindrical shaped outer surface
	R	Sphere shape: Sphere radius 500 m (Fig. Ⅲ-5•2)

(3) Accessories

A blind plug comes with order. Nut, spring washer, and grease fitting are available on request. Table Ⅲ-5•3 shows accessory codes.

Table Ⅲ-5•3 Accessory codes

	Nut	Spring washer	Grease nipple
Code	I	N	Z

(4) Special products

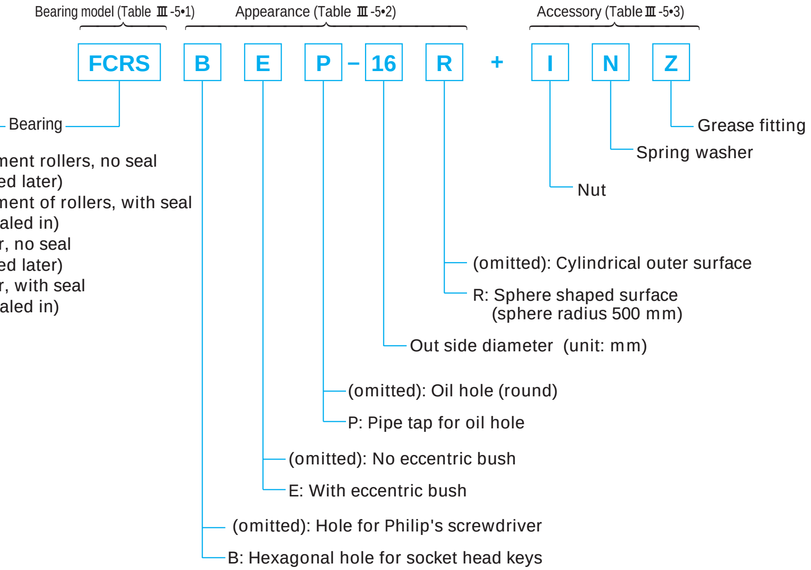
Please consult NSK for the following items manufactured by NSK.

- Items in inch sizes
- Items with black film coating on exposed surface.
- Items in special shape.

A-Ⅲ-5.3 Reference Number for Ordering

Codes for (1) Bearing models, (2) Appearances, (3) Accessories constitute a reference number to be used in ordering. If accessory is not required, omit codes after the "+" sign.

Reference number composition



FCR : Full complement rollers, no seal
(oil is supplied later)
FCRS : Full complement of rollers, with seal
(grease is sealed in)
FCJ : With retainer, no seal
(oil is supplied later)
FCJS : With retainer, with seal
(grease is sealed in)

(Example) FCJSP-16RZ: With retainer and seal (grease is sealed in); Pipe tap for oil hole; Outer diameter 16 mm, its face forms an arc; With grease nipple

FCRS-16-N: Full complement of rollers; With a hole for screwdriver; With eccentric bush; Outer diameter 16 mm; With spring washer

A-Ⅲ-5.4 Accuracy

Table Ⅲ-5.4 shows the dimensional tolerances of cam follower.

Running accuracy grade is the same as JIS 0 Grade.

Table Ⅲ-5•4 Dimensional tolerance of cam follower

Unit: μm

Model code	Tolerance of stud diameter Δdmp Fit tolerance grade	Variation of single plane mean outside diameter ΔDmp				Variation of outer ring width ΔCs	
		Cylindrical outer surface		Sphere-shaped outer surface			
		Upper	Lower	Upper	Lower	Upper	Lower
FCR, FCRS **FCJ, FCJS**	h7	Same as JIS 0 Grade		0	–50	Same as JIS 0 Grade	

A-Ⅲ-5.5 Permissible Load

(1) Permissible load of cam follower

Maximum radial load the cam follower can support is determined by the stud strength to bending or shearing force. Maximum values are shown in the dimension table.

(2) Permissible load of the rail track

Permissible load of the rail track where the bearing ring rolls are determined by the surface hardness, roughness, and state of lubrication of the rail surface. Table Ⅲ-3.5 shows load factors that correspond to the hardness of the track surface when the surface of the track is lubricated. Multiply the track's permissible load value shown in the dimension table by the coefficient that corresponds to the hardness. Hardness of HRC40 is the standard for these values.

Table Ⅲ-5.5 Permissible load factor of the track

Hardness (HRC)	Load factor
20	0.4
25	0.5
30	0.6
35	0.8
40 (Standard)	1.0
45	1.4
50	1.9
55	2.6
58	3.2

A-Ⅲ-5.6 Lubrication

A lithium soap based grease is sealed inside the cam follower which has seals. The range of temperature to use this grease is -10 to 110 °C. (Cam follower without seal uses oil lubrication, and does not have grease inside.)
Keep the lubricated track surface free of foreign mattersa.

A-Ⅲ-5.7 Permissible Rotational Speed

Cam followers with seal are suitable for high rotational operation. Table Ⅲ-5•6 shows their permissible rotational speed. Permissible rotational speed of full complement roller bearings are 1/3 of those with retainer. For grease lubrication, permissible rotational speed is 60% of the values shown in the Table.

Table Ⅲ-5•6 Permissible rotational speed of the bearing with retainer

Reference No.	Permissible rotational speed (rpm)
FCJB-10	34000
FCJ-12	26000
FCJ-16	16000
FCJ-19	12000
FCJ-22	10000
FCJ-26	10000
FCJ-30	7500
FCJ-32	7500
FCJ-35	6000
FCJ-40	5300
FCJ-47	4800
FCJ-52	4800
FCJ-62	3800
FCJ-72	3800
FCJ-80	3000
FCJ-85	3000
FCJ-90	3000

A-Ⅲ-5.8 Precautions for Installation

(1) Fits

The stud of cam follower is held on one side fixed. Fit between the stud and the bore where the stud enters must be in close tolerance.

Table Ⅲ-5•7 shows a recommended fit value.

The chamfer of the bore where the stud enters should be as small as possible, and the surface should be free of burrs.

When the fit is to be interference, press the stud into the hole, pushing the center of the end face.

To make the support face sufficiently large for the side plate, the surface diameter of the support end should be larger than *F* shown in the dimension table.

(2) Maximum tightening torque of the stud

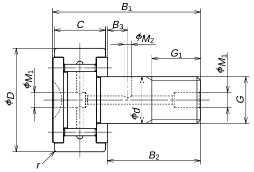
Stud receives bending and tensile stress from the load to the bearing. Therefore, a screw tightening torque must not exceed values in the dimension table. (These values are when oil is applied to the screw section. Double the value when dry.)

Table Ⅲ-5.7 Recommended fitt for stud installation

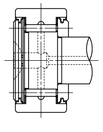
Model code	Fit tolerance, class and grade of installation hole
FCR, FCJ, FCRS, FCJS	JS7(J7)

Cam follower

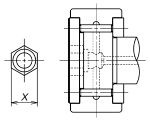
FCR : **Full complement of rollers**
FCRS : **Full complement of rollers, with seal and thrust washer**
FCJ : **With retainer**
FCJS : **With retainer, seal, and thrust washer**



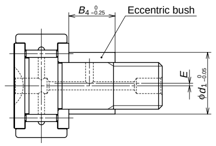
FCR



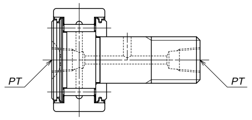
FCRS



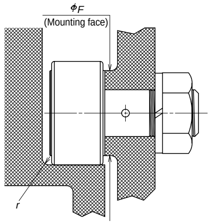
FCRB



FCRE



FCRSP



Unit: mm

Model No.		Main dimension			Detail dimension								Basic dynamic load ratiing C_r		Permissible maximum load Pmax		Permissible track load		Weight (kg)	Hexagon socket hole (width across flat)	Eccentric bush			Tap hole for lubrication pipe	Diameter, supporting surface	Thread tightening torque(4)	
FCR FCJ	FCRS FCJS	D	C	d	Thread G	G_1	B_1	B_2	B_3	M_2	M_1	$Y_{(2)}$ (Min.)	(N)	{kgf}	(N)	{kgf}	(N)	{kgf}	(Reference only)	x	B_4	d_1	E	P_T	F (Min.)	{N·cm} (Max.)	{kgf·cm} (Min.)
FCJB-10	—	**10**	7	3	M3×0.5	5	17	9	—	—	—	0.3	1390	142	590	60	1320	135	0.005	2.5	—	—	—	—	7.5	28	2.9
FCJ-12	—	**12**	8	4	M4×0.7	6	20	11	—	—	—	0.3	1970	201	1050	107	1860	190	0.008	—	—	—	—	—	9	64	6.5
FCJB-12	—		8	4	M4×0.7	6	20	11	—	—	—	0.3	1970	201	1050	107	1860	190	0.008	2.5	—	—	—	—	9	64	6.5
FCR-16	**FCRS-16**	**16**	11	6	M6×1.0	8	28	16	—	—	4(1)	0.3	5800	590	2360	240	3350	340	0.020	4	8	9	0.5	M6×0.75(3)	11	226	23
FCJ-16	**FCJS-16**		11	6	M6×1.0	8	28	16	—	—	4(1)	0.3	2830	288	2360	240	3350	340	0.018	4	8	9	0.5	M6×0.75(3)	11	226	23
FCR-19	**FCRS-19**	**19**	11	8	M8×1.25	10	32	20	—	—	4(1)	0.3	6600	670	4200	425	4150	425	0.031	4	10	11	0.5	M6×0.75(3)	13	550	56
FCJ-19	**FCJS-19**		11	8	M8×1.25	10	32	20	—	—	4(1)	0.3	3450	355	4200	425	4150	425	0.030	4	10	11	0.5	M6×0.75(3)	13	550	56
FCR-22	**FCRS-22**	**22**	12	10	M10×1.25	12	36	23	—	—	4(1)	0.3	8550	875	6550	665	5300	540	0.047	5	11	13	0.5	M6×0.75(3)	15	1060	108
FCJ-22	**FCJS-22**		12	10	M10×1.25	12	36	23	—	—	4(1)	0.3	4350	445	6550	665	5300	540	0.045	5	11	13	0.5	M6×0.75(3)	15	1060	108
FCR-26	**FCRS-26**	**26**	12	10	M10×1.25	12	36	23	—	—	4(1)	0.3	8550	875	6550	665	6000	610	0.060	5	11	13	0.5	M6×0.75(3)	15	1060	108
FCJ-26	**FCJS-26**		12	10	M10×1.25	12	36	23	—	—	4(1)	0.3	4350	445	6550	665	6000	610	0.058	5	11	13	0.5	M6×0.75(3)	15	1060	108
FCR-30	**FCRS-30**	**30**	14	12	M12×1.5	13	40	25	6	3	6	0.6	12500	1280	9250	945	7800	795	0.088	6	12	17	1	M6×0.75(3)	20	1450	148
FCJ-30	**FCJS-30**		14	12	M12×1.5	13	40	25	6	3	6	0.6	7200	735	9250	945	7800	795	0.086	6	12	17	1	M6×0.75(3)	20	1450	148
FCR-32	**FCRS-32**	**32**	14	12	M12×1.5	13	40	25	6	3	6	0.6	12500	1280	9250	945	8050	820	0.099	6	12	17	1	M6×0.75(3)	20	1450	148
FCJ-32	**FCJS-32**		14	12	M12×1.5	13	40	25	6	3	6	0.6	7200	735	9250	945	8050	820	0.096	6	12	17	1	M6×0.75(3)	20	1450	148
FCR-35	**FCRS-35**	**35**	18	16	M16×1.5	17	52	32.5	8	3	6	0.6	18600	1900	17000	1740	11800	1200	0.17	10	15.5	22	1	RC 1/8	24	4000	410
FCJ-35	**FCJS-35**		18	16	M16×1.5	17	52	32.5	8	3	6	0.6	9700	990	17000	1740	11800	1200	0.165	10	15.5	22	1	RC 1/8	24	4000	410
FCR-40	**FCRS-40**	**40**	20	18	M18×1.5	19	58	36.5	8	3	6	1	20500	2090	21700	2220	14300	1460	0.25	10	17.5	24	1	RC 1/8	26	5950	605
FCJ-40	**FCJS-40**		20	18	M18×1.5	19	58	36.5	8	3	6	1	10300	1050	21700	2220	14300	1460	0.24	10	17.5	24	1	RC 1/8	26	5950	605
FCR-47	**FCRS-47**	**47**	24	20	M20×1.5	21	66	40.5	9	4	8	1	28200	2880	26400	2690	20800	2120	0.39	12	19.5	27	1	RC 1/8	31	8450	860
FCJ-47	**FCJS-47**		24	20	M20×1.5	21	66	40.5	9	4	8	1	19200	1950	26400	2690	20800	2120	0.38	12	19.5	27	1	RC 1/8	31	8450	860
FCR-52	**FCRS-52**	**52**	24	20	M20×1.5	21	66	40.5	9	4	8	1	28200	2880	26400	2690	22900	2340	0.47	12	19.5	27	1	RC 1/8	31	8450	860
FCJ-52	**FCJS-52**		24	20	M20×1.5	21	66	40.5	9	4	8	1	19200	1950	26400	2690	22900	2340	0.455	12	19.5	27	1	RC 1/8	31	8450	860
FCR-62	**FCRS-62**	**62**	29	24	M24×1.5	25	80	49.5	11	4	8	1	40000	4100	38500	3950	34000	3450	0.80	14	24.5	34	1	RC 1/8	45	15200	1550
FCJ-62	**FCJS-62**		29	24	M24×1.5	25	80	49.5	11	4	8	1	24900	2540	38500	3950	34000	3450	0.79	14	24.5	34	1	RC 1/8	45	15200	1550
FCR-72	**FCRS-72**	**72**	29	24	M24×1.5	25	80	49.5	11	4	8	1	40000	4100	38500	3950	38000	3860	1.05	14	24.5	34	1	RC 1/8	45	15200	1550
FCJ-72	**FCJS-72**		29	24	M24×1.5	25	80	49.5	11	4	8	1	24900	2540	38500	3950	38000	3860	1.05	14	24.5	34	1	RC 1/8	45	15200	1550
FCR-80	**FCRS-80**	**80**	35	30	M30×1.5	32	100	63	15	4	8	1	60500	6200	61000	6200	52000	5300	1.55	17	31	40	1.5	RC 1/8	52	30500	3120
FCJ-80	**FCJS-80**		35	30	M30×1.5	32	100	63	15	4	8	1	39000	4000	61000	6200	52000	5300	1.55	17	31	40	1.5	RC 1/8	52	30500	3120
FCR-85	**FCRS-85**	**85**	35	30	M30×1.5	32	100	63	15	4	8	1	60500	6200	61000	6200	55500	5650	1.75	17	31	40	1.5	RC 1/8	52	30500	3120
FCJ-85	**FCJS-85**		35	30	M30×1.5	32	100	63	15	4	8	1	39000	4000	61000	6200	55500	5650	1.75	17	31	40	1.5	RC 1/8	52	30500	3120
FCR-90	**FCRS-90**	**90**	35	30	M30×1.5	32	100	63	15	4	8	1	60500	6200	61000	6200	59000	6000	1.95	17	31	40	1.5	RC 1/8	52	30500	3120
FCJ-90	**FCJS-90**		35	30	M30×1.5	32	100	63	15	4	8	1	39000	4000	61000	6200	59000	6000	1.95	17	31	40	1.5	RC 1/8	52	30500	3120

Note (1) Oil hole is only on the front face of the head.
(2) Use a value larger than γ (minimum).
(3) Pipe tap screw for oil supply is only on the front face of the head.
(4) Values are when oil is applied to the screw section. Double (approx.) the value when dry.

Remarks : Grease is sealed in for the cam follower with seals. Cam follower without seal does not have grease.

A-Ⅲ-6 Roller Follower

A-Ⅲ-6.1 Structure and Characteristics

The outer ring of the bearing functions as a rolling ring (Fig. Ⅲ-6•1). This rolling ring is thick and tough. The rollers are crowned needle rollers, and have a large load carrying capacity. This provides high impact resistance.

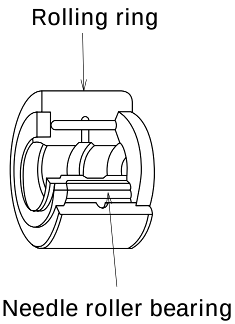


Fig. Ⅲ-6•1 Structure of Roller Follower

A-Ⅲ-6.2 Types

(1) Bearing models

There are four models: With/ without a retainer and oil/grease lubricant (Table Ⅲ-6•1).

Table Ⅲ-6•1 Bearing models

Bearing model	Description
FYCR	Full complement of rollers, no seal (oil is supplied later)
FYCRS	Full complement of rollers, with seal (grease is sealed in)
FYCJ	With retainer, no seal (oil is supplied later)
FYCJS	With retainer, with seal (grease is sealed in)

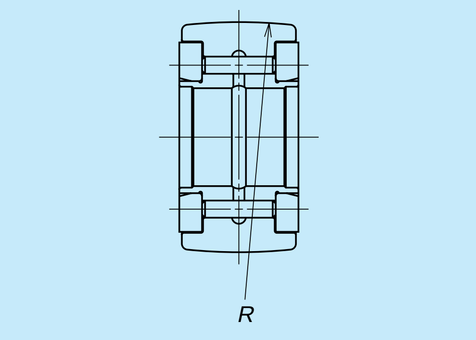


Fig. Ⅲ-6•2 Sphere shaped rolling ring

(2) Exterior appearances

There are two types as shown in Table Ⅲ-6•2.

Table Ⅲ-6•2 Types of exterior appearance

Code for appearance	Description
(no code)	Cylindrical shaped outer surface
R	Sphere shaped: Outer surface forms a part of sphere with arc of radius 500 mm. (Fig. Ⅲ-6•2)

(3) Special products

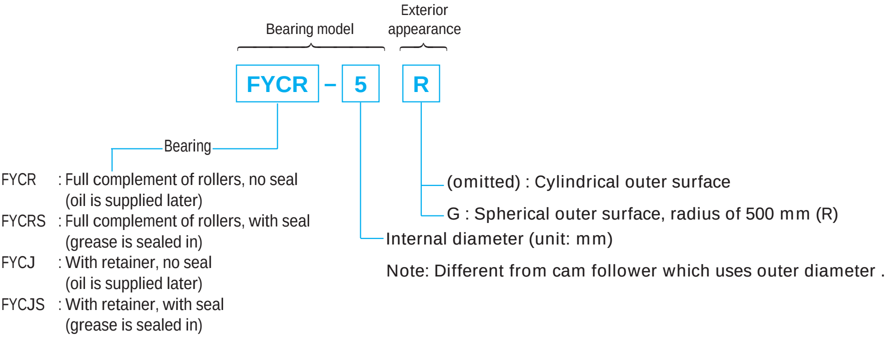
NSK manufactures the following items. Please consult NSK.

- Items in inch sizes
- Black film coating on exposed surface
- Special-shaped items.

A-Ⅲ-6.3 Reference Number for Ordering

Codes shown in (1) Bearing models, (2) Exterior Appearances constitute a reference number for ordering.

Reference number composition



FYCR : Full complement of rollers, no seal (oil is supplied later)
FYCRS : Full complement of rollers, with seal (grease is sealed in)
FYCJ : With retainer, no seal (oil is supplied later)
FYCJS : With retainer, with seal (grease is sealed in)

(omitted) : Cylindrical outer surface
G : Spherical outer surface, radius of 500 mm (R)

Internal diameter (unit: mm)

Note: Different from cam follower which uses outer diameter .

(Example) FYCR-5 : Full complement of rollers; with seal (grease is sealed in); internal diameter 5 mm
FYCJ-5R : With retainer, no seal (oil is supplied later), internal diameter 5 mm; Spherical outer surface rolling ring

A-Ⅲ-6.4 Accuracy

Dimension tolerance and running accuracy are the same as JIS 0 grade. However, the admissible difference in single plane mean outside diameter of spherical outer surface is 0.0 to -(minus) 0.05 mm.

A-Ⅲ-6.5 Permissible Load

(1) Permissible load of roller follower

As a bearing, allowable load is determined by basic load rating. Refer to load rating values in the dimension table.

(2) Permissible load of rail track

The concept is the same as for cam follower. Refer to Page A217 for permissible load values.

A-Ⅲ-6.6 Lubrication

A lithium soap based grease is sealed inside the Roller Follower which has seals. The range of temperature to use this grease is -10 to 110 °C. Supply oil to the Roller Follower which does not have a seal.

The track surface for lubrication should be nearly free of foreign matters.

A-Ⅲ-6.7 Permissible Rotational Speed

Roller Follower models with retainer are suitable for high rotational operations. Table Ⅲ-6•3 shows their permissible rotational speed. Permissible rotational speed of a roller follower with full complement of roller is 1/3 of those with retainer. In case of grease lubrication, permissible speed is 60% of the values shown in the Table.

Table Ⅲ-6•3 Permissible rotational speed of the bearing with retainer

Reference No.	Permissible rotational speed (rpm)
FYCJ-5	16000
FYCJ-6	12000
FYCJ-8	10000
FYCJ-10	8000
FYCJ-12	7100
FYCJ-15	6300
FYCJ-17	5600
FYCJ-20	5000
FYCJ-25	4000
FYCJ-30	3200
FYCJ-35	2800
FYCJ-40	2400
FYCJ-45	2000
FYCJ-50	1900

A-Ⅲ-6.8 Precautions for Installation

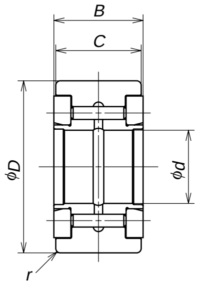
Roller Follower is generally operated by outer ring rotation. The shaft is used by "medium fit" or "clearance fit." For heavy load, the shaft is hardened by heat-treatment, and is used by "interference fit."
Table Ⅲ-6•4 shows recommended fit values.
Secure both sides of the inner ring to a flat surface which is at right angle to the center axis.
To make the support face sufficiently large for the side plate, the end face of the support should be larger than F shown in the dimension table.

Table Ⅲ-6•4 Recommended fit for shaft

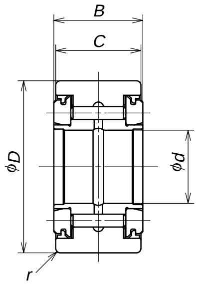
Load	Tolerance grade of shaft (class)
Light load, medium load	g6 or h6
Heavy load	k6

Roller Follower

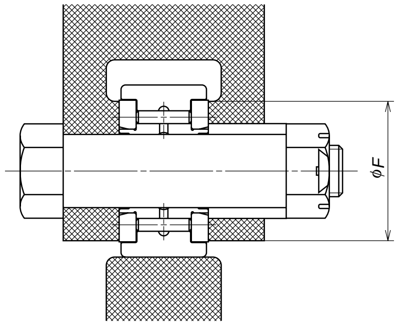
FYCR : Full complement of rollers
FYCRS : Full complement of rollers, with seal, thrust washer
FYCJ : With retainer
FYCJS : With retainer, seal, thrust washer



FYCR



FYCRS



Model No.		Main dimension					Basic load (N)		rating {kgf}		Track permissible load		Weight	Diameter, supporting surface	Model No.	
FYCR FYCJ	FYCRS FYCJS	*d*	*D*	*C*	*B* $^{0}_{-0.38}$	*r* (Min.)	Dynamic C_r	Static C_{0r}	Dynamic C_r	Static C_{0r}	(N)	{kgf}	(kg) (Reference only)	*F* (Min.)	FYCR FYCJ	FYCRS FYCJS
FYCR-5	**FYCRS-5**	5	16	11	12	0.3	5800	8000	590	815	3350	340	0.016	10	**FYCR-5**	**FYCRS-5**
FYCJ-5	**FYCJS-5**		16	11	12	0.3	2830	2620	288	267	3350	340	0.014	10	**FYCJ-5**	**FYCJS-5**
FYCR-6	**FYCRS-6**	6	19	11	12	0.3	6550	9900	665	1010	4150	425	0.022	12	**FYCR-6**	**FYCRS-6**
FYCJ-6	**FYCJS-6**		19	11	12	0.3	3450	3600	355	365	4150	425	0.020	12	**FYCJ-6**	**FYCJS-6**
FYCR-8	**FYCRS-8**	8	24	14	15	0.3	10100	15000	1030	1530	6500	665	0.044	14	**FYCR-8**	**FYCRS-8**
FYCJ-8	**FYCJS-8**		24	14	15	0.3	5700	6000	580	610	6500	665	0.042	14	**FYCJ-8**	**FYCJS-8**
FYCR-10	**FYCRS-10**	10	30	14	15	0.6	11700	18500	1190	1890	7800	795	0.069	17	**FYCR-10**	**FYCRS-10**
FYCJ-10	**FYCJS-10**		30	14	15	0.6	6950	8200	705	835	7800	795	0.067	17	**FYCJ-10**	**FYCJS-10**
FYCR-12	**FYCRS-12**	12	32	14	15	0.6	12600	21000	1280	2140	8050	820	0.076	19	**FYCR-12**	**FYCRS-12**
FYCJ-12	**FYCJS-12**		32	14	15	0.6	7650	9650	780	985	8050	820	0.074	19	**FYCJ-12**	**FYCJS-12**
FYCR-15	**FYCRS-15**	15	35	18	19	0.6	18700	29300	1910	2990	11800	1200	0.105	23	**FYCR-15**	**FYCRS-15**
FYCJ-15	**FYCJS-15**		35	18	19	0.6	12200	14100	1250	1440	11800	1200	0.097	23	**FYCJ-15**	**FYCJS-15**
FYCR-17	**FYCRS-17**	17	40	20	21	1	21100	35000	2160	3600	14300	1460	0.145	25	**FYCR-17**	**FYCRS-17**
FYCJ-17	**FYCJS-17**		40	20	21	1	13700	16700	1390	1700	14300	1460	0.14	25	**FYCJ-17**	**FYCJS-17**
FYCR-20	**FYCRS-20**	20	47	24	25	1	28900	50000	2940	5100	20800	2120	0.255	29	**FYCR-20**	**FYCRS-20**
FYCJ-20	**FYCJS-20**		47	24	25	1	18200	22600	1850	2310	20800	2120	0.245	29	**FYCJ-20**	**FYCJS-20**
FYCR-25	**FYCRS-25**	25	52	24	25	1	32500	60000	3300	6100	22900	2340	0.285	34	**FYCR-25**	**FYCRS-25**
FYCJ-25	**FYCJS-25**		52	24	25	1	22200	31000	2270	3150	22900	2340	0.275	34	**FYCJ-25**	**FYCJS-25**
FYCR-30	**FYCRS-30**	30	62	28	29	1	47500	96000	4800	9800	33000	3350	0.48	51	**FYCR-30**	**FYCRS-30**
FYCJ-30	**FYCJS-30**		62	28	29	1	31500	47000	3200	4800	33000	3350	0.47	51	**FYCJ-30**	**FYCJS-30**
FYCR-35	**FYCRS-35**	35	72	28	29	1	49000	106500	5050	10800	36500	3700	0.64	58	**FYCR-35**	**FYCRS-35**
FYCJ-35	**FYCJS-35**		72	28	29	1	33000	52500	3400	5350	36500	3700	0.635	58	**FYCJ-35**	**FYCJS-35**
FYCR-40	**FYCRS-40**	40	80	30	32	1	54500	126000	5600	12800	43500	4450	0.88	66	**FYCR-40**	**FYCRS-40**
FYCJ-40	**FYCJS-40**		80	30	32	1	38500	67500	3950	6900	43500	4450	0.865	66	**FYCJ-40**	**FYCJS-40**
FYCR-45	**FYCRS-45**	45	85	30	32	1	57500	139000	5850	14100	46500	4750	0.93	72	**FYCR-45**	**FYCRS-45**
FYCJ-45	**FYCJS-45**		85	30	32	1	40000	73000	4100	7450	46500	4750	0.91	72	**FYCJ-45**	**FYCJS-45**
FYCR-50	**FYCRS-50**	50	90	30	32	1	60500	152000	6150	15500	49500	5050	0.995	76	**FYCR-50**	**FYCRS-50**
FYCJ-50	**FYCJS-50**		90	30	32	1	41500	78000	4200	7950	49500	5050	0.965	76	**FYCJ-50**	**FYCJS-50**

Remarks : Grease is sealed in for the Roller follower with seals. Roller follower without seal does not have grease.